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Forsmark site investigation

Single-hole injection tests in borehole KFM12A

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May 2007

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Abstract

Borehole KFM12A is a deep core-drilled borehole within the site investigations in the Forsmark area. The borehole is about 600 m long and it is cased to about 60 m and the gap between the casing and the borehole wall is grouted. The inclination of the borehole is c 61 degrees from the horizontal plane at the surface. The borehole diameter below casing is 77.3 mm.

This report presents injection tests performed using the pipe string system PSS3 in borehole KFM12A and the test results.

The main aim of the injection tests in KFM12A was to characterize the hydraulic conditions of the rock adjacent to the borehole on different measurement scales (100 m and 20 m). Hydraulic parameters such as transmissivity and hydraulic conductivity were determined using analysis methods for stationary as well as transient conditions together with the dominating flow regime and possible outer hydraulic boundaries.

The injection tests gave consistent results on the different measurement scales regarding transmissivity. For almost 80% of the tests, some period with pseudo-radial flow could be identified making a relatively straight-forward transient evaluation possible. The sections 63.0–103.0, 303.0–343.0 and 363.0–383.0 m contribute most to the total transmissivity in KFM12A.

The injection tests provide a database for statistical analysis of the hydraulic conductivity distribution along the borehole on the different measurement scales. Basic statistical analysis has been made within this project and basic statistical parameters are presented in this report.

Sammanfattning

Borrhål KFM12A är ett djupt kärnborrhål borrat inom ramen för platsundersökningarna i Forsmarksområdet. Borrhålet är ca 600 m långt och det är försett med foderrör samt har spaltinjekterats till ca 60 m. Lutningen i borrhålet är ca 61 grader från horisontalplanet vid ytan och borrhålsdiametern under foderröret är 77,3 mm.

Denna rapport beskriver genomförda injektionstester med rörgångssystemet PSS3 i borrhål KFM12A samt resultaten från desamma.

Huvudsyftet med injektionstesterna var att karaktärisera de hydrauliska förhållandena i berget i anslutning till borrhålet i olika mätskalor (100 m och 20 m). Hydrauliska parametrar såsom transmissivitet och hydraulisk konduktivitet tillsammans med dominerande flödesregim och eventuella yttre hydrauliska randvillkor bestämdes med hjälp av analysmetoder för såväl stationära som transienta förhållanden.

Injektionstesterna gav samstämmiga resultat för de olika mätskalorna beträffande transmissivitet. Under närmare 80 % av testerna kunde en viss period med pseudoradiellt flöde identifieras vilket möjliggjorde en standardmässig transient utvärdering. Sektionerna 63,0–103,0, 303,0–343,0 and 363,0–383,0 m bidrar mest till den totala transmissiviteten i KFM12A.

Resultaten från injektionstesterna utgör en databas för statistisk analys av den hydrauliska konduktivitetens fördelning längs borrhålet i de olika mätskalorna. Viss statistisk analys har utförts inom ramen för denna aktivitet och grundläggande statistiska parametrar presenteras i rapporten.

Contents

1 Introduction

Injection tests were carried out in borehole KFM12A at Forsmark, Sweden, in April 2007, by Geosigma AB. Borehole KFM12A is a deep, cored borehole within the on-going site investigation in the Forsmark area. The location of the borehole is shown in Figure 1-1. The borehole is about 600 m long, cased and grouted to c 60 m and at the collaring inclined c 61 degrees from the horizontal plane. The borehole is designed as a so called telescopic borehole, with an enlarged diameter in the upper approximately 60 m, below which the borehole diameter is c 77.3 mm.

This document reports the results obtained from the injection tests in borehole KFM12A. The activity is performed within the Forsmark site investigation. The work was carried out in compliance with the SKB internal controlling documents presented in Table 1-1. Data and results were delivered to the SKB site characterization database, Sicada, where they are traceable by the Activity Plan number.

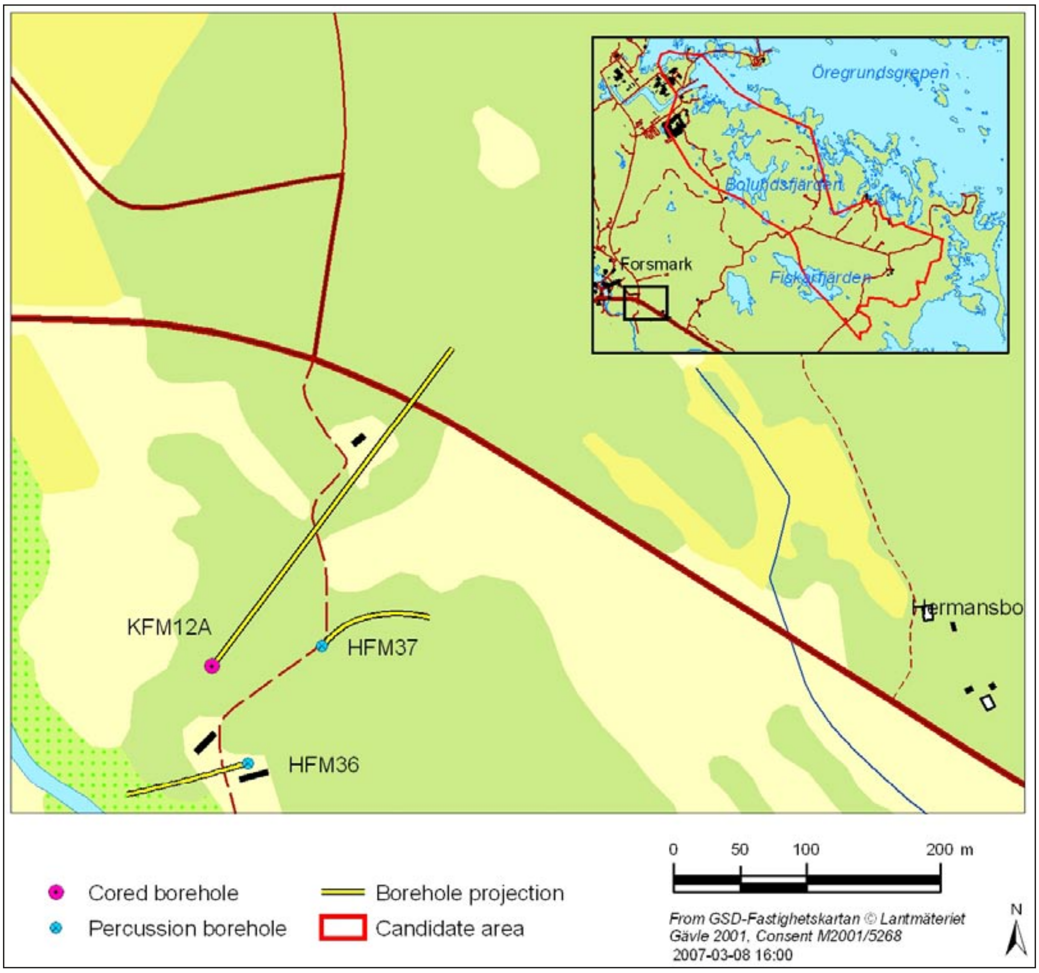

Figure 1-1. *The investigation area at Forsmark including the candidate area selected for more detailed investigations. Borehole KFM12A is situated at drill site DS12.*

Table 1-1. SKB internal controlling documents for performance of the activity.

Activity Plans	Number	Version
Hydraulic injection tests in borehole KFM12A with PSS3	AP PF 400-07-023	1.0
Method documents	**Number**	**Version**
Mätsystembeskrivning (MSB) – Allmän del. Pipe String System (PSS3)	SKB MD 345.100	1.0
Mätsystembeskrivning för: Kalibrering, PSS3	SKB MD 345.122	1.0
Mätsystembeskrivning för: Skötsel, service, serviceprotokoll, PSS3	SKB MD 345.124	1.0
Metodbeskrivning för hydrauliska injektionstester	SKB MD 323.001	1.0
Instruktion för analys av injektions- och enhålspumptester	SKB MD 320.004	1.0
Instruktion för rengöring av borrhålsutrustning och viss markbaserad utrustning	SKB MD 600.004	1.0

Original data from the reported activity are stored in the primary database Sicada, where they are traceable by the Activity Plan number (AP PF 400-07-023). Only data in SKB's databases are accepted for further interpretation and modelling. The data presented in this report are regarded as copies of the original data. Data in the databases may be revised, if needed. Such revisions will not necessarily result in a revision of the P-report, although the normal procedure is that major data revisions entail a revision of the P-report. Minor data revisions are normally presented as supplements, available at www.skb.se.

2 Objectives

The main aim of the injection tests in borehole KFM12A was to characterize the hydraulic properties of the rock adjacent to the borehole on different measurement scales (100 m and 20 m). The primary parameter to be determined was hydraulic transmissivity from which hydraulic conductivity can be derived. The results of the injection tests provide a database which can be used for statistical analyses of the hydraulic conductivity distribution along the borehole on different measurement scales. Basic statistical analyses are presented in this report.

Other hydraulic parameters of interest were flow regimes and outer hydraulic boundaries. These parameters were analysed using transient evaluation on the test responses during the flow- and recovery periods.

3 Scope

3.1 Borehole data

Technical data of the tested borehole are shown in Table 3-1 and in Appendix 4. The reference point of the borehole is defined as the centre of top of casing (ToC), given as "Elevation" in the table below. The Swedish National coordinate system (RT90) is used for the horizontal coordinates together with RHB70 for the elevation. "Northing" and "Easting" refer to the top of the boreholes.

3.2 Tests performed

The injection tests in borehole KFM12A, performed according to Activity Plan AP PF 400-07-23 (see Table 1-1), are listed in Table 3-2. The injection tests were carried out with the Pipe String System (PSS3). The test procedure and the equipment are described in the measurement system description for PSS (SKB MD 345.100) and in the corresponding method descriptions for hydraulic injection tests (SKB MD 323.001, Table 1-1).

One of the tests was not performed as intended because the time required for achieving a constant head in the test section was judged to be too long, this was due to an unexpected low transmissivity in the section measured. This test was interrupted and later repeated. 'Test number' (Test no in Table 3-2) refers to the number of tests performed in the actual section. For evaluation, data from the last test in each section were used.

The positions for the packers during the injection tests were, as far as possible, the same during tests with both 100 and 20 m test sections. To be able to measure the entire borehole length with the 100 and 20 m test sections, positions had to be shifted and one section was measured twice (see section 5.5).

Table 3-1. Pertinent technical data of borehole KFM12A (printout from SKB database, Sicada).

Borehole length (m):	601.04				
Drilling Period(s):	**From Date**	**To Date**	**Secup(m)**	**Seclow(m)**	**Drilling Type**
	2006-09-04	2006-09-18	0.00	59.75	Percussion drilling
	2007-02-22	2007-03-12	0.00	601.04	Core drilling
Starting point coordinate :	**Length (m)**	**Northing (m)**	**Easting (m)**	**Elevation**	**Coord System**
	0.00	6696576.85	1630051.64	10.74	RT90-RHB70
	3.00	6696578.04	1630052.50	8.12	RT90-RHB70
Angles:	**Length(m)**	**Bearing**	**Inclination (– = down)**		**Coord System**
	0.00	36.20	–60.67		RT90-RHB70
Borehole diameter:	**Secup (m)**	**Seclow (m)**	**Hole Diam (m)**		
	0.30	11.87	0.339		
	11.87	59.70	0.248		
	59.70	59.75	0.158		
	59.75	61.50	0.086		
	61.50	601.04	0.077		
Casing diameter:	**Secup (m)**	**Seclow (m)**	**Case In (m)**	**Case Out (m)**	
	0.00	59.40	0.200	0.208	
	0.30	11.79	0.310	0.323	
	11.79	11.87	0.280	0.339	
	59.40	59.45	0.170	0.208	

Table 3-2. Single-hole injection tests performed in borehole KFM12A.

Borehole Bh ID	Test section secup	seclow	Section length	Test type[1] (1–6)	Test no	Test start date, time YYYYMMDD hh:mm	Test stop date, time YYYYMMDD hh:mm
KFM12A	63.00	163.00	100.00	3	1	2007-04-10 10:27	2007-04-10 12:23
KFM12A	163.00	263.00	100.00	3	1	2007-04-10 15:15	2007-04-10 17:32
KFM12A	263.00	363.00	100.00	3	1	2007-04-11 09:30	2007-04-11 11:20
KFM12A	363.00	463.00	100.00	3	1	2007-04-11 13:26	2007-04-11 15:15
KFM12A	463.00	563.00	100.00	3	1	2007-04-11 16:05	2007-04-12 09:28
KFM12A	496.00	596.00	100.00	3	1	2007-04-12 10:02	2007-04-12 11:50
KFM12A	63.00	83.00	20.00	3	1	2007-04-13 15:53	2007-04-13 17:09
KFM12A	83.00	103.00	20.00	3	1	2007-04-16 08:40	2007-04-16 09:55
KFM12A	103.00	123.00	20.00	3	1	2007-04-16 10:12	2007-04-16 11:25
KFM12A	123.00	143.00	20.00	3	1	2007-04-16 12:23	2007-04-16 13:37
KFM12A	143.00	163.00	20.00	3	1	2007-04-16 13:55	2007-04-16 15:11
KFM12A	163.00	183.00	20.00	3	1	2007-04-16 15:31	2007-04-16 16:52
KFM12A	183.00	203.00	20.00	3	1	2007-04-17 08:26	2007-04-17 09:41
KFM12A	203.00	223.00	20.00	3	1	2007-04-17 09:58	2007-04-17 11:14
KFM12A	223.00	243.00	20.00	3	1	2007-04-17 12:17	2007-04-17 13:40
KFM12A	243.00	263.00	20.00	3	1	2007-04-17 14:03	2007-04-17 15:17
KFM12A	263.00	283.00	20.00	3	1	2007-04-17 15:34	2007-04-17 16:48
KFM12A	283.00	303.00	20.00	3	1	2007-04-18 08:33	2007-04-18 09:49
KFM12A	303.00	323.00	20.00	3	1	2007-04-18 10:05	2007-04-18 11:23
KFM12A	323.00	343.00	20.00	3	1	2007-04-18 12:24	2007-04-18 13:40
KFM12A	343.00	363.00	20.00	3	1	2007-04-18 13:59	2007-04-18 15:13
KFM12A	363.00	383.00	20.00	3	1	2007-04-18 15:38	2007-04-18 16:51
KFM12A	383.00	403.00	20.00	3	1	2007-04-19 08:34	2007-04-19 09:53
KFM12A	403.00	423.00	20.00	3	1	2007-04-19 10:08	2007-04-19 11:27
KFM12A	423.00	443.00	20.00	3	1	2007-04-19 12:28	2007-04-19 13:11
KFM12A	443.00	463.00	20.00	3	1	2007-04-19 13:28	2007-04-19 14:47
KFM12A	463.00	483.00	20.00	3	1	2007-04-19 15:02	2007-04-19 16:16
KFM12A	463.00	483.00	20.00	3	2	2007-04-24 09:23	2007-04-24 10:40
KFM12A	483.00	503.00	20.00	3	1	2007-04-19 16:31	2007-04-20 08:39
KFM12A	496.00	516.00	20.00	3	1	2007-04-20 09:05	2007-04-20 10:21
KFM12A	516.00	536.00	20.00	3	1	2007-04-20 10:37	2007-04-20 11:57
KFM12A	536.00	556.00	20.00	3	1	2007-04-20 12:57	2007-04-20 14:11
KFM12A	556.00	576.00	20.00	3	1	2007-04-20 14:25	2007-04-20 15:39
KFM12A	576.00	596.00	20.00	3	1	2007-04-20 15:52	2007-04-20 16:51

[1] 3: Injection test

3.3 Equipment checks

The PSS3 equipment was serviced, according to SKB internal controlling documents (SKB MD 345.124, service, and SKB MD 345.122, calibration), in November 2006.

Functioning checks of the equipment were performed during the installation of the PSS equipment at the test site. In order to check the function of the pressure sensors, the air pressure was recorded and found to be as expected. While lowering, the sensors showed good agreement with the total head of water (p/ρg). The temperature sensor displayed expected values in the water.

Simple functioning checks of down-hole sensors were done at every change of test section interval. Checks were also made continuously while lowering the pipe string along the borehole.

4 Description of equipment

4.1 Overview

4.1.1 Measurement container

All of the equipment needed to perform the injection tests is located in a steel container (Figure 4-1). The container is divided into two compartments; a data-room and a workshop. The container is placed on pallets in order to obtain a suitable working level in relation to the borehole casing.

The hoisting rig is of a hydraulic chain-feed type. The jaws, holding the pipe string, are opened hydraulically and closed mechanically by springs. The rig is equipped with a load transmitter and the load limit may be adjusted. The maximum load is 22 kN.

The packers and the test valve are operated hydraulically by water filled pressure vessels. Expansion and release of packers, as well as opening and closing of the test valve, is done using magnetic valves controlled by the software in the data acquisition system.

The injection system consists of a tank, a pump and a flow meter. The injection flow rate may be manually or automatically controlled. At small flow rates, a water filled pressure vessel connected to a nitrogen gas regulator is used instead of the pump.

4.1.2 Down-hole equipment

A schematic drawing of the down-hole equipment is shown in Figure 4-2. The pipe string consists of aluminium pipes of 3 m length, connected by stainless steel taps sealed with double o-rings. Pressure is measured above (P_a), within (P) and below (P_b) the test section, which is isolated by two packers. The groundwater temperature in the test section is also measured. The hydraulic connection between the pipe string and the test section can be closed or opened by a test valve operated by the measurement system.

At the lower end of the borehole equipment, a level indicator (calliper type) gives a signal as the reference depth marks along the borehole are passed.

The length of the test section may be varied (5, 20 or 100 metres).

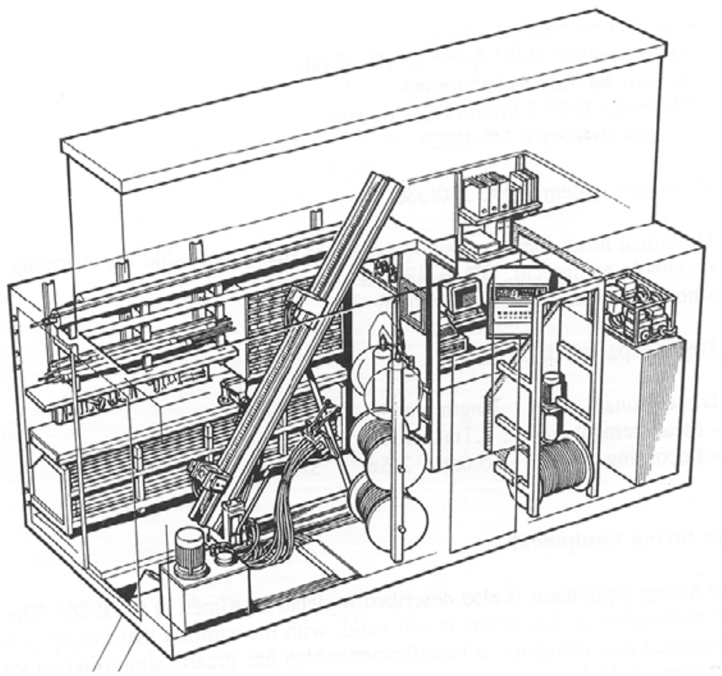

Figure 4-1. *Outline of the PSS3 container with equipment.*

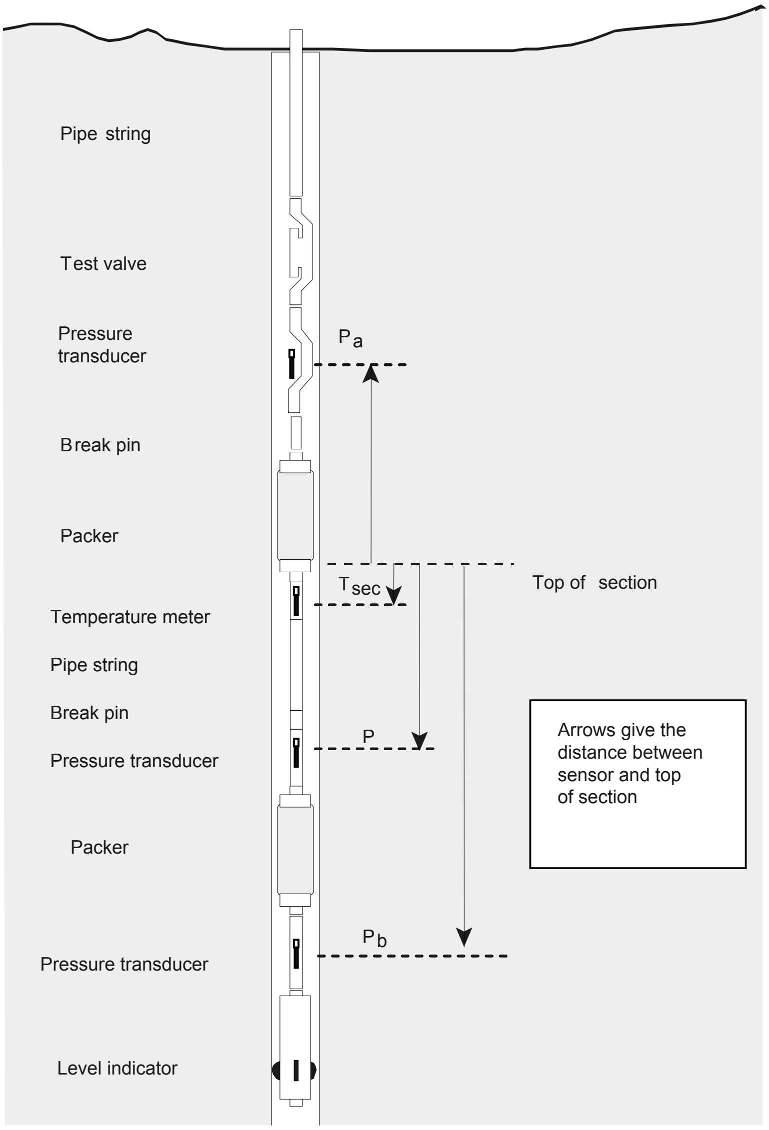

Figure 4-2. *Schematic drawing of the down-hole equipment in the PSS3 system.*

4.2 Measurement sensors

Technical data for the measurement sensors in the PSS system together with corresponding data of the system are shown in Table 4-1. The sensors are components of the PSS system. The accuracy of the PSS system may also be affected by the I/O-unit, cf. Figure 4-3, and the calibration of the system.

The sensor positions are fixed relative to the top of the test section. In Table 4-2, the position of the sensors is given with top of test section as reference (Figure 4-2).

Table 4-1. Technical data for sensors together with estimated data for the PSS system (based on current experience).

Technical specification Parameter		Unit	Sensor	PSS	Comments
Absolute pressure	Output signal	mA	4–20		
	Meas. range	MPa	0–13.5		
	Resolution	kPa	< 1.0		
	Accuracy[1)]	% F.S	0.1		
Differential pressure, 200 kPa	Accuracy	kPa		< ± 5	Estimated value
Temperature	Output signal	mA	4–20		
	Meas. range	°C	0–32		
	Resolution	°C	< 0.01		
	Accuracy	°C	± 0.1		
Flow Qbig	Output signal	mA	4–20		The specific accuracy is depending on actual flow
	Meas. range	m^3/s	$1.67\cdot10^{-5}$–$1.67\cdot10^{-3}$		
	Resolution	m^3/s	$6.7\cdot10^{-8}$		
	Accuracy[2)]	% O.R	0.15–0.7	< 1.5	
Flow Qsmall	Output signal	mA	4–20		The specific accuracy is depending on actual flow
	Meas. range	m^3/s	$1.67\cdot10^{-8}$–$1.67\cdot10^{-5}$		
	Resolution	m^3/s	$6.7\cdot10^{-10}$		
	Accuracy[3)]	% O.R	0.1–3.5	0.5–20	

[1)] 0.1% of Full Scale. Includes hysteresis, linearity and repeatability.

[2)] Maximum error in % of actual reading (% o.r.).

[3)] Maximum error in % of actual reading (% o.r.). The higher numbers correspond to the lower flow.

Table 4-2. Position of sensors in the borehole and displacement volume of equipment in the test section in borehole KFM12A.

Parameter	Length of test section (m) 20 (L)	(m)	100 (L)	(m)
Equipment displacement volume in test section [1)]	13		61	
Total volume of test section [2)]	93.9		469.3	
Position for sensor P_a, pressure above test section, (m above secup) [3)]		1.89		1.89
Position for sensor P, pressure in test section, (m above secup) [3)]		–19.11		–99.12
Position for sensor T_{sec}, temperature in test section, (m above secup) [3)]		–0.98		–0.98
Position for sensor P_b, pressure below test section, (m above secup) [3)]		–22.00		–102.00

[1)] Displacement volume in test section due to pipe string, signal cable, sensors and packer ends (in litres).

[2)] Total volume of test section (V= section length$\cdot\pi\cdot d^2/4$) (in litres).

[3)] Position of sensor relative top of test section. A negative value indicates a position below top of test section, (secup).

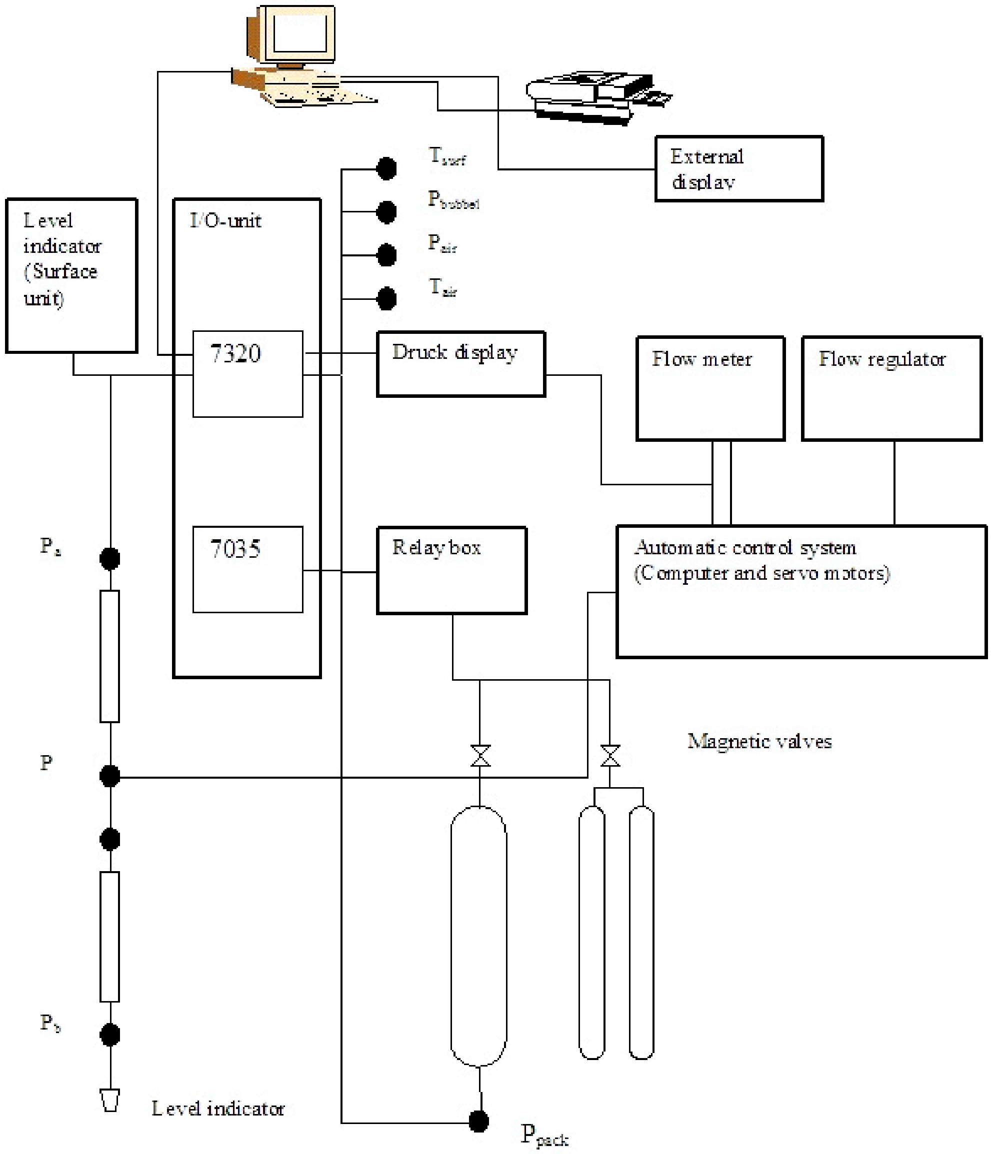

Figure 4-3. *Schematic drawing of the data acquisition system and the automatic control system in PSS.*

4.3 Data acquisition system

The data acquisition system in the PSS equipment contains a standard office PC connected to an I/O-unit (Datascan 7320). Using the Orchestrator software, pumping and injection tests are monitored and borehole sensor data are collected. In addition to the borehole parameters, packer and atmospheric pressure, container air temperature and water temperature are logged. Test evaluation may be performed on-site after a conducted test. An external display enables monitoring of test parameters.

The data acquisition system may be used to start and stop the automatic control system (computer and servo motors). These are connected as shown in Figure 4-3. The control system monitors the flow regulator and uses differential pressure across the regulating valve together with pressure in test section as input signals.

5 Execution

5.1 Preparation

5.1.1 Calibration

All sensors included in PSS are calibrated at the Geosigma engineering service station in Uppsala. Calibration is generally performed at least every year. Results from calibration, e.g. calibration constants, of sensors are kept in a document folder in PSS. If a sensor is replaced at the test site, calibration constants are altered as well. If a new, un-calibrated, sensor is to be used, calibration may be performed afterwards and data re-calculated.

5.1.2 Functioning checks

Equipment functioning checks were performed during the establishment of PSS at the test site. Simple function checks of down-hole sensors were done at every change of test section length, as well as while lowering the pipe string along the borehole.

5.1.3 Cleaning of equipment

Cleaning of the borehole equipment was performed according to the cleaning instruction SKB MD 600.004 (see Table 1-1), level 1.

5.2 Test performance

5.2.1 Test principle

The injection tests in KFM12A were carried out while maintaining a constant head of generally 200 kPa (20 m) in the test section. Before start of the injection period, approximately steady-state pressure conditions prevailed in the test section. After the injection period, the pressure recovery was measured.

For injection tests in KFM12A the injection phase was interrupted if the injection flow was clearly below the measurement limit. Thereafter, the recovery was measured for at least 5 minutes to verify the low conductivity of the section.

5.2.2 Test procedure

Generally, the tests were performed according to the Activity Plan AP PF 400-07-023. Exceptions to this are presented in section 5.5.

A test cycle of a standard injection test includes the following phases: 1) Transfer of down-hole equipment to the next section, 2) Packer inflation, 3) Pressure stabilisation, 4) Injection, 5) Pressure recovery and 6) Packer deflation.

The estimated times for the various phases are presented in Table 5-1. The packer inflation times, pressure stabilisation and actual injection and recovery times were longer for the tests in 100 m sections compared to the tests in 20 m in accordance with AP PF 400-07-023. Hence, a slightly longer test times were used for the tests in 100 m sections, cf. Table 5-1.

Table 5-1. Packer inflation times, pressure stabilisation times and test times used for the injection tests in KFM12A.

Test section length (m)	Packer inflation time (min)	Time for pressure stabilisation (min)	Injection period (min)	Recovery period (min)	Total time/test (min)[1)]
100	30	15	30	30	105
20	25	5	20	20	70

[1)] Exclusive of trip times in the borehole.

5.2.3 Test strategy

First the tests in 100 m sections were performed within the interval 63.0–596.0 m. Since all 100 m sections had a definable flow rate, the 100 m sections were measured in five successive injection tests using 20 m section length. The tests in 20 m sections were, as far as possible, carried out within the same intervals as the 100 m sections. To be able to measure as much as possible of the borehole, the section limits had to be shifted. Hence some parts of the borehole were measured twice with overlapping 100 and 20 m sections, cf. section 5.5.

Since the results of the tests in 100 m sections have a strong effect on the continued test program (i.e. whether a 100 m section would be measured with shorter sections as well), it was particularly important to ensure accurate results of these tests, including sections close to the lower measurement limit.

The total number of injection tests was thus dependent on the results of the previous tests.

5.3 Data handling

With the PSS system, primary data are handled using the Orchestrator software (Version 2.3.8). During a test, data are continuously logged in *.odl-files. After the test is finished, a report file (*.ht2) with space separated data is generated. The *.ht2-file (mio-format) contains logged parameters as well as test-specific information, such as calibration constants and background data. The parameters are presented as percentage of sensor measurement range and not in engineering units. The report file in ASCII-format is the raw data file delivered to the data base Sicada.

The *.ht2-files are automatically named with borehole id, top of test section and date and time of test start (as for example __KFM12A_063.0_200704101027.ht2) The name differs slightly from the convention stated in Instruction for analysis of injection and single-hole pumping tests, SKB MD 320.004. Using the IPPLOT software (Version 3.0), the *.ht2-files are converted to parameter files suitable for plotting using the code SKB-plot and analysis with the AQTESOLV software.

A backup of data files was created on a regular basis by CD-storage and by sending the files to the Geosigma office in Uppsala by a file transfer protocol. A file description table is presented in Appendix 1.

5.4 Analysis and interpretation

5.4.1 General

As described in section 5.2.1, the injection tests in KFM12A were performed as transient constant head tests followed by a pressure recovery period. From the injection period, the (reciprocal) flow rate versus time was plotted in log-log and lin-log diagrams together with the corresponding derivative. From the recovery period, the pressure was plotted versus Agarwal equivalent time in lin-log and log-log diagrams, respectively, together with the corresponding derivative. The routine data processing of the measured data was done according to the Instruction for analysis of injection and single-hole pumping tests (SKB MD 320.004).

For evaluation of the test data, no corrections of the measured flow rate and absolute pressure data (e.g. due to barometric pressure variations or tidal fluctuations) have been made. For short-time single-hole tests, such corrections are generally not needed, unless very small pressure changes are applied. No subtraction of the barometric pressure from the measured absolute pressure has been made, since the length of the test periods are short relative to the time scale for barometric pressure changes. In addition, pressure differences rather than the pressure magnitudes are used by the evaluation.

5.4.2 Measurement limit for flow rate and specific flow rate

The estimated standard lower measurement limit for flow rate for injection tests with PSS is c 1 mL/min ($1.7 \cdot 10^{-8}$ m^3/s). However, if the flow rate for a test was close to, or below, the standard lower measurement limit, a test-specific estimate of the lower measurement limit of flow rate was made. The test-specific lower limit was based on the measurement noise level of the flow rate before and after the injection period. The decisive factor for the varying lower measurement limit is not identified, but it might be of both technical and hydraulic character.

The lower measurement limit for transmissivity is defined in terms of the specific flow rate (Q/s). The minimum specific flow rate corresponds to the estimated lower measurement limit of the flow rate together with the actual injection pressure during the test, see Table 5-2. The intention during this test campaign was to use a standard injection pressure of 200 kPa (20 m water column). Still, the injection pressure can be considerably different (see section 6.2.3). An apparently low injection pressure is often the result of a test section of low conductivity due to a pressure increase, caused by packer expansion, before the injection start. A highly conductive section may also result in a low injection pressure due to limited flow capacity of PSS.

Whenever the final flow rate (Q_p) was not defined (i.e. not clearly above the measurement noise before and after the injection period), the estimated lower measurement limit for specific flow rate was based on the estimated lower measurement limit for flow rate for the specific test and a standard injection pressure of 200 kPa. This is done in order to avoid excessively high, apparent estimates of the specific flow rate for these low conductivity sections, which would have resulted if the actual pressure difference at start of injection had been used as injection pressure.

The lower measurement limits for the flow rate correspond to different values of steady-state transmissivity, T_M, depending on the section lengths used in the factor C_M in Moye's formula, as described in the Instruction for analysis of injection and single-hole pumping tests (SKB MD 320.004), see Table 5-2.

The practical upper measurement limit of hydraulic transmissivity for the PSS system is estimated at a flow rate of c 30 L/min ($5 \cdot 10^{-4}$ m^3/s) and an injection pressure of c 1 m. Thus, the upper measurement limit for the specific flow rate is $5 \cdot 10^{-4}$ m^2/s. However, the practical upper measurement limit may vary, depending on e.g. depth of the test section (friction losses in the pipe string).

Table 5-2. Estimated lower measurement limit for specific flow rate and steady-state transmissivity for different injection pressures, measurement scales and estimated lower measurement limits for flow rate for the injection tests in borehole KFM12A.

r_w (m)	L_w (m)	Q-measl-L (m^3/s)	Injection pressure (kPa)	Q/s-measl-L (m^2/s)	Factor C_M in Moye's formula	T_M-measl-L (m^2/s)
0.0387	100	1.7E–08	100	1.6E–09	1.30	2.1E–09
0.0387	100	1.7E–08	200	8.2E–10	1.30	1.1E–09
0.0387	100	1.7E–08	300	5.5E–10	1.30	7.1E–10
0.0387	100	1.2E–08	100	1.1E–09	1.30	1.5E–09
0.0387	100	1.2E–08	200	5.6E–10	1.30	7.3E–10
0.0387	100	1.2E–08	300	3.8E–10	1.30	4.9E–10
0.0387	100	5.0E–09	100	4.9E–10	1.30	6.4E–10
0.0387	100	5.0E–09	200	2.5E–10	1.30	3.2E–10
0.0387	100	5.0E–09	300	1.6E–10	1.30	2.1E–10
0.0387	20	1.7E–08	100	1.6E–09	1.04	1.7E–09
0.0387	20	1.7E–08	200	8.2E–10	1.04	8.5E–10
0.0387	20	1.7E–08	300	5.5E–10	1.04	5.7E–10
0.0387	20	1.2E–08	100	1.2E–09	1.04	1.2E–09
0.0387	20	1.2E–08	200	5.9E–10	1.04	6.1E–10
0.0387	20	1.2E–08	300	3.9E–10	1.04	4.1E–10
0.0387	20	5.0E–09	100	4.9E–10	1.04	5.1E–10
0.0387	20	5.0E–09	200	2.5E–10	1.04	2.6E–10
0.0387	20	5.0E–09	300	1.6E–10	1.04	1.7E–10
0.0387	5	1.7E–08	100	1.6E–09	0.82	1.3E–09
0.0387	5	1.7E–08	200	8.2E–10	0.82	6.7E–10
0.0387	5	1.7E–08	300	5.5E–10	0.82	4.5E–10
0.0387	5	1.2E–08	100	1.2E–09	0.82	9.7E–10
0.0387	5	1.2E–08	200	5.9E–10	0.82	4.8E–10
0.0387	5	1.2E–08	300	3.9E–10	0.82	3.2E–10
0.0387	5	5.0E–09	100	4.9E–10	0.82	4.0E–10
0.0387	5	5.0E–09	200	2.5E–10	0.82	2.0E–10
0.0387	5	5.0E–09	300	1.6E–10	0.82	1.3E–10

5.4.3 Qualitative analysis

Initially, a qualitative evaluation of actual flow regimes, e.g. wellbore storage (WBS), pseudo-linear flow regime (PLF), pseudo-radial flow regime (PRF), pseudo-spherical flow regime (PSF) and pseudo-stationary flow regime (PSS), respectively, was performed. In addition, indications of outer boundary conditions during the tests were identified. The qualitative evaluation was mainly interpreted from the log-log plots of flow rate and pressure together with the corresponding derivatives.

In particular, time intervals with pseudo-radial flow, reflected by a constant (horizontal) derivative in the test diagrams, were identified. Pseudo-linear flow may, at the beginning of the test, be reflected by a straight line of slope 0.5 or less in log-log diagrams, both for the measured variable (flow rate or pressure) and the derivative. A true spherical flow regime is reflected by a straight line with a slope of –0.5 for the derivative. However, other slopes may indicate transitions to pseudo-spherical (leaky) or pseudo-stationary flow. The latter flow regime corresponds to almost stationary conditions with a derivative approaching zero.

The interpreted flow regimes can also be described in terms of the distance from the borehole:

- **Inner zone:** Representing very early responses that may correspond to the fracture properties close to the borehole which may possibly be affected by turbulent head losses. These properties are generally reflected by the skin factor.
- **Middle zone:** Representing the first response from which it is considered possible to evaluate the hydraulic properties of the formation close to the borehole.
- **Outer zone:** Representing the response at late times of hydraulic structure(s) connected to the hydraulic feature for the middle zone. Sometimes it is possible to deduce the possible character of the actual feature or boundary and evaluate the hydraulic properties.

Due to the limited resolution of the flow meter and pressure sensor, the derivative may some times indicate a false horizontal line by the end of periods with pseudo-stationary flow. Apparent no-flow (NFB) and constant head boundaries (CHB), or equivalent boundary conditions of fractures, are reflected by an increase/decrease of the derivative, respectively.

5.4.4 Quantitative analysis

Injection tests

A preliminary steady-state analysis of transmissivity according to Moye's formula (denoted T_M) was made for the injection period for all tests in conjunction with the qualitative analysis according to the following equations:

$$T_M = \frac{Q_p \cdot \rho_w \cdot g}{dp_p} \cdot C_M \tag{5-1}$$

$$C_M = \frac{1 + \ln\left(\frac{L_w}{2r_w}\right)}{2\pi} \tag{5-2}$$

Q_p = flow rate by the end of the flow period (m^3/s)

ρ_w = density of water (kg/m^3)

g = acceleration of gravity (m/s^2)

C_M = geometrical shape factor (–)

dp_p = injection pressure $p_p - p_i$ (Pa)

r_w = borehole radius (m)

L_w = section length (m)

From the results of the qualitative evaluation, appropriate interpretation models for the quantitative evaluation of the tests were selected. When possible, transient analysis was made on both the injection and recovery periods of the tests.

The transient analysis was performed using a special version of the test analysis software AQTESOLV, which enables both visual and automatic type curve matching. The quantitative transient evaluation is generally carried out as an iterative process of manual type curve matching and automatic matching. For the injection period, a model based on the Jacob and Lohman (1952) /1/ solution was applied for estimating the transmissivity and skin factor for an assumed value on the storativity when a certain period with pseudo-radial flow could be identified. The model is based on the effective wellbore radius concept to account for non-zero (negative) skin factors according to Hurst, Clark and Brauer (1969) /2/.

In borehole KFM12A, the storativity was calculated using an empirical regression relationship between storativity and transmissivity, see Equation 5-3 (Rhén et al. 1997) /3/.

$$S=0.0007 \cdot T^{0.5} \tag{5-3}$$

S = storativity (–)

T = transmissivity (m^2/s)

Firstly, the transmissivity and skin factor were obtained by type curve matching on the data curve using a fixed storativity value of 10^{-6}, according to the instruction SKB MD 320.004. From the transmissivity value obtained, the storativity was then calculated according to Equation 5-3 and the type curve matching was repeated. In most cases the change of storativity did not significantly alter the calculated transmissivity by the new type curve matching. Instead, the estimated skin factor, which is strongly correlated to the storativity using the effective borehole radius concept, was altered correspondingly.

For transient analysis of the recovery period, a model presented by Dougherty and Babu (1984) /4/ was used when a certain period with pseudo-radial flow could be identified. In this model, a variety of transient solutions for flow in fractured porous media are available, accounting for e.g. wellbore storage and skin effects, double porosity etc. The solution for wellbore storage and skin effects is analogous to the corresponding solution presented in Earlougher (1977) /5/ based on the effective wellbore radius concept to account for non-zero (negative) skin factors. However, for tests in isolated test sections, wellbore storage are represented by a radius of a fictive standpipe (denoted fictive casing radius, r(c)) connected to the test section, cf. Equation 5-6. This concept is equivalent to calculating the wellbore storage coefficient C from the compressibility in an isolated test section according to Equation 5-5. The storativity was calculated using Equation 5-3 in the same way as described above for the transient analysis of the injection period. In addition, the wellbore storage coefficient was estimated, both from the simulated value on the fictive casing radius r(c) and from the slope of 1:1 in the log-log recovery plots.

For tests characterized by pseudo-spherical (leaky) flow or pseudo-stationary flow during the injection period, a model by Hantush (1959) /6/ for constant head tests was adopted for the evaluation. In this model, the skin factor is not separated but can be calculated from the simulated effective borehole radius according to Equation 5-4. This model also allows calculation of the wellbore storage coefficient according to Equation 5-6. In addition, the leakage coefficient K'/b' can be calculated from the simulated leakage factor r/B. The corresponding model for constant flow rate tests, Hantush (1955) /7/, was applied for evaluation of the recovery period for tests showing pseudo-spherical- or pseudo-stationary flow during this period.

$$\zeta=ln(r_w/r_{wf}) \tag{5-4}$$

ζ = skin factor

r_w = borehole radius (m)

r_{wf} = effective borehole radius

Some tests showed fracture responses (initial slope of 0.5 or less in a log-log plot). A model for an equivalent single fracture was then used for the transient analysis as a complement to standard models for pseudo-radial flow. The model presented in Ozkan and Raghavan (1991a) /8/ and (1991b) /9/ for a uniform-flux vertical fracture embedded in a porous medium was employed. With this model the hydraulic conductivity of the rock perpendicular (K_x) and parallel (K_y) to the fracture can be estimated. In this case, the quotient K_x/K_y was assumed to be 1.0 (one). Type curve matching provided values of K_x and L_f assuming a value on the specific storativity S_s based on Equation (5-3), where L_f is the theoretical fracture length. The test section length was then used to convert K_x and S_s to transmissivity $T= K_x \cdot L$ and to storativity $S= S_s \cdot L$, respectively of the rock in analysis by fracture models. Such estimates of transmissivity from fracture models may be compared with corresponding values from models for pseudo-radial flow in the same test section.

The different transient estimates of transmissivity from the injection and recovery period, respectively, were then compared and examined. One of these was chosen as the best representative value of the transient transmissivity of the formation adjacent to the test section. This value is denoted T_T. In cases with more than one pseudo-radial flow regime during the injection or recovery period, the first one is in most cases assumed as the most representative for the hydraulic conditions in the rock close to the tested section.

Finally, a representative value of transmissivity of the test section, T_R, was chosen from T_T and T_M. The latter transmissivity is to be chosen whenever a transient evaluation of the test data is not possible or not being considered as reliable. If the flow rate by the end of an injection period (Q_p) is too low to be defined, and thus neither T_T nor T_M can be estimated, the representative transmissivity for the test section is considered to be less than T_M based on the estimated lower measurement limit for Q/s (i.e. $T_R < T_M$=Q/s-measl-L·C_M).

Estimated values of the borehole storage coefficient, C, based on actual borehole geometrical data and assumed fluid properties are shown in Table 5-3 together with the estimated effective C_{eff} from laboratory experiments (Ludvigson et al. 2007) /10/. The net water volume in the test section, V_w, has in Table 5-3 been calculated by subtracting the volume of equipment in the test section (pipes and thin hoses) from the total volume of the test section. For an isolated test section, the wellbore storage coefficient, C, may be calculated as by Almén et al. (1986) /11/:

$$C = V_w \cdot c_w = L_w \cdot \pi \cdot r_w^2 \cdot c_w \qquad (5\text{-}5)$$

V_w = water volume in test section (m^3)

r_w = nominal borehole radius (m)

L_w = section length (m)

c_w = compressibility of water (Pa^{-1})

When appropriate, estimation of the actual borehole storage coefficient C in the test sections was made from the recovery period, based on the early borehole response with 1:1 slope in the log-log diagrams. The coefficient C was calculated only for tests with a well-defined line of slope 1:1 in the beginning of the recovery period. In the most conductive sections, this period occurred during very short periods at early test times. The latter values may be compared with the net values of C based on geometry and the value of C_{eff} based on laboratory experiments /10/, (Table 5-3).

Furthermore, when using the model by Dougherty and Babu /4/ or Hantush /7/, a fictive casing radius, r(c), is obtained from the parameter estimation of the recovery period. This value can then be used for calculating C as by Almén et al. /11/:

$$C = \frac{\pi \cdot r(c)^2}{\rho \cdot g} \qquad (5\text{-}6)$$

Table 5-3. Calculated net values of C, based on the actual geometrical properties of the borehole and equipment configuration in the test section (C_{net}) together with the effective wellbore storage coefficient (C_{eff}) for injection tests from laboratory experiments /10/.

r_w (m)	L_w (m)	Volume of test section (m^3)	Volume of equipment in section (m^3)	V_w (m^3)	C_{net} (m^3/Pa)	C_{eff} (m^3/Pa)
0.0387	100	0.469	0.061	0.408	1.9E–10	1.9E–10
0.0387	20	0.094	0.013	0.081	3.7E–11	4.4E–11

Although this calculation was not done regularly and the results are not presented in this report, the calculations corresponded in most cases well to the value of C obtained from the line of slope 1:1 in the beginning of the recovery period.

The estimated values of C from the tests may differ from the net values in Table 5-3 based on geometry. For example, the effective compressibility for an isolated test section may sometimes be higher than the water compressibility due to e.g. packer compliance, resulting in increased C-values.

The radius of influence at a certain time may be estimated from Jacob's approximation of the Theis' well function, Cooper and Jacob (1946) /12/:

$$r_i = \sqrt{\frac{2.25Tt}{S}} \qquad (5\text{-}7)$$

T = representative transmissivity from the test (m^2/s)

S = storativity estimated from Equation 5-3

r_i = radius of influence (m)

t = time after start of injection (s)

If a certain time interval of pseudo-radial flow (PRF) from t_1 to t_2 can be identified during the test, the radius of influence is estimated using time t_2 in Equation 5-7. If no interval of PRF can be identified, the actual total flow time t_p is used. The radius of influence can be used to deduce the length of the hydraulic feature(s) tested.

Furthermore, an r_i-index (–1, 0 or 1) is defined to characterize the hydraulic conditions by the end of the test. The r_i-index is defined as shown below. It is assumed that a certain time interval of PRF can be identified between t_1 and t_2 during the test.

- r_i-index = 0: The transient response indicates that the size of the hydraulic feature tested is greater than the radius of influence based on the actual test time (t_2=t_p), i.e. the PRF is continuing at stop of the test. This fact is reflected by a flat derivative at this time.
- r_i-index = 1: The transient response indicates that the hydraulic feature tested is connected to a hydraulic feature with lower transmissivity or an apparent barrier boundary (NFB). This fact is reflected by an increase of the derivative. The size of the hydraulic feature tested is estimated as the radius of influence based on t_2.
- r_i-index = –1: The transient response indicates that the hydraulic feature tested is connected to a hydraulic feature with higher transmissivity or an apparent constant head boundary (CHB). This fact is reflected by a decrease of the derivative. The size of the hydraulic feature tested is estimated as the radius of influence based on t_2.

If a certain time interval of PRF cannot be identified during the test, the r_i–indices –1 and 1 are defined as above. In such cases the radius of influence is estimated using the flow time t_p in Equation 5-7.

In some tests there may be signs of pressure interference in the section above or below the test section due to a hydraulic interconnection of the sections. This kind of pressure interference may result in an overestimation of the transmissivity in the test section. If pressure interference is detected during a test, a qualitative evaluation is performed to determine if it is likely that the estimated transmissivity of the test section is overestimated or not. The qualitative evaluation includes a comparison of the injection pressure and evaluated transmissivity of the test section with the corresponding pressure interference and transmissivity of the borehole interval in which interference is observed. Furthermore, a comparison with transmissivity from tests with other section lengths is made to detect deviating results. The type of dominating flow regime in the test section may also support the qualitative evaluation whether the interference is likely to affect the evaluated transmissivity or not.

5.5 Nonconformities

The test programme in KFM12A was carried out according to the Activity Plan AP PF 400-07-023 with the following exceptions:

- One of the tests listed in Table 3-2 was not analysed since it was considered to provide uncertain information. The test, performed in section 463.0–483.0, was re-performed when lifting the pipe string again to ensure that the section was undisturbed from the previous, failed, test.
- The length of the borehole made measurements with overlapping sections necessary. section 496.0–563.0 was measured twice with overlapping 100 m sections, and section 496.0–503.0 m was also measured twice with overlapping 20 m sections.

6 Results

6.1 Nomenclature and symbols

The nomenclature and symbols used for the results of the injection tests in KFM12A are in accordance with the Instruction for analysis of injection and single-hole pumping tests (SKB MD 320.004). Additional symbols are explained in the text and in Appendix 5. Symbols used by the AQTESOLV software are explained in Appendix 3.

Original data from the reported activity are stored in the primary database Sicada. Data are traceable in Sicada by the Activity Plan number (AP PF 400-07-023).

6.2 Routine evaluation of the single-hole injection tests

6.2.1 General test data

General test data and selected pressure and flow data from all tests are listed in Appendix 2.1 and 2.2, respectively.

6.2.2 Length corrections

The down-hole equipment is supplied with a level indicator located c 3 m below the lower packer in the test section, see Figure 4-2. The level indicator transmits a signal each time a reference mark in the borehole is passed. In KFM12A, reference marks were milled into the borehole wall at approximately every 50 m.

During the injection tests in KFM12A with the PSS, length reference marks were detected as presented in Table 6-1. As seen from Table 6-1, all of the length marks of the borehole were detected, except for the 100 m reference mark which was not measured with the 100 m section since the building of the section was not finished at this level. At each detected mark, the length scale for the injection tests was adjusted according to the reported length to the reference mark.

Table 6-1. Detected reference marks during the injection tests and after drilling in KFM12A.

Borehole length (m)	Detected during the injection tests in 100 m sections	Detected during the injection tests in 20 m sections
100.0	No[1)]	Yes
150.0	Yes	Yes
200.0	Yes	Yes
251.0	Yes	Yes
300.0	Yes	Yes
350.0	Yes	Yes
400.0	Yes	Yes
451.0	Yes	Yes
500.0	Yes	Yes
550.0	Yes	Yes

[1)] Not detected since the building of the 100 m section was not finished at this level.

The largest difference between the reported and measured lengths at the reference marks during the injection tests was 0.23 m, at the 450 m reference mark. The difference between two consecutive measurements over a 50 m borehole interval was 0.07 m or less in all cases. A comparison of the measurements performed with different section lengths results in a maximum difference of 0.02 m.

Since the length scale was adjusted in the field every time a reference mark was detected and since the difference between consecutive marks were small, it was not found worthwhile to make any further adjustments after the measurements, e.g. by linear interpolation between reference marks.

6.2.3 General results

For the injection tests, transient evaluation was conducted, whenever possible, both on the injection and recovery periods (e.g. transmissivity T_f and T_s, respectively) according to the methods described in section 5.4.4. The steady-state transmissivity (T_M) was calculated by Moye's formula according to Equation 5-1. Injection tests with a final flow rate below the measurement limit, Q_p, or with a non-definable flow regime were only evaluated by the steady-state method. All other tests were evaluated with both transient and steady-state methods. The quantitative analysis was conducted using the AQTESOLV software. A summary of the results of the routine evaluation of the injection tests can be seen in Table 6-2.

The dominating transient flow regimes during the injection and recovery periods, as interpreted from the qualitative test evaluation, are listed in Table 6-2 and further commented on in section 6.2.4. The transmissivity considered as the most reliable from the transient evaluation of the flow- and recovery periods of the tests was selected as T_T, see Table 6-2.The bore-hole displays, with a few exceptions, PRF: s as dominating flow regimes during injection. Dominating flow regimes during the recovery of the tests were also mainly PRF:s often preceded by a WBS.

For 29 out of 30 tests with a definable final flow rate in KFM12A, the transient evaluation of the injection period was considered to give the most representative transient transmissivity value. The corresponding number for the recovery period was 0. Several of the responses during the recovery period were strongly influenced by wellbore storage effects. On the other hand, during the injection period a certain time interval with pseudo-radial flow could, in about 80% of the tests, be identified. Consequently, standard methods for single-hole tests with wellbore storage and skin effects were commonly used for the routine evaluation of the tests. The approximate start and stop times of the pseudo-radial flow regime used for the transient evaluation are also listed in Table 6-2.

For one test with a definable final flow rate no transient evaluation was considered representative. Hence the steady-state transmissivity, $T_{M,}$ was chosen as the representative transmissivity value. If the final flow rate Q_p was below the actual test-specific measurement limit, the representative transmissivity value was assumed to be less than the estimated T_M, based on Q/s-measl-L.

The estimated standard lower measurement limit for flow rate for injection tests with PSS is c 1 mL/min ($1.7 \cdot 10^{-8}$ m^3/s). However, for approximately 15% of the injection tests in KFM12A, the final flow rate was close to, or below, the standard lower measurement limit. Hence a test-specific estimate of the lower measurement limit of flow rate was made which ranged from $3.6 \cdot 10^{-9}$ m^3/s to $5.1 \cdot 10^{-9}$ m^3/s. The lower measurement limit for transmissivity is defined in terms of the specific flow rate (Q/s), and the overall estimated test specific lower measurement limit for the specific flow rate in KFM12A ranged from $1.8 \cdot 10^{-10}$ m^2/s to $2.5 \cdot 10^{-10}$ m^2/s (see section 5.4.2).

Selected test diagrams are presented in Appendix 3. In general, one linear diagram showing the entire test sequence together with lin-log and log-log diagrams from the injection and recovery periods, respectively, are presented for the injection tests. The quantitative analysis was performed from such diagrams using the AQTESOLV software. From injection tests with a flow rate below the estimated lower measurement limit for the specific test, only the linear diagram is presented. The results of the routine evaluation of the tests in borehole KFM12A are also compiled in appropriate tables in Appendix 5 to be stored in the Sicada database.

For a few tests, a type curve fit is displayed in the diagrams in Appendix 3 despite the fact that the estimated parameters from the fit are judged as ambiguous or non-representative and not included in the result tables in Sicada. For these tests, the type curve fit is presented as an example, e.g. to illustrate that an assumption of pseudo-radial flow regime is not justified for the test and some other flow regime is dominating or, alternatively, to show one possible fit in the case of unambiguous evaluation. For example, for test responses showing only wellbore storage or no flow boundary response, no unambiguous transient evaluation is possible.

In Figure 6-1, a comparison of calculated transmissivities in 20 m sections from steady-state evaluation (T_M) and transmissivity values from the transient evaluation (T_T) is shown. The agreement between the two populations is very good. Steady-state analysis of transmissivity according to Moye's formula (denoted T_M) may slightly overestimate the transmissivity if steady-state conditions do not prevail in the borehole. In addition, skin effects (both positive and negative) may cause discrepancies between transient and steady-state evaluation. For example, a test showing a strong negative skin factor (fracture response) with an interpreted PLF from the transient evaluation of the injection period may result in a much higher (c one order of magnitude) steady-state transmissivity. For low values of transmissivity, discrepancies in transmissivity may also occur due to the definition of the lower measurement limit in transient and steady-state evaluation, respectively. In the latter evaluation the measurement limit is based on the test-specific flow rate while in transient evaluation, the transmissivity is based on the change of the (inverse) flow rate during the injection period.

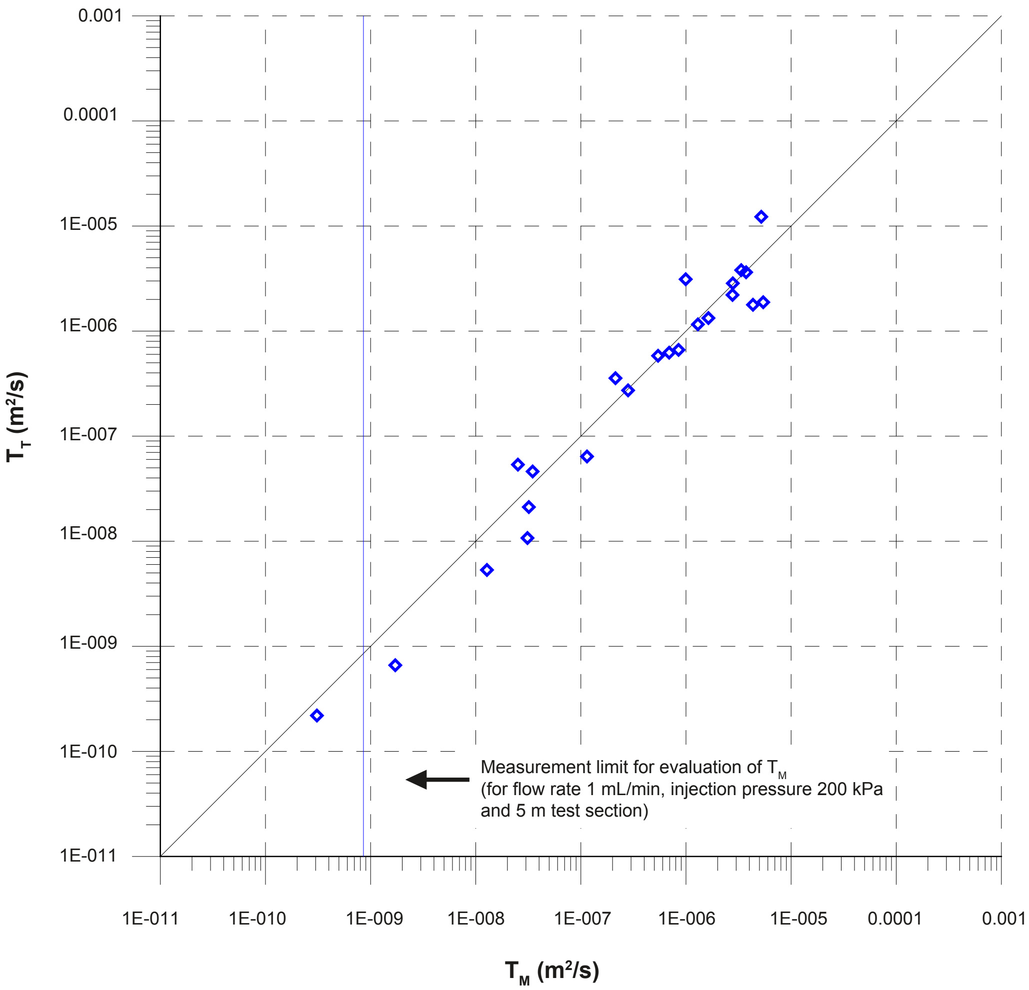

Figure 6-1. *Estimated transmissivities in 20 m sections from steady-state (T_M) and transient (T_T) evaluation for the injection tests in KFM12A.*

In cases where apparent no-flow boundaries appear at the end of the injection period and transient evaluation is performed on the early part of the data curve, the steady-state transmissivity T_M may be low in comparison with the transient estimate of transmissivity. In this case, two different zones of the bedrock are measured during the early and late parts of the injection period, respectively.

The lower standard measurement limit of steady-state transmissivity in 5 m sections based on a flow rate of 1 mL/min and an injection pressure of 20 m is indicated in Figure 6-1. However, for some test sections in KFM12A, the actual injection pressure was considerably different, as previously denoted in section 5.4.2. The highest injection pressure during the tests in KFM12A was 23.53 m, and the lowest 12.54 m.

The wellbore storage coefficient, C, was calculated from the straight line with a unit slope in the log-log diagrams from the recovery period, see Table 6-2. The coefficient C was only calculated for tests with a well-defined line of unit slope in the beginning of the recovery period. In the most conductive sections, this period occurred during very short intervals at very early times and is not visible in the diagrams. In sections with a very low transmissivity, the estimates of C may be uncertain due to difficulties in defining an accurate time for the start of the recovery period. Furthermore, the resolution of the pressure sensors causes the recovery to be quite scattered in sections of low transmissivity. The values of C presented in Table 6-2 may be compared with the net values of C, C_{net} (based on geometry) and the value of C obtained from laboratory experiments, C_{eff} /11/, both found in Table 5-3. Figure 6-2 shows a comparison between the C values calculated from the straight line with a unit slope in the log-log diagrams from the recovery period and the C values obtained from laboratory experiments, $C_{eff.}$.

The number of injection tests with a well-defined line of unit slope from which it was possible to calculate C was 6 out of 27 tests with a definable Q_p, when using the 20 m test section, and none when using the 100 m test section. Table 6-2 and Figure 6-2 shows that the calculated C-values from the tests tend to be slightly higher than the C values obtained from laboratory experiments, $C_{eff..}$ The higher C-values observed in the tests may partly be explained by the compressibility contribution of the rock formation and water in good hydraulic connection (i.e. open fractures or cavities) with the section and partly by uncertainties in the determination of C from the tests.

When constructing 95% confidence intervals (using a t-distribution) from calculated values of C from the tests with 20 m section length, the values of C listed in Table 5-3 are within these confidence intervals.. The wellbore storage coefficient was also calculated from the simulation of the recovery responses in AQTESOLV based on the estimated radius of the fictive standpipe, r(c), to the test section according to Equation 5-6.

Table 6-2. Summary of the routine evaluation of the single-hole injection tests in borehole KFM12A.

Secup (m)	Seclow (m)	Test start YYYY-MM-DD hh:mm	b (m)	Flow regime [1] injection	Recovery	T_M (m²/s)	T_f (m²/s)	T_s (m²/s)	T_T (m²/s)	T_R [2] (m²/s)	ξ (–)	t_1 (s)	t_2 (s)	dte_1 (s)	dte_2 (s)	C (m³/Pa)	r_i (m)	r_i-index (–)
63.00	163.00	2007-04-10 10:27	100.0	PSF	PLF–>PSF	1.26E–05	2.60E–06	2.43E–06	2.60E–06	2.60E–06	–6.04						97.00	–1
163.00	263.00	2007-04-10 15:15	100.0	PRF	(WBS)–>PRF–>NFB?	2.14E–06	1.46E–06	2.33E–06	1.46E–06	1.46E–06	–2.19	150	1,800	60	500		83.60	0
263.00	363.00	2007-04-11 09:30	100.0	PRF	PRF–>PSF?	1.98E–05	1.01E–05	1.39E–05	1.01E–05	1.01E–05	–4.07	200	1,800	50	500		135.60	0
363.00	463.00	2007-04-11 13:26	100.0	PRF	(WBS)–>PRF–>NFB	6.62E–06	3.98E–06	8.54E–06	3.98E–06	3.98E–06	–3.15	300	1,800	60	300		107.46	0
463.00	563.00	2007-04-11 16:05	100.0	PRF	WBS–>PRF	3.13E–07	3.41E–07	7.10E–07	3.41E–07	3.41E–07	1.54	200	1,800	200	1,000		58.14	0
496.00	596.00	2007-04-12 10:02	100.0	PRF	WBS–>PRF	3.09E–07	2.32E–07	5.83E–07	2.32E–07	2.32E–07	–1.22	60	1,800	200	1,000		52.77	0
63.00	83.00	2007-04-13 15:53	20.0	PRF	PSF?	9.93E–07	3.11E–06	1.03E–06	3.11E–06	3.11E–06	12.89	25	1,200				82.48	0
83.00	103.00	2007-04-16 08:40	20.0	PSF	PRF	2.79E–06	2.85E–06	8.73E–06	2.85E–06	2.85E–06	–0.31			60	600		81.30	–1
103.00	123.00	2007-04-16 10:12	20.0	PRF	PRF–>NFB?	2.14E–07	3.56E–07	4.50E–07	3.56E–07	3.56E–07	3.75			100	400		48.33	0
123.00	143.00	2007-04-16 12:23	20.0	–'>PSF	(WBS)–'>PSF	2.77E–06	2.21E–06	2.11E–06	2.21E–06	2.21E–06	–2.06						76.23	–
143.00	163.00	2007-04-16 13:55	20.0	PRF	PLF–>(PRF)	5.43E–06	1.89E–06	1.23E–06	1.89E–06	1.89E–06	–5.52						73.07	–
163.00	183.00	2007-04-16 15:31	20.0	PRF–'>PSF	WBS–>PSF	3.48E–08	4.62E–08	3.04E–08	4.62E–08	4.62E–08	2.21						28.98	–1
183.00	203.00	2007-04-17 08:26	20.0	PRF	WBS–>PRF	3.20E–08	2.11E–08	2.53E–08	2.11E–08	2.11E–08	–2.22	20	1,217	200	700	4.60E–11	23.85	0
203.00	223.00	2007-04-17 09:58	20.0	PSF	–>PSF	1.14E–07	6.40E–08	2.23E–08	6.40E–08	6.40E–08	–2.80						31.45	–1
223.00	243.00	2007-04-17 12:17	20.0	PRF	(WBS)–>PRF	1.63E–06	1.33E–06	2.65E–06	1.33E–06	1.33E–06	–2.18	40	1,200	30	500		66.70	0
243.00	263.00	2007-04-17 14:03	20.0	PSF	WBS–>PSF	1.28E–08	5.33E–09	9.43E–09	5.33E–09	5.33E–09	–2.93					3.91E–11	16.90	–1
263.00	283.00	2007-04-17 15:34	20.0	PRF	PLF–>PRF	4.34E–06	1.78E–06	2.24E–06	1.78E–06	1.78E–06	–5.02	50	1,200	300	700		71.73	0
283.00	303.00	2007-04-18 08:33	20.0	PRF	PRF	1.30E–06	1.16E–06	1.05E–06	1.16E–06	1.16E–06	–1.62	200	1,200	5	700		64.44	0
303.00	323.00	2007-04-18 10:05	20.0	PRF–'>PSF	(WBS)–>PRF	5.20E–06	1.23E–05	2.25E–05	1.23E–05	1.23E–05	7.60	100	500	50	500		75.00	–1
323.00	343.00	2007-04-18 12:24	20.0	PRF	PRF?	3.35E–06	3.80E–06		3.80E–06	3.80E–06	–0.35	30	1,200				86.73	0
343.00	363.00	2007-04-18 13:59	20.0	PSF–>NFB?	PSS–>NFB	8.49E–07	6.63E–07		6.63E–07	6.63E–07	–1.67						56.46	1
363.00	383.00	2007-04-18 15:38	20.0	PRF	WBS–>(PRF)–>NFB	3.73E–06	3.63E–06	5.92E–06	3.63E–06	3.63E–06	–1.41	70	1,218				86.38	0
383.00	403.00	2007-04-19 08:34	20.0	PRF	WBS–>	1.72E–09	6.60E–10	1.01E–09	6.60E–10	6.60E–10	–3.20	20	1,220			4.68E–11	10.04	0
403.00	423.00	2007-04-19 10:08	20.0	PRF	WBS–>PRF	5.43E–07	5.82E–07	8.94E–07	5.82E–07	5.82E–07	–0.27	30	1,218	30	120		54.65	0
423.00	443.00	2007-04-19 12:28	20.0	–	–	< 2.55E–10				< 2.55E–10							–	–
443.00	463.00	2007-04-19 13:28	20.0	PRF	PRF–>(PSF)	6.92E–07	6.23E–07	6.03E–07	6.23E–07	6.23E–07	–1.38	30	1,200	30	400		55.18	0
463.00	483.00	2007-04-24 09:23	20.0	PRF–>NFB?	WBS–>PRF?	2.52E–08	5.37E–08		5.37E–08	5.37E–08	6.89	100	1,000			9.45E–11	27.29	1
483.00	503.00	2007-04-19 16:31	20.0	–	–	< 2.65E–10				< 2.65E–10							–	–
496.00	516.00	2007-04-20 09:05	20.0	PRF	WBS–>PRF?	3.10E–08	1.07E–08		1.07E–08	1.07E–08	–4.23	20	1,200				19.98	0
516.00	536.00	2007-04-20 10:37	20.0	PRF	WBS–>PRF	2.81E–07	2.73E–07	8.58E–07	2.73E–07	2.73E–07	–0.77	20	1,200	50	700		44.89	0
536.00	556.00	2007-04-20 12:57	20.0	PRF–>NFB?	WBS–>	3.08E–10	2.20E–10		2.20E–10	2.20E–10	–1.50	20	700			4.49E–11	5.77	1
556.00	576.00	2007-04-20 14:25	20.0	–	–	3.81E–10				3.81E–10						1.14E–10	8.75	–
576.00	596.00	2007-04-20 15:52	20.0	–	–	< 2.55E–10				< 2.55E–10							–	–

[1] The acronyms in the column "Flow regime" are as follows: wellbore storage (WBS), pseudo-linear flow (PLF), pseudo-radial flow (PRF), pseudo-spherical flow (PSF), pseudo-stationary flow (PSS) and apparent no-flow boundary (NFB). The flow regime definitions are further discussed in section 5.4.3 above.

[2] For the tests where Q_p was not detected, T_R was assumed to be less than T_M based on the estimated Q/s-measl-L.

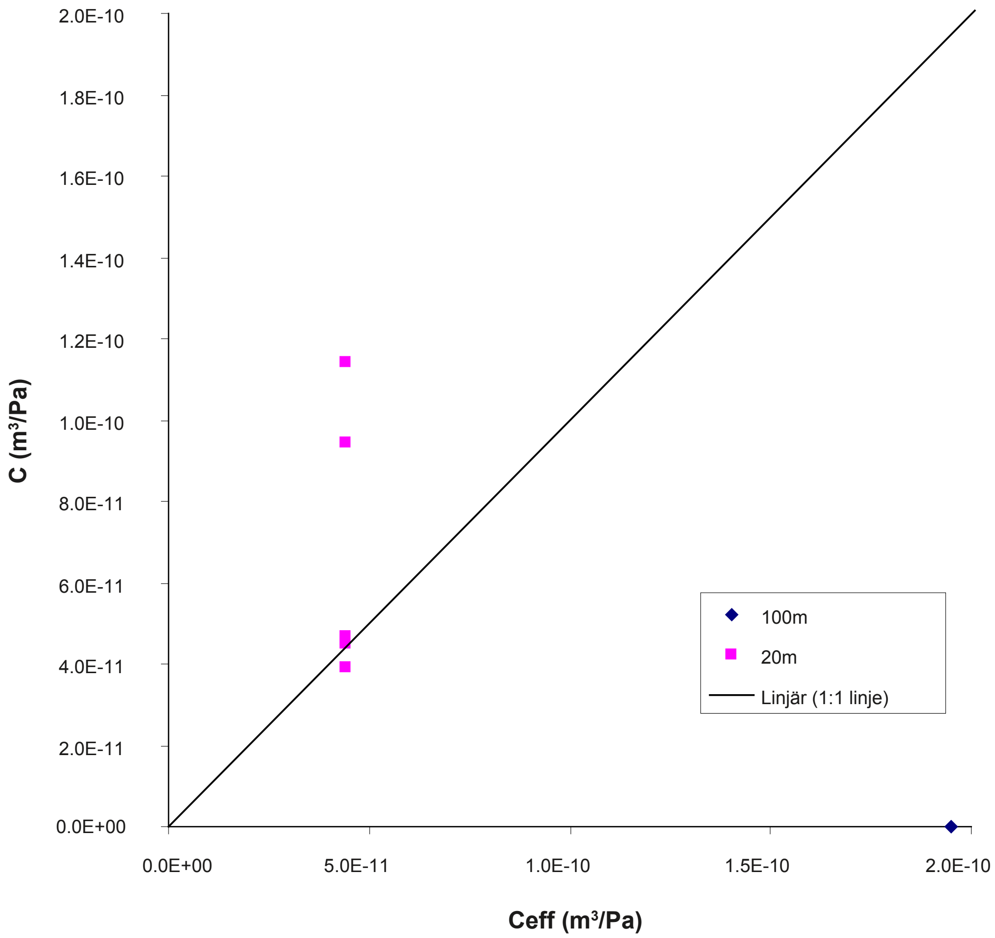

Figure 6-2. *The wellbore storage coefficient calculated from the straight line with a unit slope in the log-log diagrams from the recovery period, C, compared to the wellbore storage coefficient obtained from laboratory experiments, C_{eff}. None of the 100 m-tests displayed a well defined line with a unit slope.*

6.2.4 Comments on the tests

Short comments on each test follow below. Tests were performed within the interval 63.0–596.0 m in KFM12A. Flow regimes and hydraulic boundaries, as discussed in section 5.4.3, are in the text referred to as:

WBS = Wellbore storage

PRF = Pseudo-radial flow regime

PLF = Pseudo-linear flow regime

PSF = Pseudo-spherical flow regime

PSS = Pseudo-stationary flow regime

NFB = No-flow boundary

CHB = Constant-head boundary

63.0–163.0 m

Both the injection- and recovery period are dominated by an obvious PSF by the end. A pressure interference of c 4 kPa was observed in the borehole interval above the test section during the injection period. The recovery period starts with a PLF which may be masked during the injection period. Transient evaluations with the Hantush model gave consistent results for both periods. The transient evaluation from the injection period is chosen as representative for this section.

163.0–263.0 m

Due to a malfunction in the pressure regulating computer, this test was repeated. The first test was interrupted and the computer restarted. Since the transmissivity in the section is rather high, no major impact from the first short test was expected on the last test. Both the injection and recovery period display an obvious PRF. The PRF during the injection period starts after c 150 s and lasts for the rest of the period. After initial effects of WBS, the PRF during the recovery period lasts from c 60 s to c 500 s when an apparent NFB is weakly indicated. The stationary and transient evaluations give consistent results. Transient evaluation from the injection period is chosen as representative for the section.

263.0–363.0 m

Although two consecutive PRF:s are indicated during the injection period a common PRF can be interpreted from c 200 s to the end of this period. The pressure in the section below the test section increased by c 12.6 kPa during the injection period. The transmissivity in the section below 363.0 m is lower than the transmissivity in the section 263.0–363.0 m. Therefore this pressure interference should not have resulted in an overestimation of the transmissivity in this section. The recovery period is dominated by a clear PRF, possibly transitioning to a PSF by the end. The transient evaluations of the injection and recovery period as well as the stationary transmissivity TM give consistent results. No unambiguous estimate of the fictive casing radius r_c could be obtained from the recovery period. The transient evaluation from the injection period is chosen as representative for the section.

363.0–463.0 m

The pressure during the injection period was not fully stabilized until after c 5 minutes. Then an obvious PRF that continues for the rest of the period is observed. The recovery period starts with effects of WBS transitioning to a PRF lasting between c 60 and 300 s, followed by an apparent NFB by the end. The transient evaluations on the injection and recovery period give rather consistent results. The transient evaluation of the injection period is chosen as representative for this section.

463.0–563.0 m

The injection period is dominated by a clear PRF. The recovery period starts with WBS transitioning to a PRF. The transient evaluations from the injection and the recovery period provide slightly different results. The recovery period indicates slightly higher transmissivity with a high positive skin factor. Though, since the injection period displays a clear PRF, the transient evaluation of this period was considered to be the most representative for this section.

496.0–596.0 m

The responses during this test are similar to the responses during the test in the previous section 463–563 m. Thus, similar results were obtained. The injection period is dominated by a clear PRF from c 60 s and throughout the period. The recovery period starts with WBS transitioning to a PRF. The transient evaluations from the injection and recovery period provide slightly different results. The recovery period indicates a slightly higher transmissivity and a higher positive skin factor. Though, since the injection period displays a clear PRF, the transient evaluation of this period was considered to be the most representative for this section. A major pressure interference was observed in the borehole interval below the test section at start of packer expansion and start of injection. This fact may indicate that there is a small pressure bypass at the lower packer and that the borehole interval below the test section is rather tight.

63.0–83.0 m

The injection period exhibits a PRF with a high positive skin factor, possibly indicating turbulence or other head losses during the test. The recovery period indicates dominating PSF (leaky flow) although the late part is uncertain. Transient evaluations for both the injection and recovery period result in a high, positive skin factor. The transient evaluation of the injection period is regarded as the most representative for the section.

83.0–103.0 m

The injection period is dominated by a PSF while the recovery period is displaying a PRF with a high positive skin. The responses from the injection and recovery period are thus inconsistent. The stationary transmissivity supports the estimated transmissivity from the injection period. The transient evaluation of the injection period is regarded as the most representative for the section.

103.0–123.0 m

The injection period is dominated by a PRF. The recovery period also displays a PRF with weak indications of an apparent NFB by the end. The Hurst-Clark-Brauer model for the injection period and the Dougherty-Babu model for the recovery period provide consistent results. The transient evaluation from the injection period is regarded as the most representative for the test section. Since the measurement noise with a zero flow was centred slightly below zero, the flow data were manually elevated by $1.48 \cdot 10^{-9}$ m^3/s.

123.0–143.0 m

After an initial transition period an apparent PSF is observed during the injection phase. After initial effects of WBS, a PSF is also observed during the recovery period. The pressure in the section below the test section distinctly increased by c 5.6 kPa during the injection period and declined during the recovery period. Since the transmissivity in the section below 143.0 m is higher than the transmissivity in the section 123.0–143.0 m, this pressure interference may have resulted in an overestimation of the transmissivity in the latter section. However, the representative transmissivity for this section was derived by the Hantush model, which to some degree accounts for leakage. The transient evaluations of both periods give similar results and are also supported by the stationary transmissivity from the injection period. The transient evaluation from the injection period is chosen as representative for the test section.

143.0–163.0 m

During the injection period an approximate PRF is indicated after c 200 s and lasts throughout the period. The recovery period shows a clear PLF transitioning towards an approximate PRF by the end. The pressure in the section above the test section increased c 1.5 kPa during the injection period. Since the transmissivity in the section above is higher than the transmissivity in the section 143.0–163.0, this relatively small pressure interference may still have resulted in an overestimation of the transmissivity in the test section. Transient evaluations of the recovery period using a PRF-model and the single fracture model by Ozkan-Raghavan support the estimated transmissivity from the injection period. The transient evaluation from the injection period is regarded as representative for this test section.

163.0–183.0 m

During the injection period a short period of PRF is observed between c 200–400 s, transitioning to a PSF by the end. The recovery period starts with WBS and a transition period towards a PSF. For both the injection and recovery period transient evaluation was made with the Hantush model for pseudo-spherical flow. The results from the injection period are consistent with those from the recovery period as well as the stationary transmissivity TM. The transient evaluation from the injection period is chosen as representative for the test section.

183.0–203.0 m

The injection period displays a well-defined PRF from c 20 s throughout the period. The recovery period starts with WBS and a transition period that ends up in a PRF after about 200 s. The transient evaluations from the injection and recovery period give consistent results. The transient evaluation from the injection period is chosen as representative for the section.

203.0–223.0 m

The injection period indicates a dominating PSF after c 100 s, and the recovery period shows a transition to a possible PSF. The transient evaluation of the injection period is chosen to represent this section.

223.0–243.0 m

A PRF is assumed to dominate the entire injection period although some variations in flow rate occurred. After initial effects of WBS and skin, the recovery period is dominated by a PRF until about 500 s when a temporary change of pressure by the end of the recovery period appears. The responses during the injection and recovery period provide slightly different values on the hydraulic parameters. During the injection period a slightly lower transmissivity and (negative) skin factor were obtained. During the recovery period a positive skin factor is indicated. The transient evaluation of the injection period is chosen as representative for this section.

243.0–263.0 m

Due to an expected higher transmissivity in this section the pressure is somewhat unstable in the beginning of the injection period. Still a PSF is assumed to dominate the injection period after about 200 s. The recovery period begins with a WBS followed by a transition period to a PSF. Transient evaluation with the Hantush-model provides consistent parameter values for the injection and recovery period. The transient evaluation of the injection period is chosen as representative for the section.

263.0–283.0 m

A PRF is assumed to dominate the entire injection period. The recovery period starts with a PLF and is transitioning to a PRF by the end. The Hurst-Clark-Brauer model for the injection period and the Dougherty-Babu model for the recovery period provide consistent results. No unambiguous estimate on r_c can be obtained from the recovery period since this parameter is insensitive and poorly defined in this case due to the high transmissivity of the section. A slight (c 1 kPa) pressure interference was observed in the borehole interval below the test section during the injection period. This pressure interference remained during the recovery period. The transient evaluation of the injection period is regarded as the most representative for the section.

283.0–303.0 m

Both the injection- and recovery period are dominated by a clear PRF. The Hurst-Clark-Brauer model for the injection period and the Dougherty-Babu model for the recovery period provide consistent results. No unambiguous estimate on r_c can be obtained from the recovery period since this parameter is insensitive and poorly defined in this case due to the high transmissivity of the section. The transient evaluation of the injection period was considered as the most representative for this section.

303.0–323.0 m

The injection period starts with a PRF transitioning to a PSF by the end. During the recovery period initial effects of WBS and positive skin are seen, possibly transitioning to a PRF by the end. Transient evaluations from the injection and recovery period give consistent results. High positive skin was obtained from both the injection and recovery period, possibly indicating turbulence or other head losses. The pressure in the section below the test section increased distinctly by c 11.8 kPa during the injection period and declined rapidly after stop of injection. The transmissivity in the section below 323.0 m is lower than the transmissivity in the section 303.0–323.0 m. Therefore, this pressure interference should not significantly affect the estimated transmissivity of the test section. In addition, the representative transmissivity for this section was derived by using the Hantush model, which to some degree accounts for leakage. The transient evaluation on the injection period is regarded as representative for the section.

323.0–343.0 m

A PRF is indicated after c 30 s throughout the injection period. The recovery period is also indicating an apparent PRF with a very high positive skin factor, possibly due to turbulence or other head losses. No representative transient evaluation was considered as possible on the recovery period. The stationary transmissivity TM supports the estimated transmissivity from the Hurst-Clark-Brauer model from the injection period. The pressure in the section above the test section increased by c 1.7 kPa during the injection period indicating slight pressure interference between the sections. Although the transmissivity in the section above 323.0 m is higher than the transmissivity in the section 323.0–343.0 m, the relatively small pressure interference above the test section should not have a major impact on the test. The transient evaluation of the injection period is regarded as representative for the section.

343.0–363.0 m

The injection period indicates a short initial PSF transitioning to a possible apparent NFB by the end. The pressure recovery period is rapidly approaching a PSS which then transitions into an apparent NFB. No unambiguous transient evaluation was possible on the recovery period. An example evaluation is shown assuming the same transmissivity and storativity as determined from the injection period. The pressure in the section below the test section increased distinctly by c 9.2 kPa during the injection period and declined at stop of injection. The transmissivity in the section below 363.0 m is lower than the transmissivity in the section 343.0–363.0 m. Therefore, this pressure interference should not significantly affect the estimated transmissivity of the test section. In addition, the representative transmissivity for this section was derived by using the Hantush model, which to some degree accounts for leakage. The transient evaluation from the injection period was regarded as representative for the section.

363.0–383.0 m

The injection period is dominated by a PRF from c 70 s until the end. The recovery period starts with initial WBS and skin and a transition towards a possible, short PRF appearing between 50 and 200 s. Then the flow makes a transition towards an apparent NFB at the end of the period. The transient evaluation from the injection period was regarded as representative for the section.

383.0–403.0 m

This section has a low transmissivity. Furthermore the flow during the test made a short dip after about 15 minutes but this did not seem to affect either the test or the evaluation. However, the injection period displays an obvious PRF throughout the entire period. Recovery begins with a WBS followed by a transition period. Although no significant flow features were seen, transient evaluation of the recovery with the Dougherty-Babu model provides consistent results with the evaluation of the injection period. The transient evaluation from the injection period was regarded as representative for the section.

403.0–423.0 m

The flow exhibits an apparent PRF throughout the entire injection period. The recovery is showing an approximate PRF after initial effects of WBS and skin, slightly declining by the end. Consistent results are obtained from the evaluation of the injection period and recovery period, respectively. The transient evaluation from the injection period is regarded as representative for the section.

423.0–443.0 m

The test section has a low transmissivity. Since the flow rate was not detectable, neither steady-state nor transient evaluation of transmissivity were possible. Hence, in accordance with AP PF 400-07-023, the injection time was shortened. As a result TM, based on Q/s-measl-L, was considered to be the most representative transmissivity value for this section.

443.0–463.0 m

During the injection period a PRF is assumed throughout the period. During the recovery period a PRF is shown between c 30 and 400 seconds. By the end a transition towards a possible PSF is indicated. Transient evaluation of the injection and recovery provide consistent results. The transient evaluation from the injection period is regarded as representative for the section.

463.0–483.0 m

The injection period is dominated by a PRF transitioning to a possible, apparent NFB by the end. A relatively high, positive skin factor is determined for the injection period, possibly indicating turbulence or other head losses. The recovery is fast and showing initial WBS followed by a possible PRF. No representative transient evaluation was considered possible on the recovery period due to an apparent very high calculated skin factor. An example evaluation of the recovery period is shown. Transient evaluation of the injection period is considered as representative for this section.

483.0–503.0 m

The test section has a low transmissivity. Since the flow rate was not detectable, neither steady-state nor transient evaluation of transmissivity were possible. Hence, in accordance with AP PF 400-07-023, the injection time was shortened. As a result TM, based on Q/s-measl-L, was considered to be the most representative transmissivity value for this section. Since the measurement noise with a zero flow was centred slightly above zero, the flow rate measurement limit was manually lowered by 1.06·10–9 m^3/s.

496.0–516.0 m

A PRF is indicated after c 20 s and throughout the injection period. The recovery period is showing initial WBS transitioning to a possible PRF. Transient evaluation of the recovery period results in a very high apparent skin. No representative transient evaluation was considered possible on the recovery period due to an apparent very high skin factor. An example of an evaluation is shown. The pressure in the section below the test section increased by c 1.9 kPa during the injection period. The transmissivity in the section below 516.0 m is lower than the transmissivity in the section 496.0–516.0 m. Therefore, this pressure interference should not significantly affect the estimated transmissivity of the test section. Transient evaluation of the injection period is considered as representative for this section.

516.0–536.0 m

Both the injection and recovery period are displaying a clear PRF, preceded by a period of WBS during the recovery period. The stationary transmissivity TM supports the transient evaluation with the Hurst-Clark-Brauer model of the injection period. The transient evaluation of the recovery period with the Babu model resulted in a high positive skin. Transient evaluation of the injection period is considered as representative for this section.

536.0–556.0 m

The flow rate is low, close to the lower measurement limit. Hence the data, especially the flow derivative, are quite scattered. Still, a possible PRF can be seen after c 20 s to c 700 s, possibly transitioning to an apparent NFB by the end. The recovery only displays WBS and a transition period. No unambiguous transient evaluation was possible of the recovery period. Since the injection period displays an apparent PRF, transient evaluation of the injection period was considered to give the most representative transmissivity value for this section.

556.0–576.0 m

The flow rate is low, close to the measurement limit. Hence the data, especially the flow derivative, are quite scattered. No unambiguous transient evaluation was possible of either the injection or the recovery period. Example evaluations are shown. The stationary transmissivity from the injection period is chosen as representative for this section.

576.0–596.0 m

The test section has a low transmissivity. Since the flow rate was not detectable, neither steady-state nor transient evaluation of transmissivity was possible. Hence, in accordance with AP PF 600-07-023, the injection time was shortened. As a result TM, based on Q/s-measl-L, was considered to be the most representative transmissivity value for this section.

6.2.5 Flow regimes

A summary of the frequency of identified flow regimes on different scales is presented in Table 6-3, which shows all identified flow regimes during the tests. For example, a pseudo-radial flow regime (PRF) transitioning to a pseudo-spherical flow regime (PSF) will contribute to one observation of PRF and one observation of PSF. The numbers within parenthesis denote the number of tests where the actual flow regime is the only one present.

It should be noted that the interpretation of flow regimes is only tentative and just based on visual inspection of the data curves. It should also be observed that the number of tests with a pseudo-linear flow regime during the beginning of the injection period may be underestimated due to the fact that a certain time is required for achieving a constant pressure, which fact may mask the initial flow regime.

Table 6-3. Interpreted flow regimes during the injection tests in KFM12A. The figures within the parentheses show the number of tests with only one interpreted flow regime.

Section length (m)	Number of tests	Borehole interval (m)	Number of tests with definable Q_p	Injection period					Recovery period					
				PLF	PRF	PSF	PSS	NFB	WBS	PLF	PRF	PSF	PSS	NFB
20	27	63.0–596.0	24	0(0)	18(14)	7(4)	0(0)	3(0)	13(2)	2(0)	15(3)	6(2)	1(0)	3(0)
100	6	63.0–596.0	6	0(0)	5(5)	1(1)	0(0)	0(0)	4(0)	1(0)	5(0)	2(0)	0(0)	2(0)

Table 6-3 shows that in c 69% of the tests with a definable final flow rate, a certain period of pseudo-radial flow during the injection period could be identified for KFM12A. For the recovery period, the corresponding result is c 46%. It should be observed that the borehole intervals measured with 20 m and 100 m sections do not exactly comply with each other in KFM12A, see section 5.5.

For only 5 tests in the borehole, more than one flow regime during the injection period could be identified. These transitions in KFM12A during the injection period were as follows: two tests from PRF to NFB, two tests from PSF to NFB and one from PRF to PSF. During the recovery period, 77% of the tests showed more than one flow regime. The most common transitions were from WBS to PRF followed by PRF to NFB.

6.3 Comparison of transmissivity values on different test scales

The transmissivity values considered as the most representative, T_R, from the injection tests in KFM12A in the tested sections of 100 m and 20 m length, respectively, are shown in Figure 6-3. This figure demonstrates a fairly good agreement between results obtained from tests on different scales in KFM12A. However, some tests in short (20 m) section lengths display a higher transmissivity than the corresponding longer section length. This discrepancy may be caused by hydraulic interference with adjacent sections. A consistency check of the transmissivity values on the different scales was made by summation of calculated values from 20 m scale and comparing with the estimated values in 100 m sections. The total transmissivity of KFM12A is dominated by the intervals between 63.0–103.0, 303.0–343.0 and 363.0–383.0 m.

In Table 6-4, estimated transmissivity values in 100 m and 20 m test sections in KFM12A according to steady-state (T_M) and most representative evaluation (T_R) are listed together with summed transmissivities in 20 m sections over the corresponding 100 m sections. When the transmissivity values are below the measurement limit (Q_p could not be defined), the most representative transmissivity value, T_R, was considered to be less than T_M, based on Q/s-measl-L, for the test section. The measurement limit values are included in the summed values in Table 6-4. This leads to overestimated values of the summed transmissivities.

In Figure 6-4. transmissivity values considered as the most representative for 100 m sections (T_R–100 m) in KFM12A are plotted versus the sum of the representative transmissivity values in 20 m sections in the corresponding intervals (SUM T_R–20 m). The lower measurement limit of T_M for the different section lengths (Q_p=1 mL/min and an assumed pressure difference of 200 kPa) together with the cumulative measurement limit for the sum of 20 m sections are also shown in the figure.

Figure 6-4 indicates a good agreement between estimated transmissivity values in 100 m sections and summed transmissivity values in corresponding 20 m sections for the injection tests. The first section, 63.0–163.0 m, shows a summed transmissivity from tests in 20 m sections five times higher than the corresponding figure from the 100 m section. Overall, a small tendency of data points being located slightly below the straight line can be observed. This indicates that the sum of the transmissivity from the shorter sections is slightly higher than the estimated transmissivity in longer sections. Hydraulic interference between adjacent sections may contribute to an overestimation of the sum of transmissivity when summing the transmissivity from several sections together. Since the measurement limit values also are summed up, the sum of transmissivity in shorter sections can become higher than the estimated transmissivity value in the longer section for very low conductive sections. There might also be other reasons for discrepancies.

Since neither difference flow logging nor tests with a 5 m test section were made in the hole, no comparison on that test scales was possible.

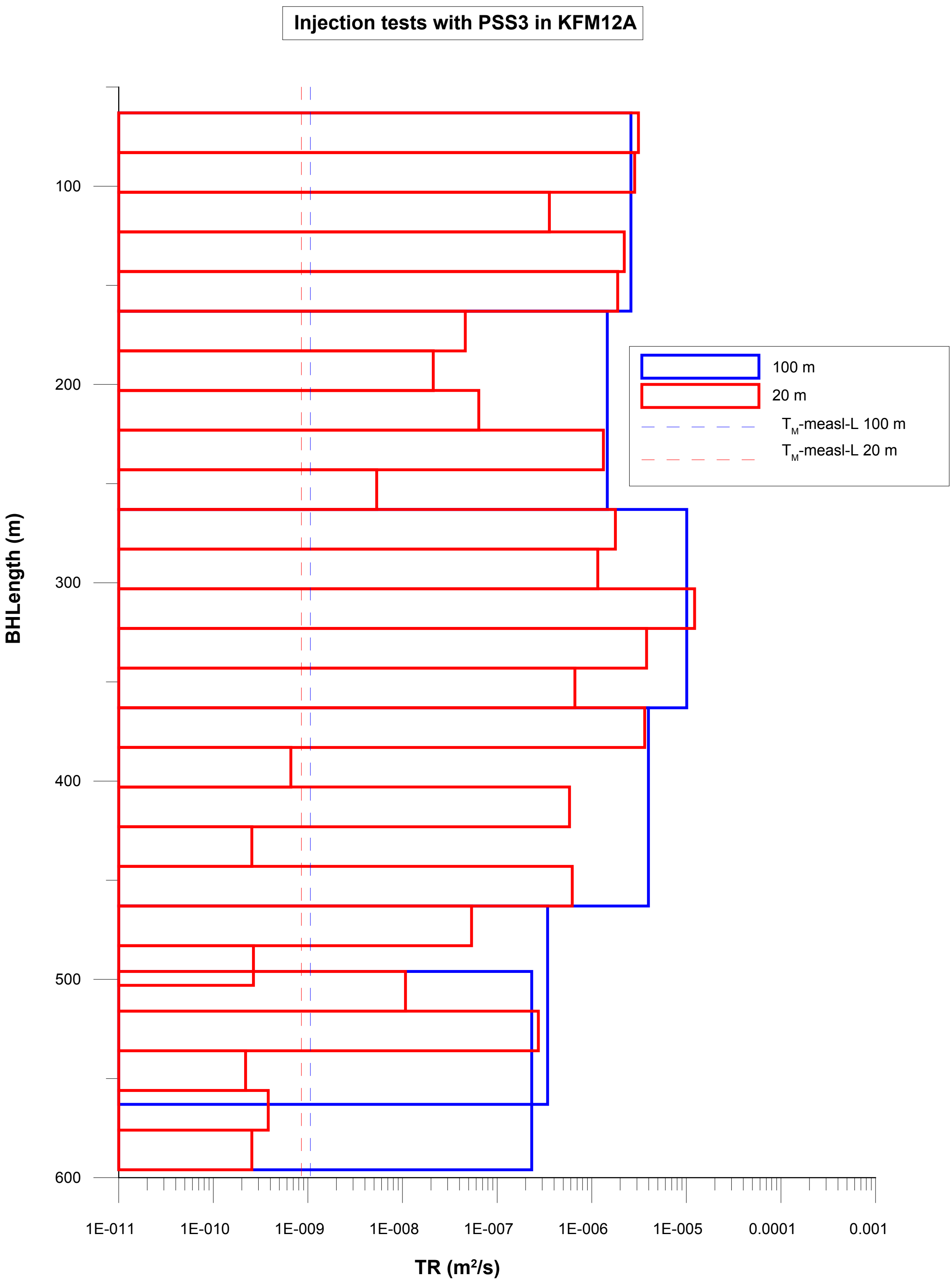

Figure 6-3. *Estimated best representative transmissivity values (T_R) from injection tests for sections of 100 m and 20 m length in borehole KFM12A. Estimated transmissivity values for the lower standard measurement limit from stationary evaluation (T_M-measl-L) for different test section lengths are also shown.*

Table 6-4. Estimated transmissivity values in 100 m and 20 m test sections together with summed up transmissivity values in 20 m and 5 m sections in the corresponding borehole intervals from the injection tests in KFM12A.

Bore-hole Idcode	Secup inj. tests (m)	Seclow inj. tests (m)	L_w (m)	T_M inj. tests (m^2/ s)	T_R inj. tests (m^2/s)	SUM T_M(20m) inj. tests (m^2/s)	SUM T_R(20m) inj. tests (m^2/s)
KFM12A	63.00	163.00	100.00	1.26E–05	2.60E–06	1.22E–05	1.04E–05
KFM12A	163.00	263.00	100.00	2.14E–06	1.46E–06	1.83E–06	1.47E–06
KFM12A	263.00	363.00	100.00	1.98E–05	1.01E–05	1.50E–05	1.97E–05
KFM12A	363.00	463.00	100.00	6.62E–06	3.98E–06	4.97E–06	4.84E–06
KFM12A	463.00	563.00	100.00	3.13E–07	3.41E–07	3.38E–07[1)]	3.38E–07[1)]
KFM12A	496.00	596.00	100.00	3.09E–07	2.32E–07	3.13E–07	2.85E–07
KFM12A	63.00	83.00	20.00	9.93E–07	3.11E–06		
KFM12A	83.00	103.00	20.00	2.79E–06	2.85E–06		
KFM12A	103.00	123.00	20.00	2.14E–07	3.56E–07		
KFM12A	123.00	143.00	20.00	2.77E–06	2.21E–06		
KFM12A	143.00	163.00	20.00	5.43E–06	1.89E–06		
KFM12A	163.00	183.00	20.00	3.48E–08	4.62E–08		
KFM12A	183.00	203.00	20.00	3.20E–08	2.11E–08		
KFM12A	203.00	223.00	20.00	1.14E–07	6.40E–08		
KFM12A	223.00	243.00	20.00	1.63E–06	1.33E–06		
KFM12A	243.00	263.00	20.00	1.28E–08	5.33E–09		
KFM12A	263.00	283.00	20.00	4.34E–06	1.78E–06		
KFM12A	283.00	303.00	20.00	1.30E–06	1.16E–06		
KFM12A	303.00	323.00	20.00	5.20E–06	1.23E–05		
KFM12A	323.00	343.00	20.00	3.35E–06	3.80E–06		
KFM12A	343.00	363.00	20.00	8.49E–07	6.63E–07		
KFM12A	363.00	383.00	20.00	3.73E–06	3.63E–06		
KFM12A	383.00	403.00	20.00	1.72E–09	6.60E–10		
KFM12A	403.00	423.00	20.00	5.43E–07	5.82E–07		
KFM12A	423.00	443.00	20.00	< 2.55E–10	< 2.55E–10		
KFM12A	443.00	463.00	20.00	6.92E–07	6.23E–07		
KFM12A	463.00	483.00	20.00	2.52E–08	5.37E–08		
KFM12A	483.00	503.00	20.00	< 2.65E–10	< 2.65E–10		
KFM12A	496.00	516.00	20.00	3.10E–08	1.07E–08		
KFM12A	516.00	536.00	20.00	2.81E–07	2.73E–07		
KFM12A	536.00	556.00	20.00	3.08E–10	2.20E–10		
KFM12A	556.00	576.00	20.00	3.81E–10	3.81E–10		
KFM12A	576.00	596.00	20.00	< 2.55E–10	< 2.55E–10		

[1)] Section 556–563 m not summed into this section.

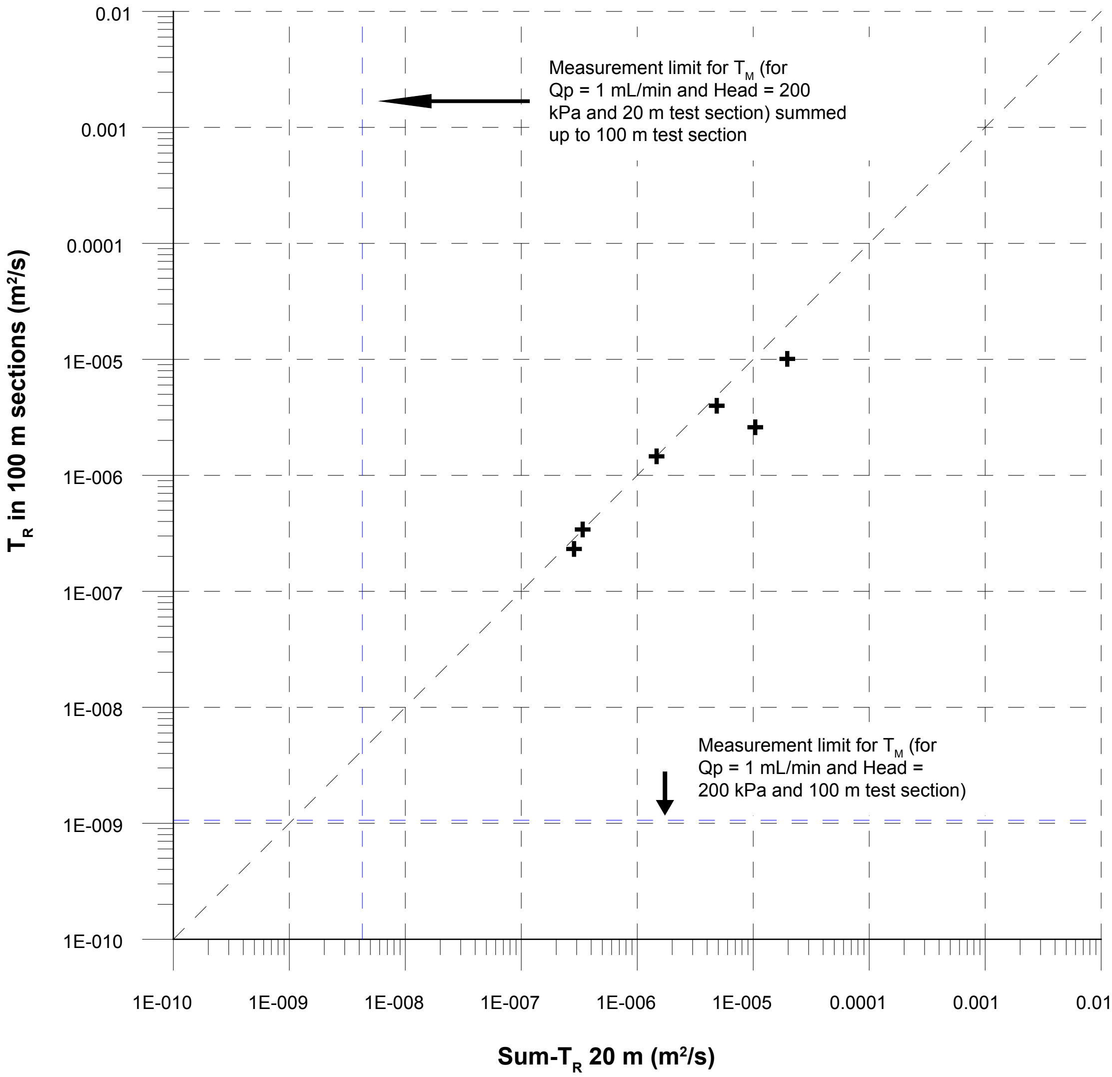

Figure 6-4. *Transmissivity values considered most representative (T_R) for 100 m section versus the sum of most representative transmissivity values (T_R) in 20 m sections in the corresponding borehole intervals from the injection tests in KFM12A together with the standard lower measurement limit at different scales.*

6.4 Basic statistics of hydraulic conductivity distributions in different scales

Some basic statistical parameters were calculated for the steady-state hydraulic conductivity (K_M) distributions in different scales (100 m and 20 m) from the injection tests in borehole KFM12A. The hydraulic conductivity is obtained by dividing the transmissivity by the section length, in this case T_M/L_w. Results from all tests are included in the statistical analyses of both K_R and K_M. Tests below the measurement limit are assigned a transmissivity value at the lower measurement limit. The same basic statistical parameters were derived for the hydraulic conductivity considered most representative (K_R=T_R/L_w), including all tests. In the statistical analysis, the logarithm (base 10) of K_M and K_R was used. Selected results are shown in Table 6-5. It should be noted that the statistics for the different section lengths is based on different borehole intervals.

6.5 Comparison of results from different hydraulic tests in KFM12A

In Table 6-6 a comparison of the sum of estimated transmissivity values from tests with the two different section lengths in KFM12A is presented. It is important to point out that this is a very rough way of comparing the tests in different test scales, since no major consideration to overlapping sections is made. The sum of transmissivity from shorter sections is slightly higher than corresponding transmissivity for longer sections. This tendency can be seen between 100 m and 20 m sections on T_R in Table 6-6.

Table 6-6 shows that the transmissivity evaluated from transient analysis of the 100 m test section is lower than the corresponding stationary value. Tests using 20 m section however, show very good agreement between transient and stationary evaluations.

Table 6-5. Basic statistical parameters for steady-state hydraulic conductivity (K_M) and hydraulic conductivity considered most representative (K_R) in borehole KFM12A. L_w=section length, m=arithmetic mean, s=standard deviation.

Parameter	Unit	KFM12A L_w=100 m	KFM12A L_w=20 m[2]
Measured borehole interval	m	63.0–596.0	63.0–596.0
Number of tests	–	6	27
N:o of tests below E.L.M.L.[1]	–	0	3
m (Log10(KM))	Log10 (m/s)	–7.58	–8.29
s (Log10(KM))	–	0.79	1.53
m (Log10(KR))	Log10 (m/s)	–7.82	–8.34
s (Log10(KR))	–	0.63	1.57

[1] Number of tests where Q_p could not be defined (E.L.M.L. = estimated test-specific lower measurement limit).

[2] Contains partly overlapping sections, see section 5.5.

Table 6-6. Comparison of calculated transmissivity values from different hydraulic tests in borehole KFM12A.

Hydraulic test method		Sum of T (m^2/s)
Injection tests	∑TM(100 m)[1]	$4.19 \cdot 10^{-5}$
	∑TR(100 m)[1]	$1.87 \cdot 10^{-5}$
	∑TM(20 m)[1]	$3.44 \cdot 10^{-5}$
	∑TR(20 m)[1]	$3.67 \cdot 10^{-5}$

[1] For actual measured intervals and partly overlapping sections, see Chapter 5.5.

7 References

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APPENDIX 1. File description table

Bh id	Test section		Test type	Test no	Test start Date, time	Test stop Date, time	Data files of raw and primary data	Parameters in file	Comments
idcode	(m)	(m)	(1-6)[1)]		YYYYMMDD hh:mm	YYYYMMDD hh:mm	__Borehole id_secup_date and time of test start		
KFM12A	63.00	163.00	3	1	2007-04-10 10:27	2007-04-10 12:23	__KFM12A_063.00_200704101027.ht2	P, Q, Te	
KFM12A	163.00	263.00	3	1	2007-04-10 15:15	2007-04-10 17:32	__KFM12A_0163.00_200704101515.ht2	P, Q, Te	
KFM12A	263.00	363.00	3	1	2007-04-11 09:30	2007-04-11 11:20	__KFM12A_0263.00_200704110930.ht2	P, Q, Te	
KFM12A	363.00	463.00	3	1	2007-04-11 13:26	2007-04-11 15:15	__KFM12A_0363.00_200704111326.ht2	P, Q, Te	
KFM12A	463.00	563.00	3	1	2007-04-11 16:05	2007-04-12 09:28	__KFM12A_0463.00_200704111605.ht2	P, Q, Te	
KFM12A	496.00	596.00	3	1	2007-04-12 10:02	2007-04-12 11:50	__KFM12A_0496.00_200704121002.ht2	P, Q, Te	
KFM12A	63.00	83.00	3	1	2007-04-13 15:53	2007-04-13 17:09	__KFM12A_0063.00_200704131553.ht2	P, Q, Te	
KFM12A	83.00	103.00	3	1	2007-04-16 08:40	2007-04-16 09:55	__KFM12A_0083.00_200704160840.ht2	P, Q, Te	
KFM12A	103.00	123.00	3	1	2007-04-16 10:12	2007-04-16 11:25	__KFM12A_0103.00_200704161012.ht2	P, Q, Te	
KFM12A	123.00	143.00	3	1	2007-04-16 12:23	2007-04-16 13:37	__KFM12A_0123.00_200704161223.ht2	P, Q, Te	
KFM12A	143.00	163.00	3	1	2007-04-16 13:55	2007-04-16 15:11	__KFM12A_0143.00_200704161355.ht2	P, Q, Te	
KFM12A	163.00	183.00	3	1	2007-04-16 15:31	2007-04-16 16:52	__KFM12A_0163.00_200704161531.ht2	P, Q, Te	
KFM12A	183.00	203.00	3	1	2007-04-17 08:26	2007-04-17 09:41	__KFM12A_0183.00_200704170826.ht2	P, Q, Te	
KFM12A	203.00	223.00	3	1	2007-04-17 09:58	2007-04-17 11:14	__KFM12A_0203.00_200704170958.ht2	P, Q, Te	
KFM12A	223.00	243.00	3	1	2007-04-17 12:17	2007-04-17 13:40	__KFM12A_0223.00_200704171217.ht2	P, Q, Te	
KFM12A	243.00	263.00	3	1	2007-04-17 14:03	2007-04-17 15:17	__KFM12A_0243.00_200704171403.ht2	P, Q, Te	
KFM12A	263.00	283.00	3	1	2007-04-17 15:34	2007-04-17 16:48	__KFM12A_0263.00_200704171534.ht2	P, Q, Te	
KFM12A	283.00	303.00	3	1	2007-04-18 08:33	2007-04-18 09:49	__KFM12A_0283.00_200704180833.ht2	P, Q, Te	
KFM12A	303.00	323.00	3	1	2007-04-18 10:05	2007-04-18 11:23	__KFM12A_0303.00_200704181005.ht2	P, Q, Te	
KFM12A	323.00	343.00	3	1	2007-04-18 12:24	2007-04-18 13:40	__KFM12A_0323.00_200704181224.ht2	P, Q, Te	
KFM12A	343.00	363.00	3	1	2007-04-18 13:59	2007-04-18 15:13	__KFM12A_0343.00_200704181359.ht2	P, Q, Te	
KFM12A	363.00	383.00	3	1	2007-04-18 15:38	2007-04-18 16:51	__KFM12A_0363.00_200704181538.ht2	P, Q, Te	
KFM12A	383.00	403.00	3	1	2007-04-19 08:34	2007-04-19 09:53	__KFM12A_0383.00_200704190834.ht2	P, Q, Te	
KFM12A	403.00	423.00	3	1	2007-04-19 10:08	2007-04-19 11:27	__KFM12A_0403.00_200704191008.ht2	P, Q, Te	
KFM12A	423.00	443.00	3	1	2007-04-19 12:28	2007-04-19 13:11	__KFM12A_0423.00_200704191228.ht2	P, Q, Te	
KFM12A	443.00	463.00	3	1	2007-04-19 13:28	2007-04-19 14:47	__KFM12A_0443.00_200704191328.ht2	P, Q, Te	
KFM12A	463.00	483.00	3	1	2007-04-19 15:02	2007-04-19 16:16	__KFM12A_0463.00_200704191502.ht2	P, Q, Te	Interrupted[2)]
KFM12A	463.00	483.00	3	2	2007-04-24 09:23	2007-04-24 10:40	__KFM12A_0463.00_200704240923.ht2	P, Q, Te	Reperformed
KFM12A	483.00	503.00	3	1	2007-04-19 16:31	2007-04-20 08:39	__KFM12A_0483.00_200704191631.ht2	P, Q, Te	
KFM12A	496.00	516.00	3	1	2007-04-20 09:05	2007-04-20 10:21	__KFM12A_0496.00_200704200905.ht2	P, Q, Te	
KFM12A	516.00	536.00	3	1	2007-04-20 10:37	2007-04-20 11:57	__KFM12A_0516.00_200704201037.ht2	P, Q, Te	
KFM12A	536.00	556.00	3	1	2007-04-20 12:57	2007-04-20 14:11	__KFM12A_0536.00_200704201257.ht2	P, Q, Te	
KFM12A	556.00	576.00	3	1	2007-04-20 14:25	2007-04-20 15:39	__KFM12A_0556.00_200704201425.ht2	P, Q, Te	
KFM12A	576.00	596.00	3	1	2007-04-20 15:52	2007-04-20 16:51	__KFM12A_0576.00_200704201552.ht2	P, Q, Te	

1) 3: Injection test
2) Due to an instable injection pressure this tests was interrupted and hence re-performed later

Appendix 2.1. General test data

Borehole:	KFM12A
Testtype:	CHir (Constant Head injection and recovery)
Field crew:	J. Harrström, E. Walger, J. Florberger
General comment:	

Test section secup	**Test section seclow**	**Test start**	**Start of flow period**	**Stop of flow period**	**Test stop**	**Total flow time t_p**	**Total recovery time t_F**
(m)	(m)	YYYYMMDD hh:mm	YYYYMMDD hh:mm:ss	YYYYMMDD hh:mm:ss	YYYYMMDD hh:mm	(min)	(min)
63.00	163.00	2007-04-10 10:27	2007-04-10 11:20:35	2007-04-10 11:50:51	2007-04-10 12:23	30	30
163.00	263.00	2007-04-10 15:15	2007-04-10 16:29:31	2007-04-10 16:59:48	2007-04-10 17:32	30	30
263.00	363.00	2007-04-11 09:30	2007-04-11 10:17:38	2007-04-11 10:47:48	2007-04-11 11:20	30	30
363.00	463.00	2007-04-11 13:26	2007-04-11 14:12:54	2007-04-11 14:43:10	2007-04-11 15:15	30	30
463.00	563.00	2007-04-11 16:05	2007-04-12 08:26:01	2007-04-12 08:56:19	2007-04-12 09:28	30	30
496.00	596.00	2007-04-12 10:02	2007-04-12 10:47:57	2007-04-12 11:18:07	2007-04-12 11:50	30	30
63.00	83.00	2007-04-13 15:53	2007-04-13 16:26:58	2007-04-13 16:47:15	2007-04-13 17:09	20	20
83.00	103.00	2007-04-16 08:40	2007-04-16 09:12:35	2007-04-16 09:32:53	2007-04-16 09:55	20	20
103.00	123.00	2007-04-16 10:12	2007-04-16 10:43:18	2007-04-16 11:03:36	2007-04-16 11:25	20	20
123.00	143.00	2007-04-16 12:23	2007-04-16 12:54:37	2007-04-16 13:14:54	2007-04-16 13:37	20	20
143.00	163.00	2007-04-16 13:55	2007-04-16 14:29:22	2007-04-16 14:49:32	2007-04-16 15:11	20	20
163.00	183.00	2007-04-16 15:31	2007-04-16 16:09:32	2007-04-16 16:29:48	2007-04-16 16:52	20	20
183.00	203.00	2007-04-17 08:26	2007-04-17 08:58:56	2007-04-17 09:19:13	2007-04-17 09:41	20	20
203.00	223.00	2007-04-17 09:58	2007-04-17 10:32:13	2007-04-17 10:52:29	2007-04-17 11:14	20	20
223.00	243.00	2007-04-17 12:17	2007-04-17 12:57:27	2007-04-17 13:17:44	2007-04-17 13:40	20	20
243.00	263.00	2007-04-17 14:03	2007-04-17 14:34:46	2007-04-17 14:55:03	2007-04-17 15:17	20	20
263.00	283.00	2007-04-17 15:34	2007-04-17 16:05:54	2007-04-17 16:26:09	2007-04-17 16:48	20	20
283.00	303.00	2007-04-18 08:33	2007-04-18 09:06:33	2007-04-18 09:26:51	2007-04-18 09:49	20	20
303.00	323.00	2007-04-18 10:05	2007-04-18 10:40:54	2007-04-18 11:01:08	2007-04-18 11:23	20	20
323.00	343.00	2007-04-18 12:24	2007-04-18 12:57:36	2007-04-18 13:17:53	2007-04-18 13:40	20	20
343.00	363.00	2007-04-18 13:59	2007-04-18 14:30:50	2007-04-18 14:51:08	2007-04-18 15:13	20	20
363.00	383.00	2007-04-18 15:38	2007-04-18 16:09:24	2007-04-18 16:29:42	2007-04-18 16:51	20	20
383.00	403.00	2007-04-19 08:34	2007-04-19 09:11:01	2007-04-19 09:31:21	2007-04-19 09:53	20	20
403.00	423.00	2007-04-19 10:08	2007-04-19 10:44:58	2007-04-19 11:05:16	2007-04-19 11:27	20	20
423.00	443.00	2007-04-19 12:28	2007-04-19 13:01:29	2007-04-19 13:03:52	2007-04-19 13:11	2	5
443.00	463.00	2007-04-19 13:28	2007-04-19 14:04:38	2007-04-19 14:24:56	2007-04-19 14:47	20	20
463.00	483.00	2007-04-24 09:23	2007-04-24 09:57:29	2007-04-24 10:17:47	2007-04-24 10:40	20	20
483.00	503.00	2007-04-19 16:31	2007-04-20 08:22:48	2007-04-20 08:32:14	2007-04-20 08:39	9	5
496.00	516.00	2007-04-20 09:05	2007-04-20 09:38:29	2007-04-20 09:58:47	2007-04-20 10:21	20	20
516.00	536.00	2007-04-20 10:37	2007-04-20 11:14:29	2007-04-20 11:34:46	2007-04-20 11:57	20	20
536.00	556.00	2007-04-20 12:57	2007-04-20 13:29:06	2007-04-20 13:49:25	2007-04-20 14:11	20	20
556.00	576.00	2007-04-20 14:25	2007-04-20 14:56:39	2007-04-20 15:16:59	2007-04-20 15:39	20	20
576.00	596.00	2007-04-20 15:52	2007-04-20 16:23:31	2007-04-20 16:43:36	2007-04-20 16:51	20	5
463.00[1)]	483.00	2007-04-19 15:02	2007-04-19 15:34:06	2007-04-19 15:54:24	2007-04-19 16:16	20	20

[1)] Due to an instable injection pressure this tests was interrupted and hence re-performed later

Appendix 2.2 Pressure and flow data

Summary of pressure and flow data for all tests in KFM12A

Test section		Pressure			Flow		
secup	seclow	p_i	p_p	p_F	Q_p [1)]	Q_m [1)]	V_p [1)]
(m)	(m)	(kPa)	(kPa)	(kPa)	(m^3/s)	(m^3/s)	(m^3)
63.00	163.00	2288.695	2454.01	2303.53	0.0001636	0.000194	3.53E-01
163.00	263.00	3143.3	3339.1	3156.48	3.278E-05	3.61E-05	6.58E-02
263.00	363.00	3990.22	4139.61	3997.36	0.0002317	0.000254	4.61E-01
363.00	463.00	4834.39	4957.41	4845.92	6.371E-05	7.01E-05	1.27E-01
463.00	563.00	5693.39	5890.69	5699.42	4.829E-06	5.13E-06	9.34E-03
496.00	596.00	5963.34	6162.97	5972.40	4.823E-06	5.34E-06	9.67E-03
63.00	83.00	926.41	1113.69	926.95	0.0000181	1.84E-05	2.25E-02
83.00	103.00	1093.37	1268.79	1092.82	4.768E-05	4.87E-05	5.94E-02
103.00	123.00	1270.08	1479.93	1277.91	4.366E-06	4.61E-06	5.63E-03
123.00	143.00	1441.03	1631.62	1447.08	5.148E-05	5.57E-05	6.78E-02
143.00	163.00	1610.61	1779.12	1633.82	8.903E-05	0.000116	1.40E-01
163.00	183.00	1785.95	1998.78	1784.31	7.21E-07	7.78E-07	9.47E-04
183.00	203.00	1952.65	2152.01	1968.29	6.206E-07	7.16E-07	8.73E-04
203.00	223.00	2121.25	2320.9	2124.28	2.223E-06	2.48E-06	3.02E-03
223.00	243.00	2290.14	2482.79	2302.23	3.063E-05	3.37E-05	4.11E-02
243.00	263.00	2461.78	2692.73	2469.75	2.879E-07	3.13E-07	3.81E-04
263.00	283.00	2630.81	2835.54	2650.44	8.655E-05	0.000103	1.26E-01
283.00	303.00	2799.97	2996.59	2810.27	2.488E-05	2.72E-05	3.32E-02
303.00	323.00	2970.65	3167.41	2973.38	0.0000996	0.000102	1.23E-01
323.00	343.00	3138.71	3319.69	3139.81	5.901E-05	6.3E-05	7.68E-02
343.00	363.00	3315.29	3500.32	3320.51	0.0000153	1.6E-05	1.95E-02
363.00	383.00	3480.2	3674.21	3497.36	7.049E-05	7.66E-05	9.34E-02
383.00	403.00	3661.58	3863.06	3687.94	3.372E-08	5.17E-08	6.31E-05
403.00	423.00	3831.42	4028.19	3841.17	1.041E-05	1.11E-05	1.35E-02
423.00	443.00	4013.09	4194.34	4187.75			
443.00	463.00	4168.11	4364.42	4177.86	1.323E-05	1.42E-05	1.73E-02
463.00	483.00	4336.44	4534.72	4339.33	4.865E-07	5.41E-07	6.60E-04
483.00	503.00	4484.19	4681.5	4667.77			
496.00	516.00	4617.65	4788.19	4623.84	5.151E-07	6.7E-07	8.16E-04
516.00	536.00	4785.31	4977.12	4792.44	5.252E-06	5.67E-06	6.91E-03
536.00	556.00	4925.9	5140.66	5030.81	6.451E-09	1.99E-08	2.40E-05
556.00	576.00	5114.29	5305.43	5245.01	7.085E-09	1.84E-08	2.22E-05
576.00	596.00	5281.4	5468.55	5460.31			
463.00 [2)]	483.00	5020.03	5258.47	5022.23	3.414E-07	3.92E-07	4.78E-04

[1)] No value indicates a flow below measurement limit (measurement limit is unique for each test but nominally 1.67 E-8 m^3/s).
[2)] Due to an instable injection pressure this tests was interrupted and hence re-performed later.

p_i	Pressure in test section before start of flow period
p_p	Pressure in test section before stop of flow period
p_F	Pressure in test section at the end of recovery period
Q_p	Flow rate just before stop of flow period
Q_m	Mean (arithmetic) flow rate during flow period
V_p	Total volume injected during the flow period

Appendix 3. Test diagrams – Injection and pressure pulse tests

In the following pages the selected test diagrams are presented for all test sections. A linear diagram of pressure and flow rate is presented for each test. For most tests are lin-log and log-log diagrams presented, from injection and recovery period respectively. From the tests with a flow rate below the estimated lower measurement limit for the specific test, only the linear diagram is presented. Additionally, for a few tests, a type curve fit is displayed in the diagrams despite the the fact that the estimated parameters from the fit are judged as non-representative. For these tests, the type curve fit is presented, as an example, to illustrate that an assumption of a certain flow regime is not justified for the test. Instead, some other flow regime is likely to dominate.

Nomenclature for Aqtesolv:

T	=	transmissivity (m^2/s)
S	=	storativity (-)
K_z/K_r	=	ratio of hydraulic conductivities in the vertical and radial direction (set to 1)
Sw	=	skin factor
r(w)	=	borehole radius (m)
r(c)	=	effective casing radius (m)
C	=	well loss constant (set to 0)
r/B	=	leakage factor (-)

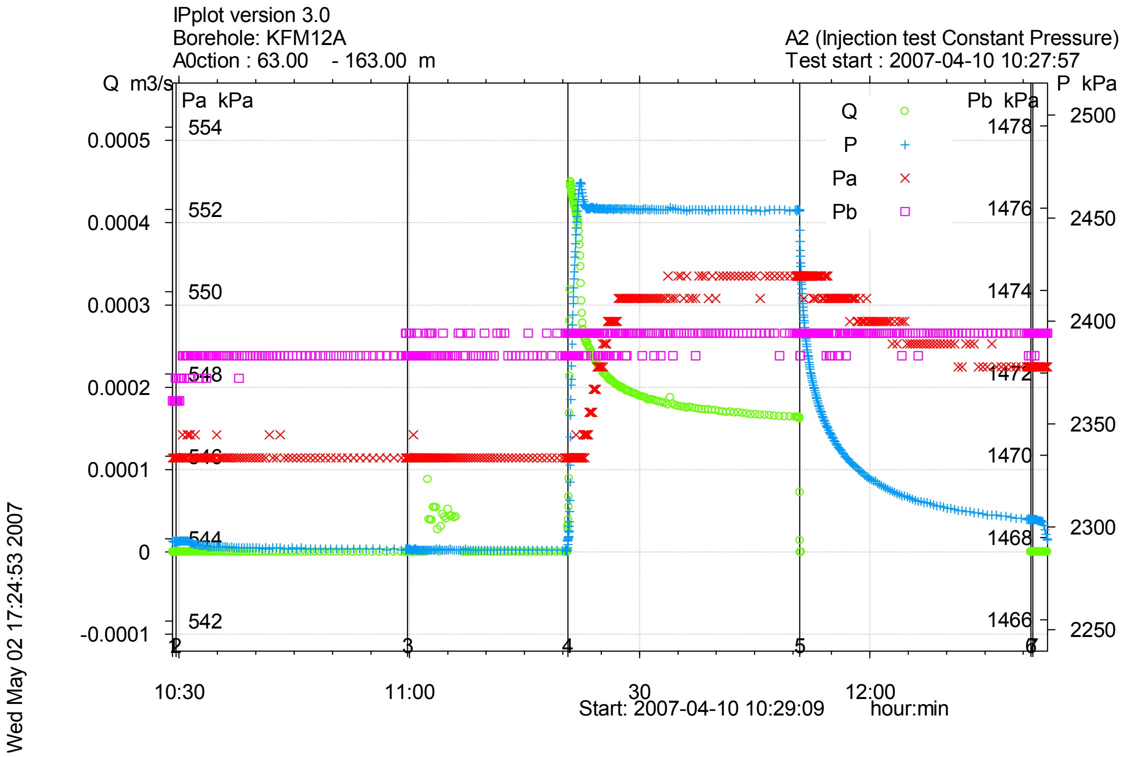


Figure A3-1. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 63.0-163.0 m in borehole KFM12A.*

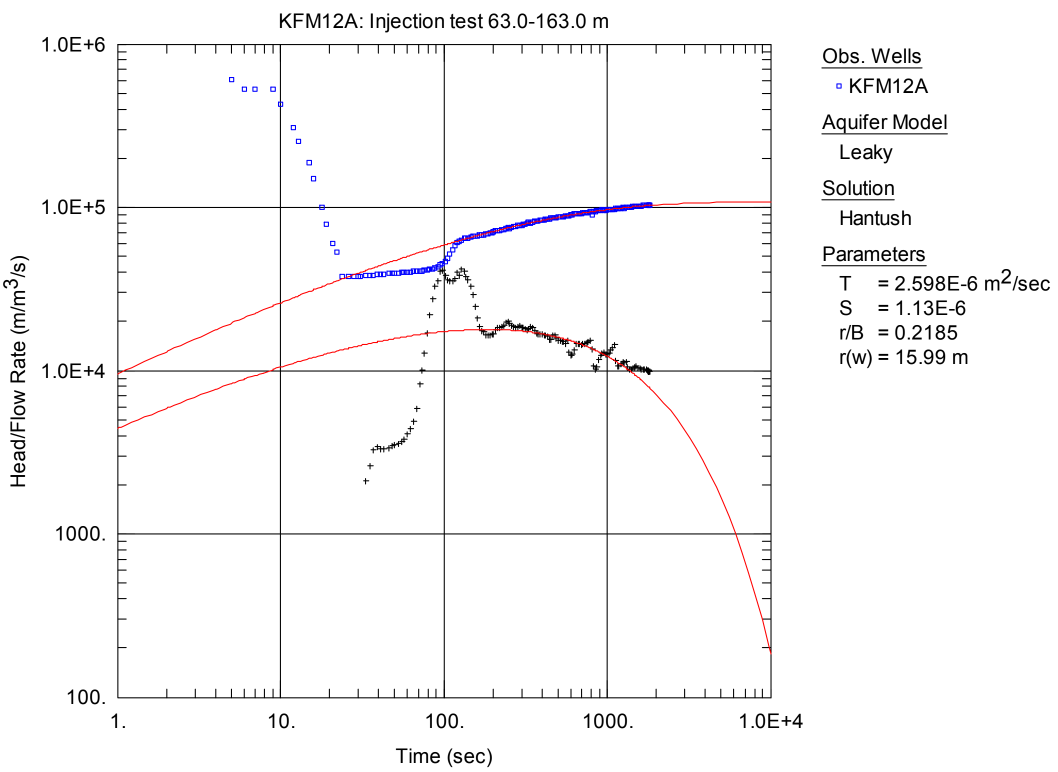


Figure A3-2. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 63.0-163.0 m in KFM12A.*

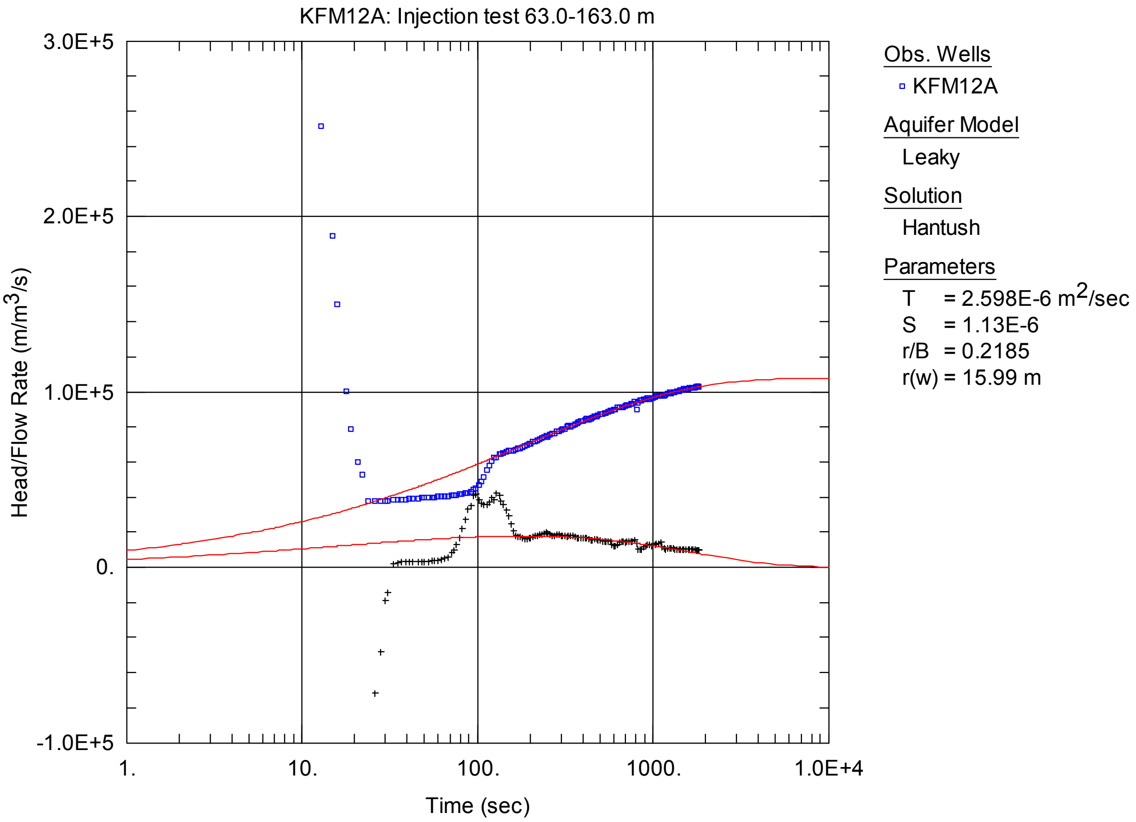


Figure A3-3. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 63.0-163.0 m in KFM12A.*

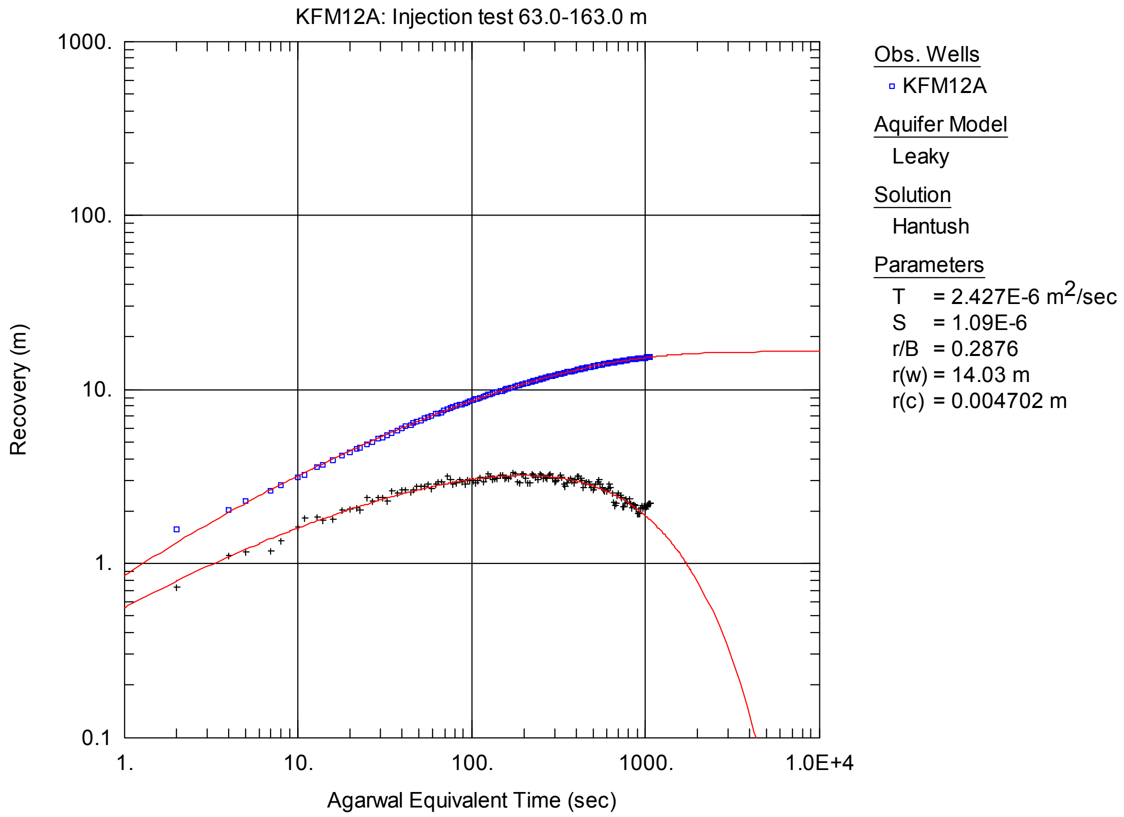


Figure A3-4. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 63.0-163.0 m in KFM12A.*

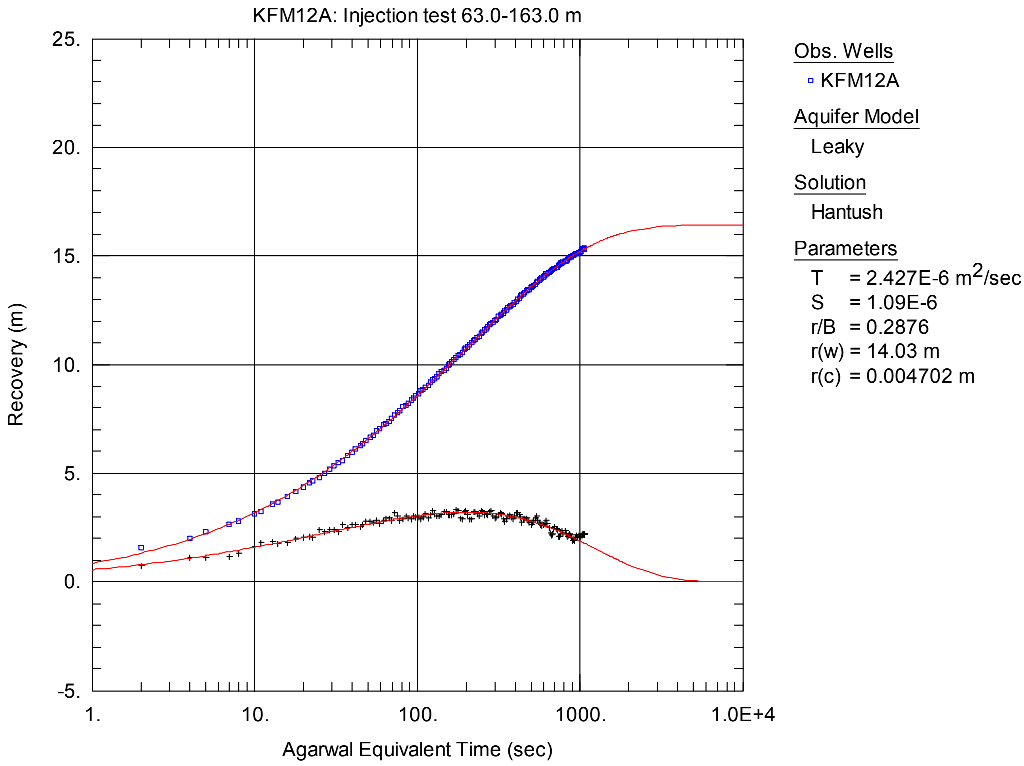


Figure A3-5. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 63.0-163.0 m in KFM12A.*

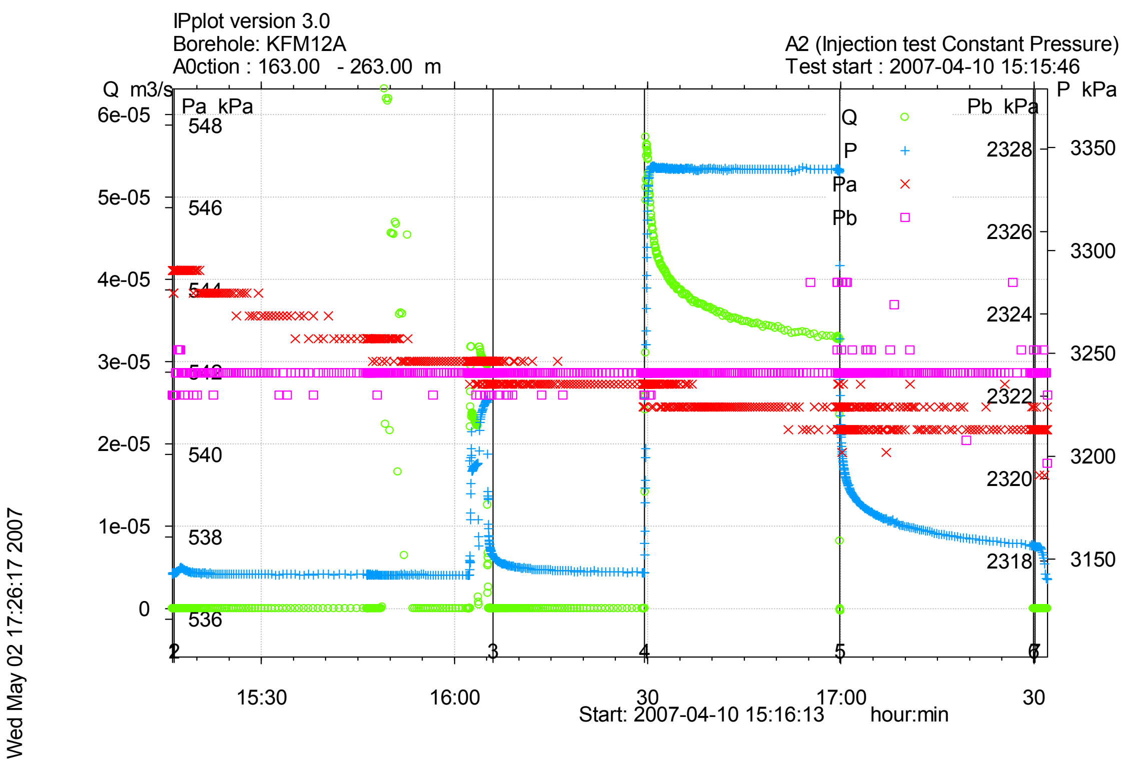


Figure A3-6. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 163.0-263.0 m in borehole KFM12A.*

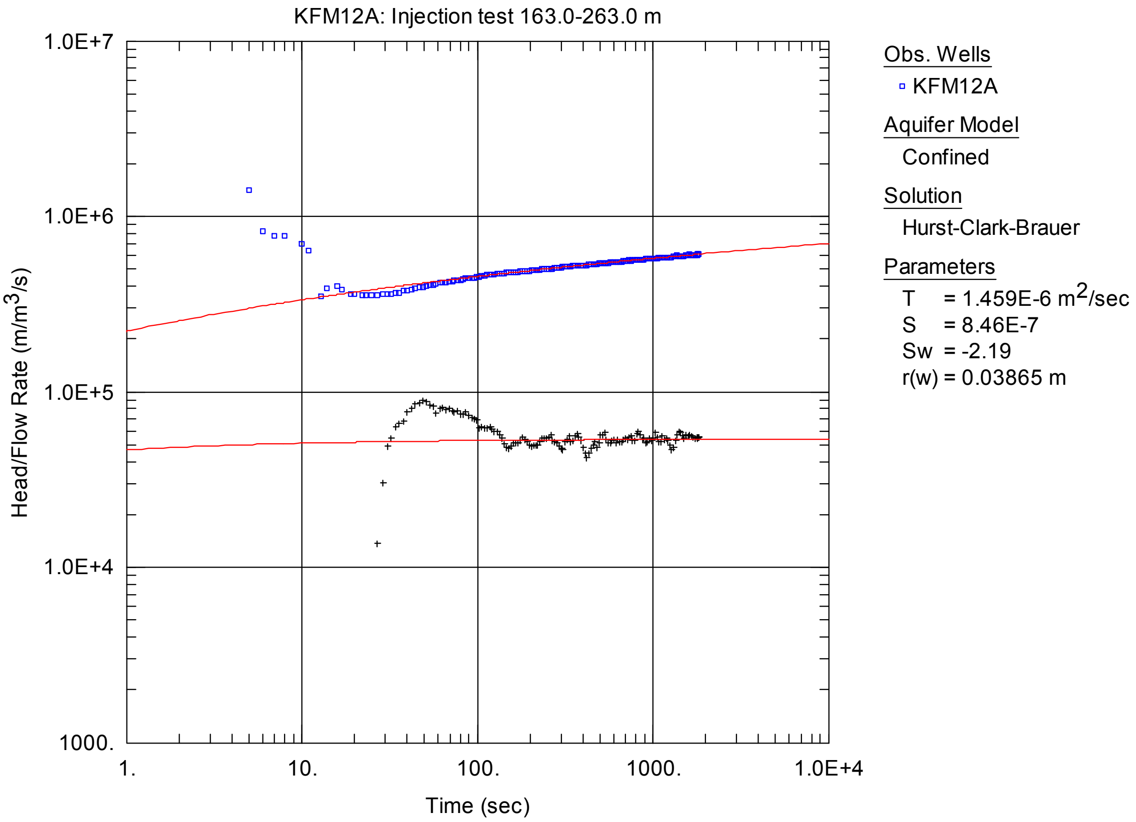


Figure A3-7. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 163.0-263.0 m in borehole KFM12A.*

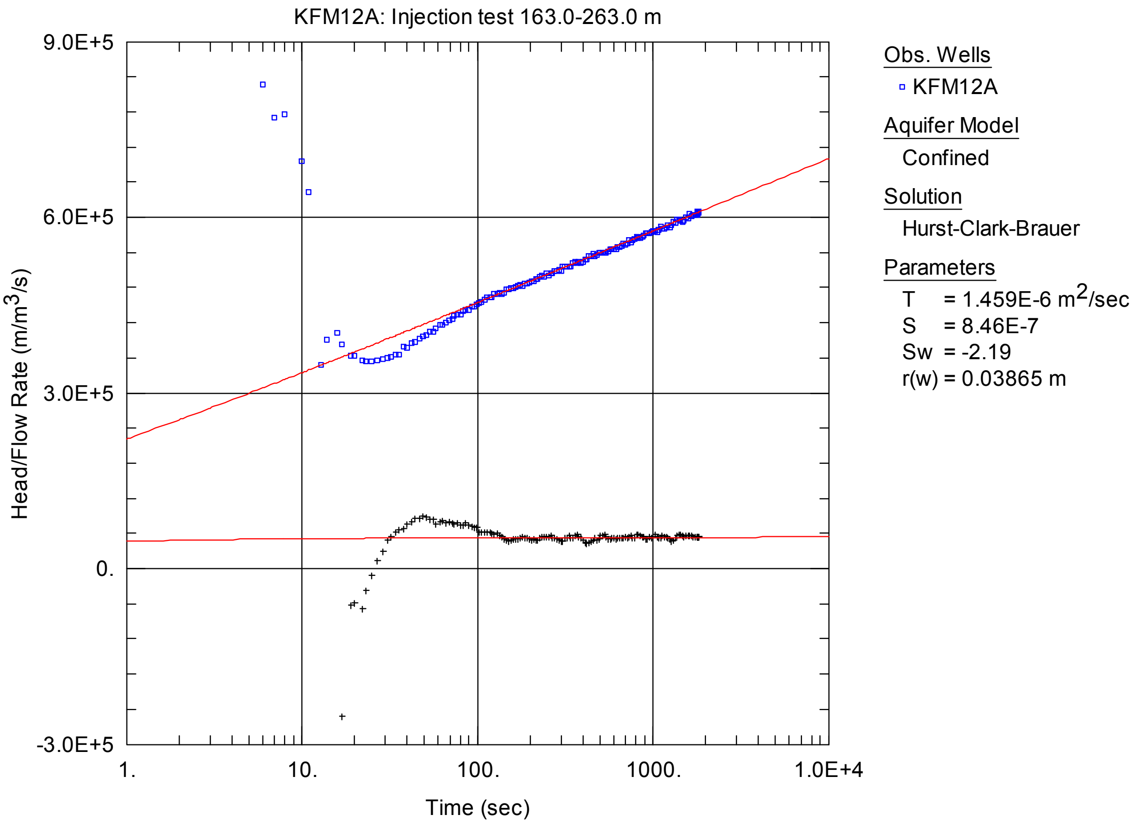


Figure A3-8. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 163.0-263.0 m in KFM12A.*

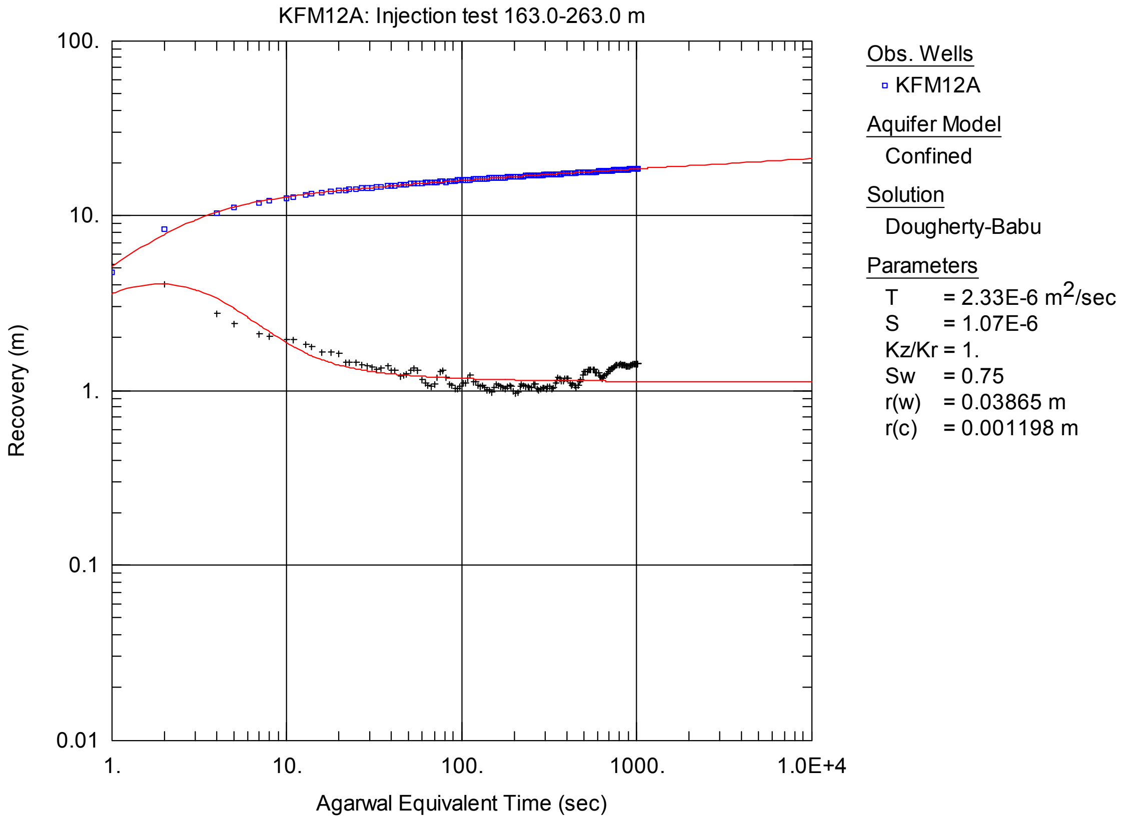


Figure A3-9. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 163.0-263.0 m in KFM12A.*

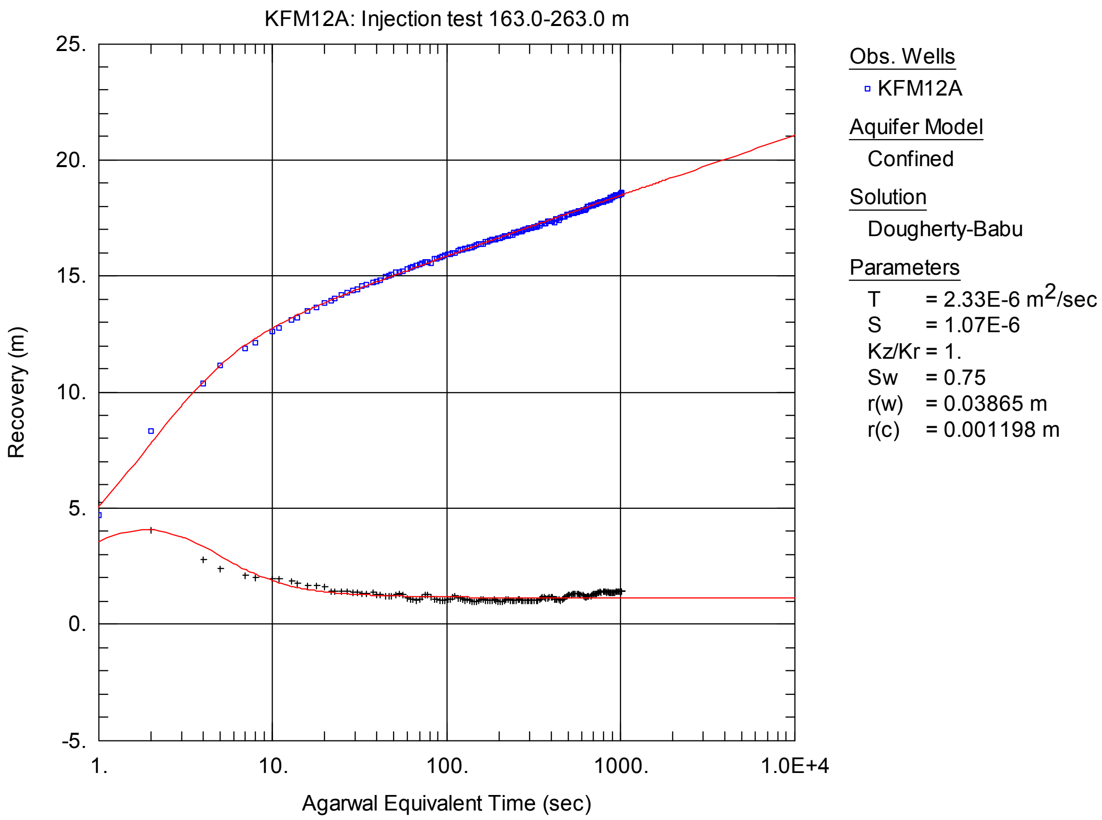


Figure A3-10. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 163.0-263.0 m in KFM12A.*

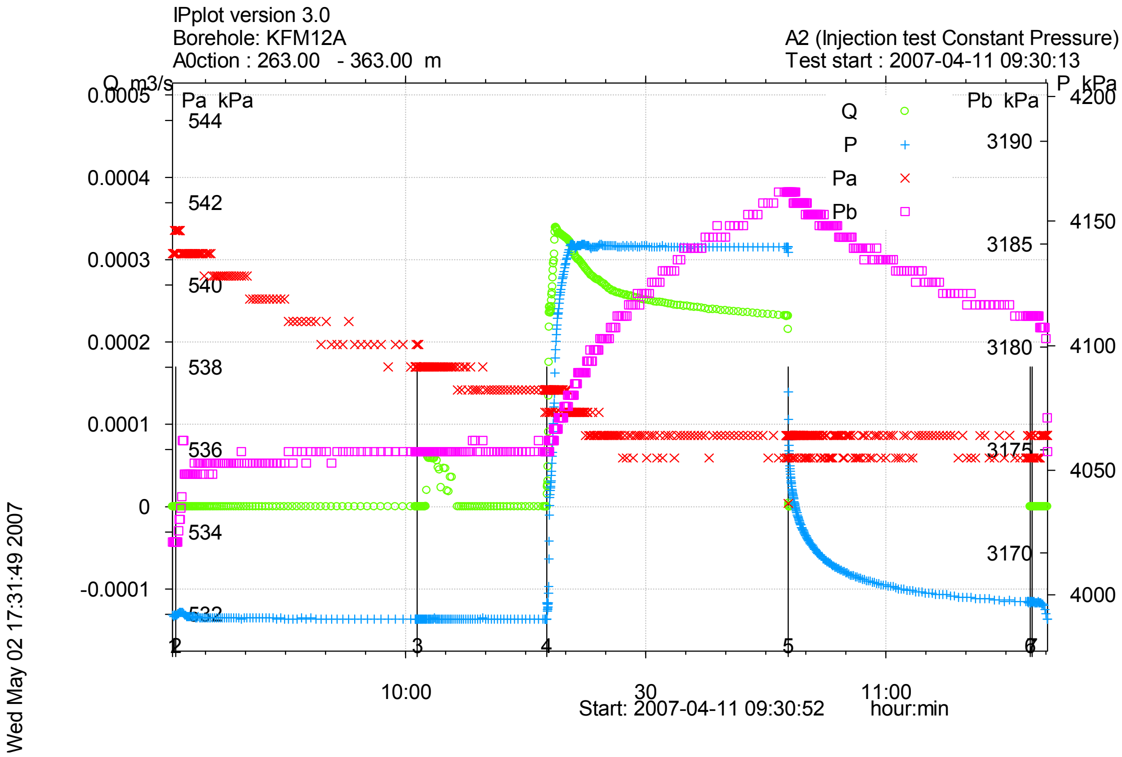


Figure A3-11. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 263.0-363.0 m in borehole KFM12A.*

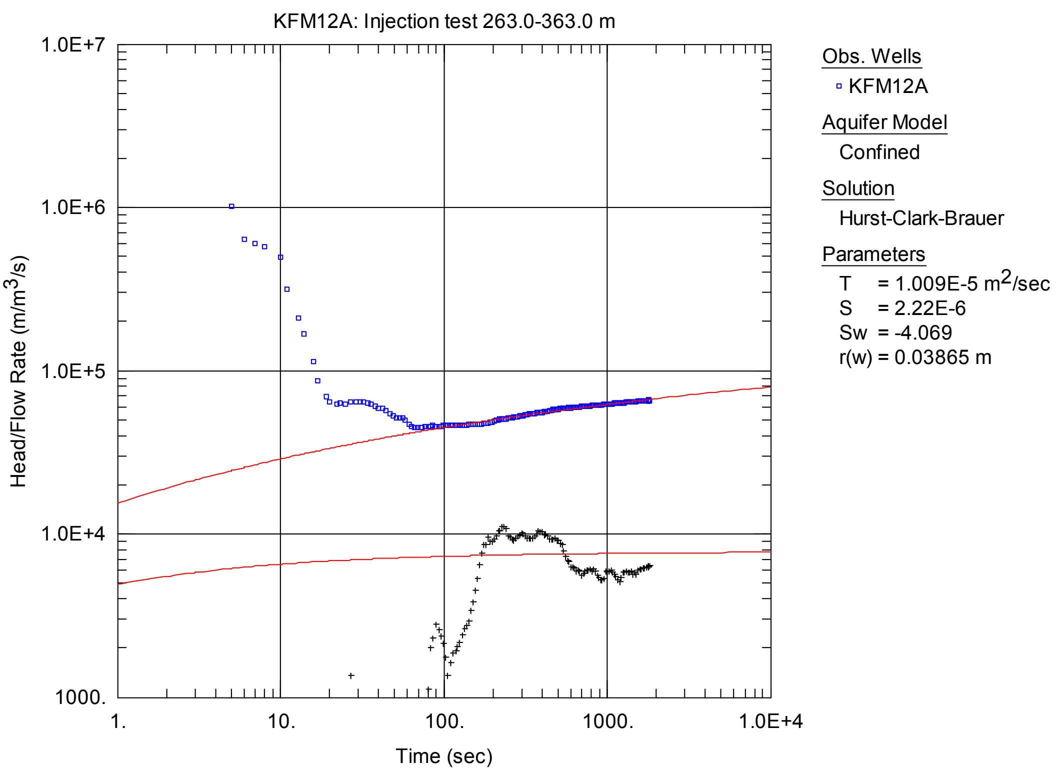


Figure A3-12. Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section *263.0-363.0* m in KFM12A.

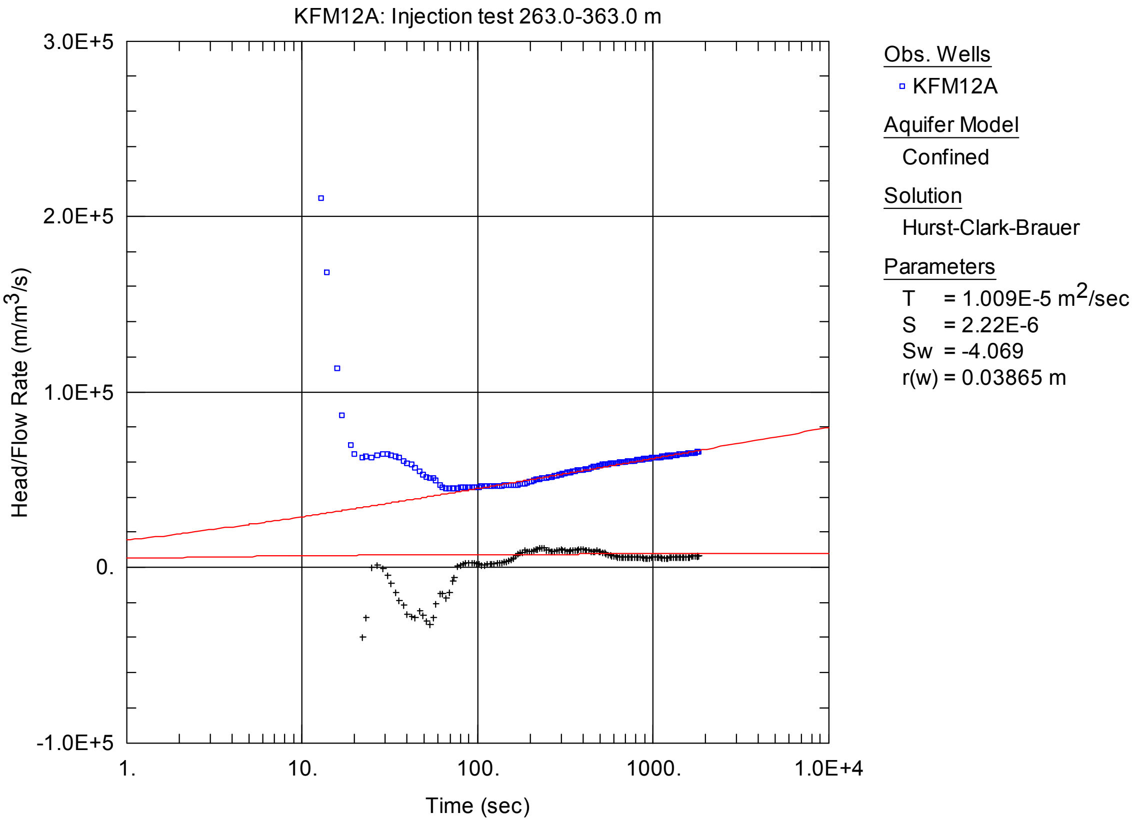


Figure A3-13. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 263.0-363.0 m in KFM12A.*

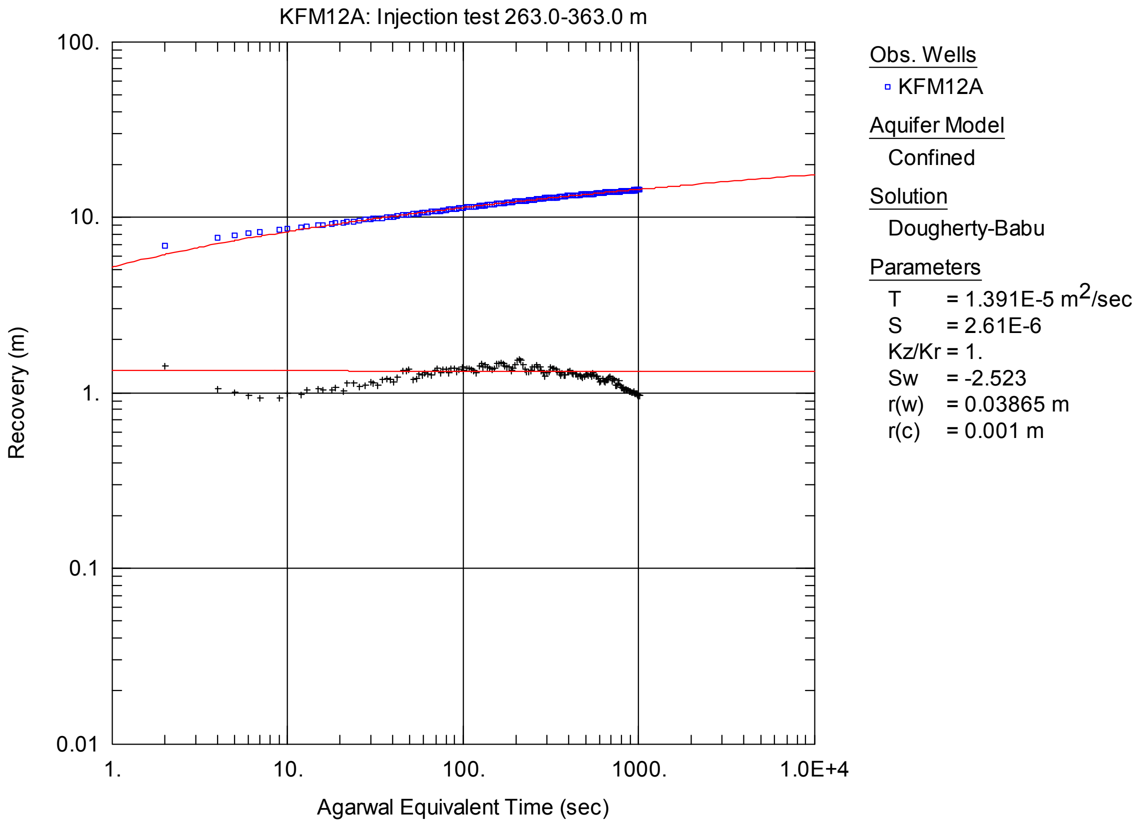


Figure A3-14. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 263.0-363.0 m in KFM12A.*

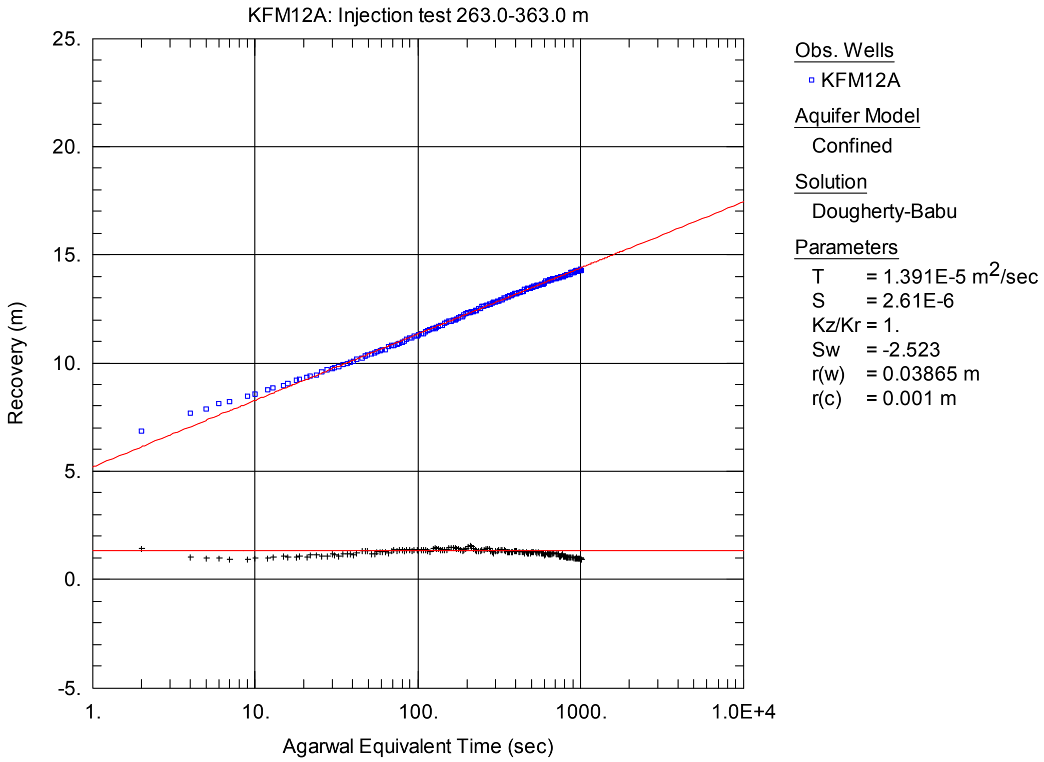


Figure A3-15. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 263.0-363.0 m in KFM12A.*

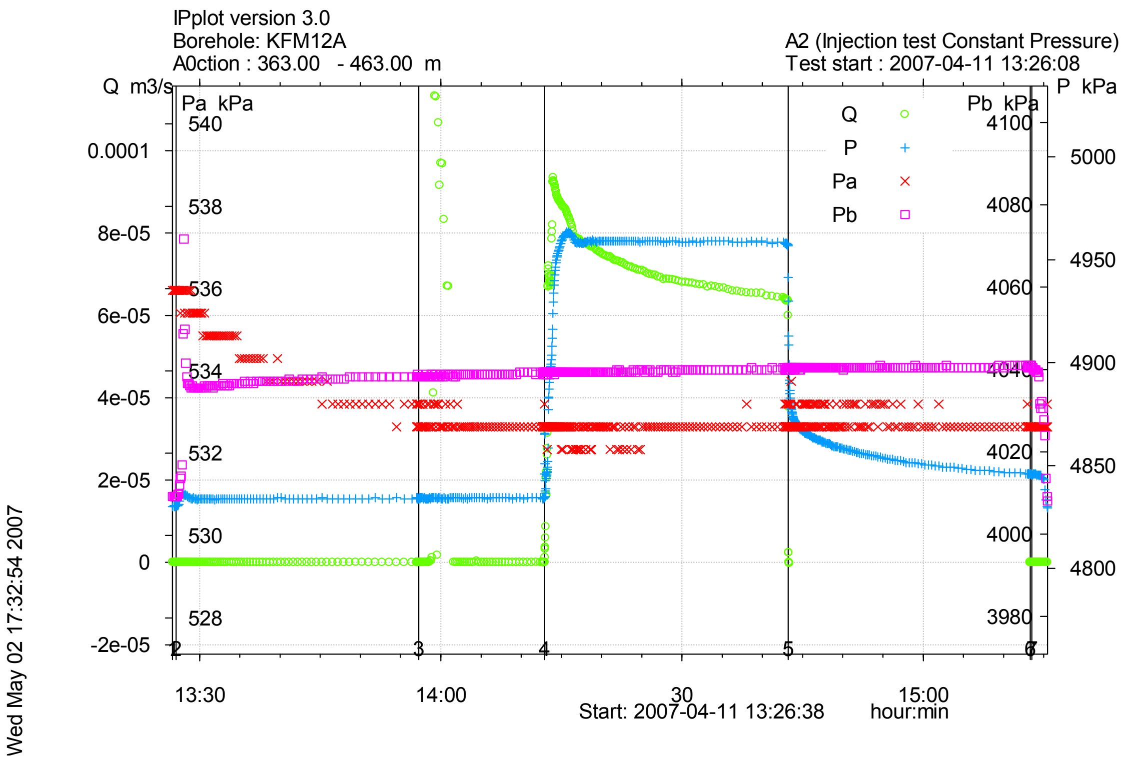


Figure A3-16. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 363.0-463.0 m in borehole KFM12A.*

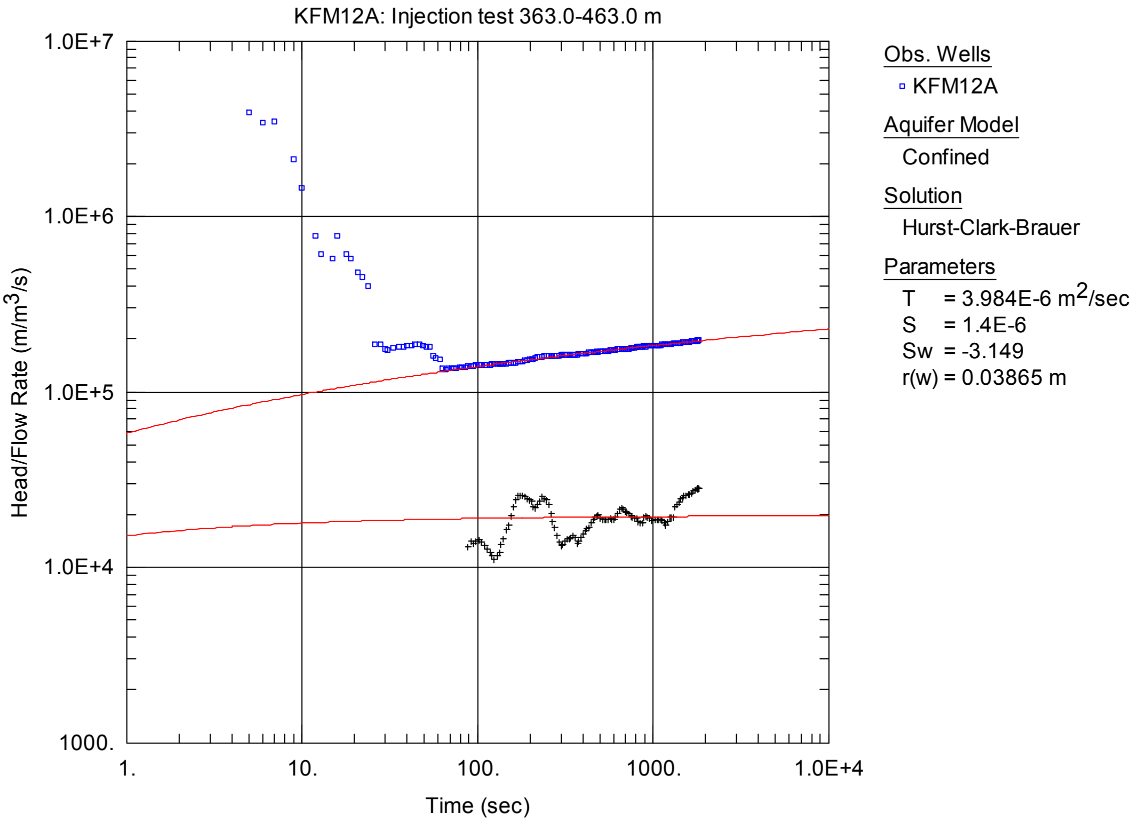


Figure A3-17. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 363.0-463.0 m in borehole KFM12A.*

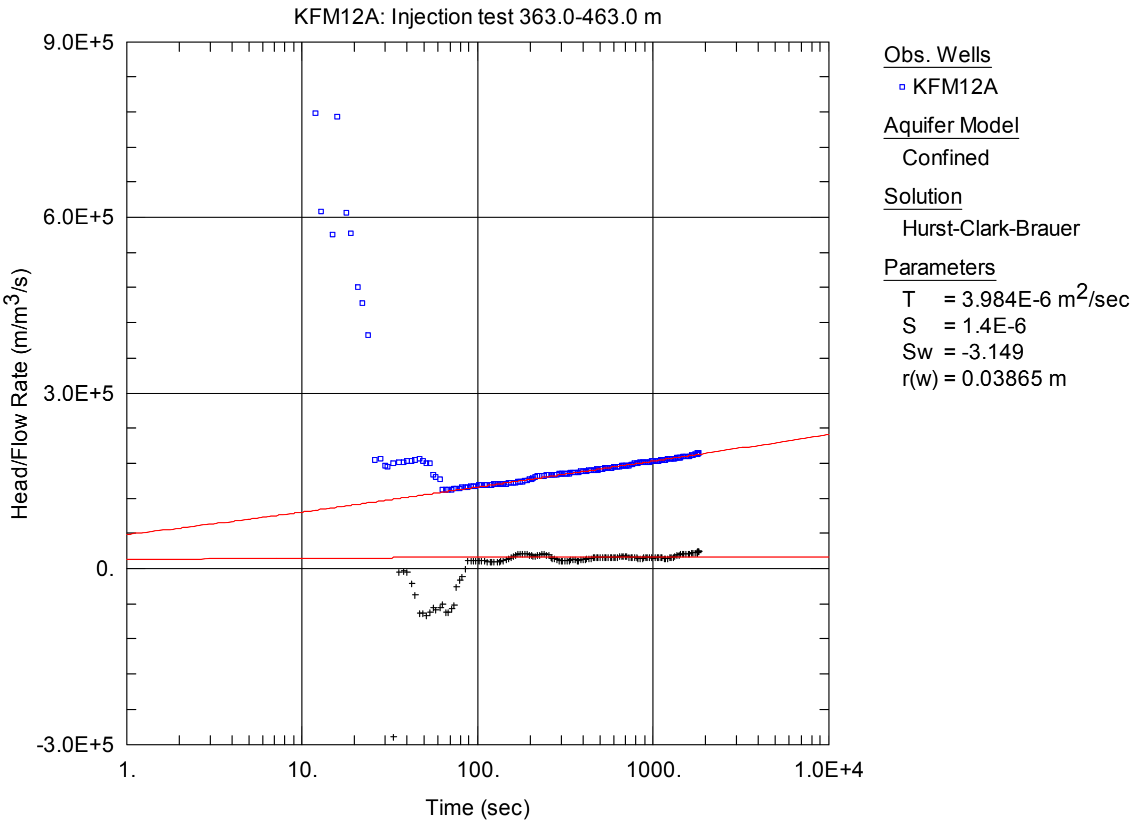


Figure A3-18. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 363.0-463.0 m in KFM12A.*

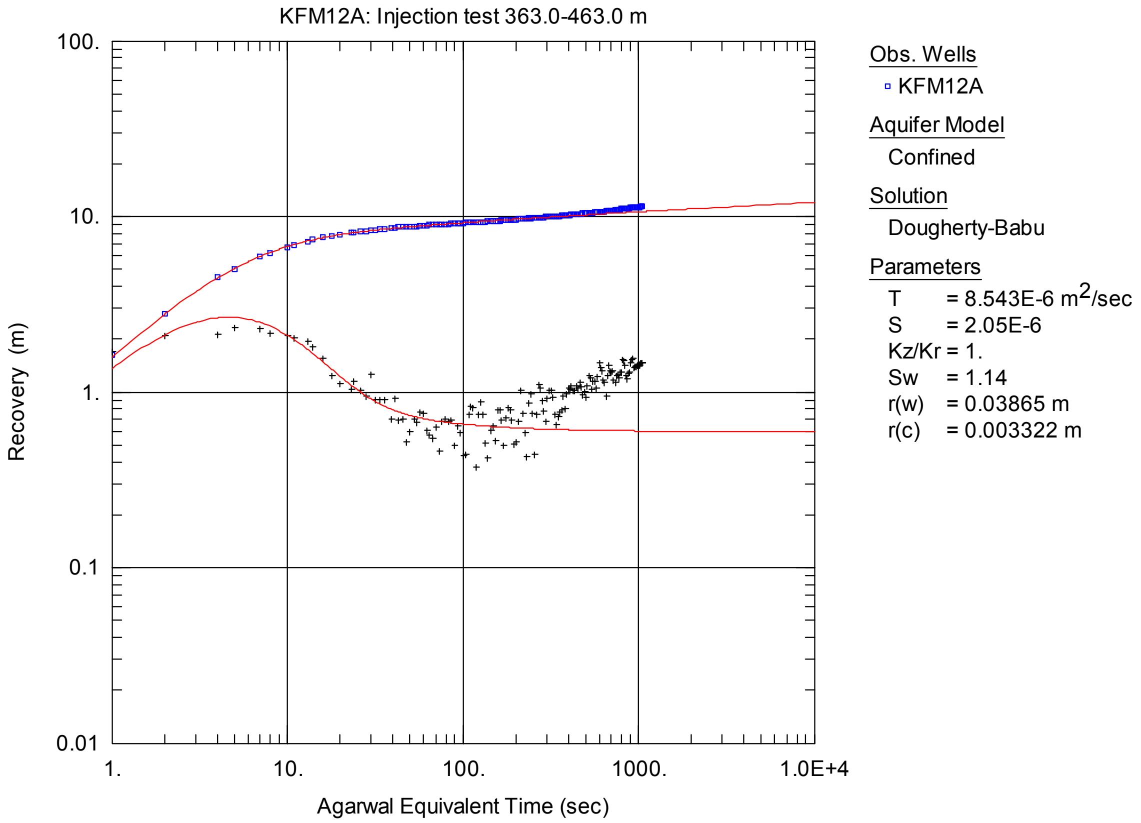


Figure A3-19. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 363.0-463.0 m in KFM12A.*

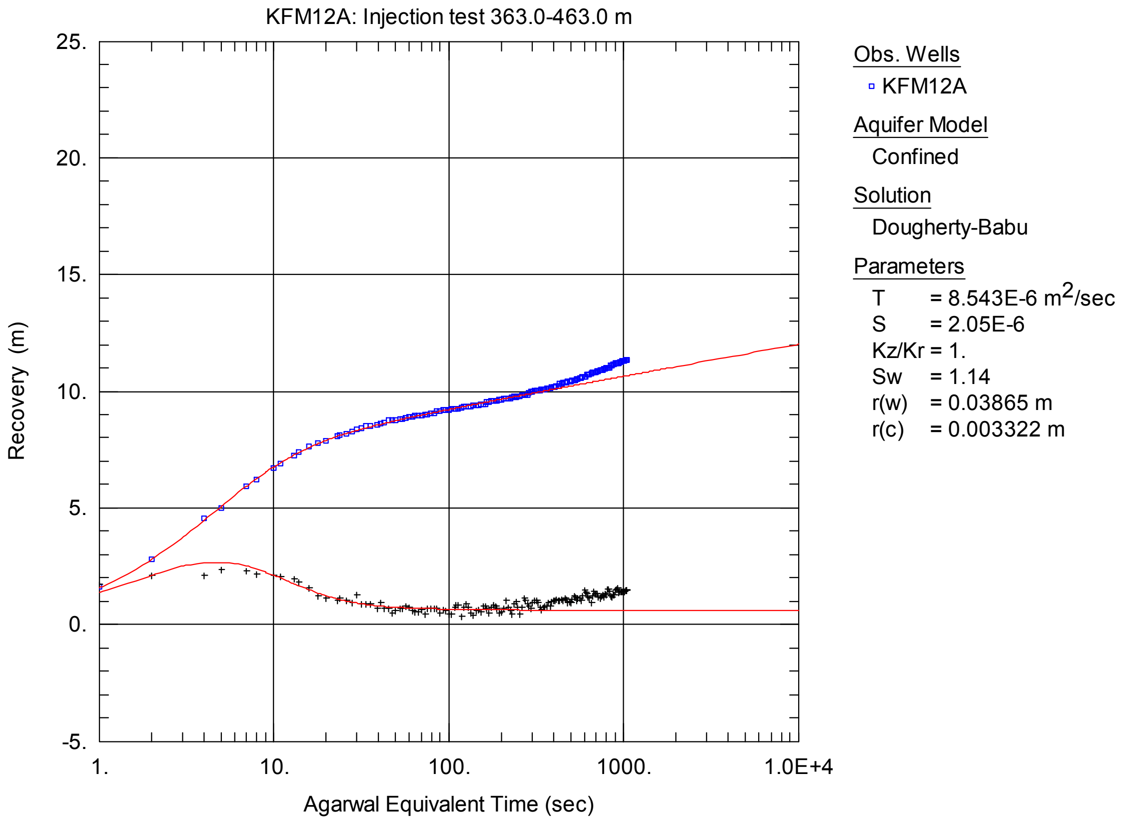


Figure A3-20. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 363.0-463.0 m in KFM12A.*

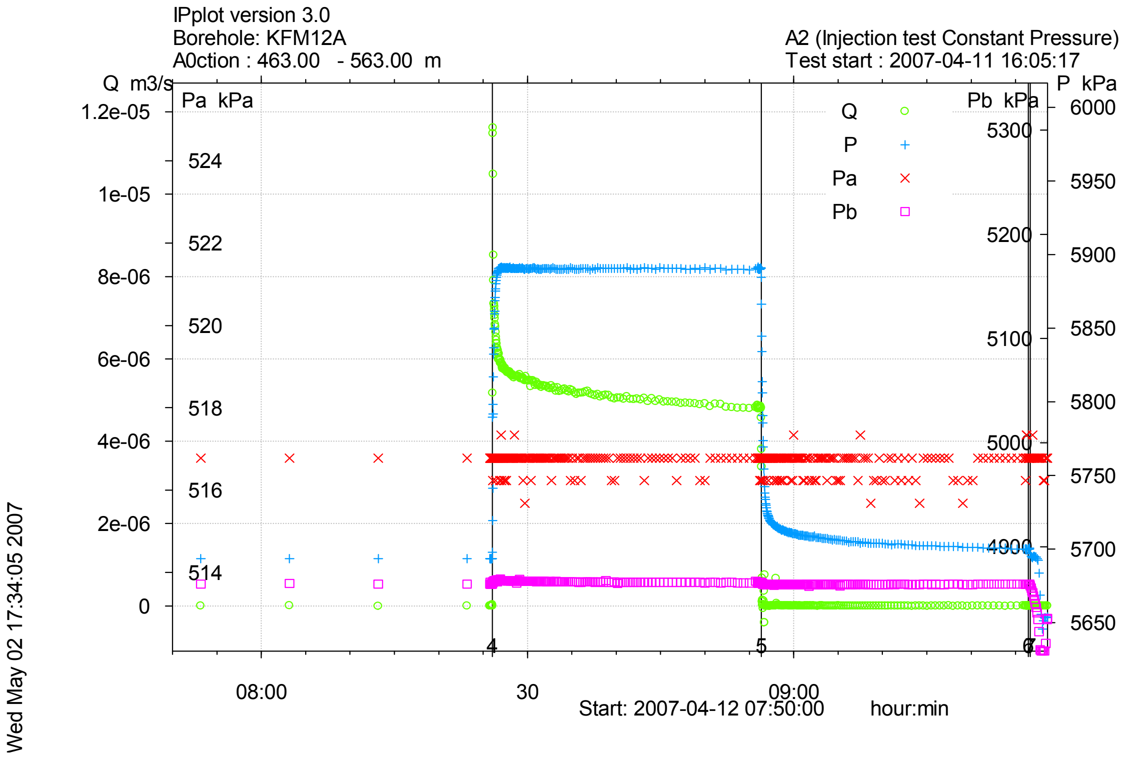


Figure A3-21. Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 463.0-563.0 m in borehole KFM12A.

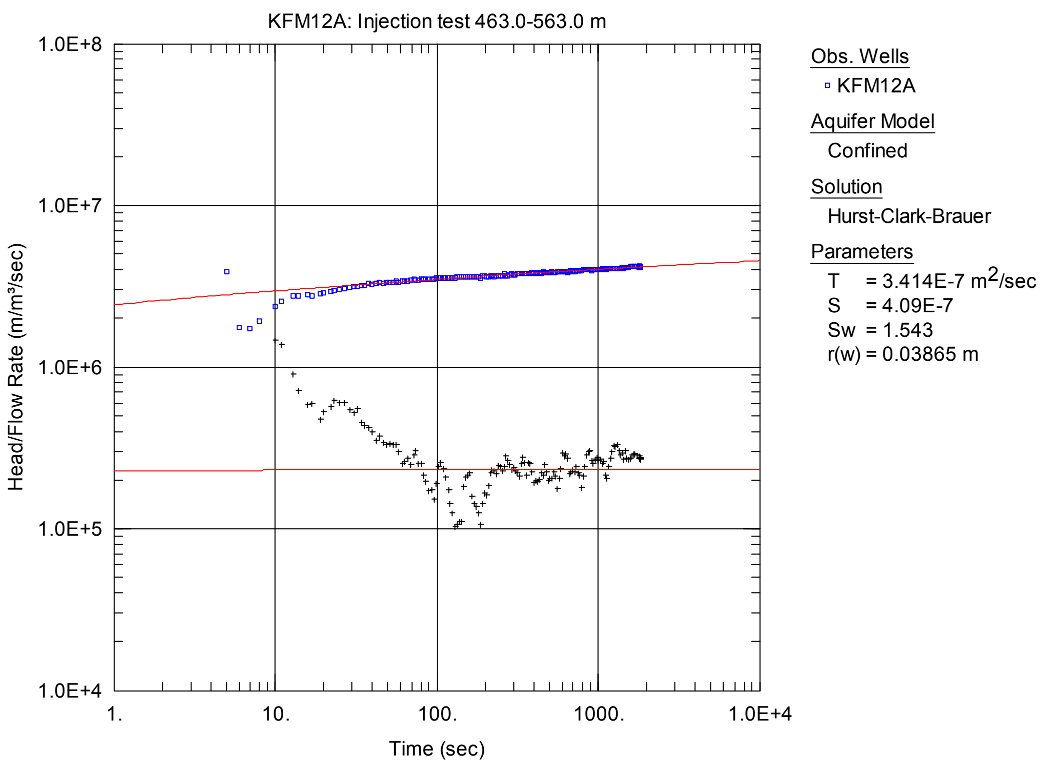


Figure A3-22. Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 463.0-563.0 m in KFM12A.

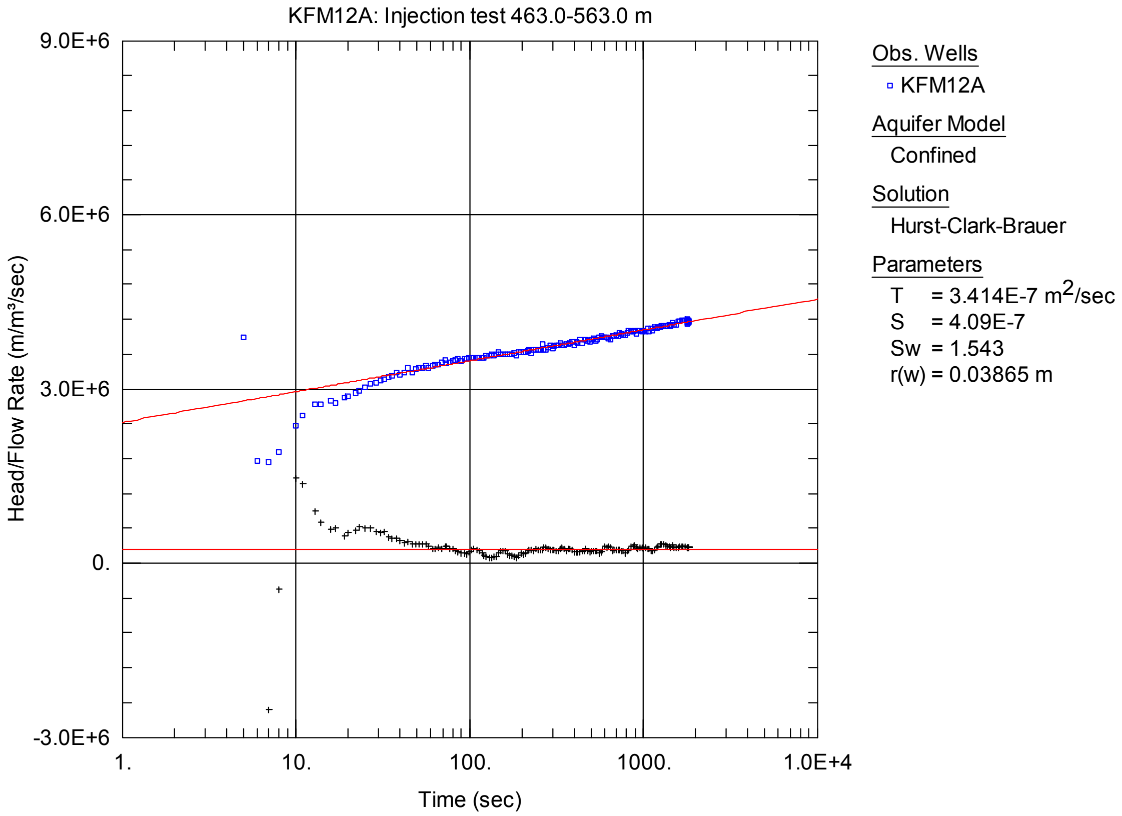


Figure A3-23. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 463.0-563.0 m in KFM12A.*

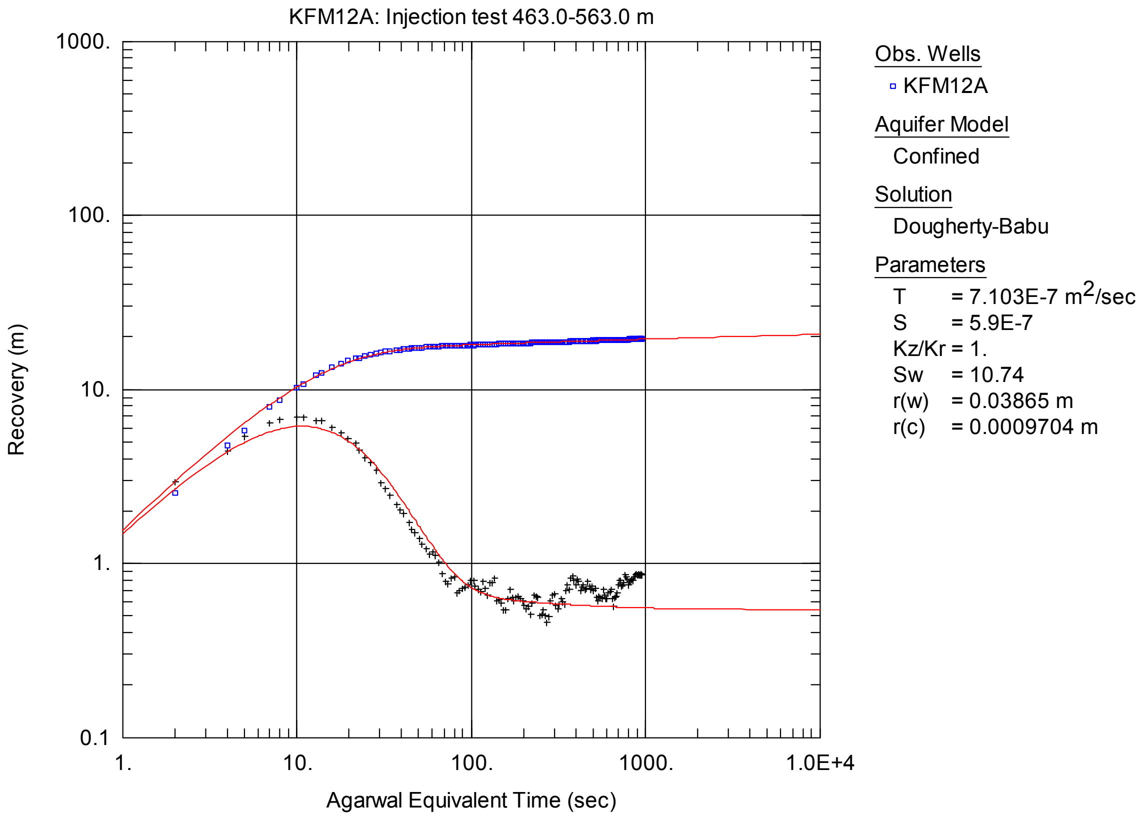


Figure A3-24. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 463.0-563.0 m in KFM12A.*

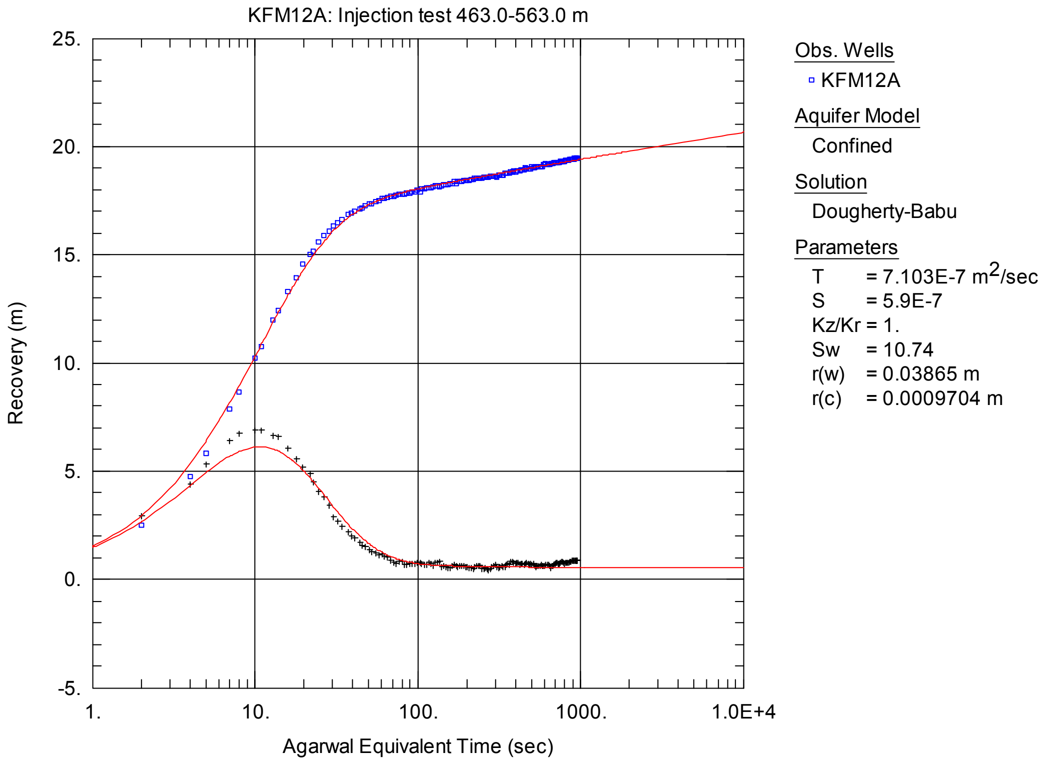


Figure A3-25. Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 463.0-563.0 m in KFM12A.

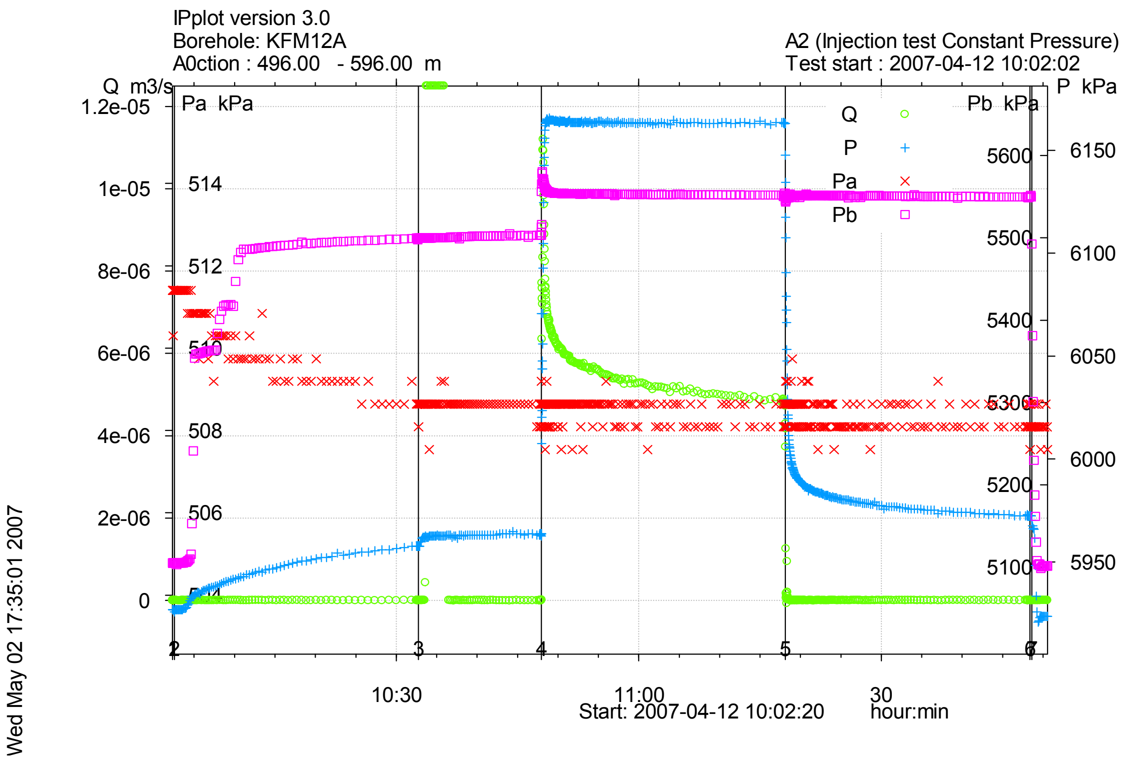


Figure A3-26. Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 496.0-596.0 m in borehole KFM12A.

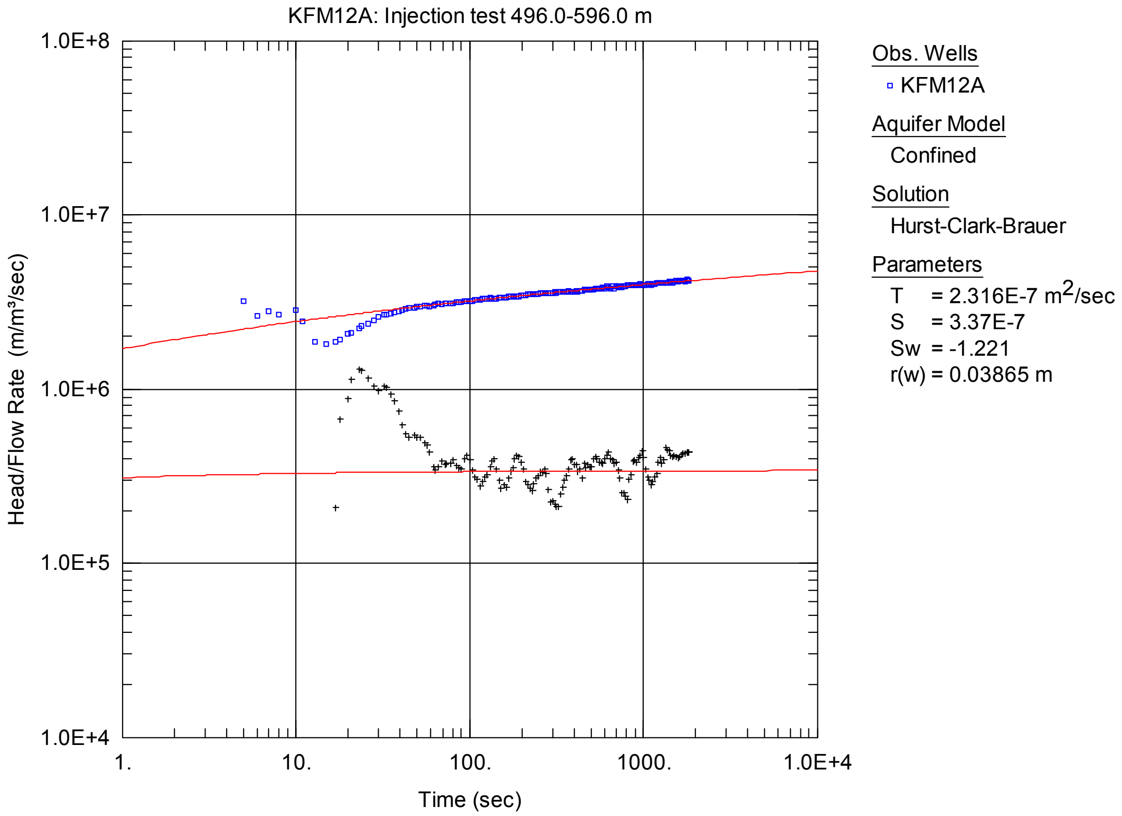


Figure A3-27. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 496.0-596.0 m in borehole KFM12A.*

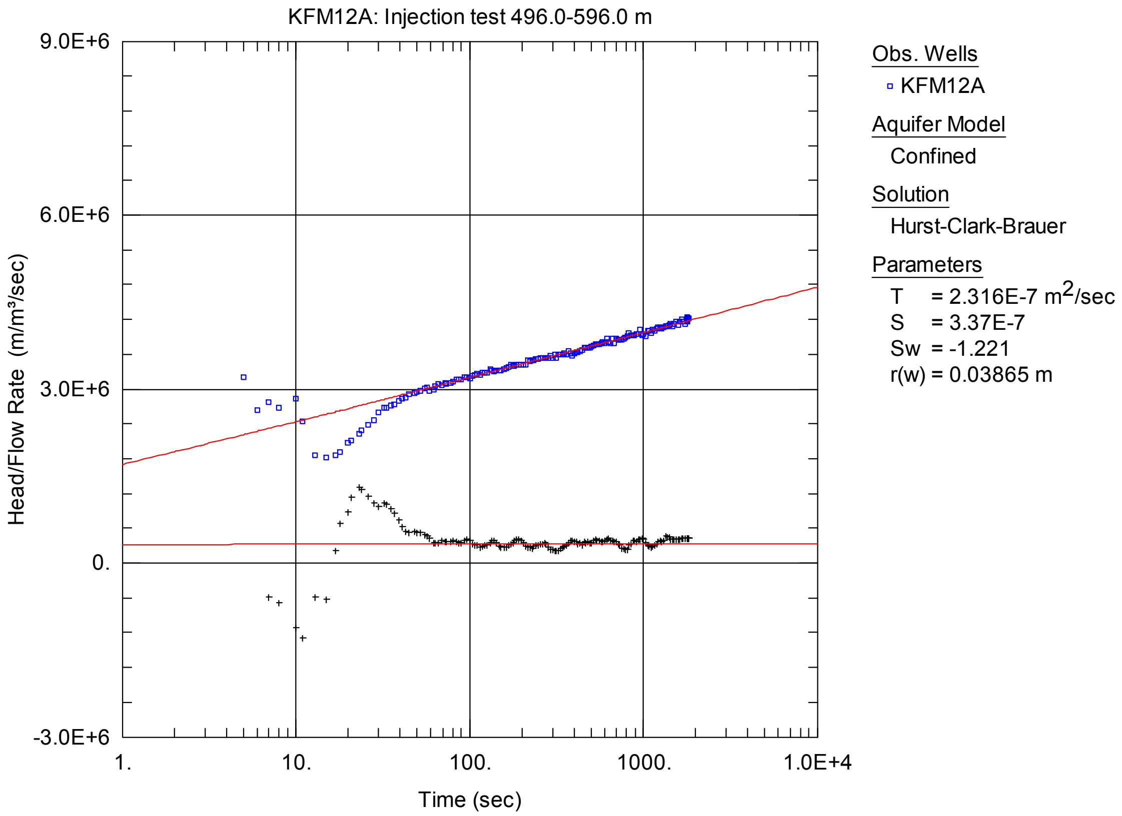


Figure A3-28. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 496.0-596.0 m in KFM12A.*

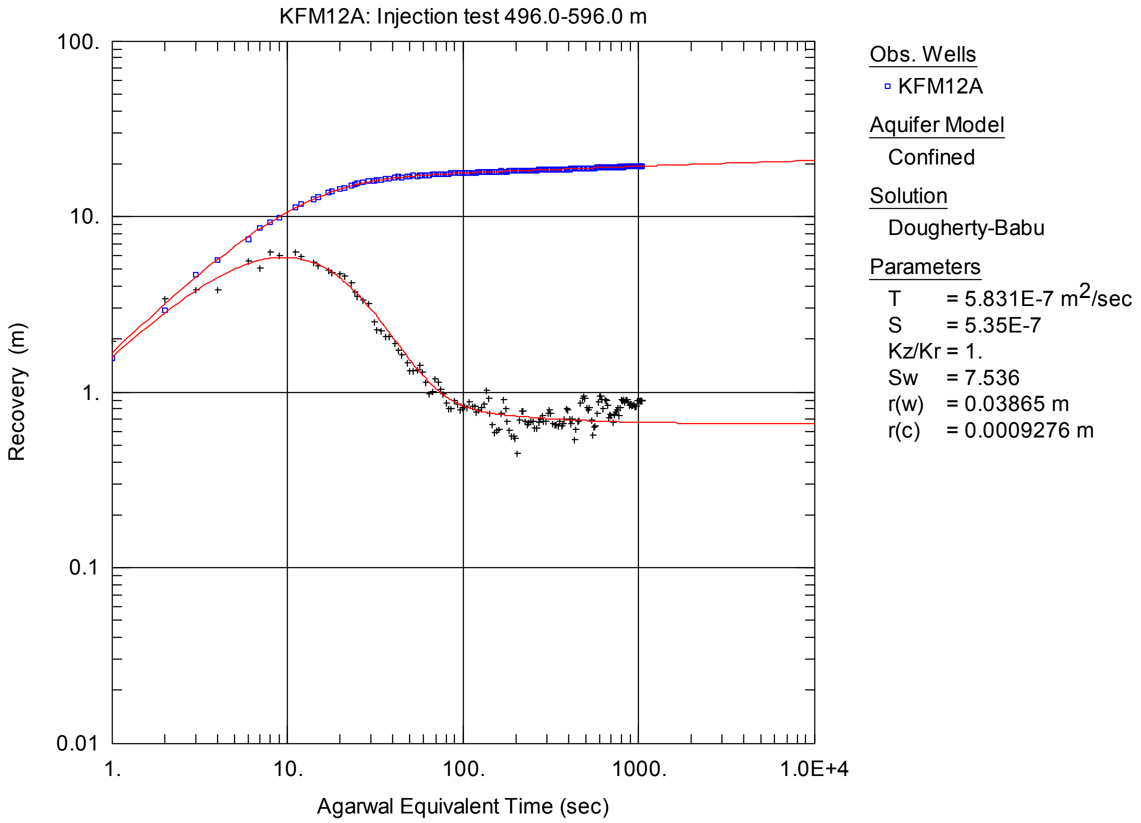


Figure A3-29. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 496.0-596.0 m in KFM12A.*

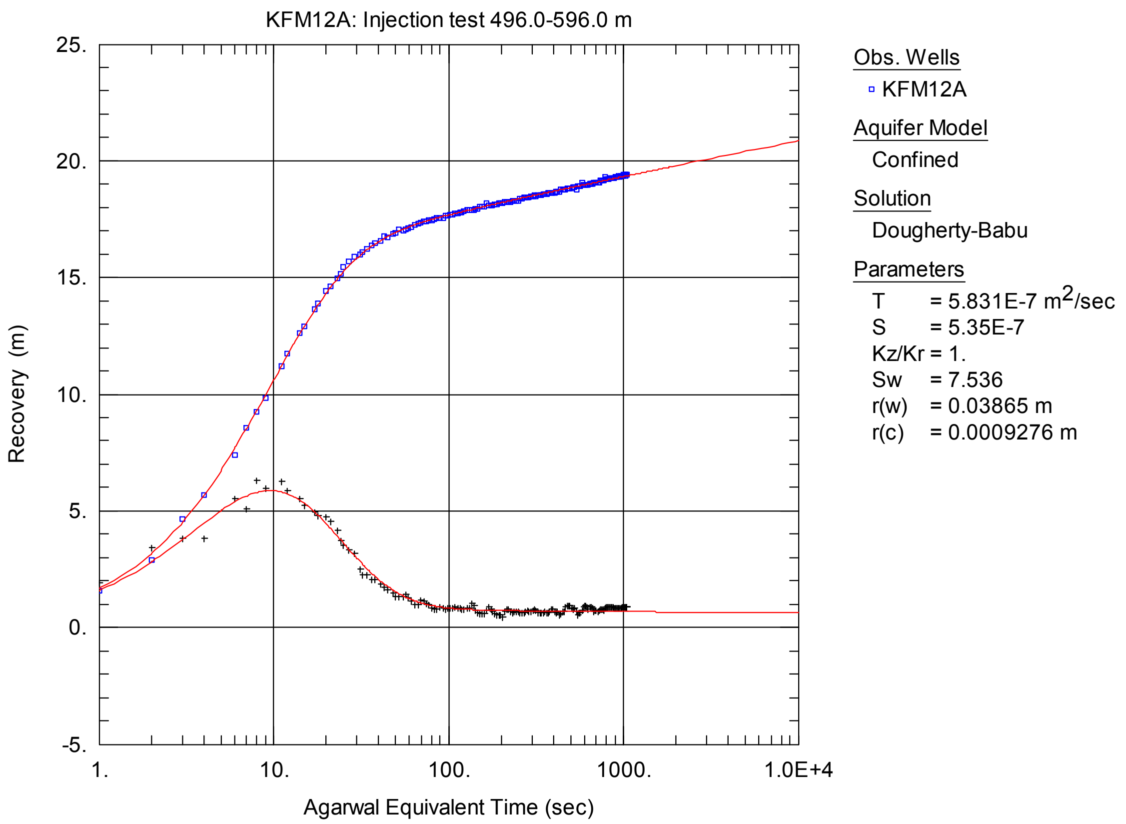


Figure A3-30. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 496.0-596.0 m in KFM12A.*

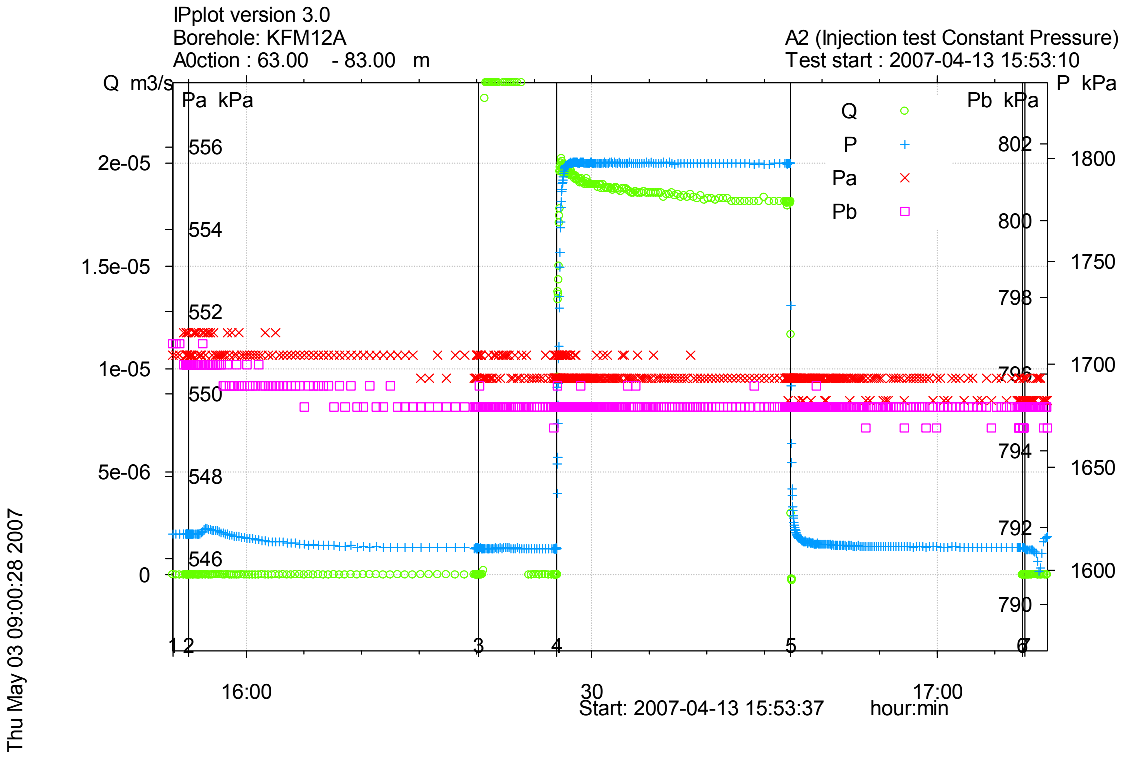


Figure A3-31. Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 63.0-83.0 m in borehole KFM12A.

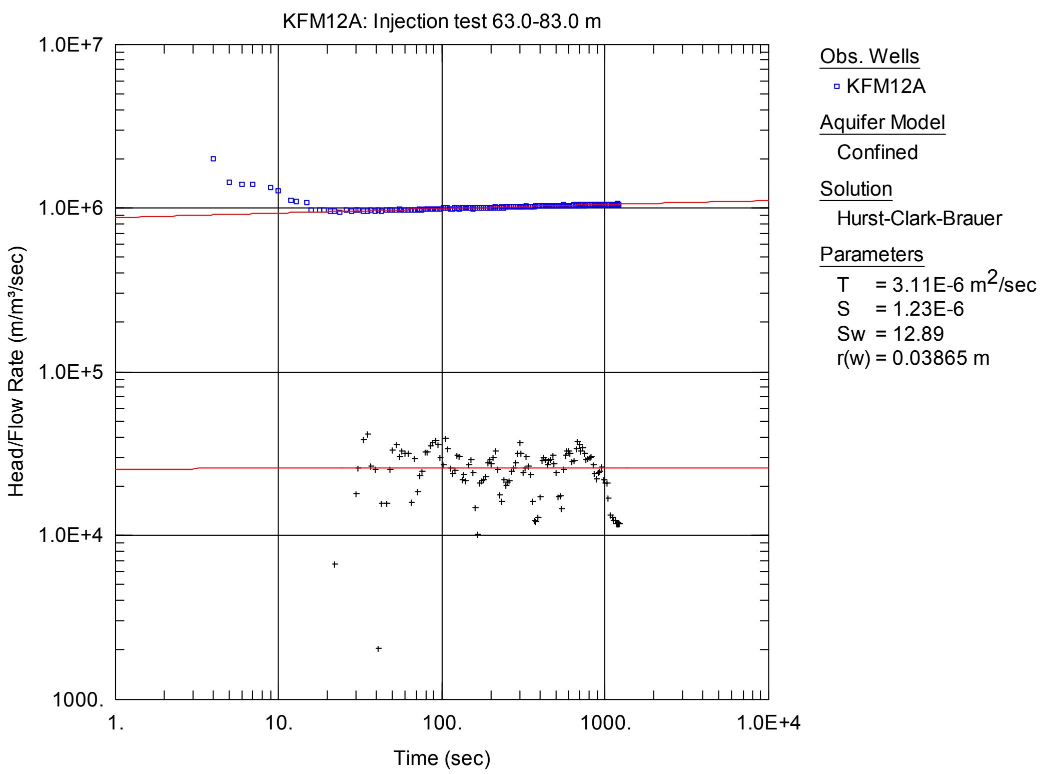


Figure A3-32. Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 63.0-83.0 m in KFM12A.

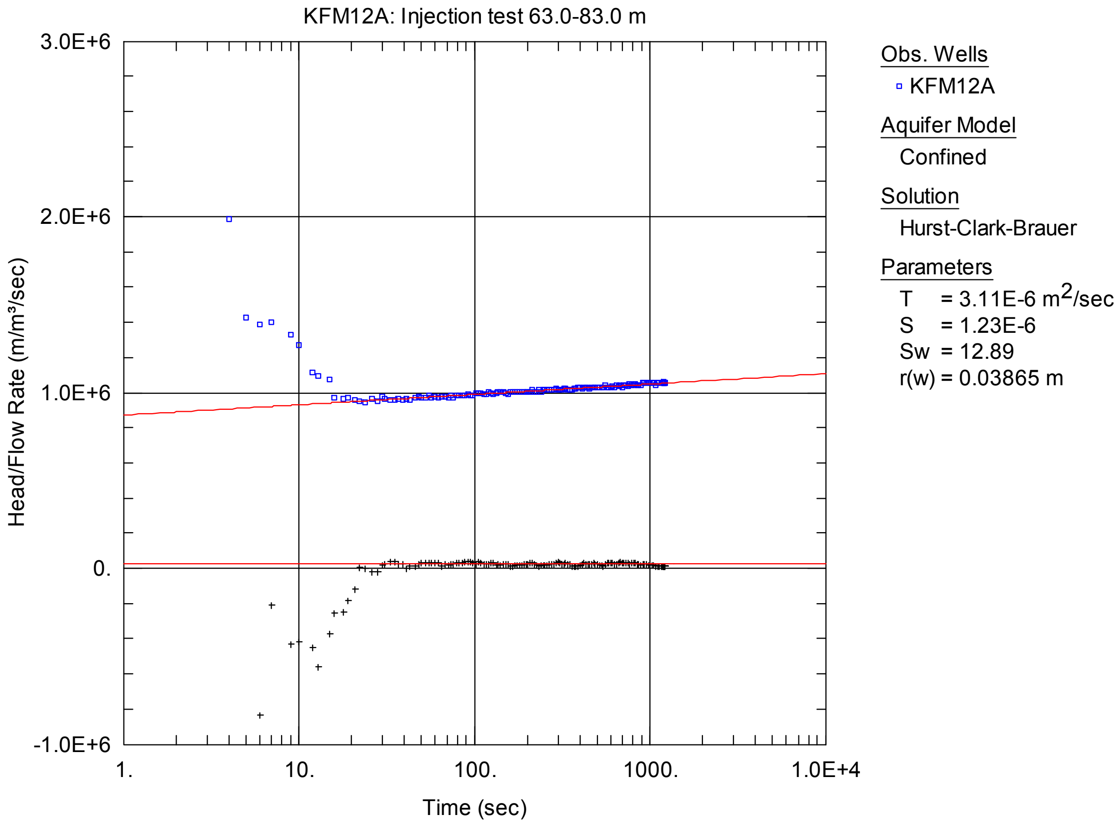


Figure A3-33. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 63.0-83.0 m in KFM12A.*

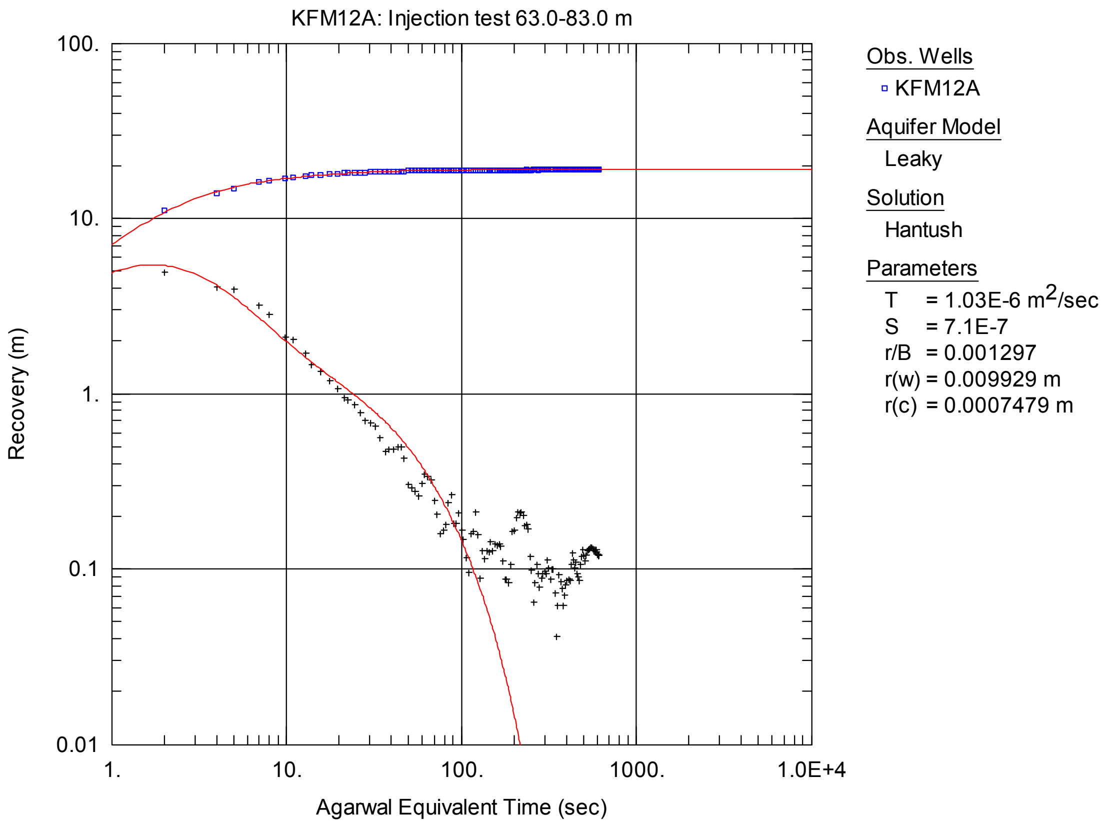


Figure A3-34. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 63.0-83.0 m in KFM12A.*

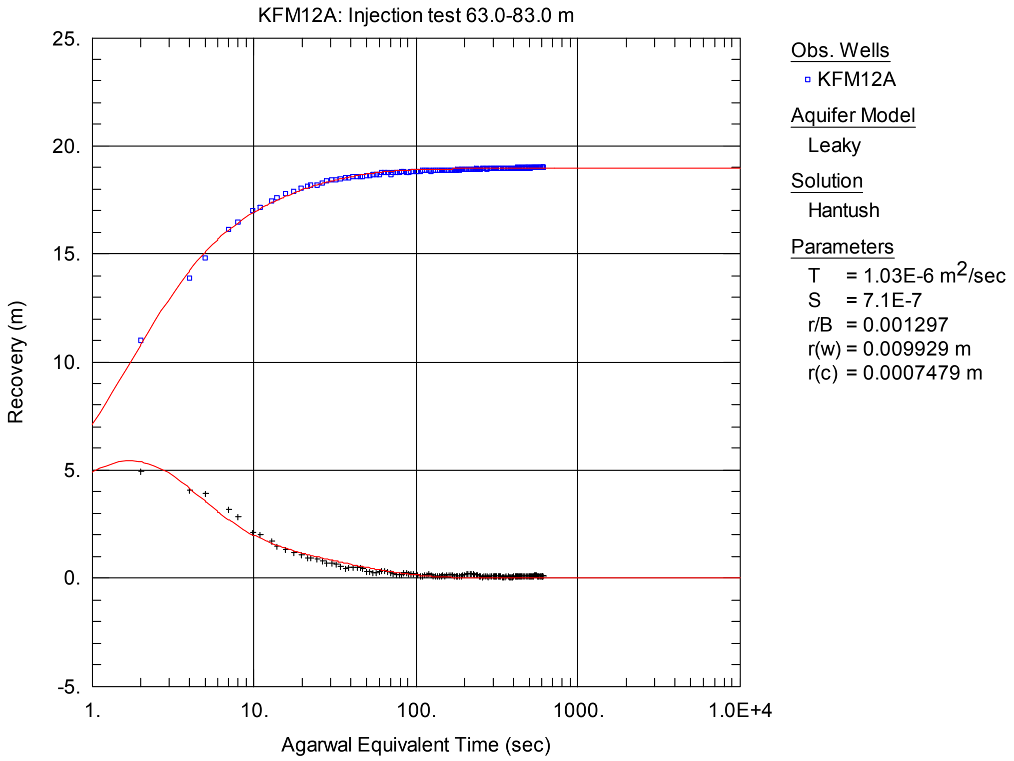


Figure A3-35. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 63.0-83.0 m in KFM12A.*

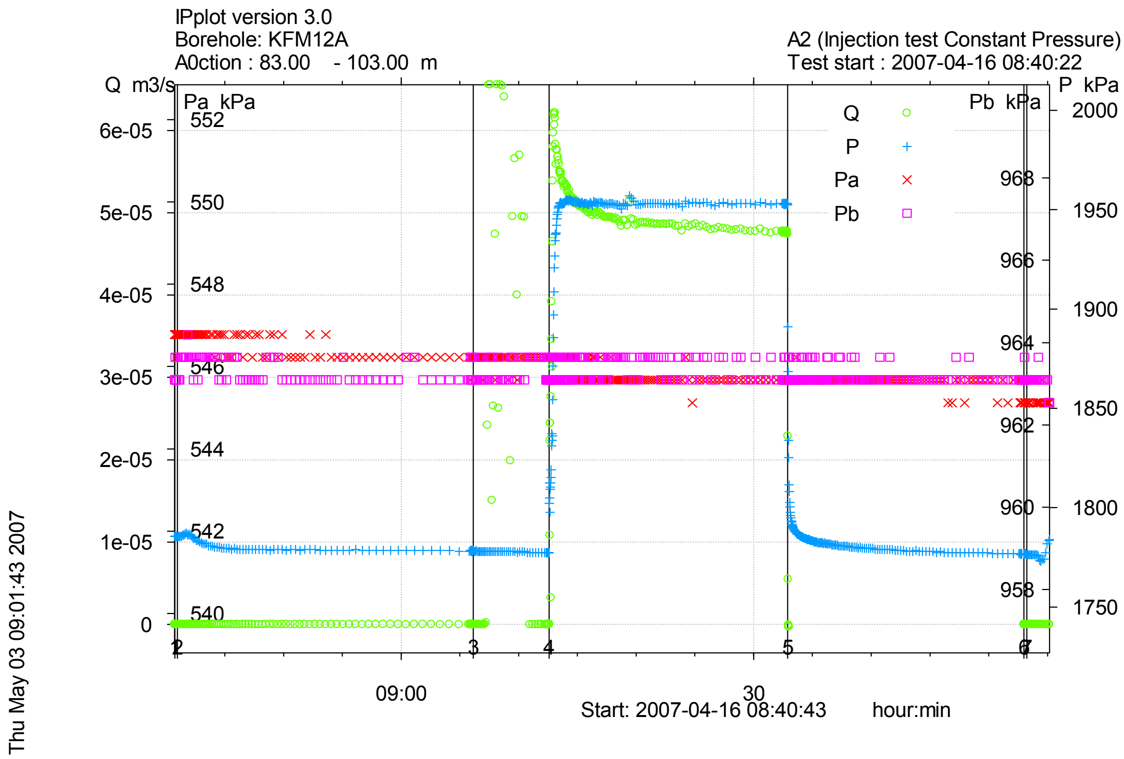


Figure A3-36. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 83.0-103.0 m in borehole KFM12A.*

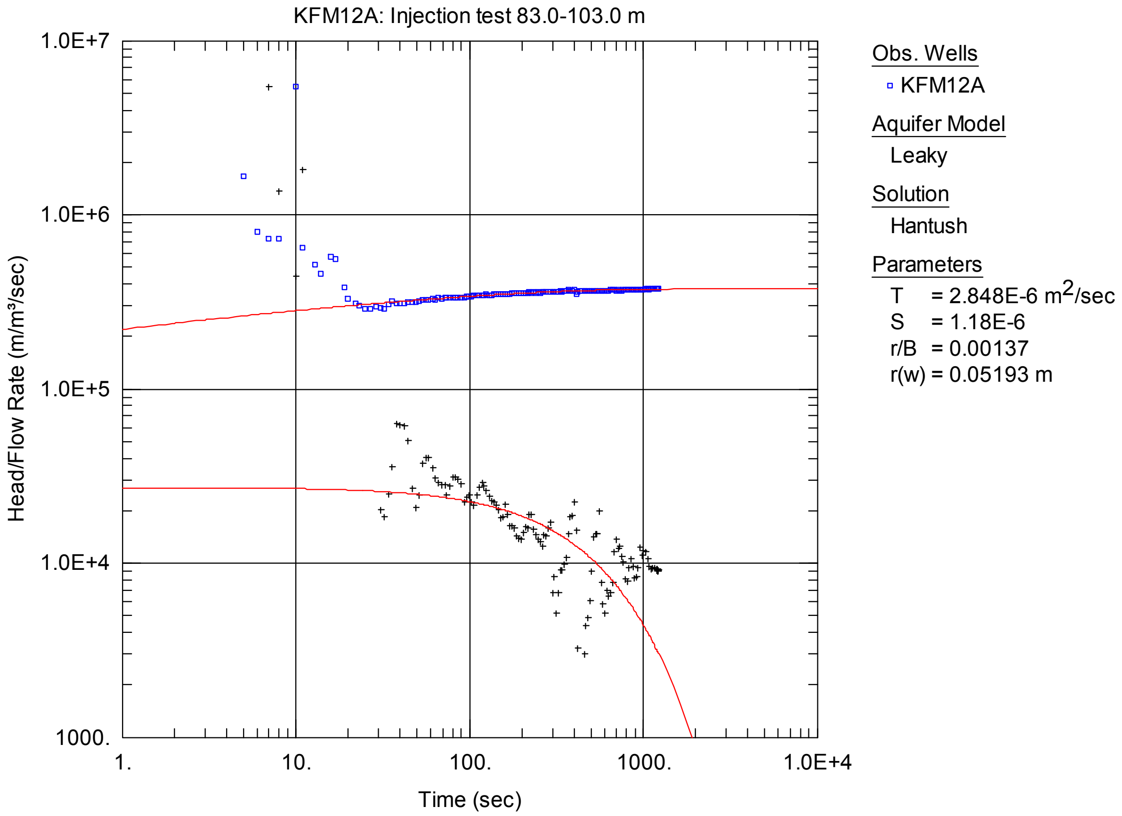


Figure A3-37. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 83.0-103.0 m in borehole KFM12A.*

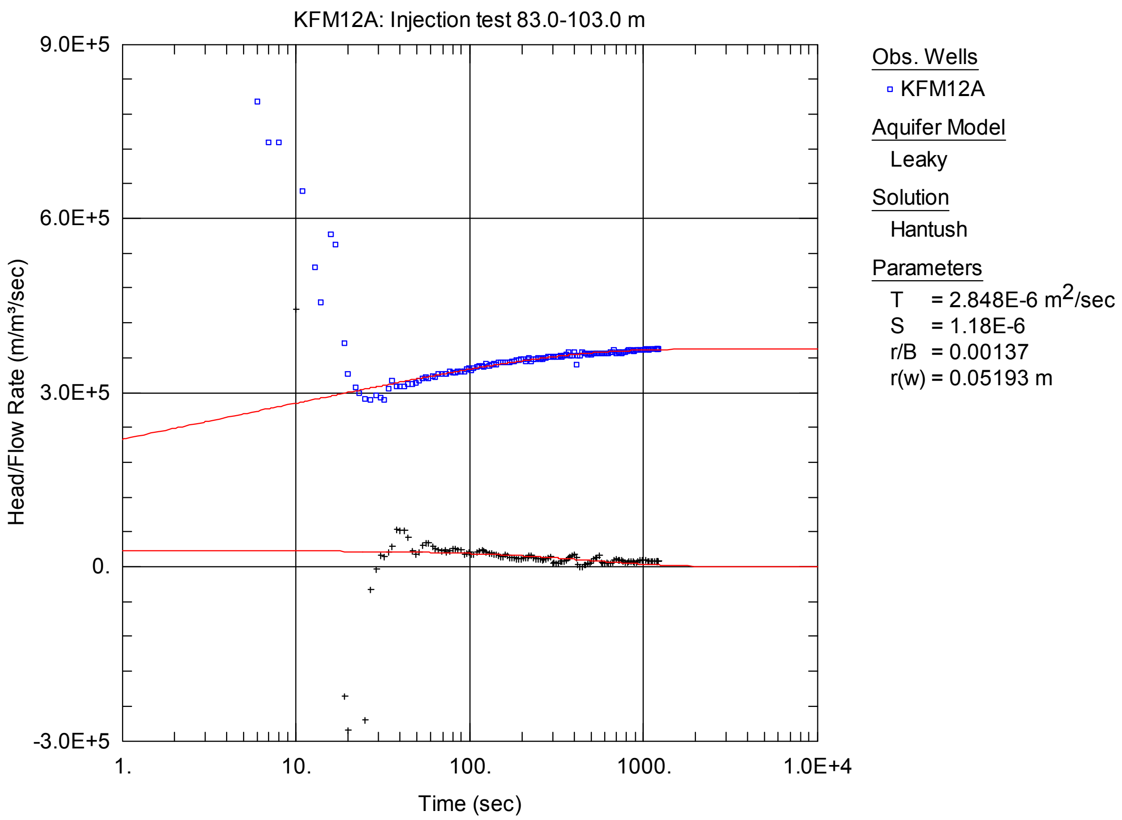


Figure A3-38. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 83.0-103.0 m in KFM12A.*

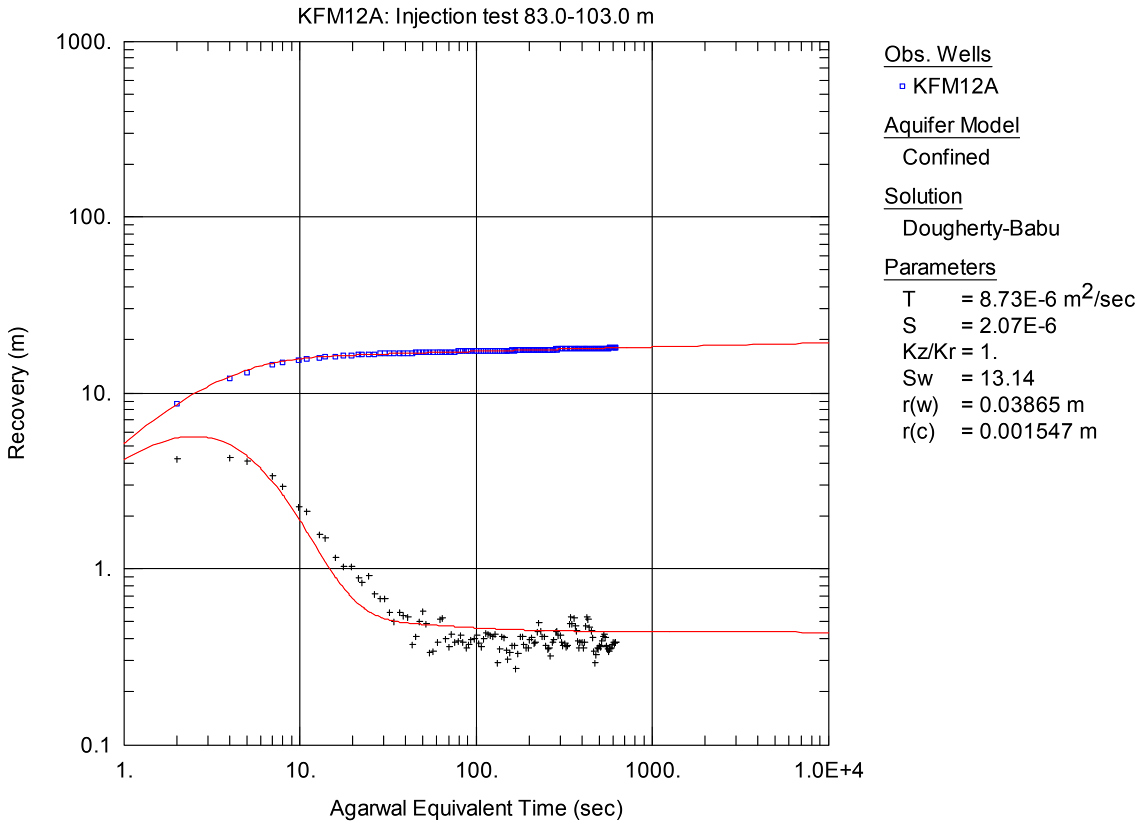


Figure A3-39. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 83.0-103.0 m in KFM12A.*

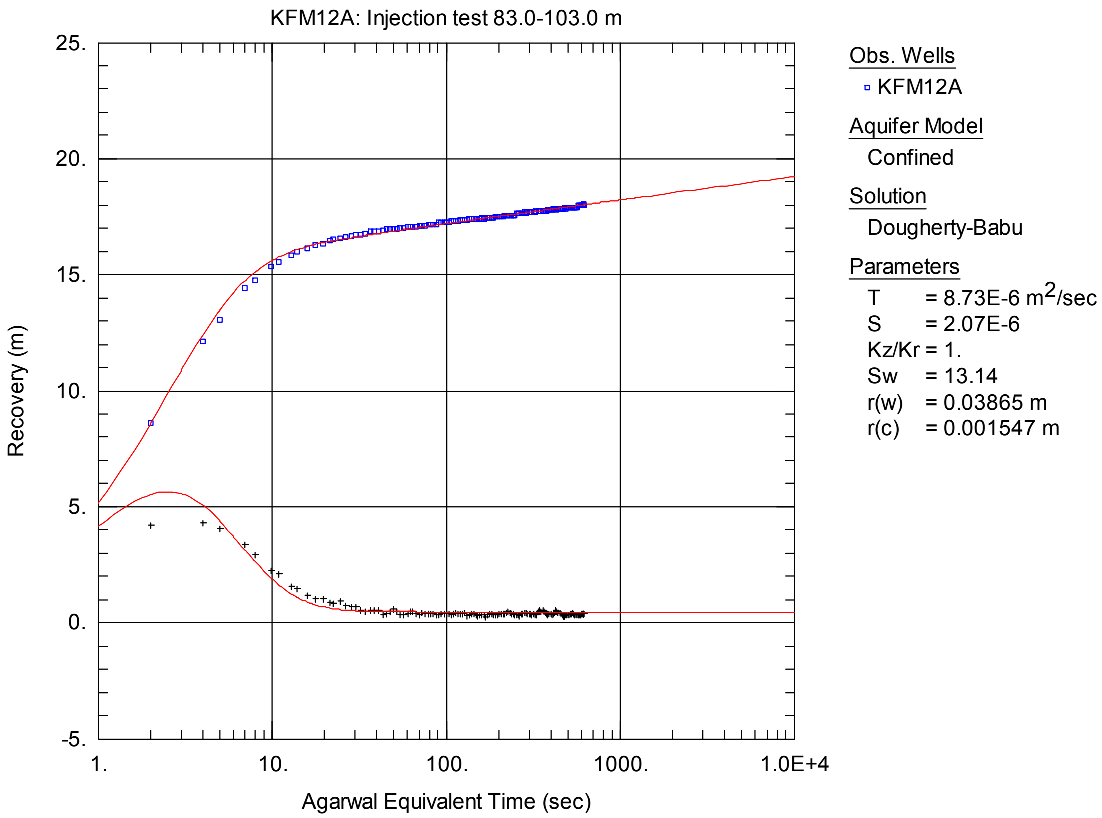


Figure A3-40. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 83.0-103.0 m in KFM12A.*

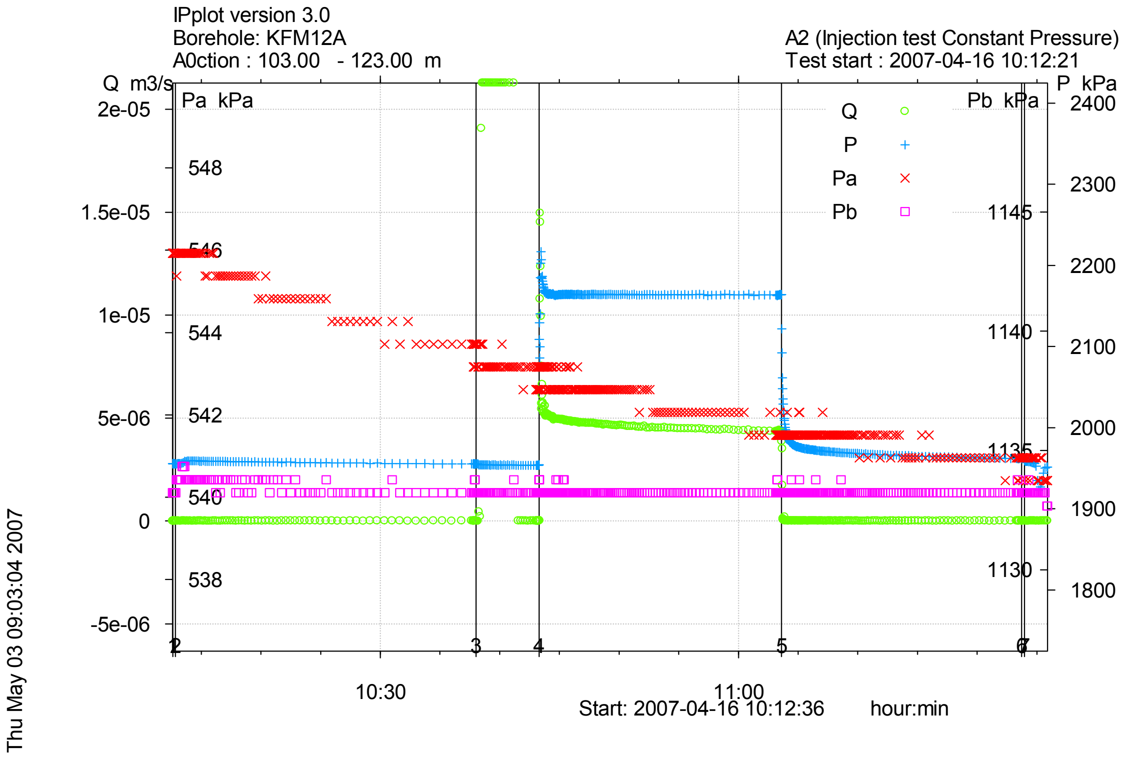


Figure A3-41. Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 103.0-123.0 m in borehole KFM12A.

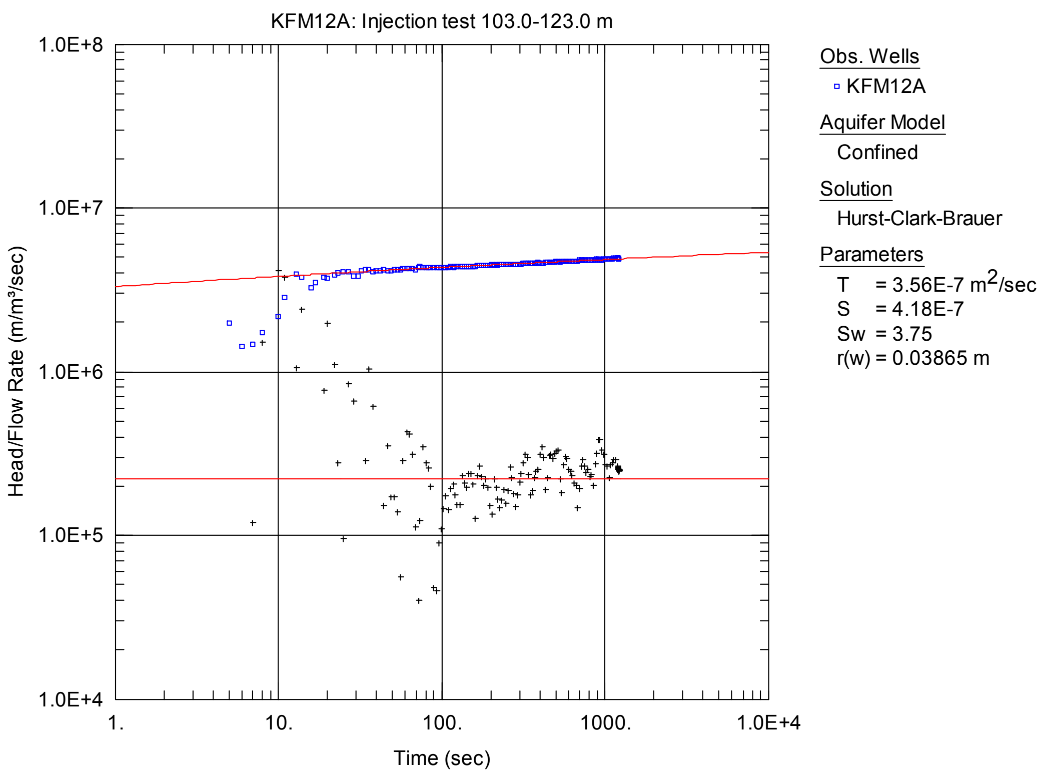


Figure A3-42. Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 103.0-123.0 m in KFM12A.

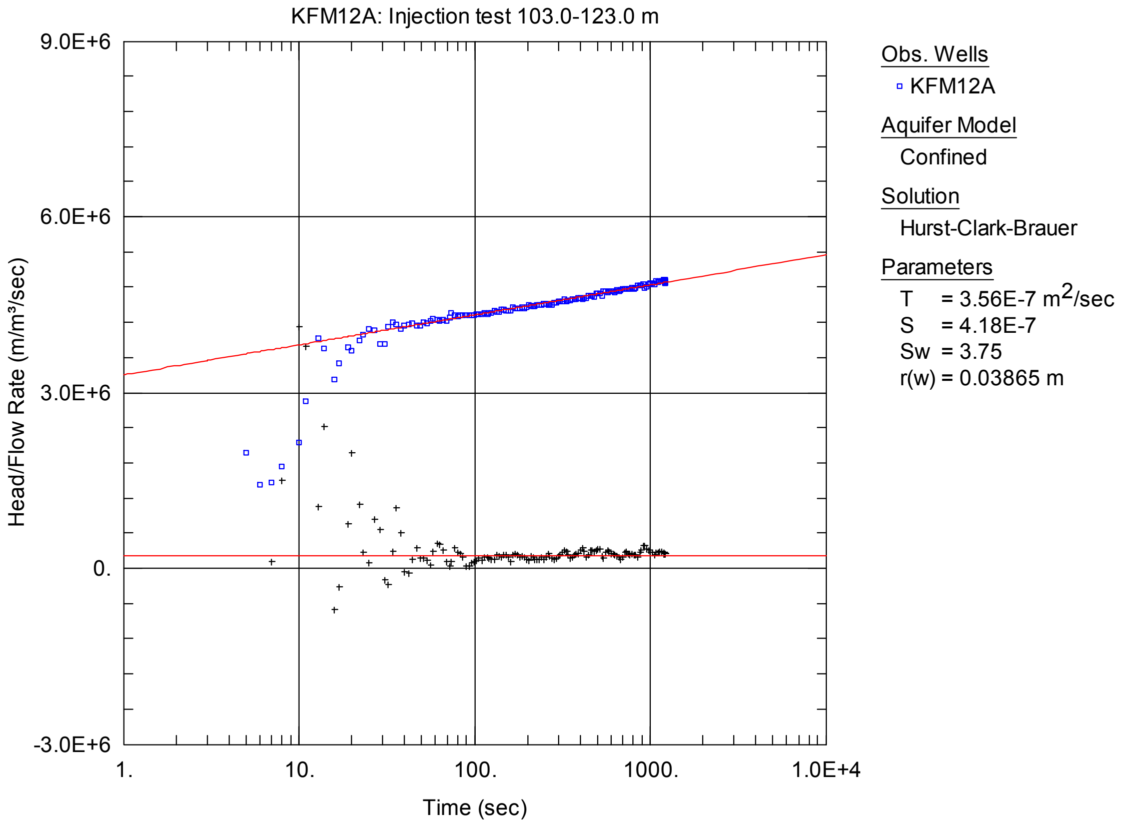


Figure A3-43. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 103.0-123.0 m in KFM12A.*

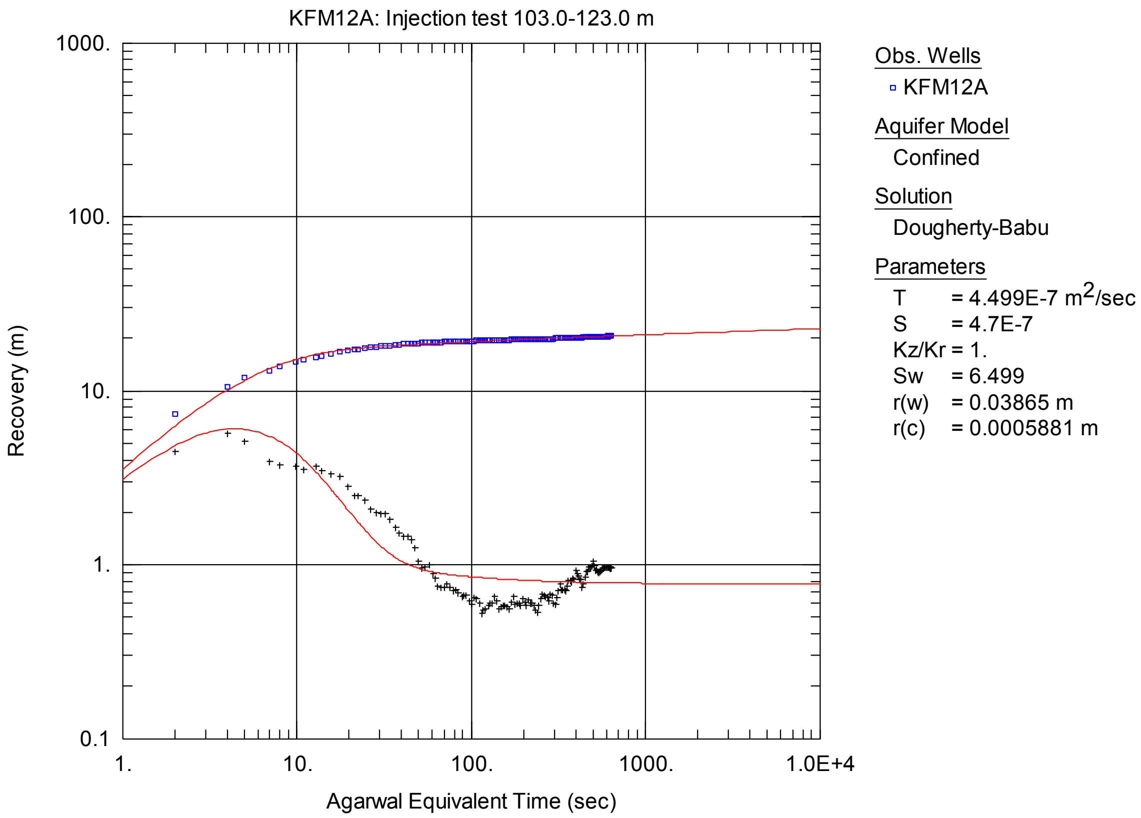


Figure A3-44. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 103.0-123.0 m in KFM12A.*

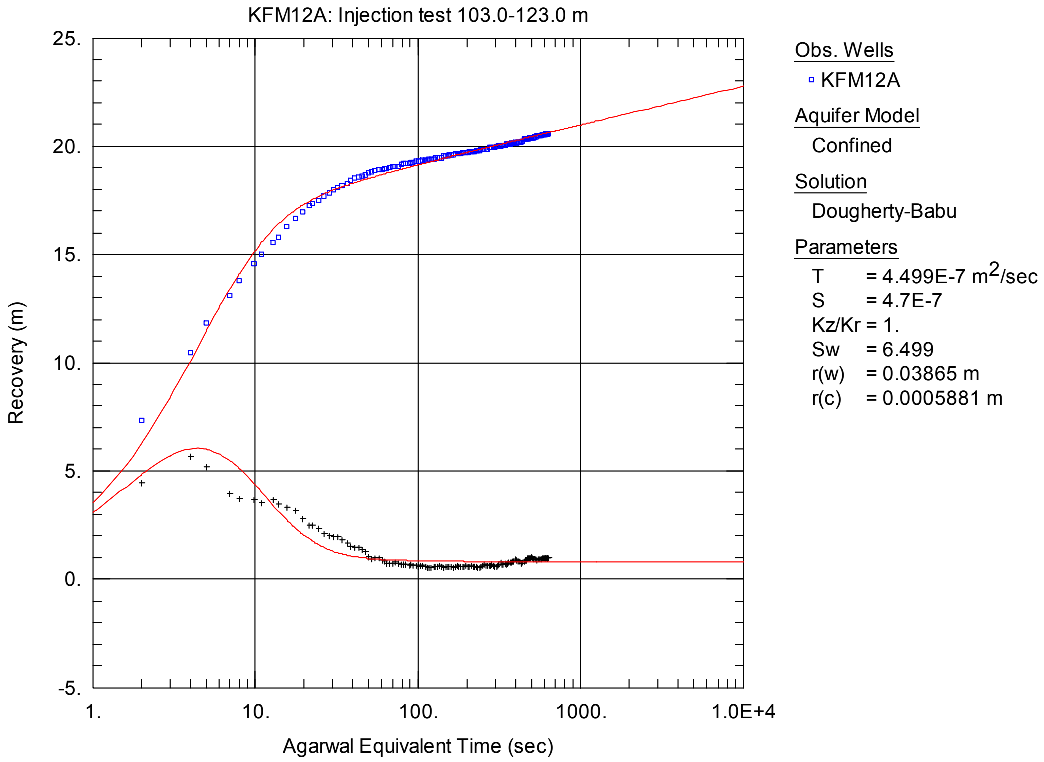


Figure A3-45. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 103.0-123.0 m in KFM12A.*

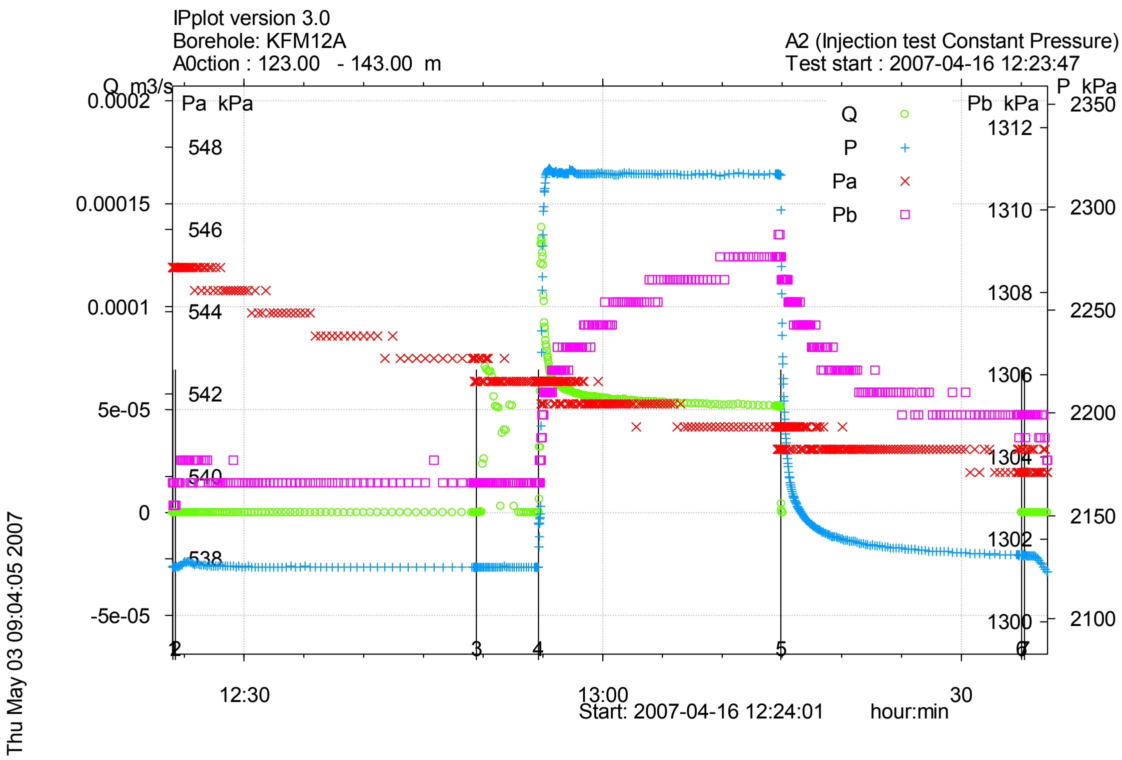


Figure A3-46. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 123.0-143.0 m in borehole KFM12A.*

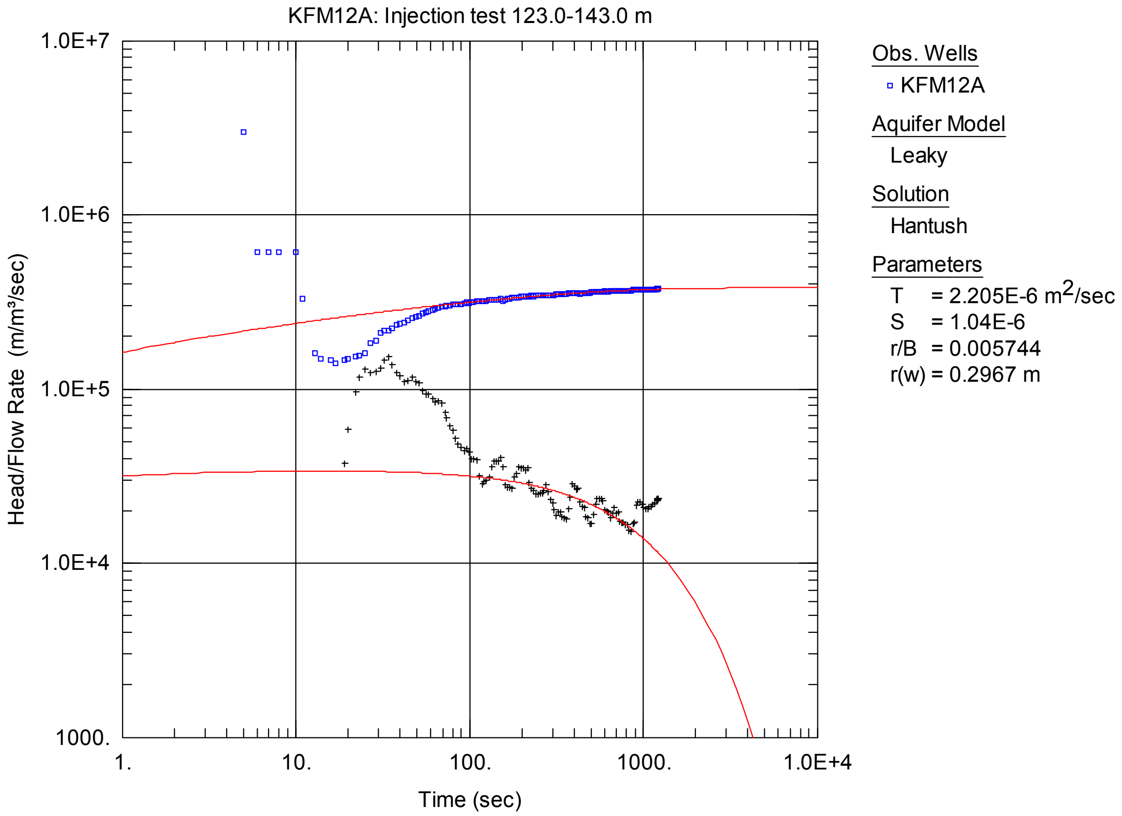


Figure A3-47. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 123.0-143.0 m in borehole KFM12A.*

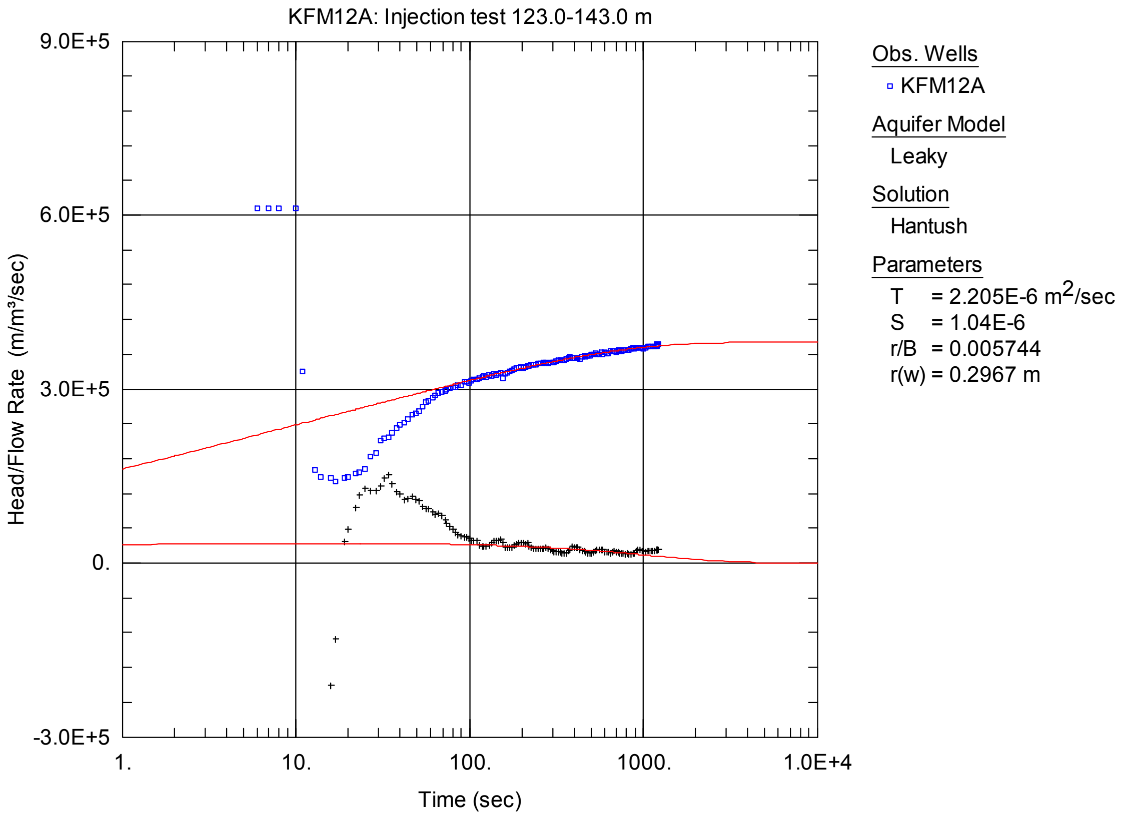


Figure A3-48. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 123.0-143.0 m in KFM12A.*

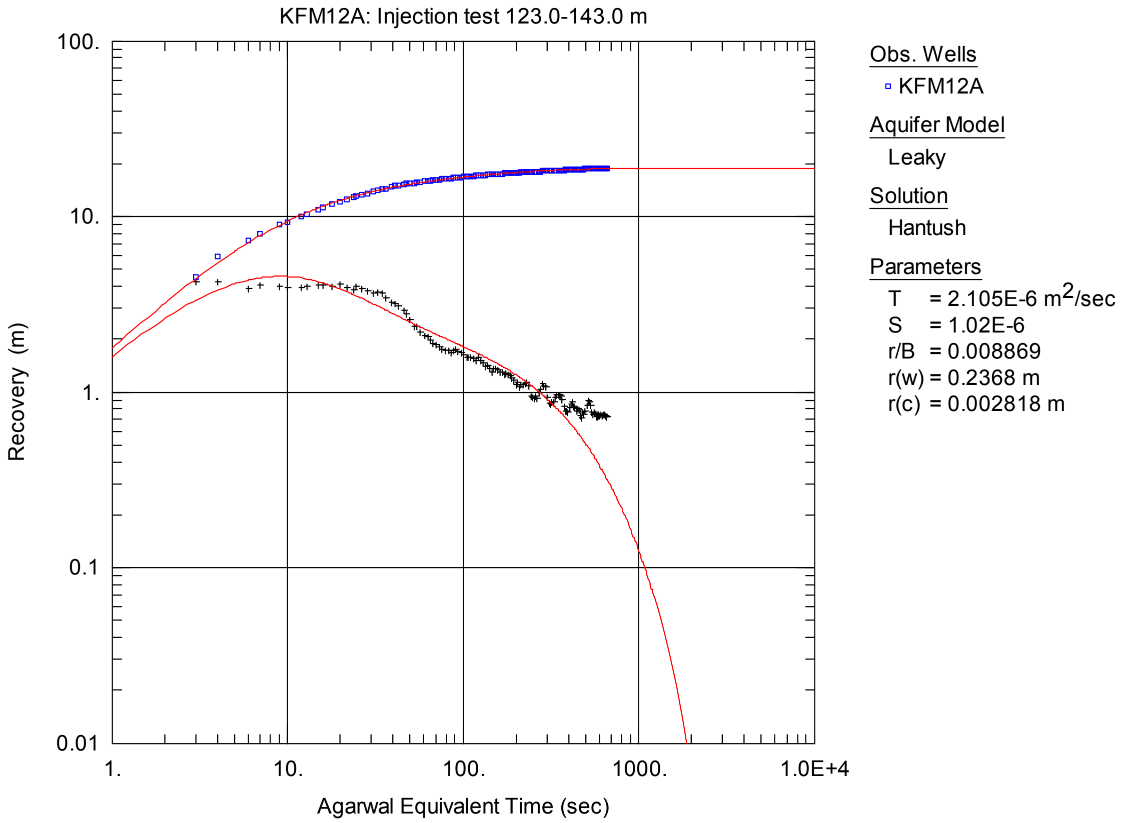


Figure A3-49. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 123.0-143.0 m in KFM12A.*

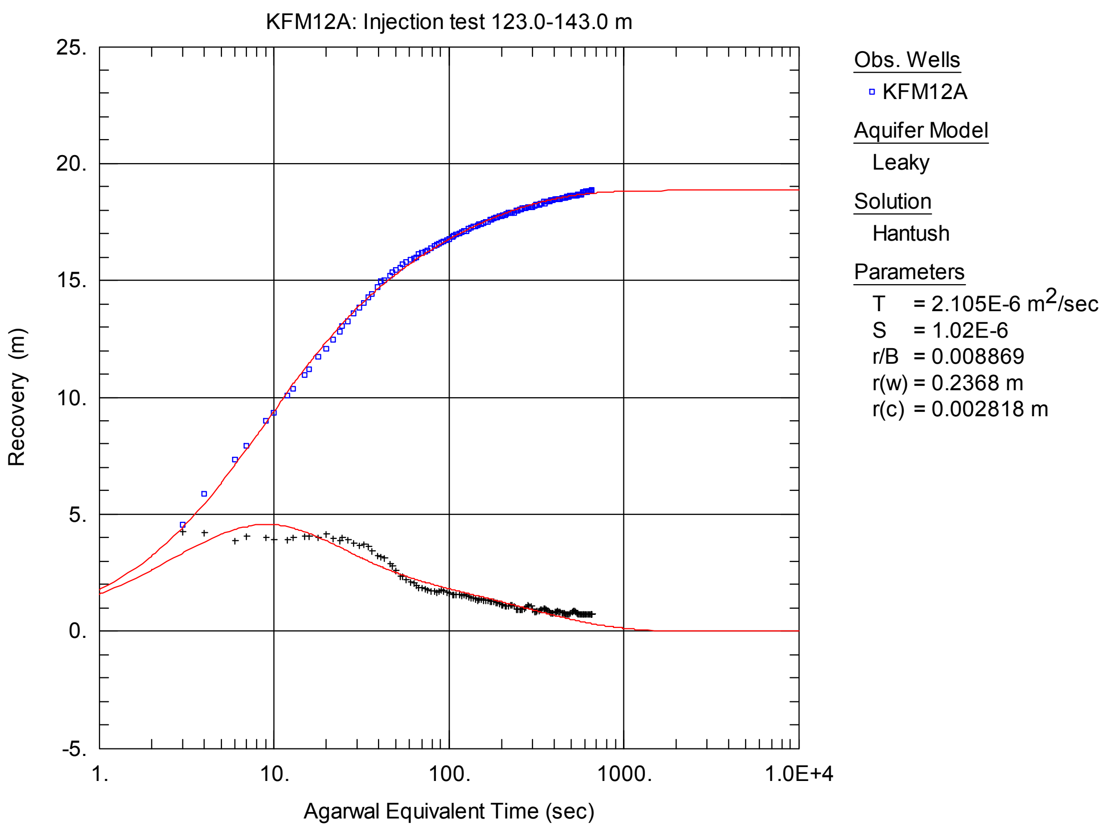


Figure A3-50. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 123.0-143.0 m in KFM12A.*

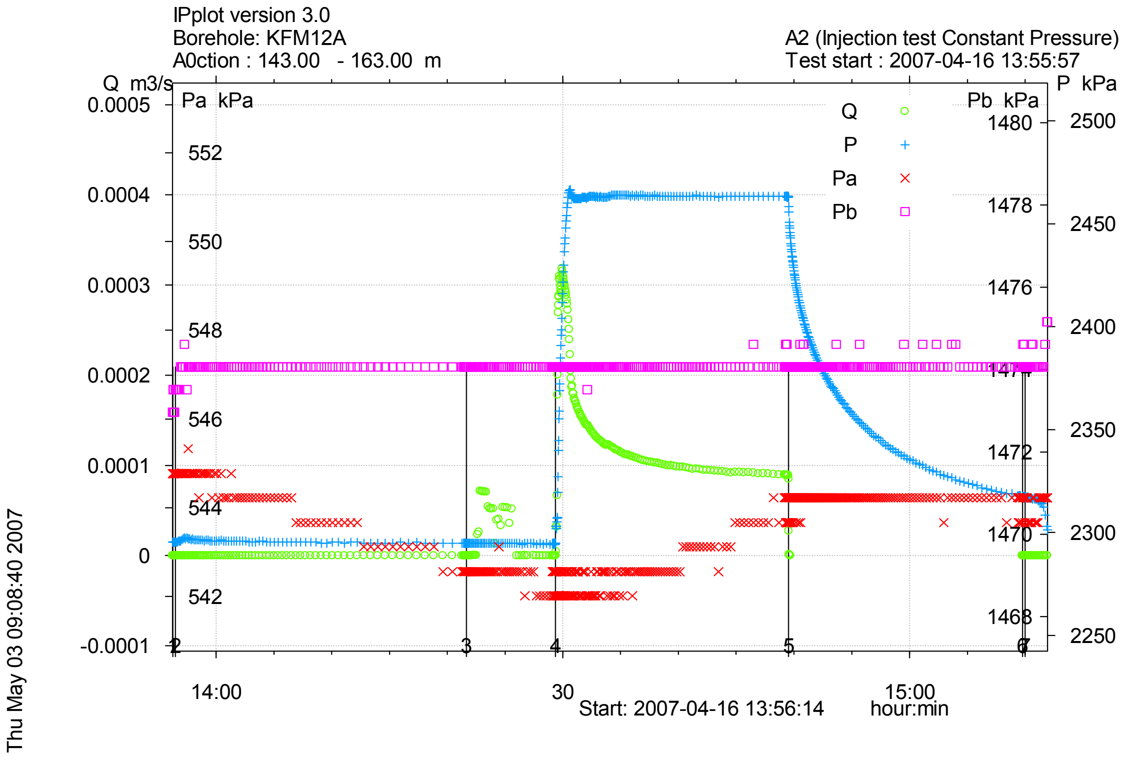


Figure A3-51. Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 143.0-163.0 m in borehole KFM12A.

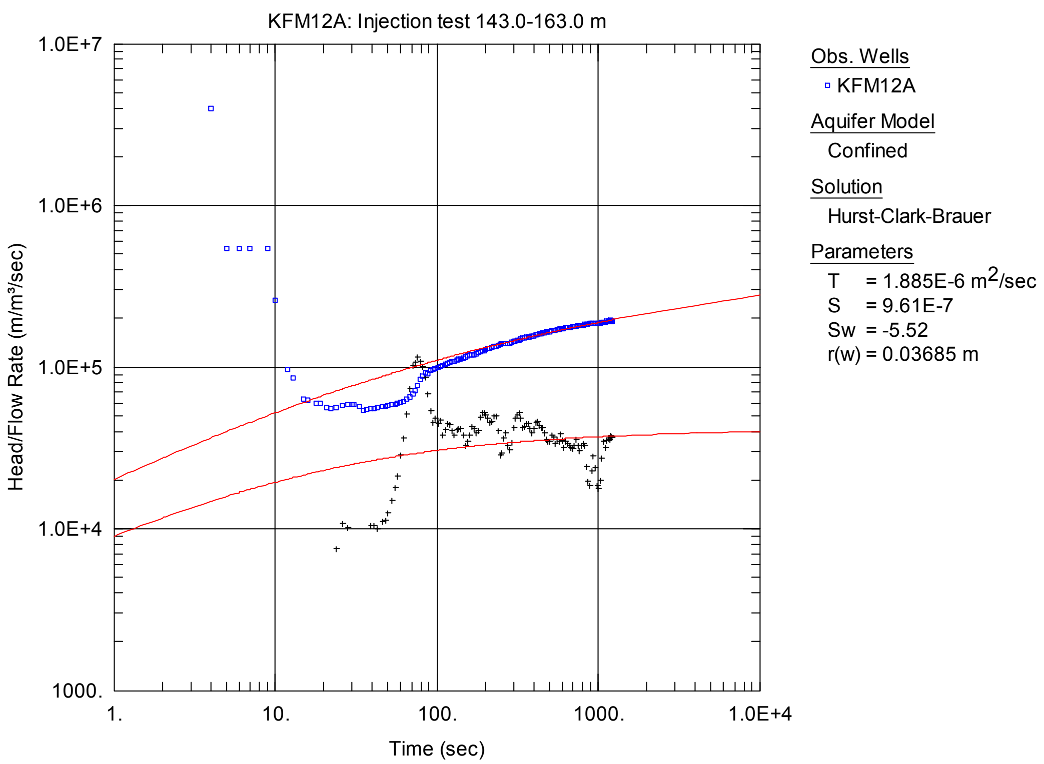


Figure A3-52. Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 143.0-163.0 m in KFM12A.

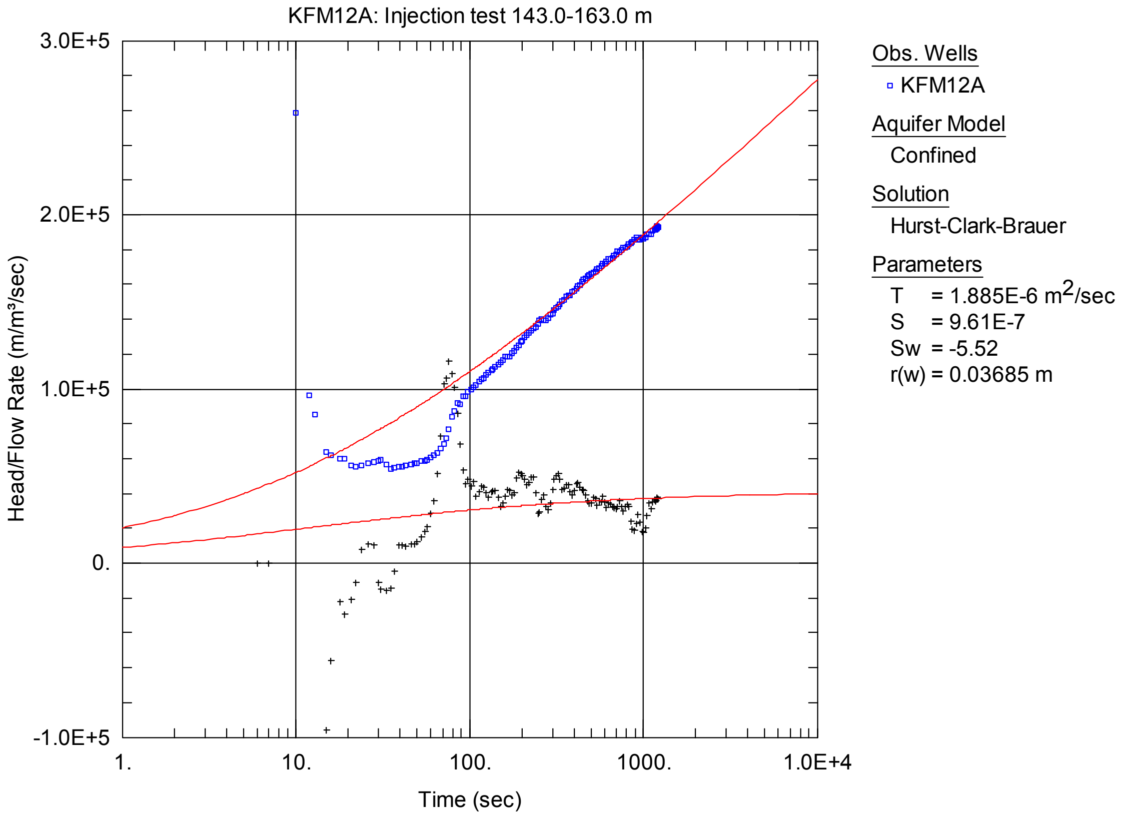


Figure A3-53. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 143.0-163.0 m in KFM12A.*

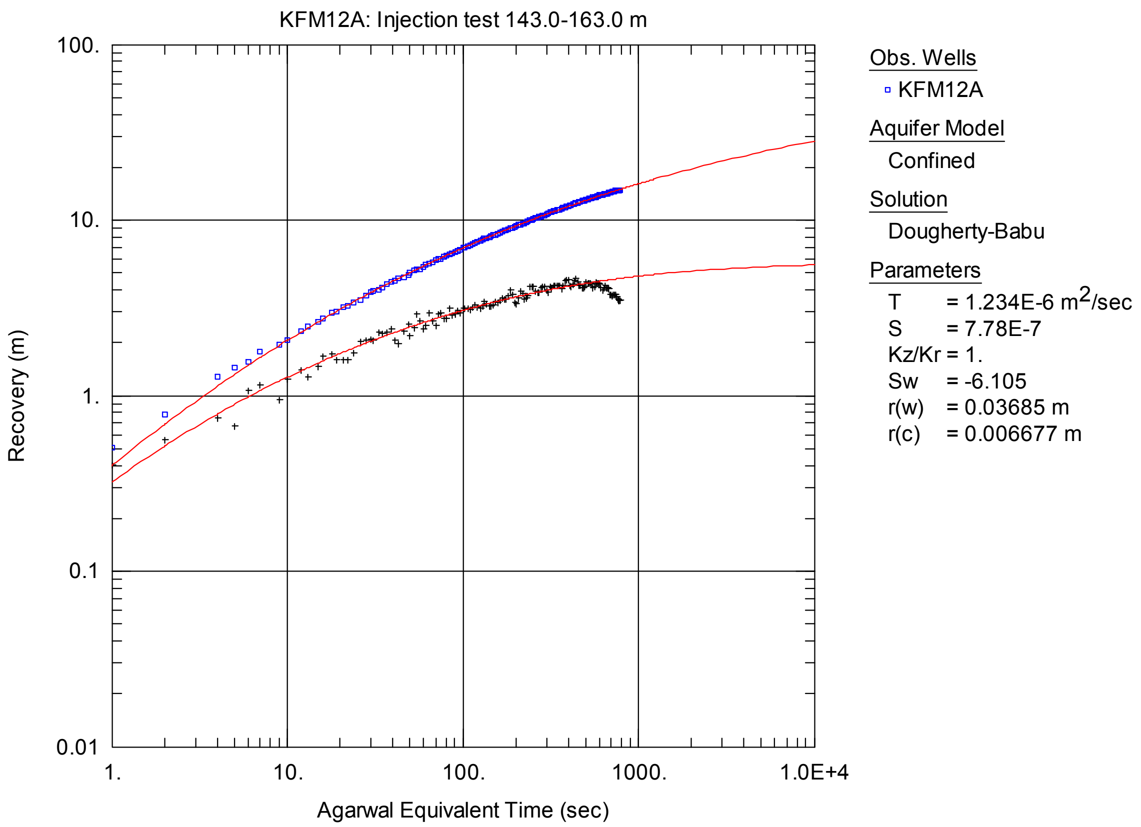


Figure A3-54. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 143.0-163.0 m in KFM12A.*

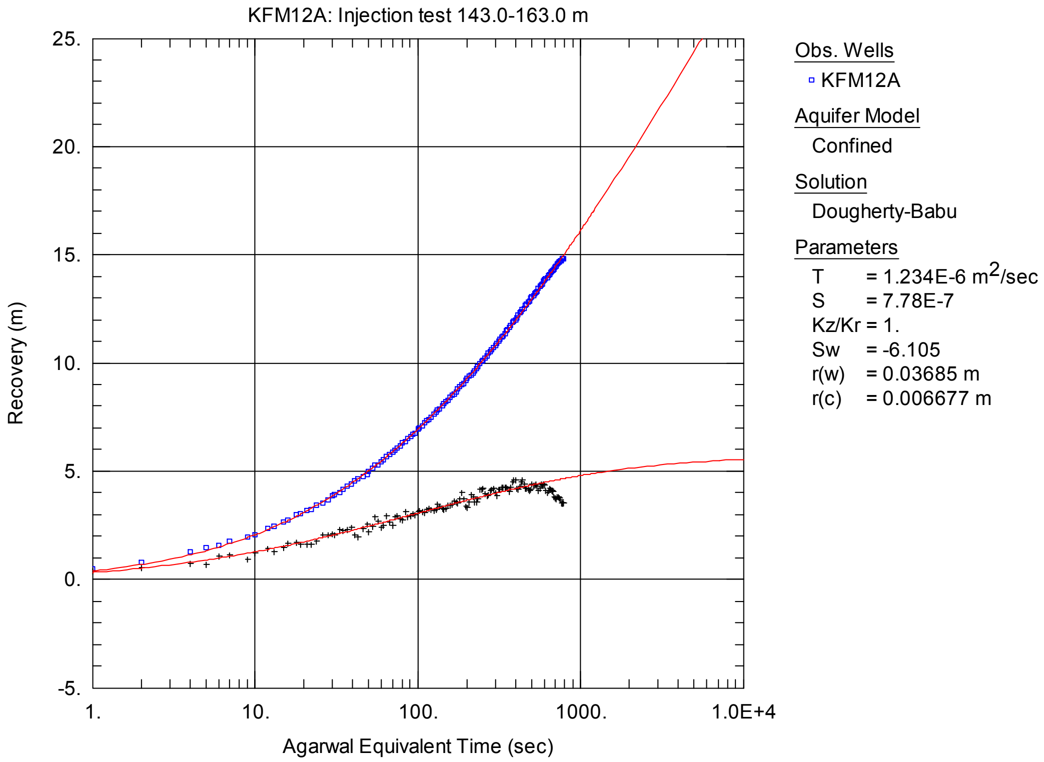


Figure A3-55. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 143.0-163.0 m in KFM12A.*

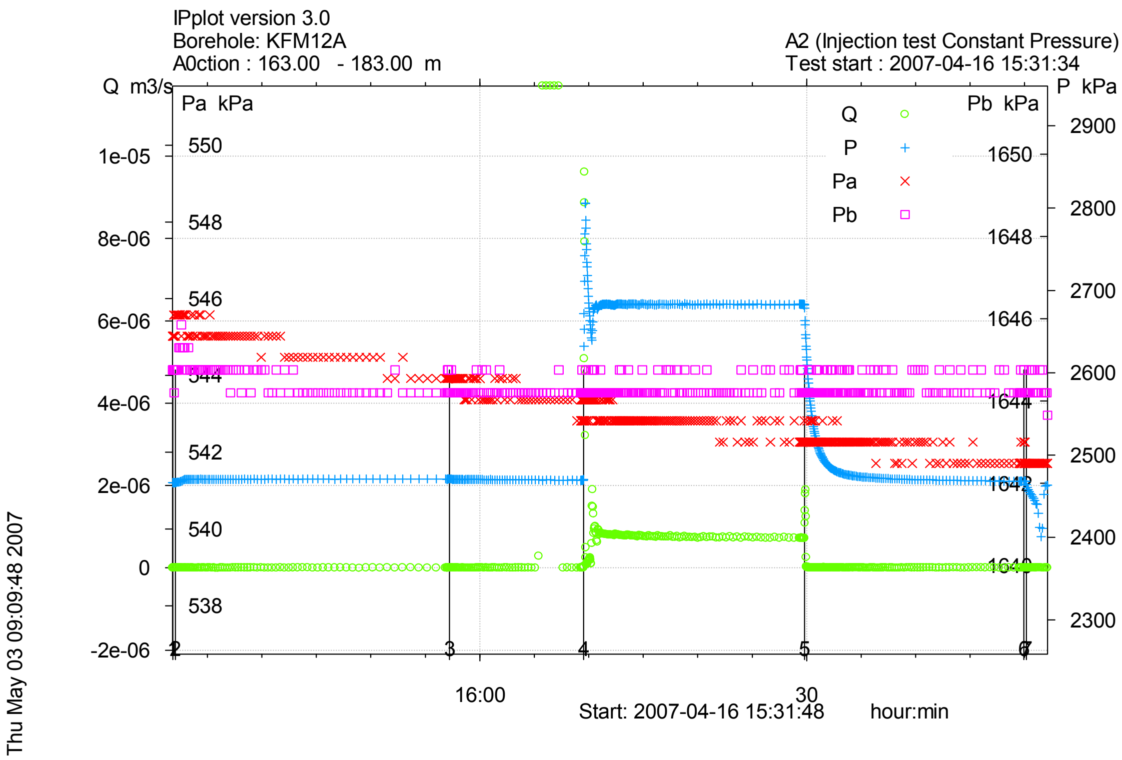


Figure A3-56. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 163.0-183.0 m in borehole KFM12A.*

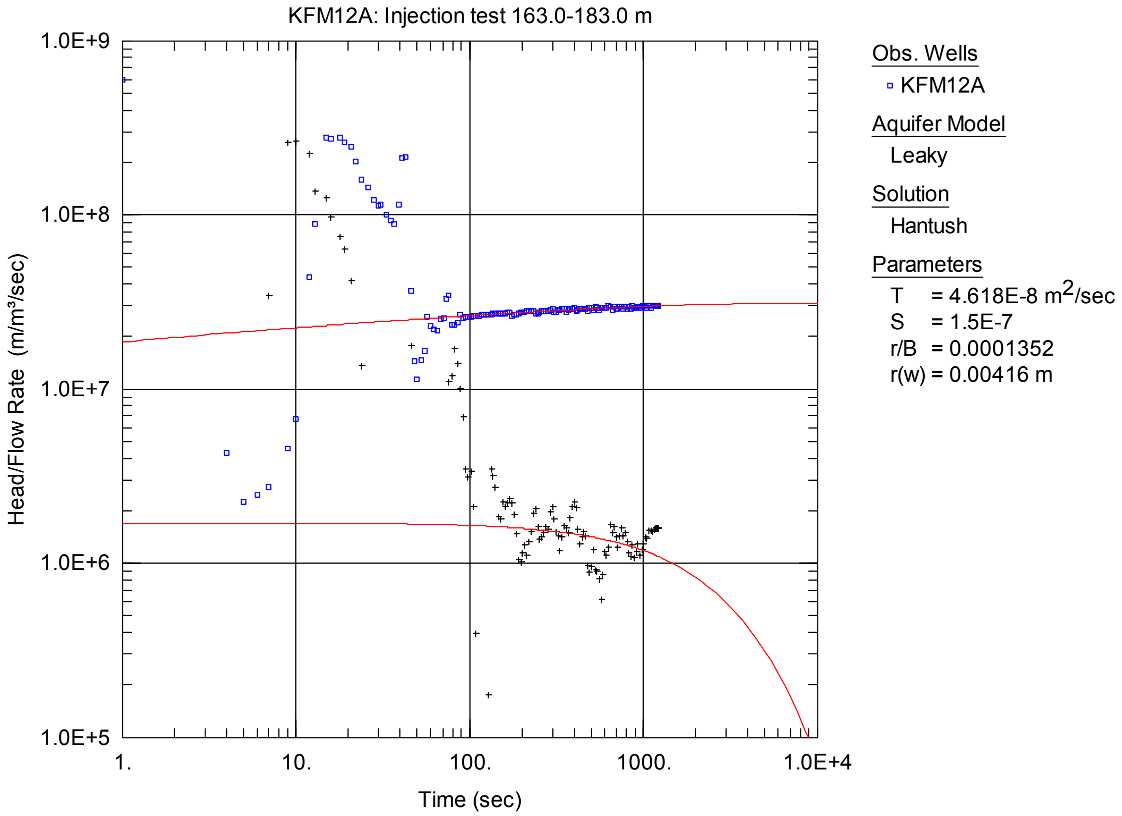


Figure A3-57. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 163.0-183.0 m in borehole KFM12A.*

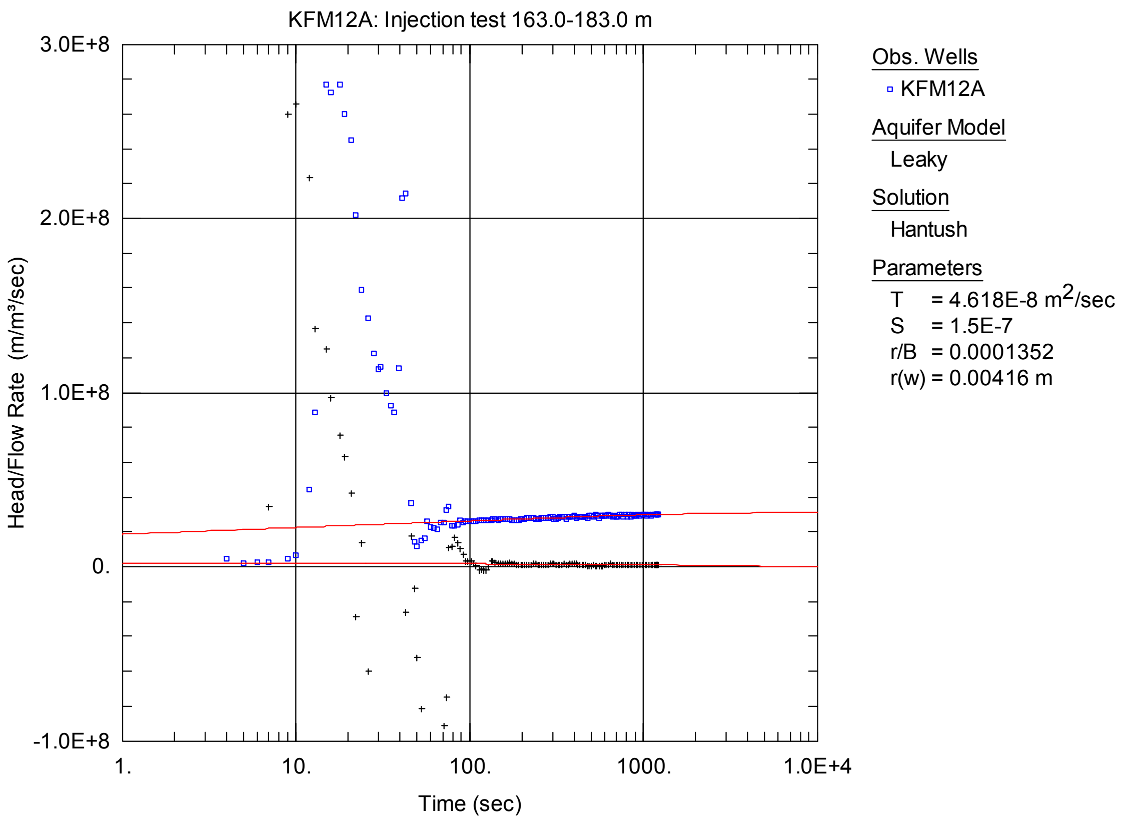


Figure A3-58. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 163.0-183.0 m in KFM12A.*

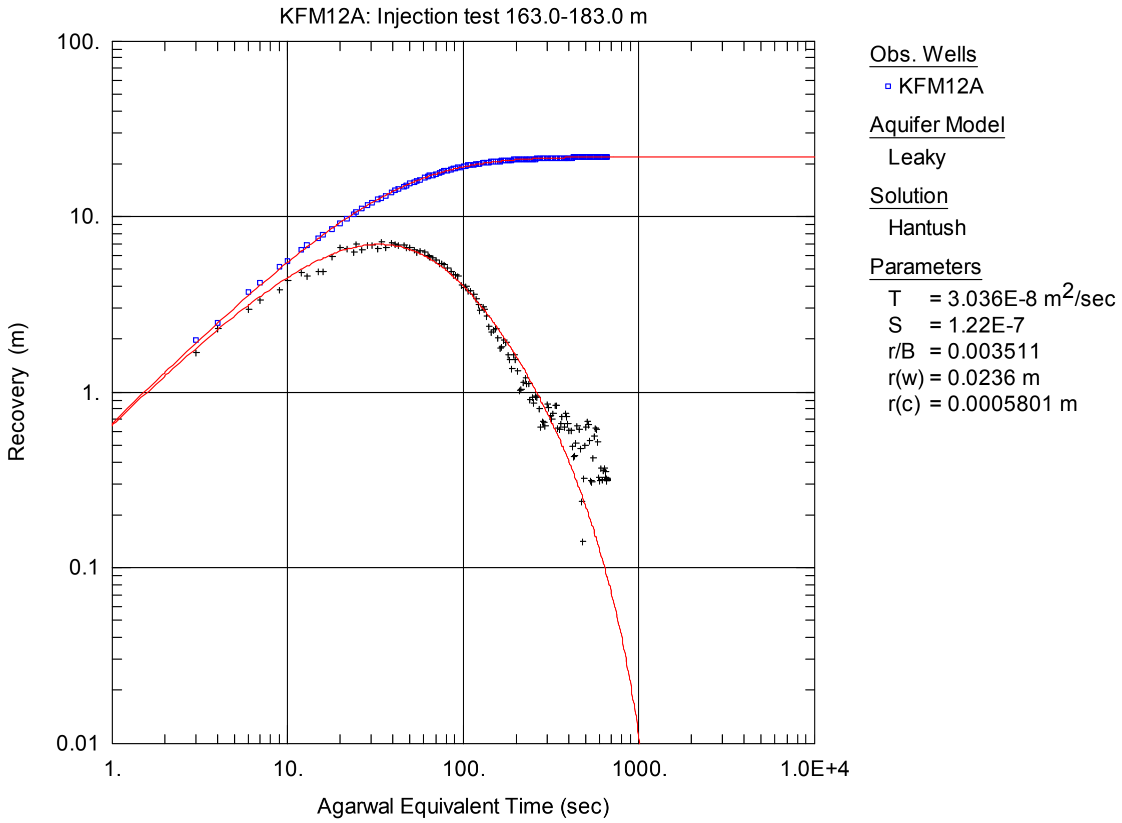


Figure A3-59. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 163.0-183.0 m in KFM12A.*

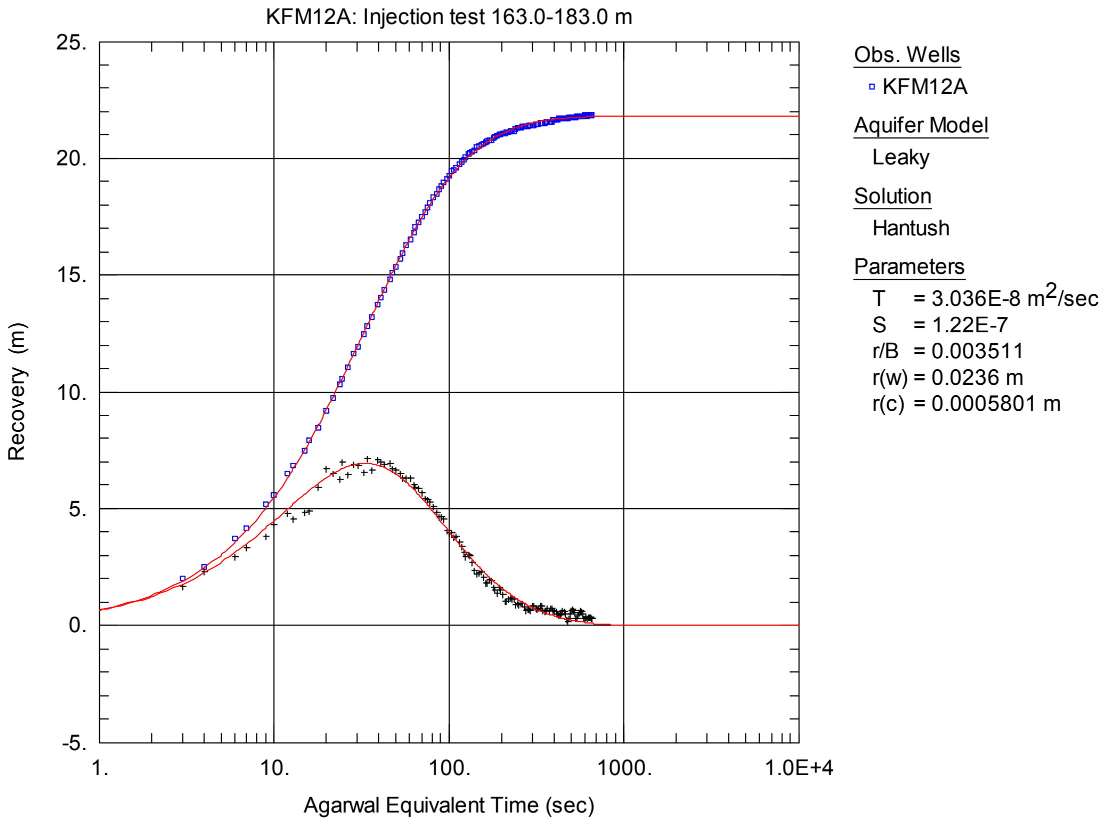


Figure A3-60. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 163.0-183.0 m in KFM12A.*

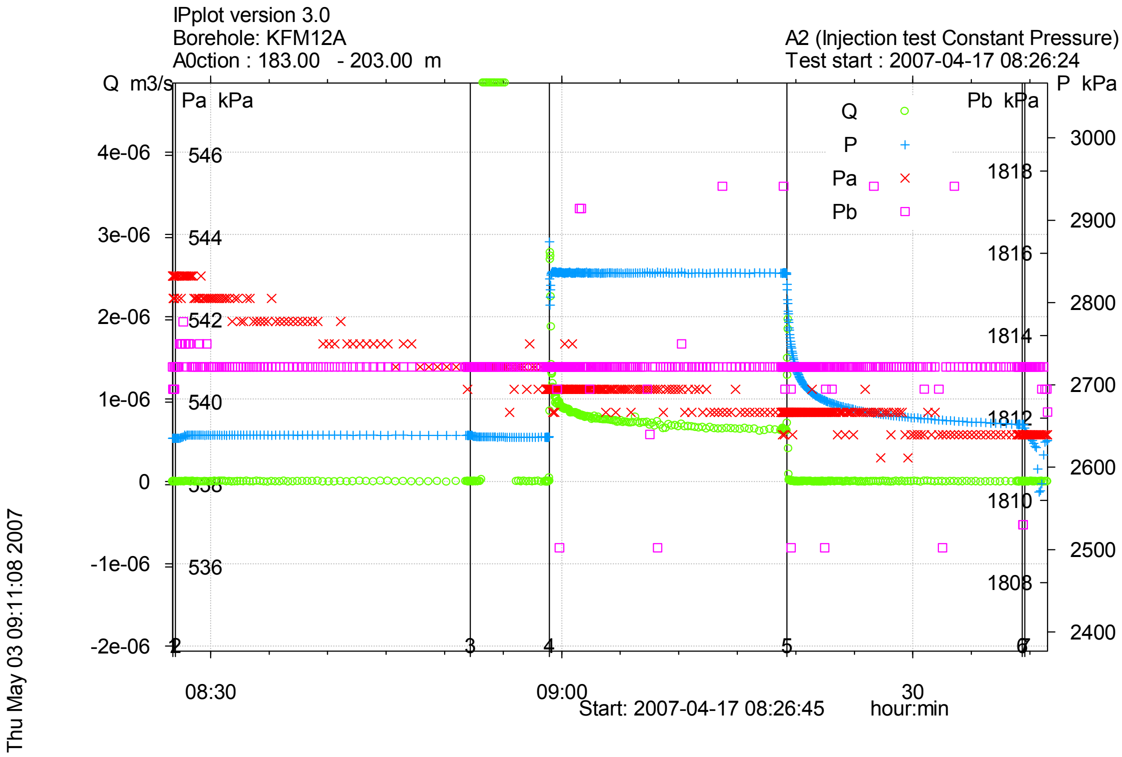


Figure A3-61. Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 183.0-203.0 m in borehole KFM12A.

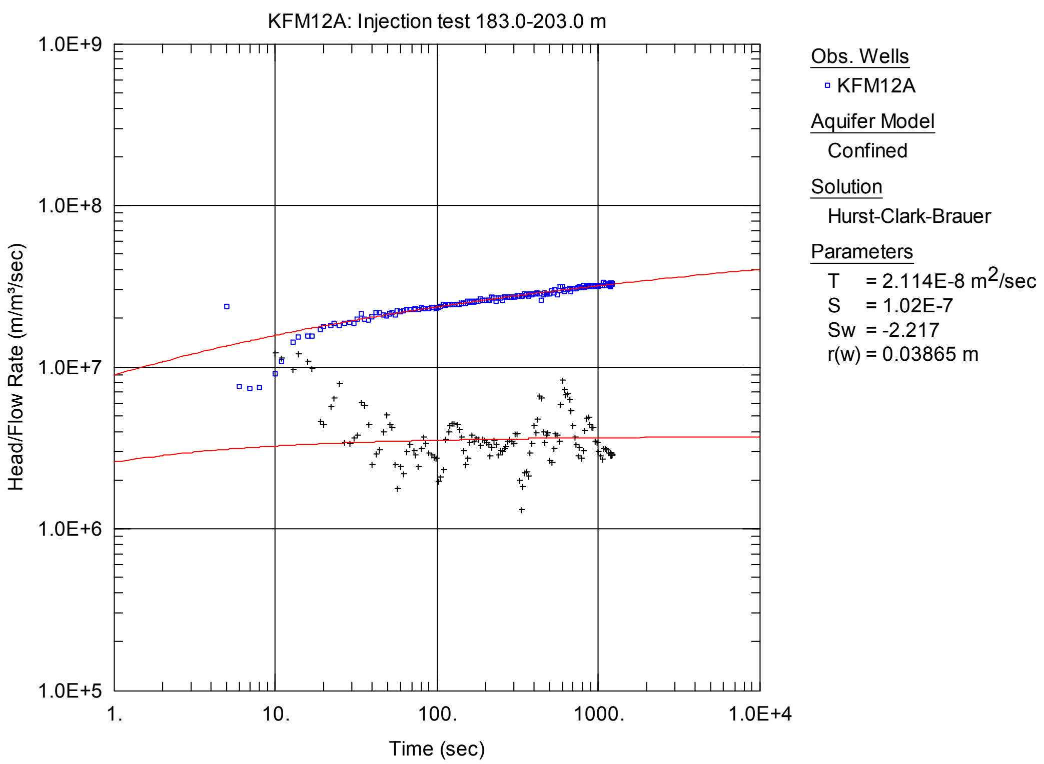


Figure A3-62. Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 183.0-203.0 m in KFM12A.

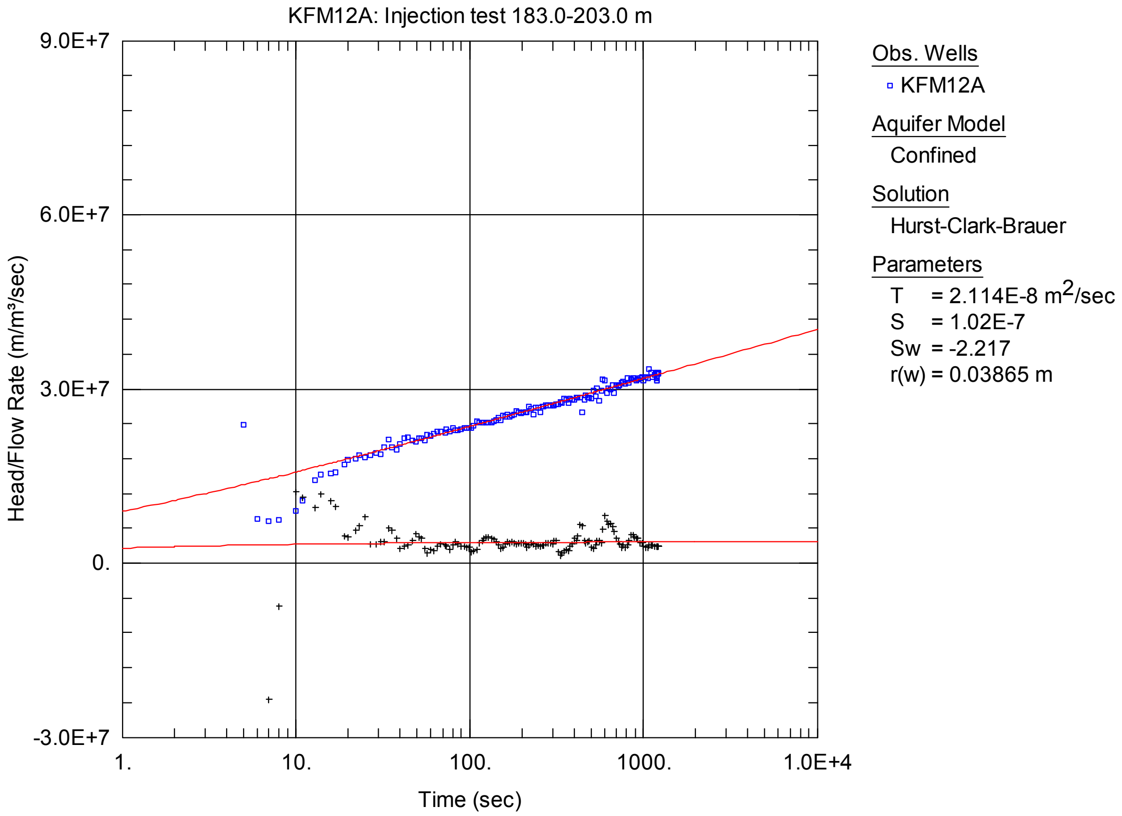


__Figure A3-63.__ Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 183.0-203.0 m in KFM12A.

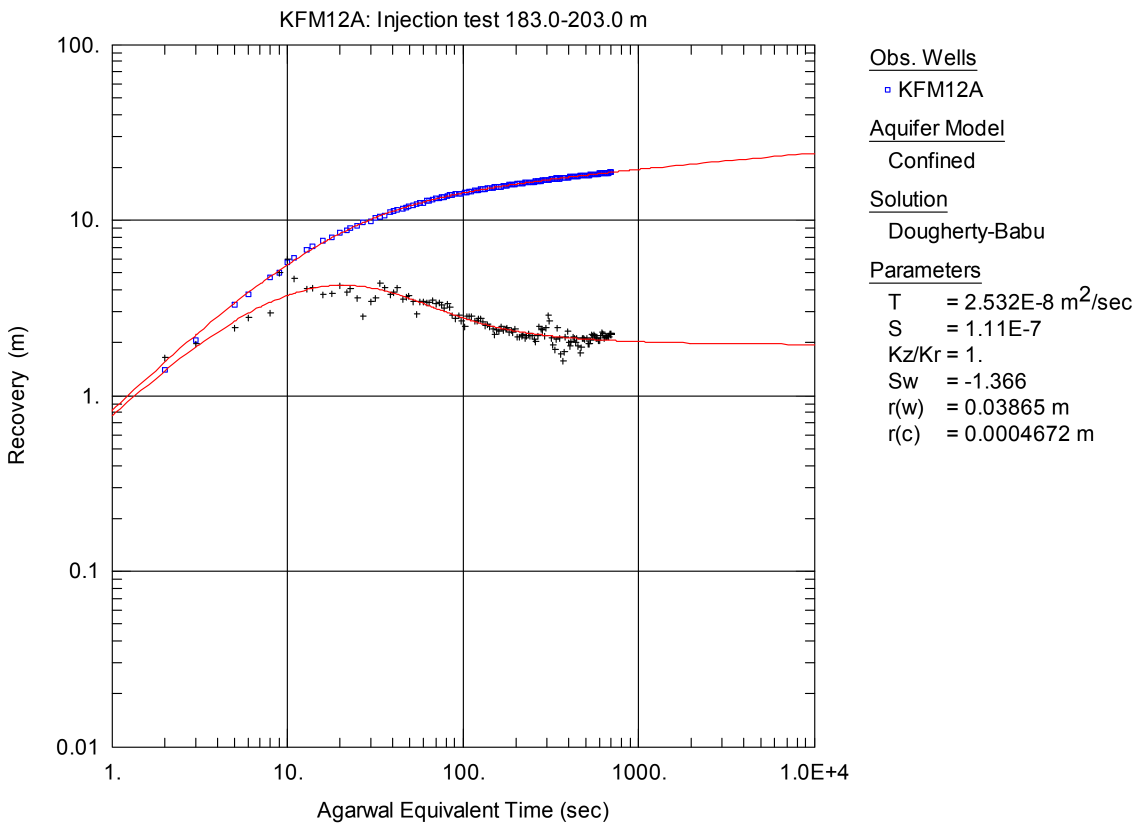


__Figure A3-64.__ Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 183.0-203.0 m in KFM12A.

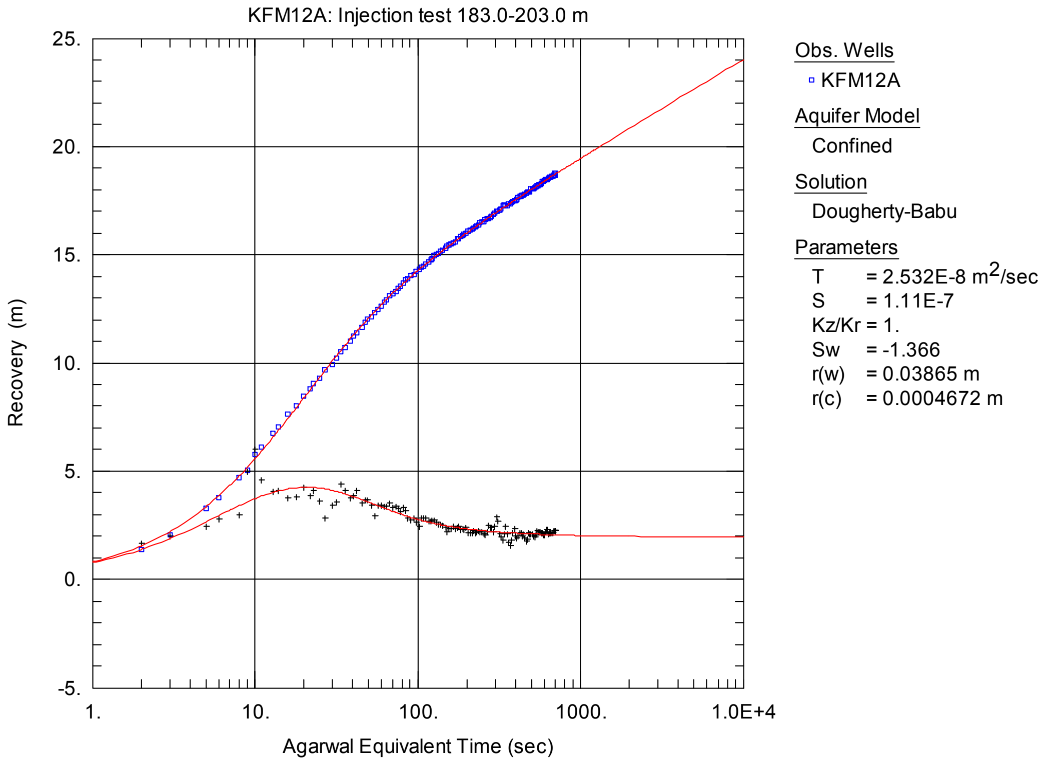


Figure A3-65. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 183.0-203.0 m in KFM12A.*

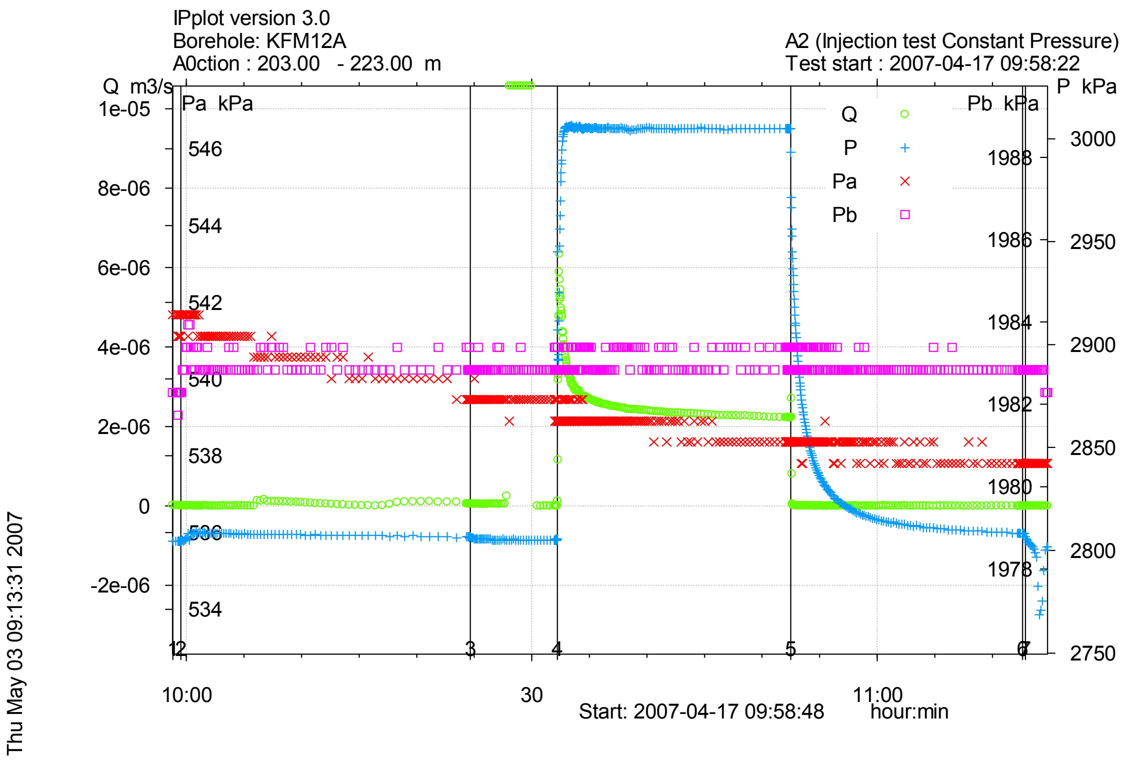


Figure A3-66. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 203.0-223.0 m in borehole KFM12A.*

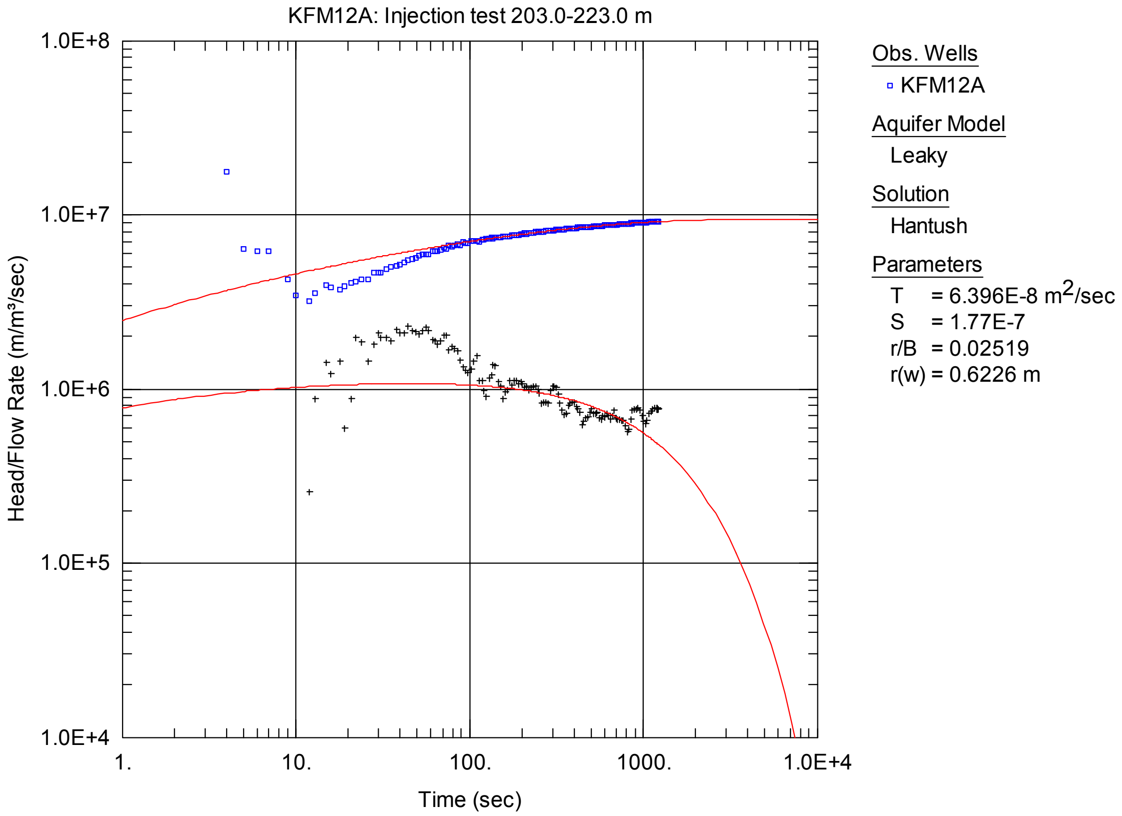


Figure A3-67. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 203.0-223.0 m in borehole KFM12A.*

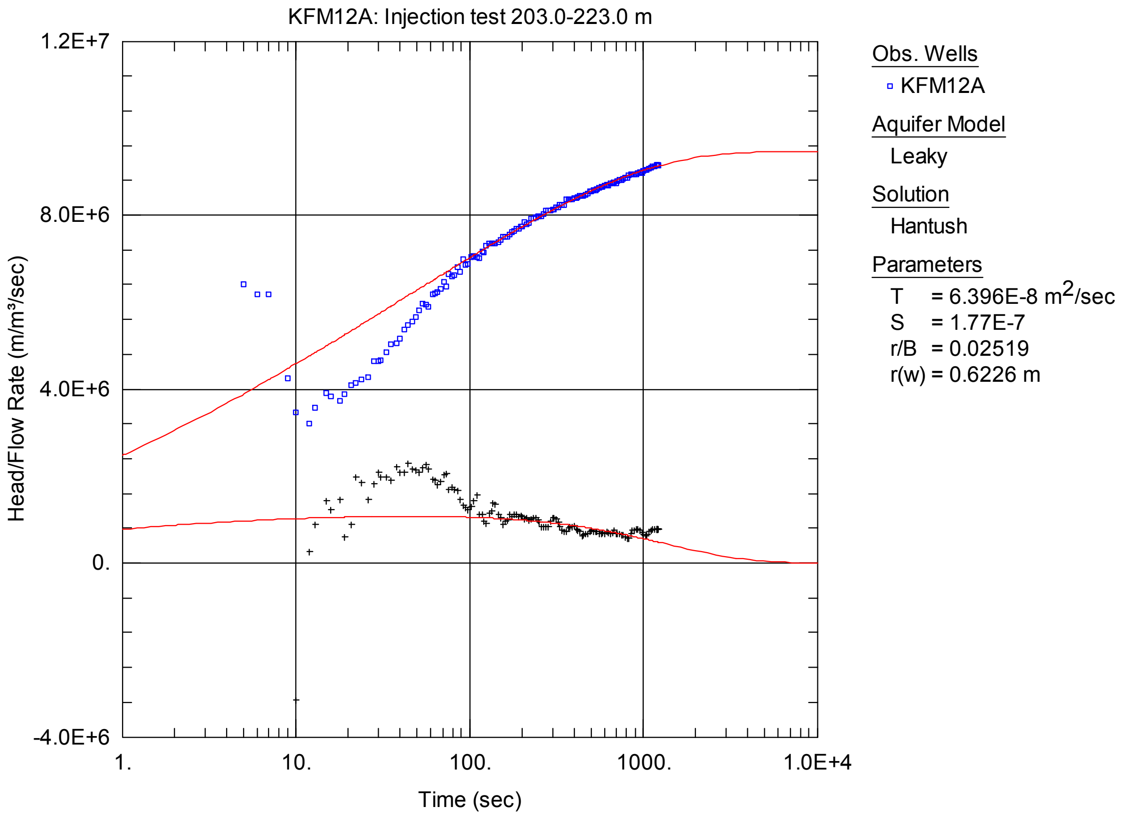


Figure A3-68. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 203.0-223.0 m in KFM12A.*

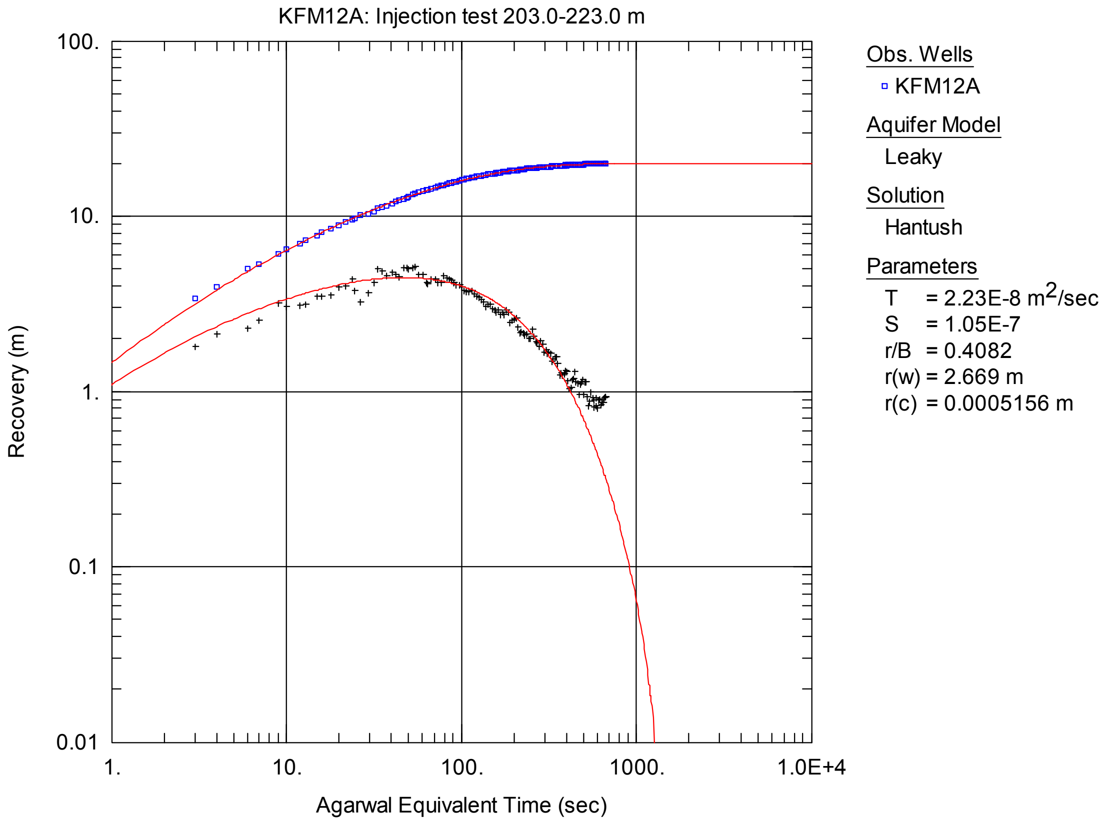


Figure A3-69. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 203.0-223.0 m in KFM12A.*

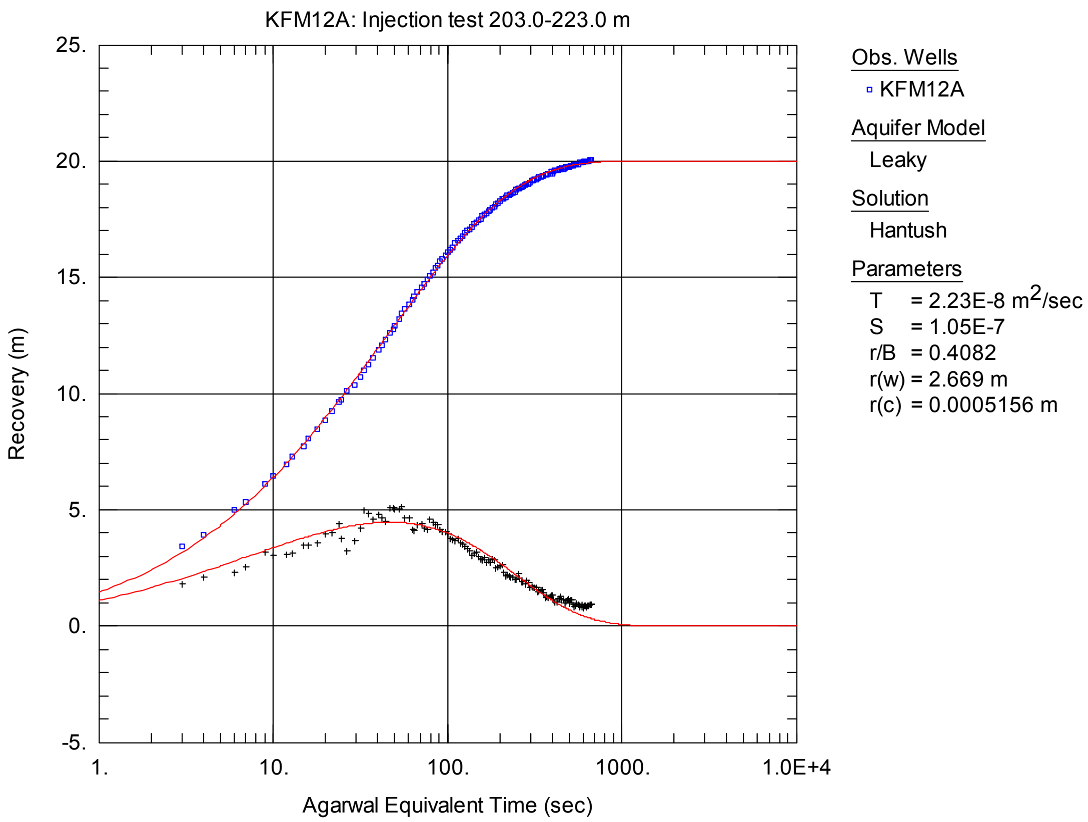


Figure A3-70. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 203.0-223.0 m in KFM12A.*

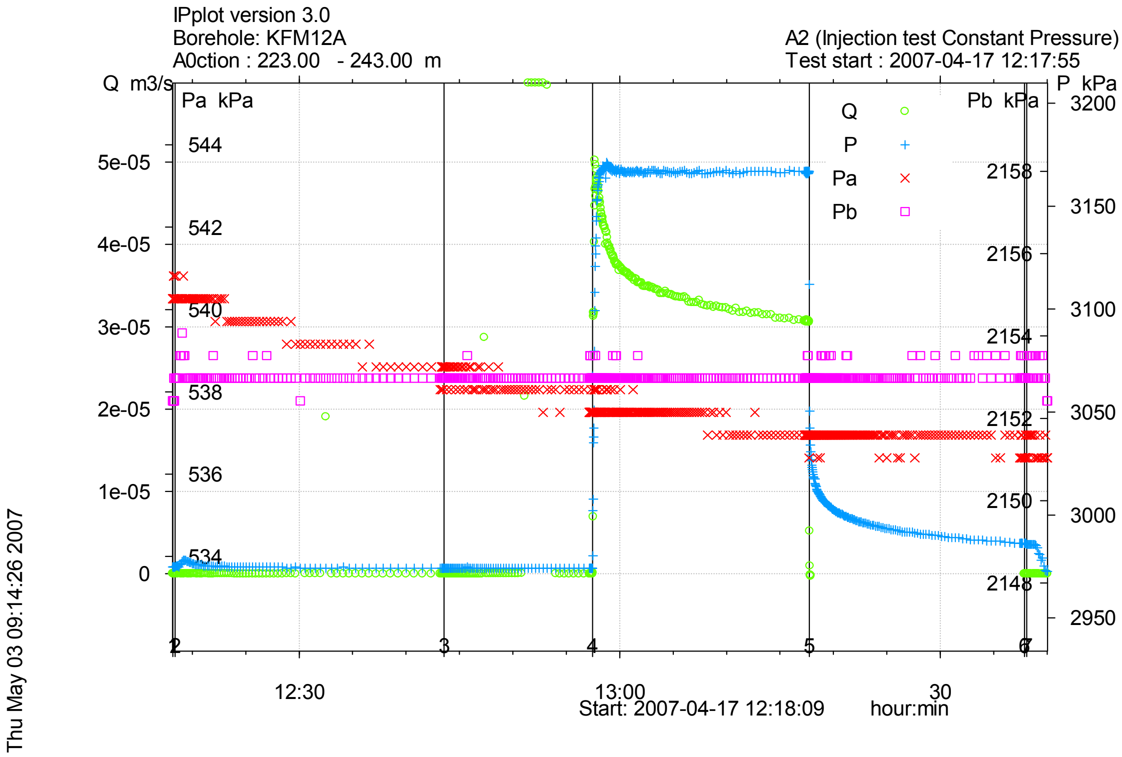


Figure A3-71. Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 223.0-243.0 m in borehole KFM12A.

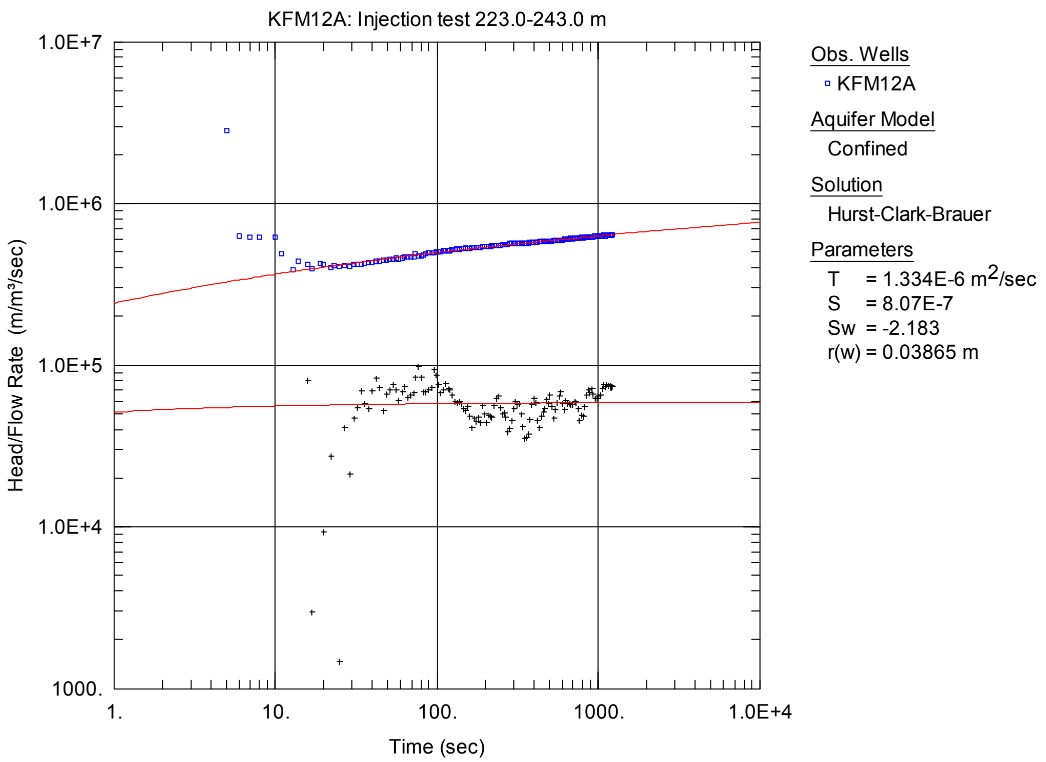


Figure A3-72. Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 223.0-243.0 m in KFM12A.

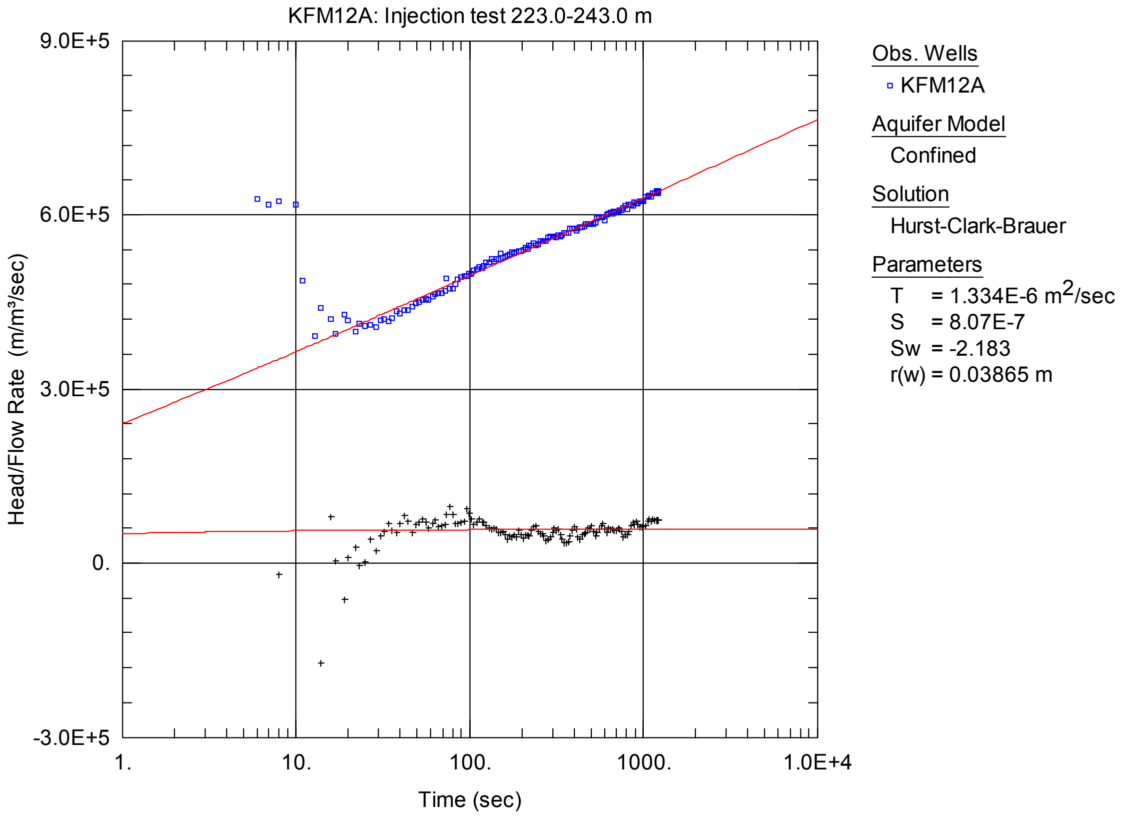


Figure A3-73. Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 223.0-243.0 m in KFM12A.

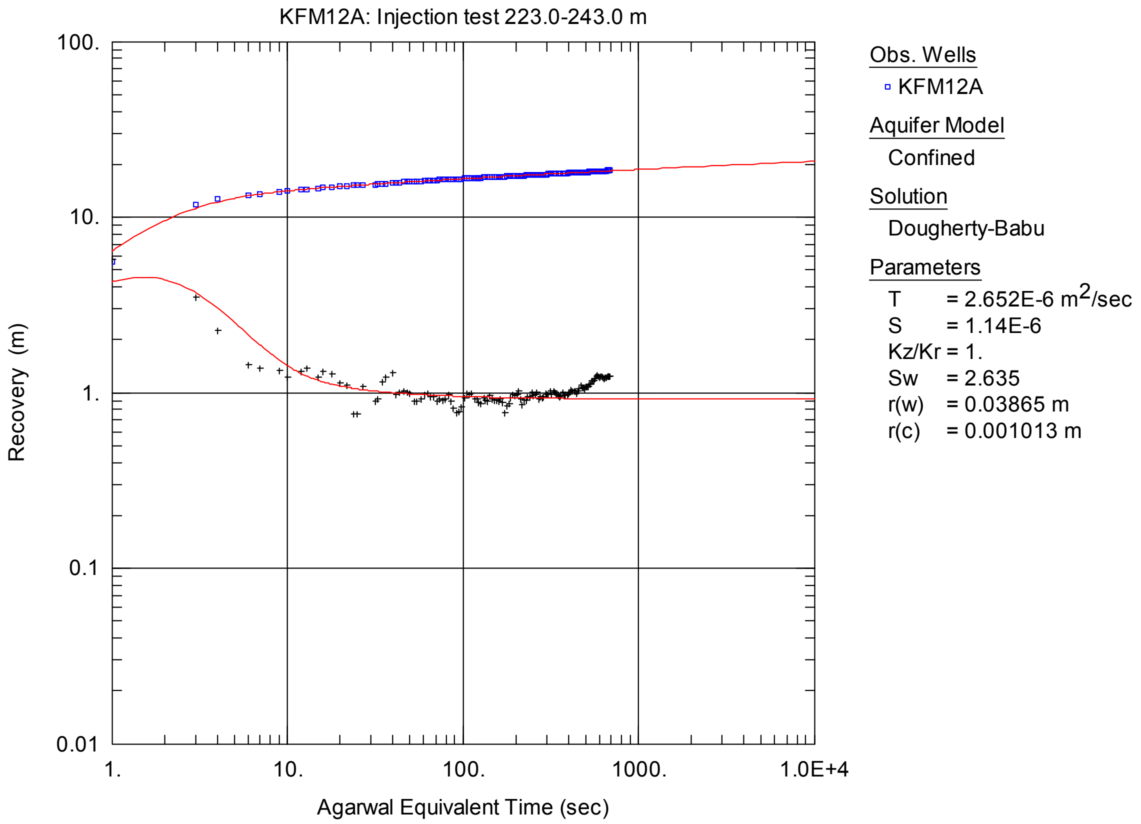


Figure A3-74. Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 223.0-243.0 m in KFM12A.

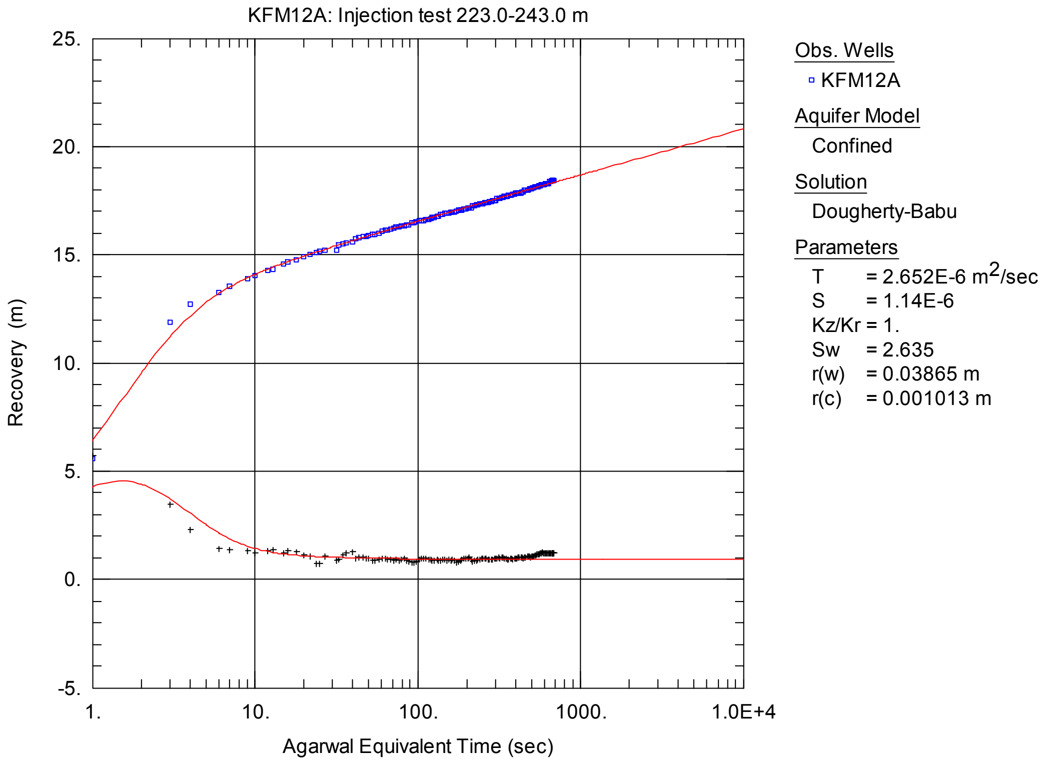


Figure A3-75. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 223.0-243.0 m in KFM12A.*

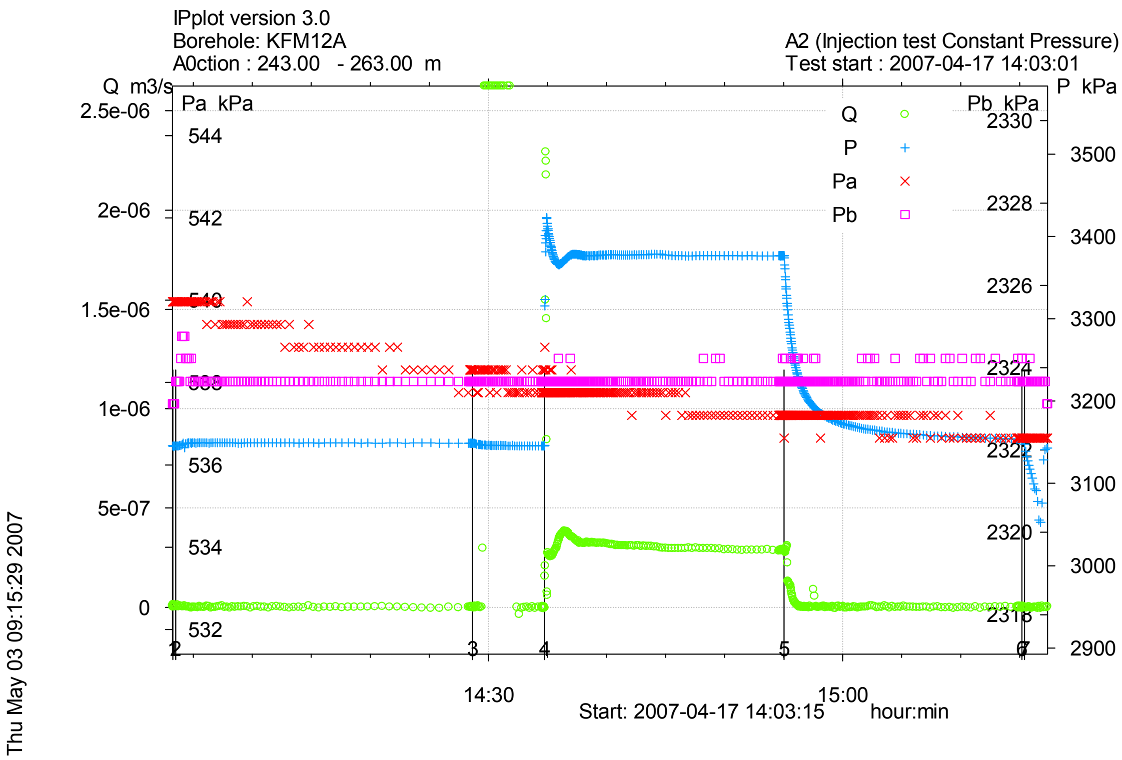


Figure A3-76. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 243.0-263.0 m in borehole KFM12A.*

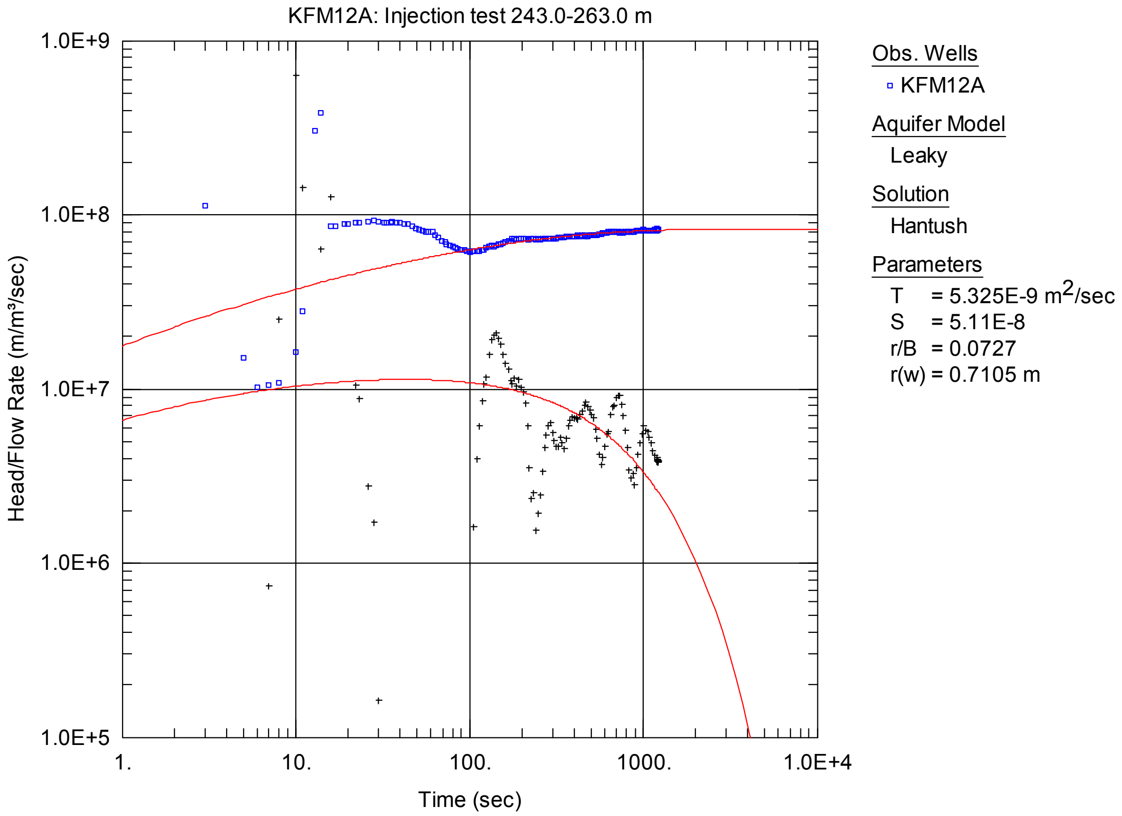


Figure A3-77. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 243.0-263.0 m in borehole KFM12A.*

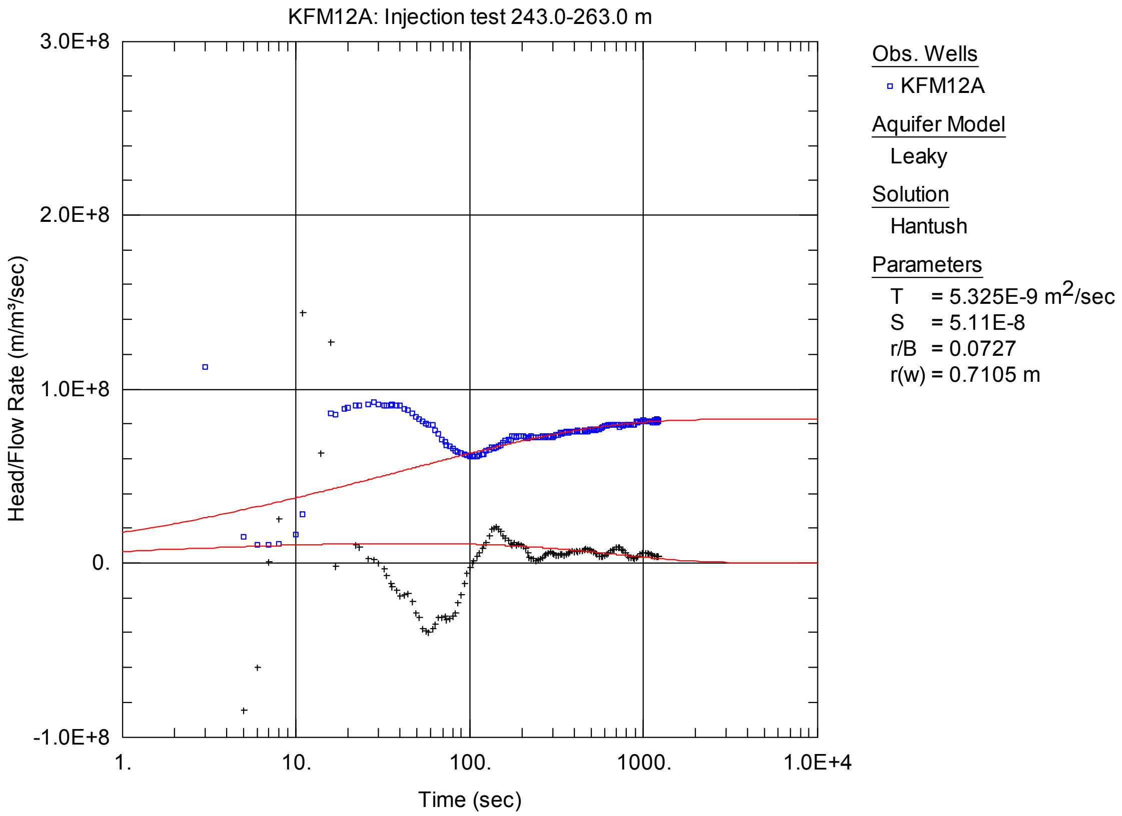


Figure A3-78. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 243.0-263.0 m in KFM12A.*

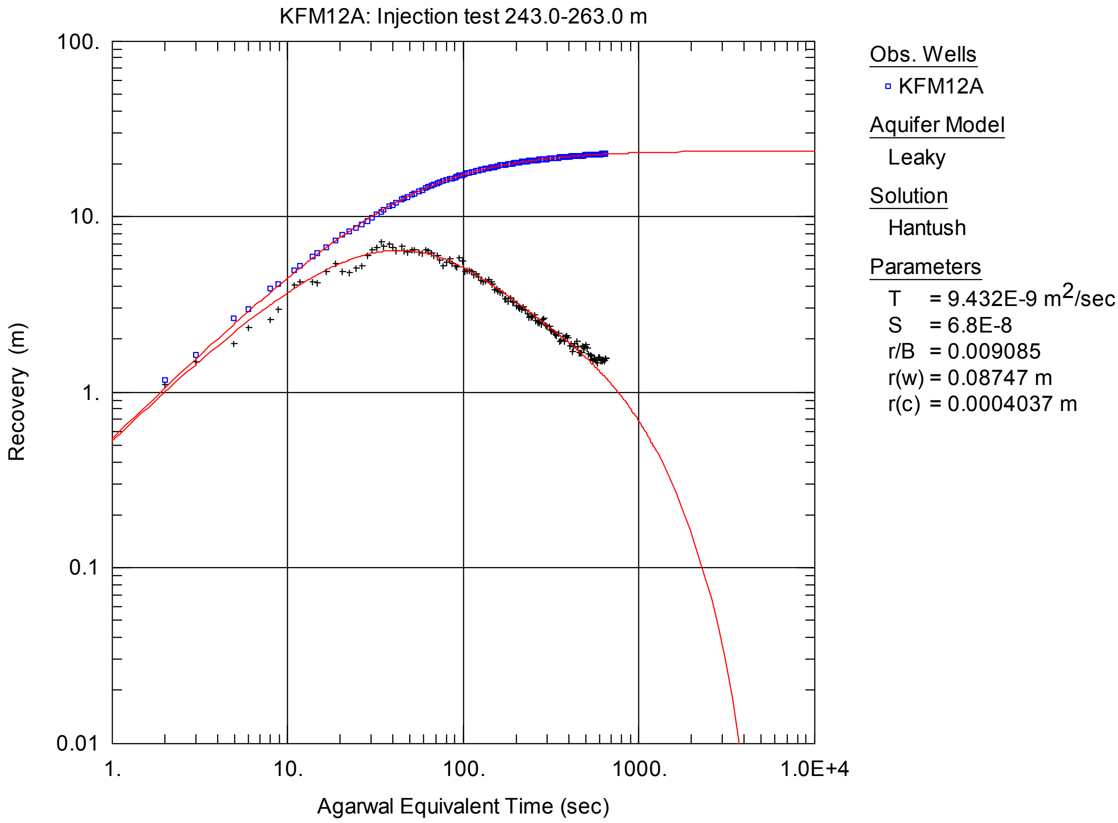


Figure A3-79. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 243.0-263.0 m in KFM12A.*

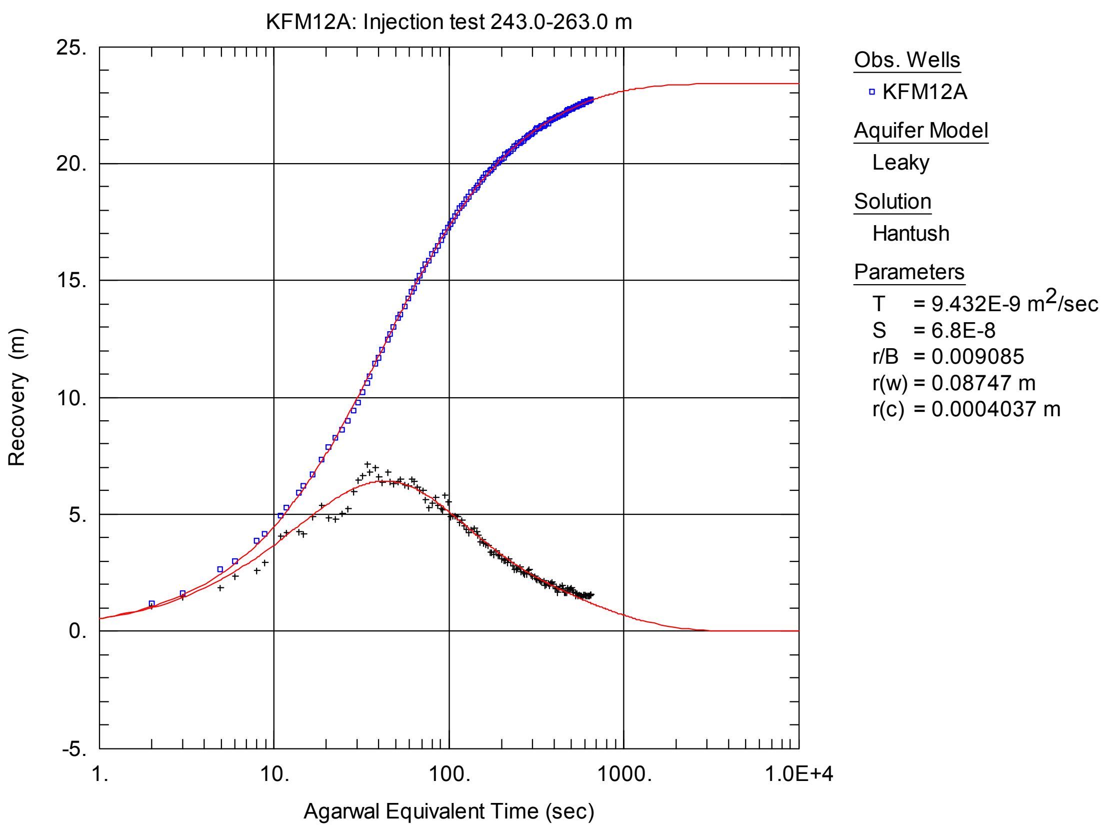


Figure A3-80. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 243.0-263.0 m in KFM12A.*

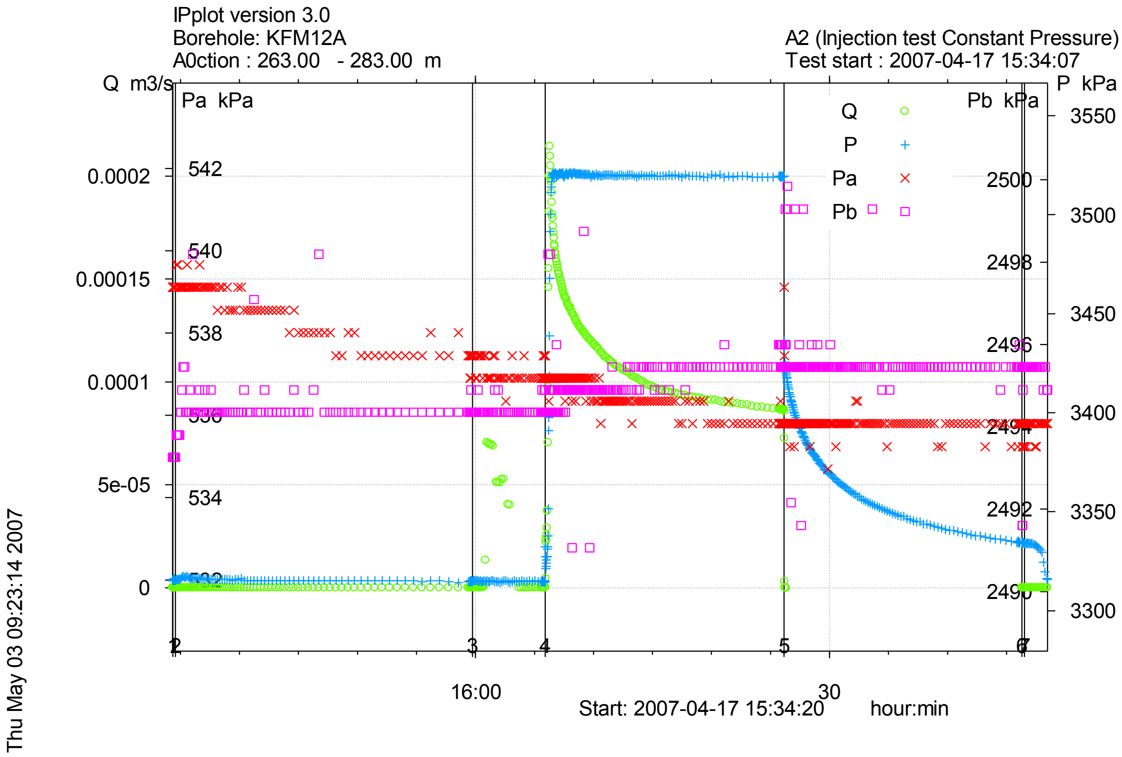


Figure A3-81. Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 263.0-283.0 m in borehole KFM12A.

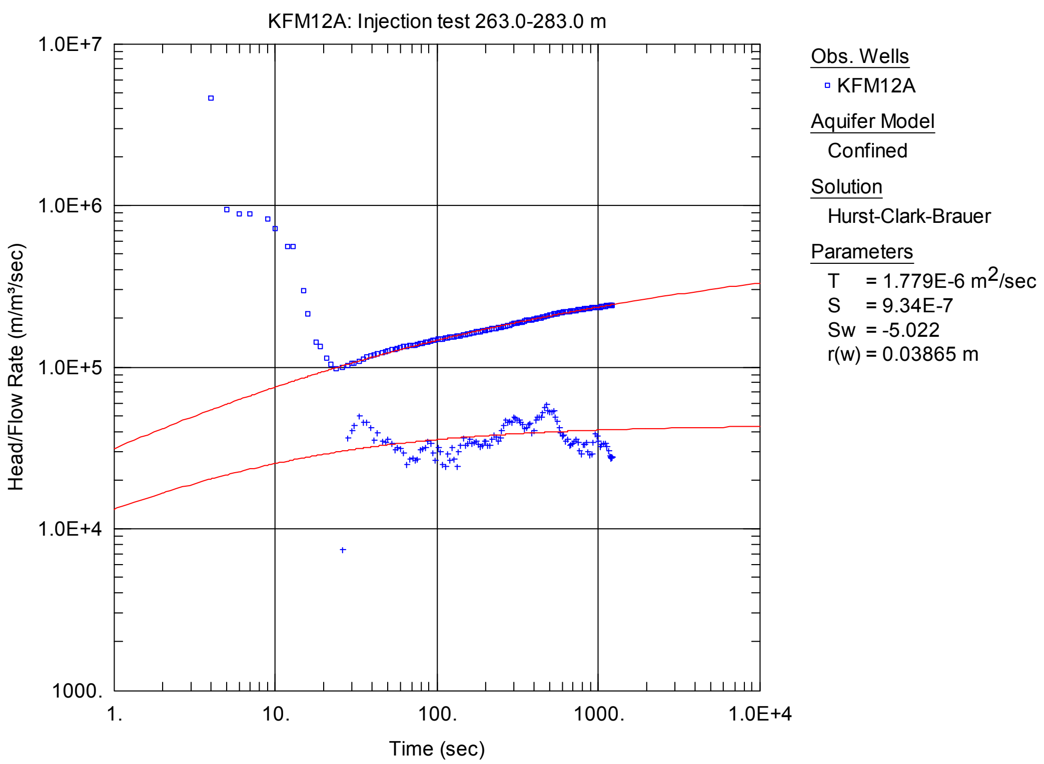


Figure A3-82. Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 263.0-283.0 m in KFM12A.

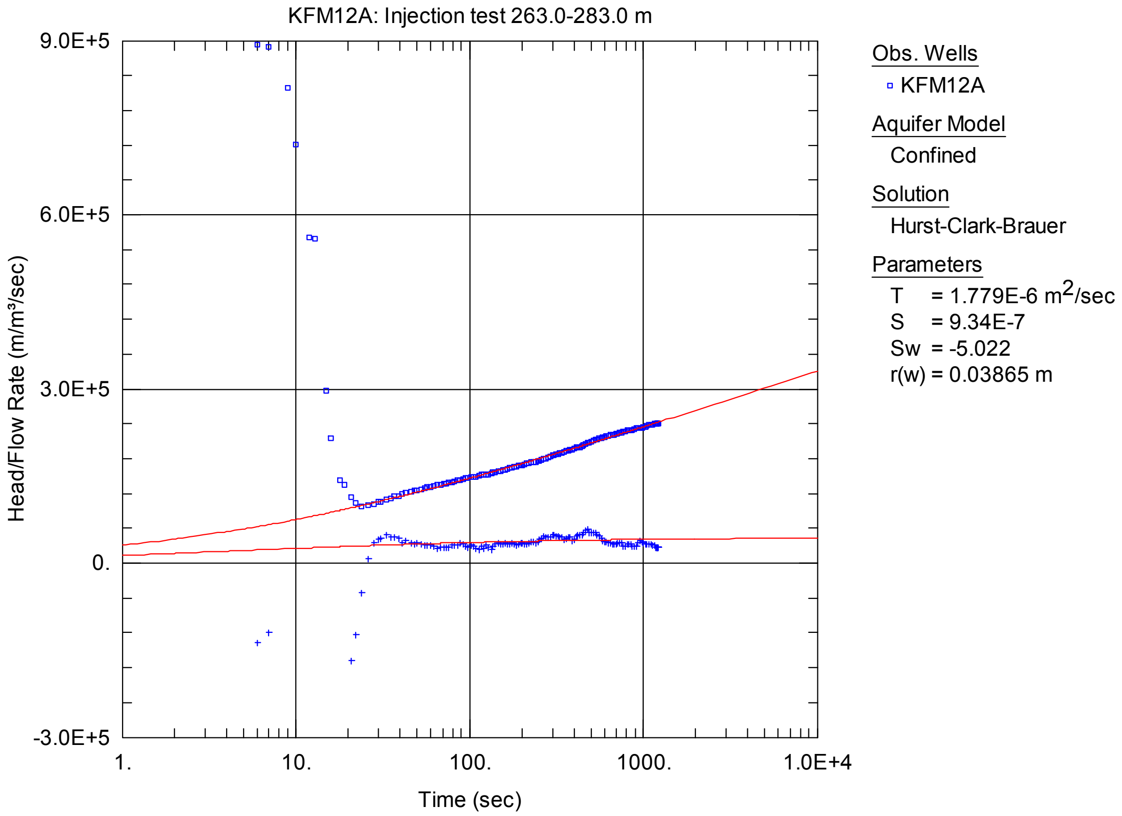


Figure A3-83. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 263.0-283.0 m in KFM12A.*

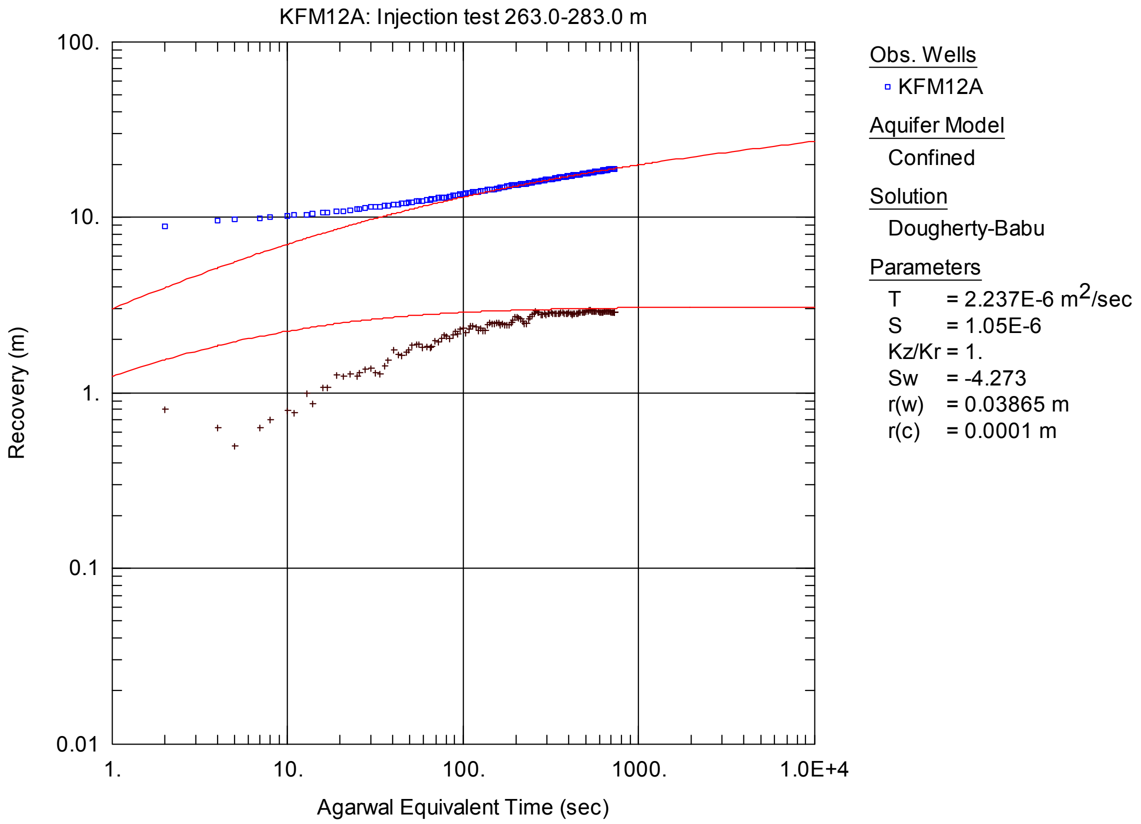


Figure A3-84. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 263.0-283.0 m in KFM12A.*

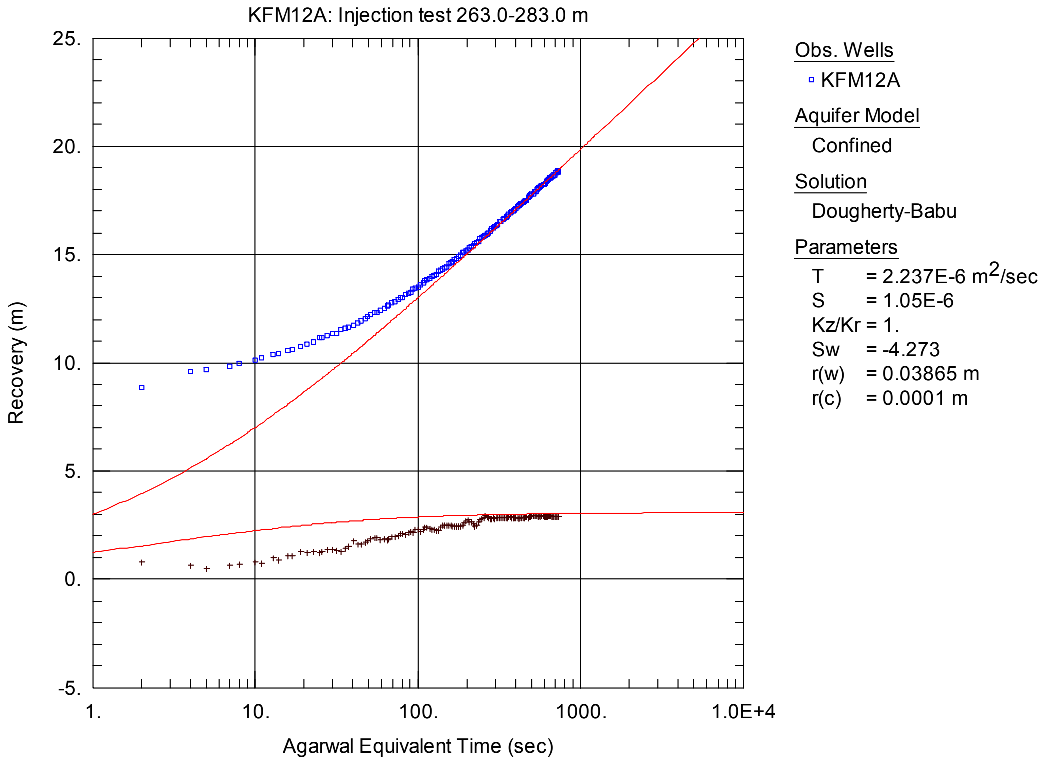


Figure A3-85. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 263.0-283.0 m in KFM12A.*

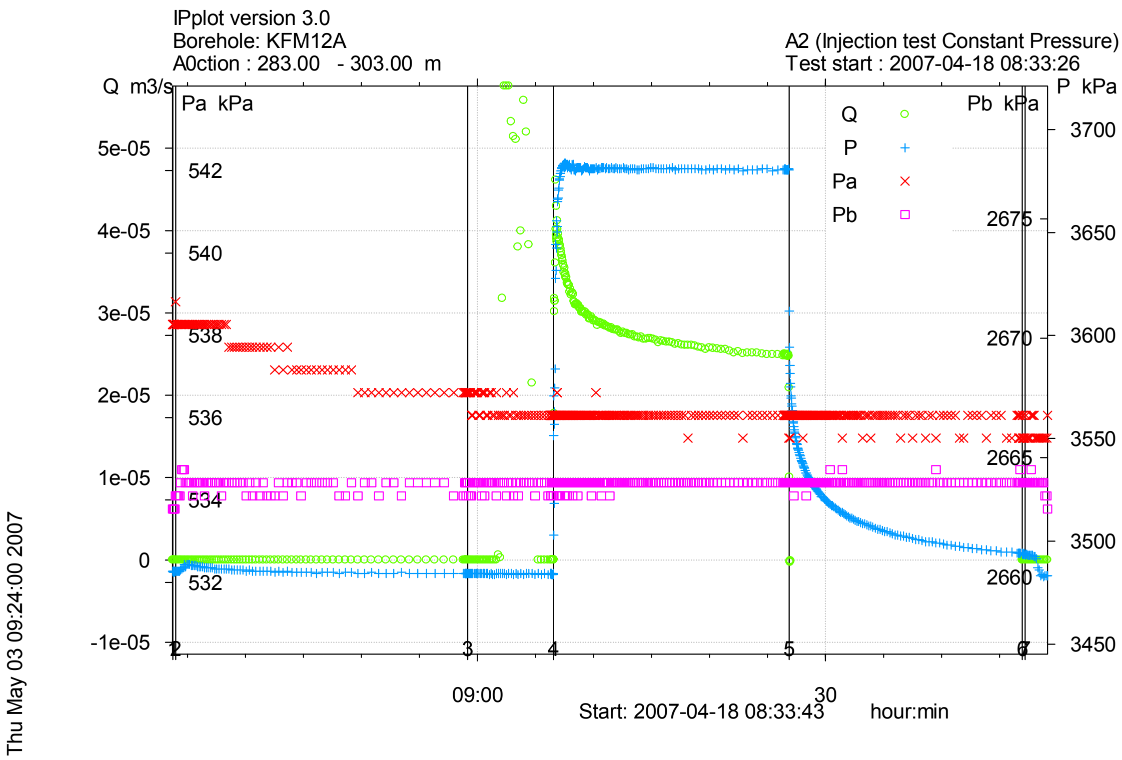


Figure A3-86. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 283.0-303.0 m in borehole KFM12A.*

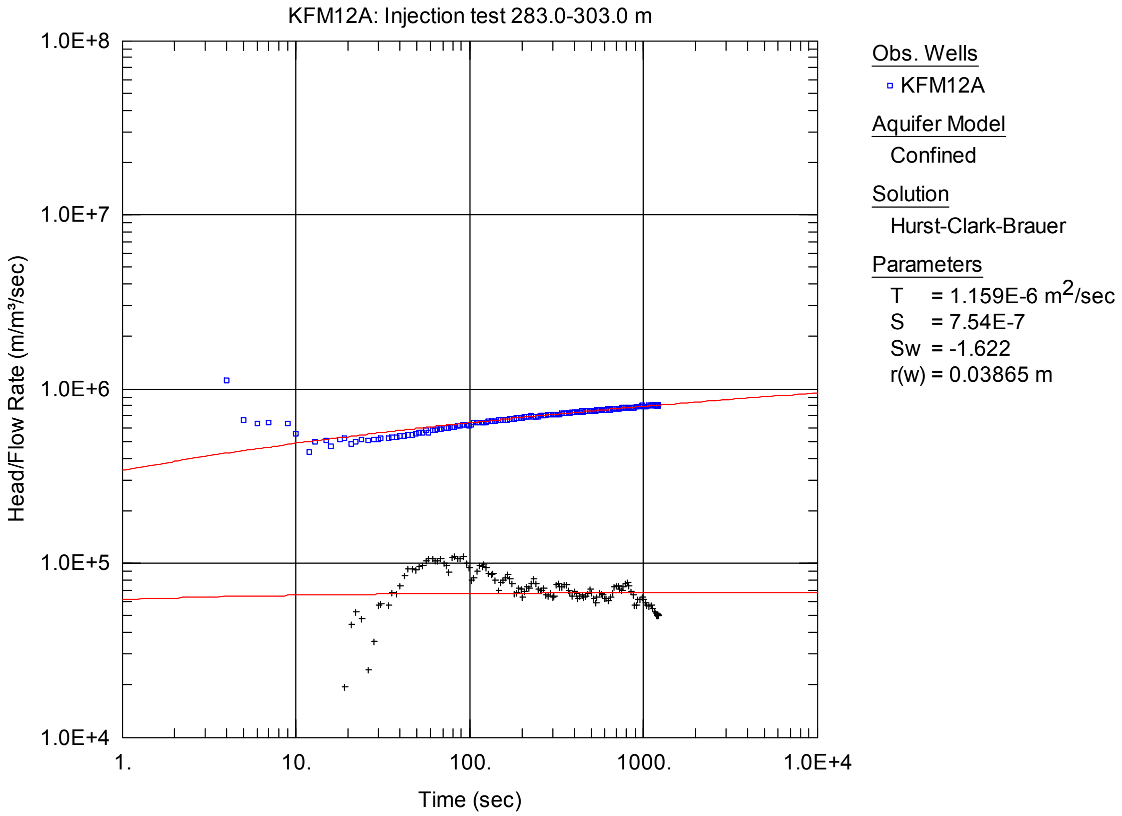


Figure A3-87. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 283.0-303.0 m in borehole KFM12A.*

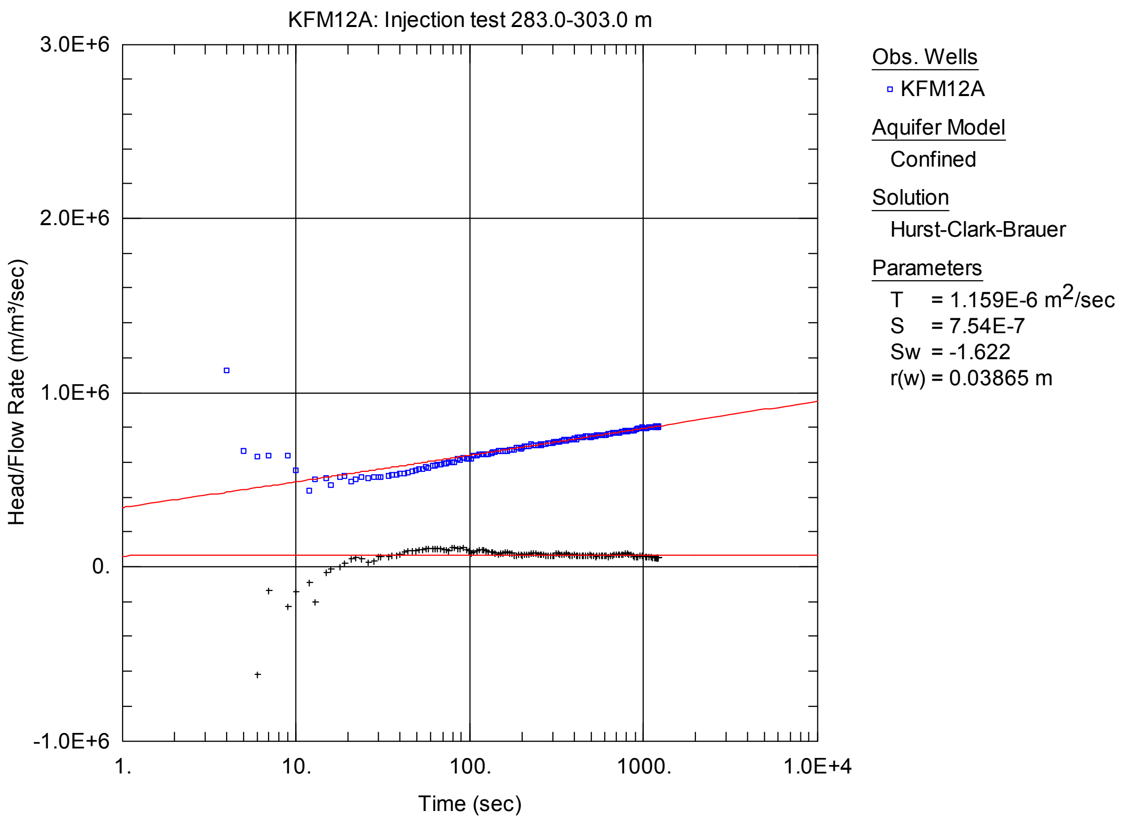


Figure A3-88. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 283.0-303.0 m in KFM12A.*

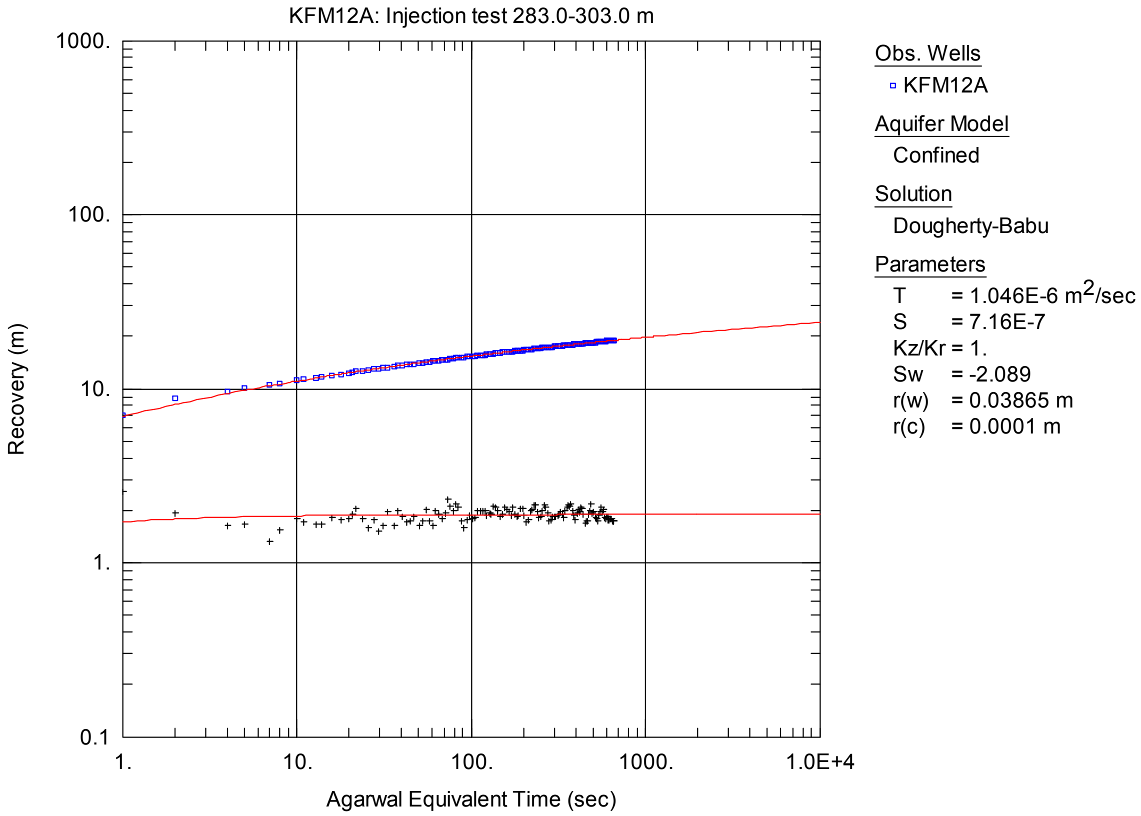


Figure A3-89. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 283.0-303.0 m in KFM12A.*

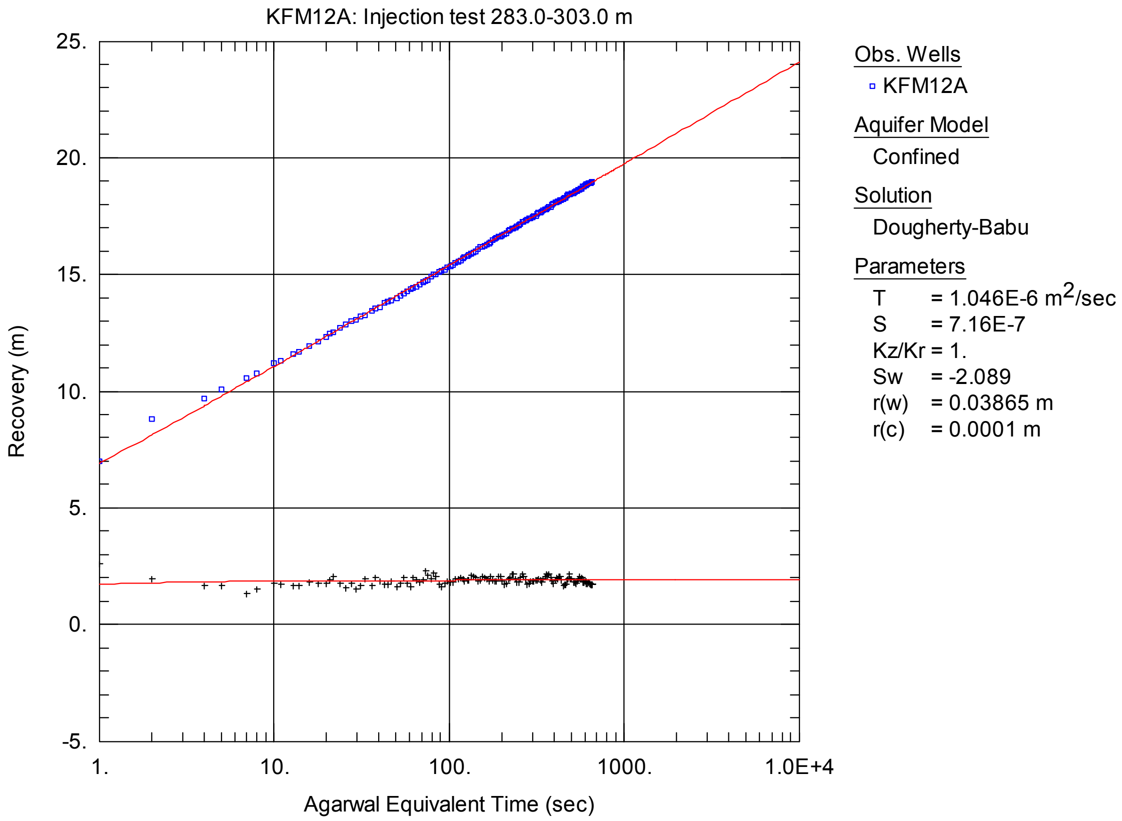


Figure A3-90. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 283.0-303.0 m in KFM12A.*

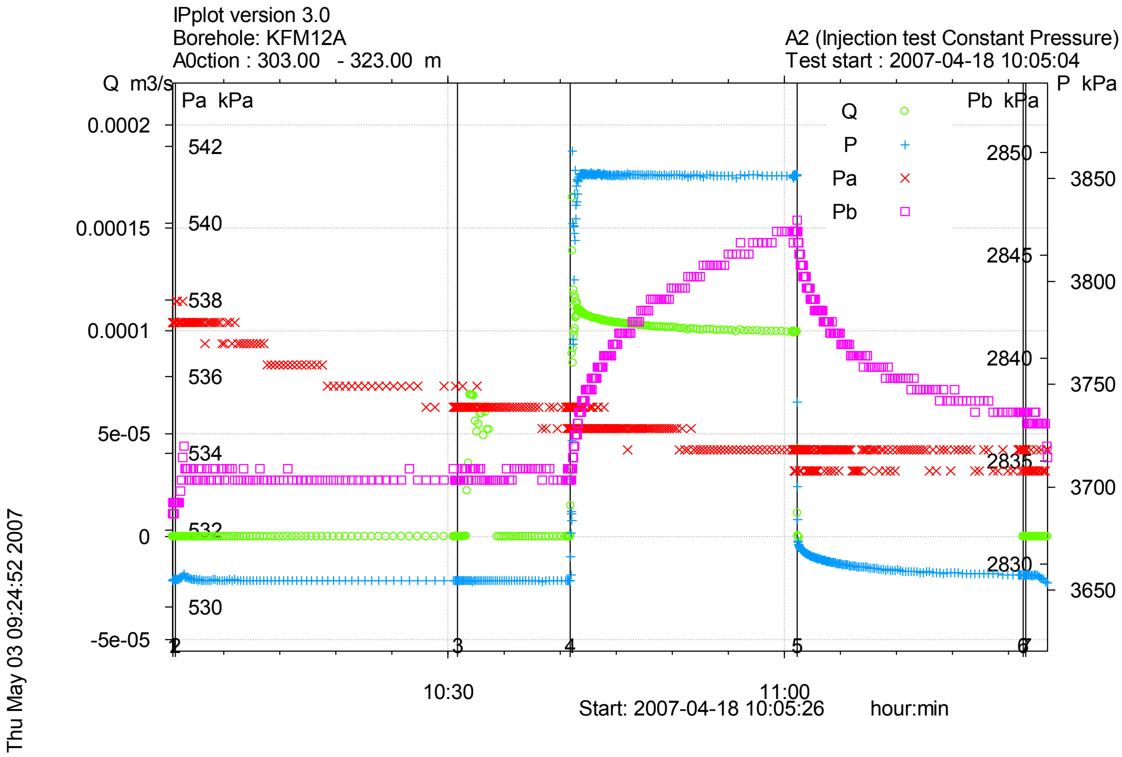


Figure A3-91. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 303.0-323.0 m in borehole KFM12A.*

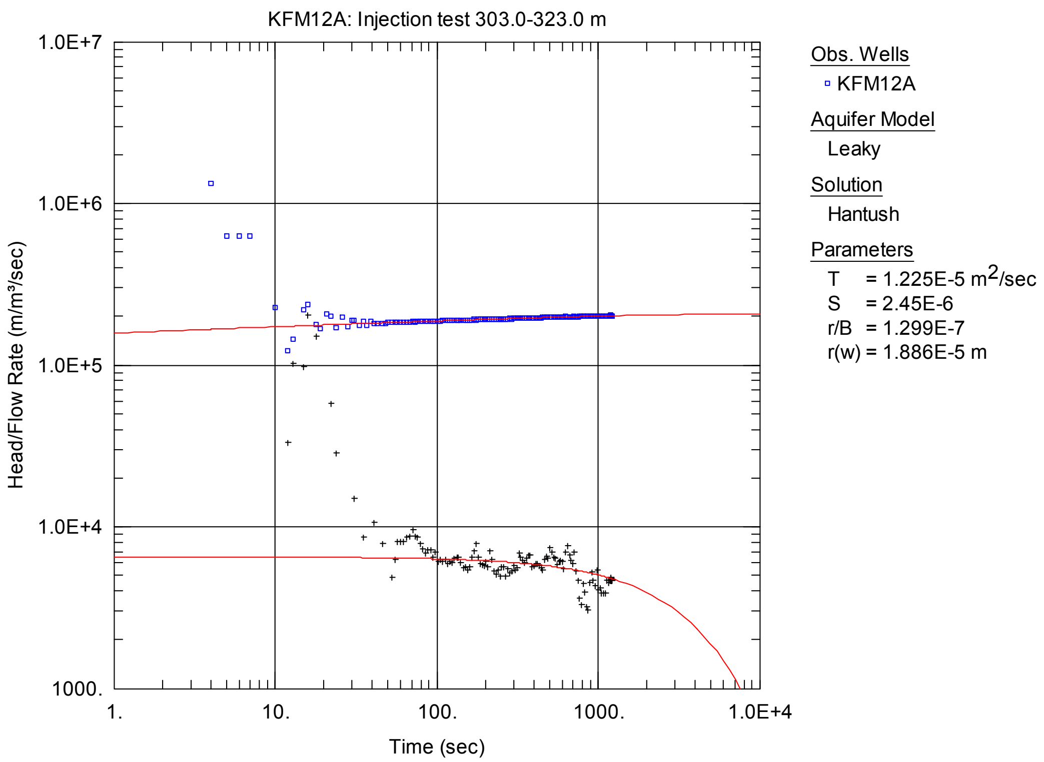


Figure A3-92. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 303.0-323.0 m in KFM12A.*

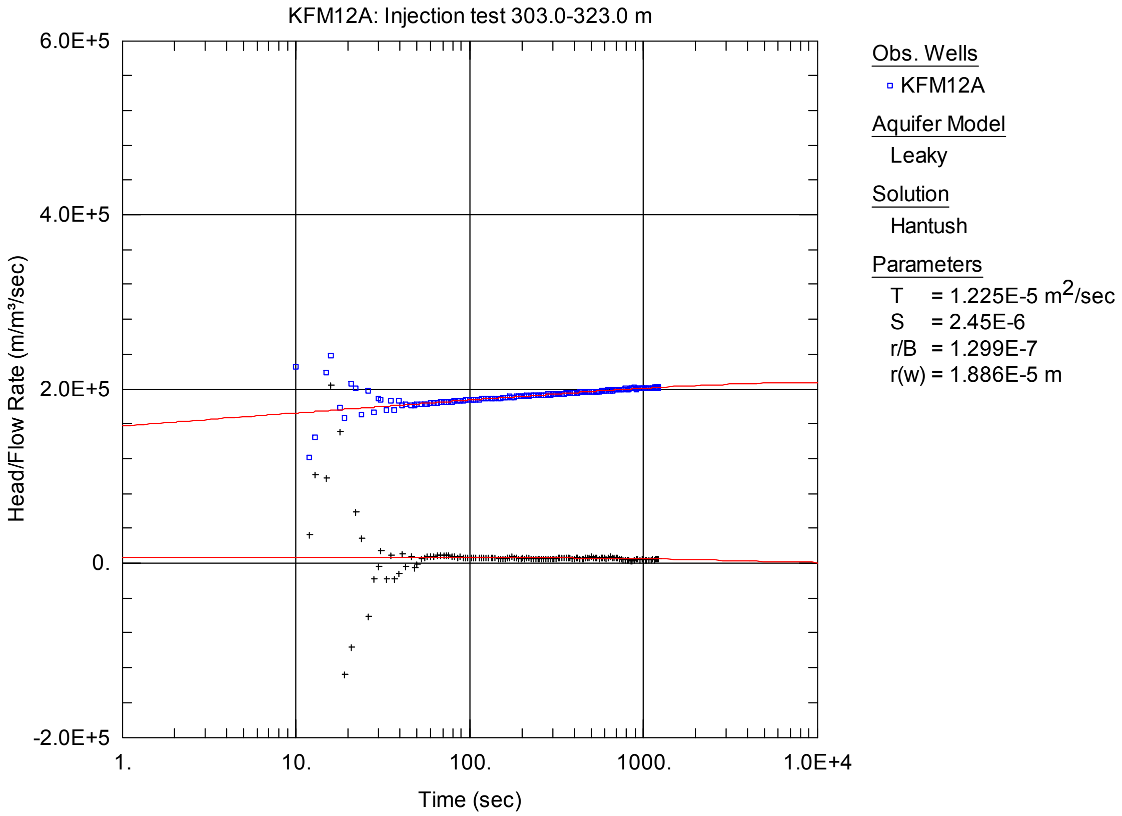


Figure A3-93. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 303.0-323.0 m in KFM12A.*

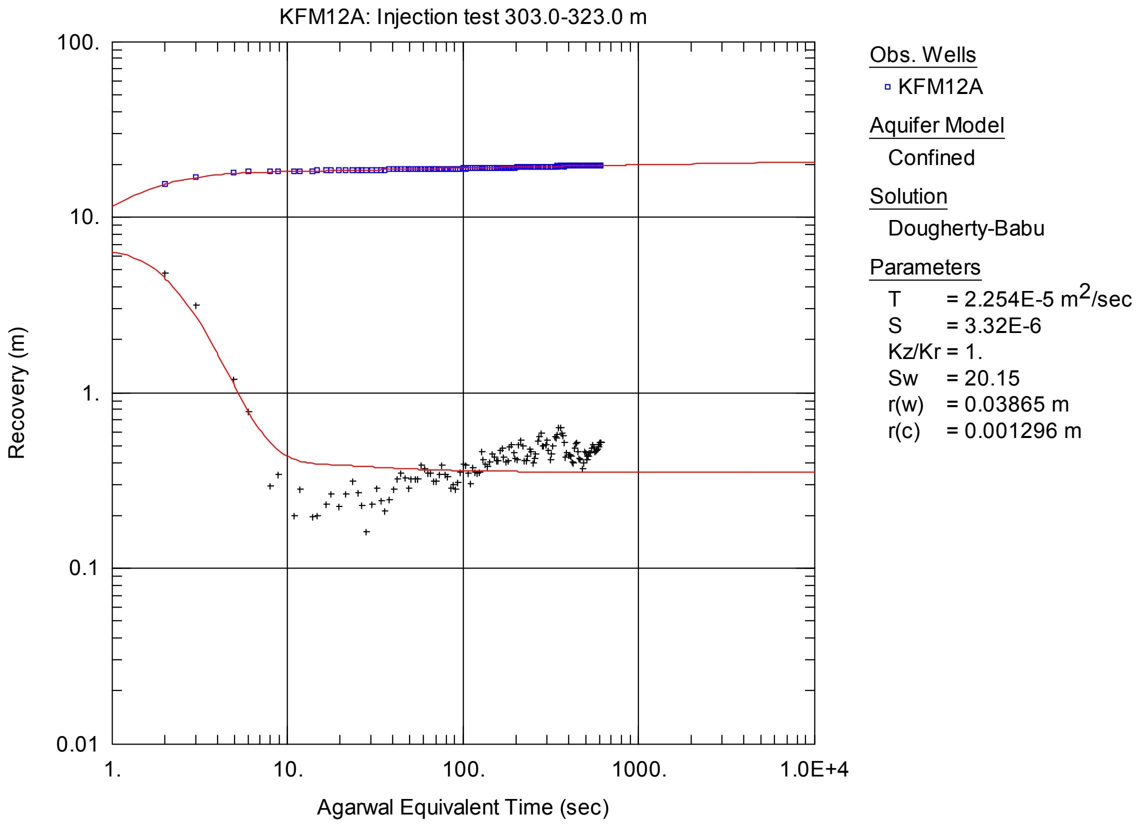


Figure A3-94. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 303.0-323.0 m in KFM12A.*

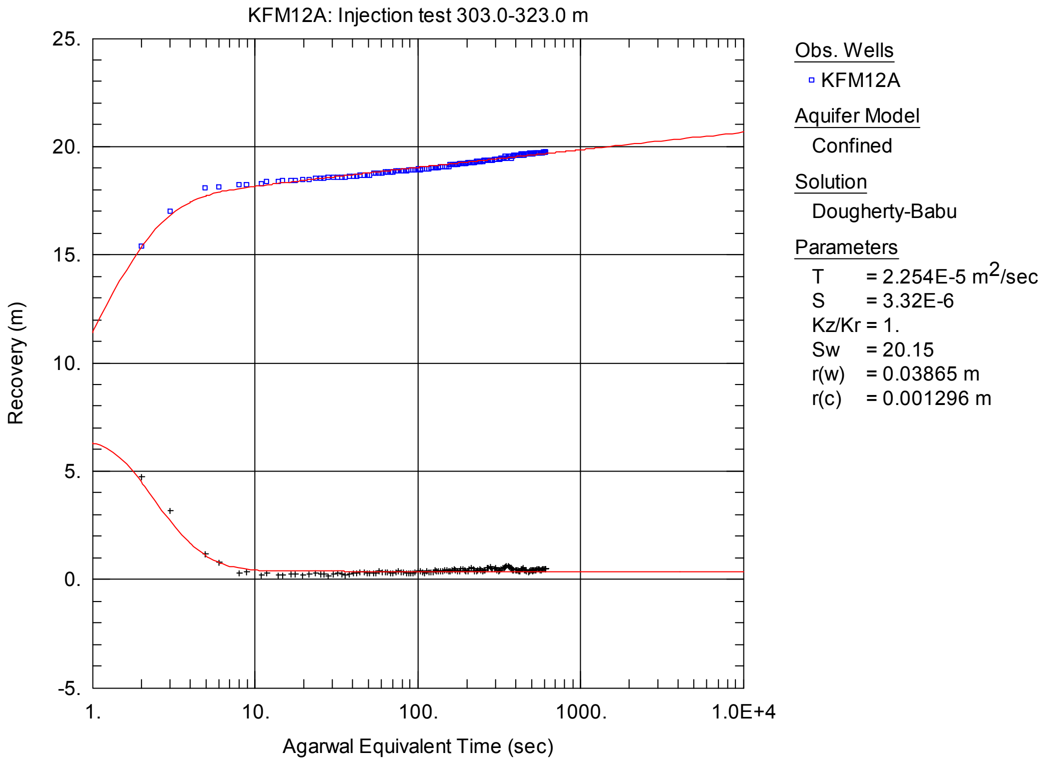


Figure A3-95. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 303.0-323.0 m in KFM12A.*

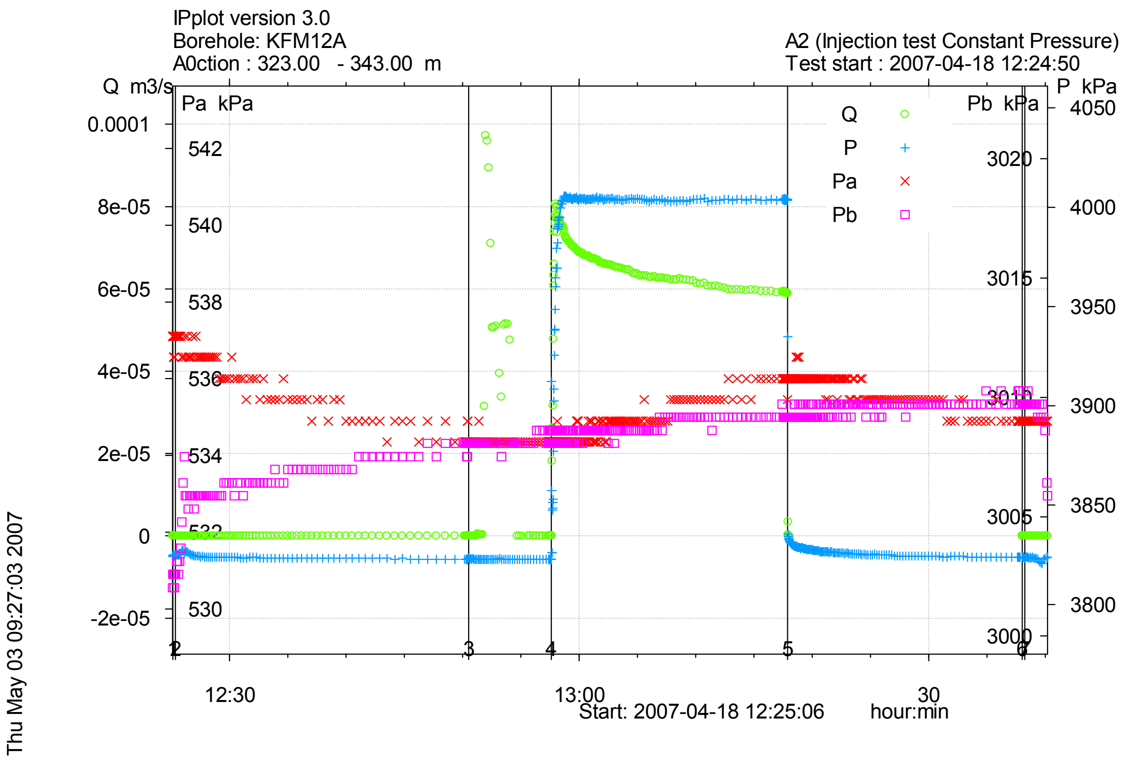


Figure A3-96. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 323.0-343.0 m in borehole KFM12A.*

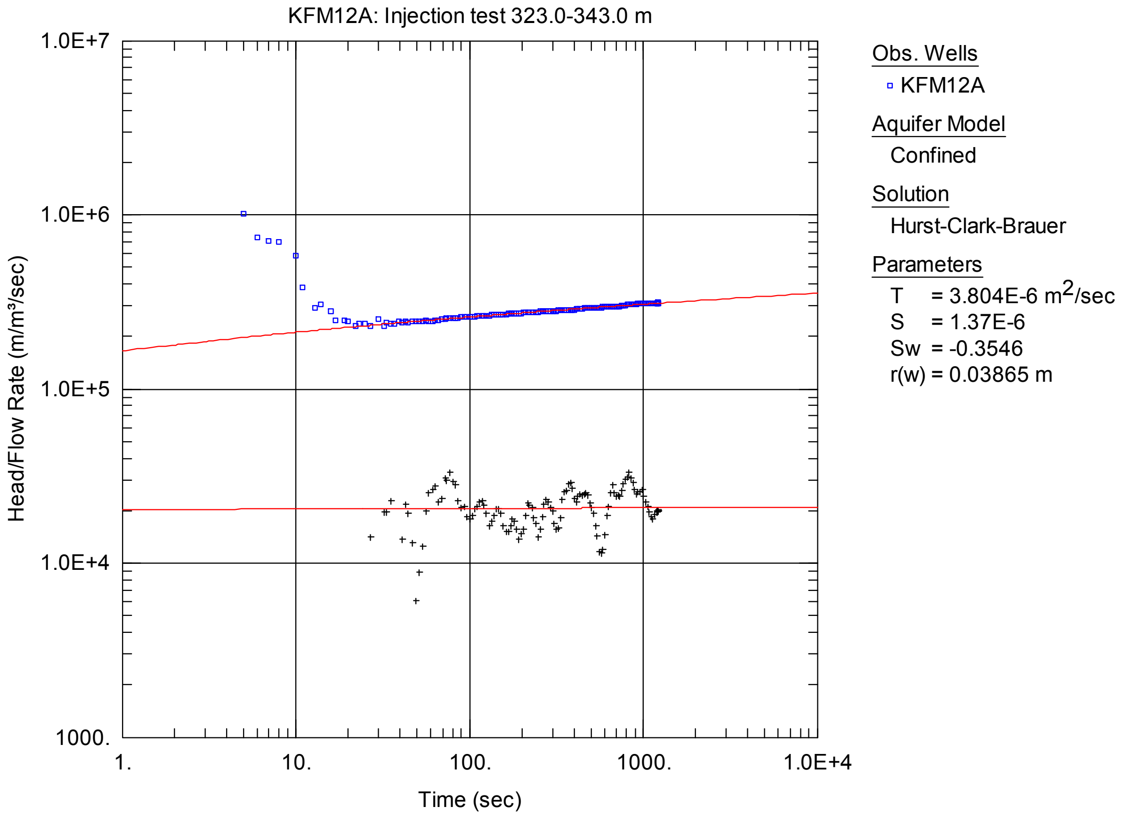


Figure A3-97. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 323.0-343.0 m in borehole KFM12A.*

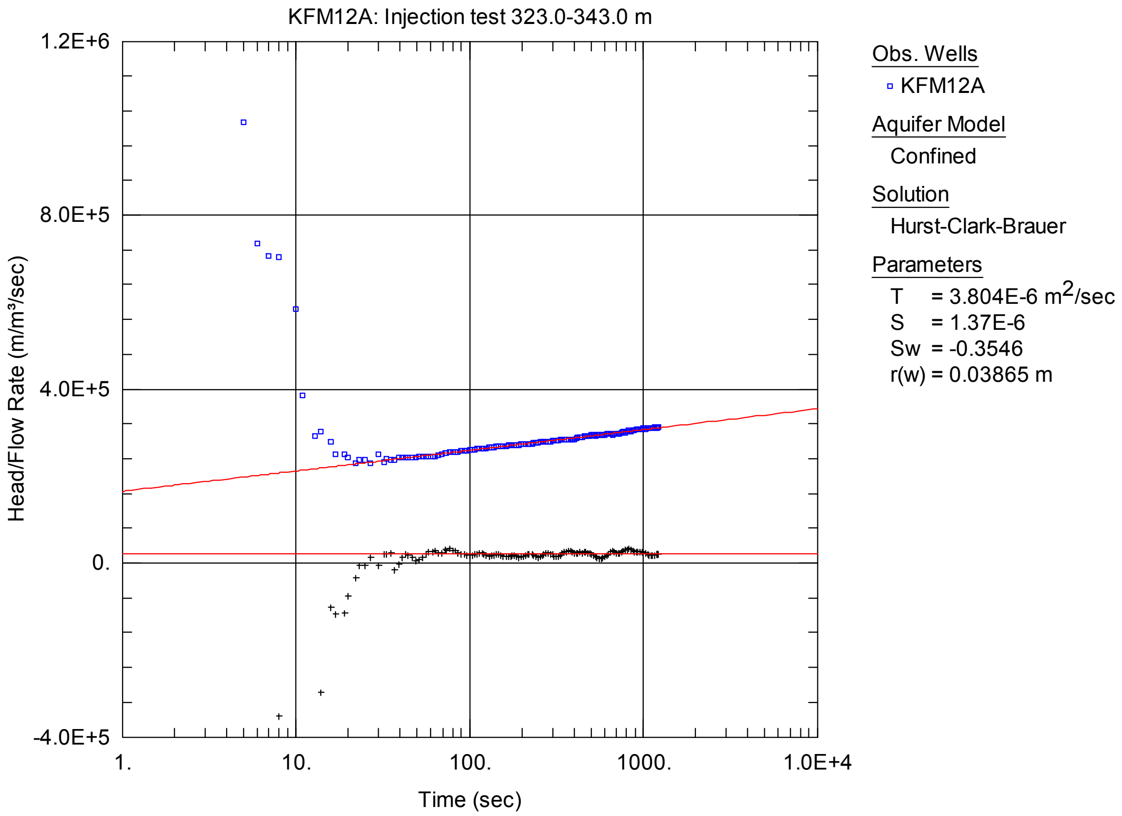


Figure A3-98. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 323.0-343.0 m in KFM12A.*

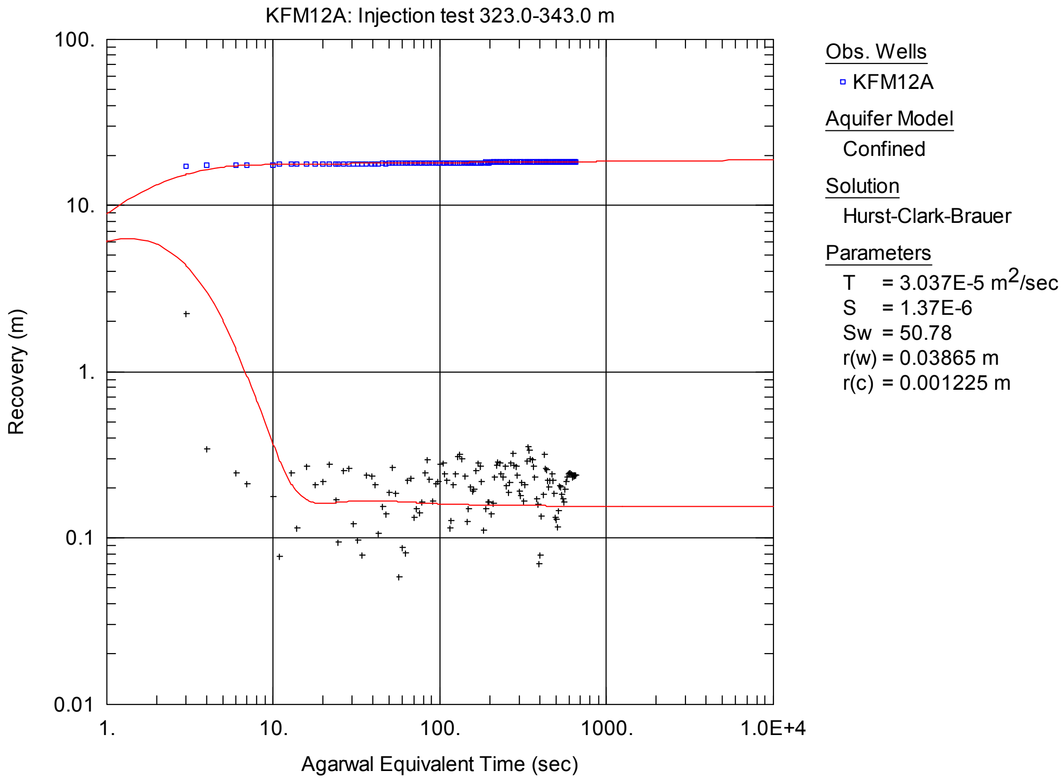


Figure A3-99. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 323.0-343.0 m in KFM12A. The type curve fit is showing a possible, however not unambiguous, evaluation.*

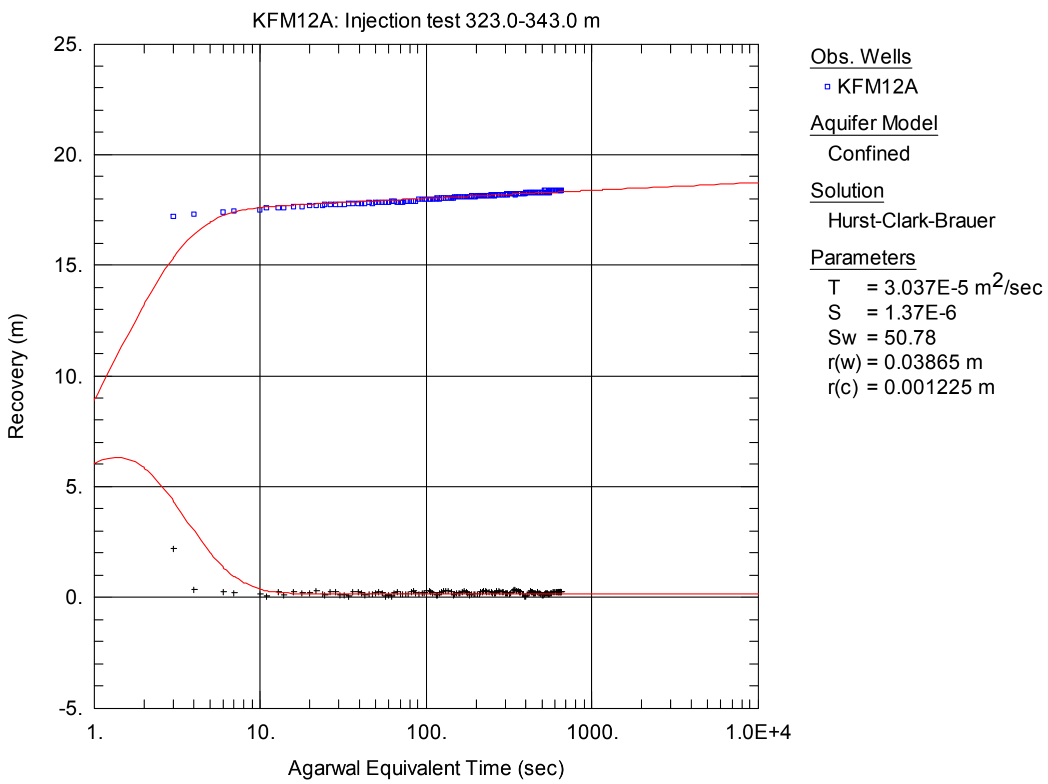


Figure A3-100. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 323.0-343.0 m in KFM12A. The type curve fit is showing a possible, however not unambiguous, evaluation.*

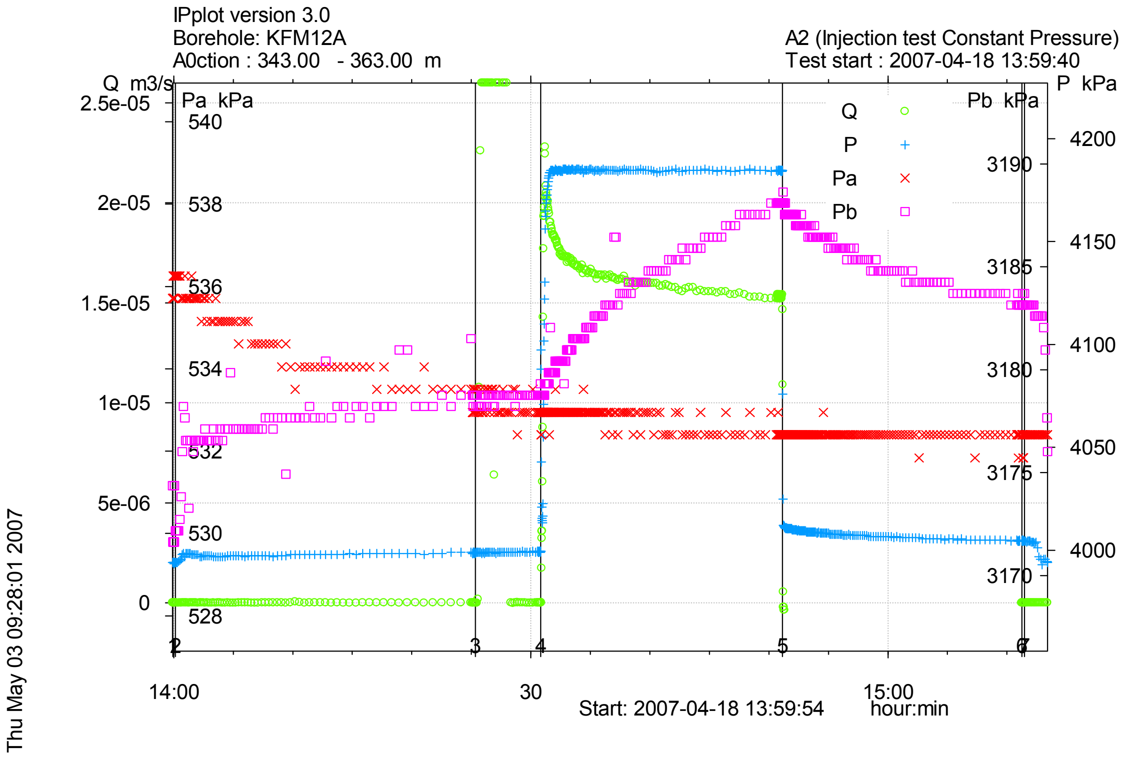


Figure A3-101. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 343.0-363.0 m in borehole KFM12A.*

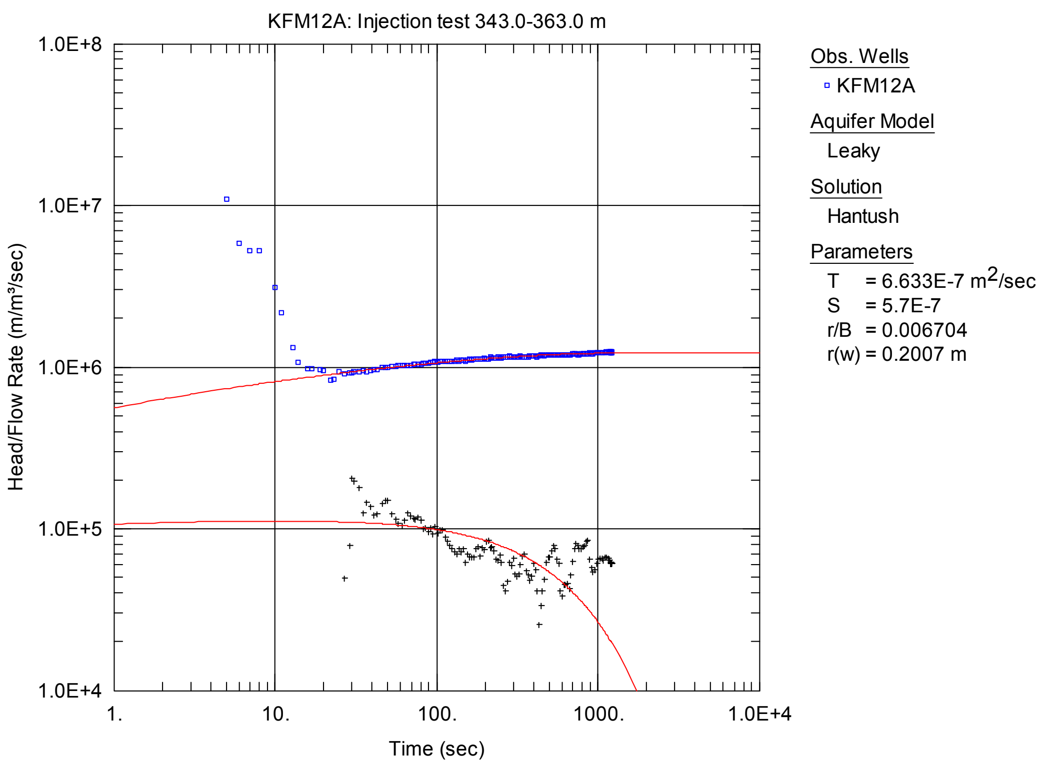


Figure A3-102. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 343.0-363.0 m in KFM12A.*

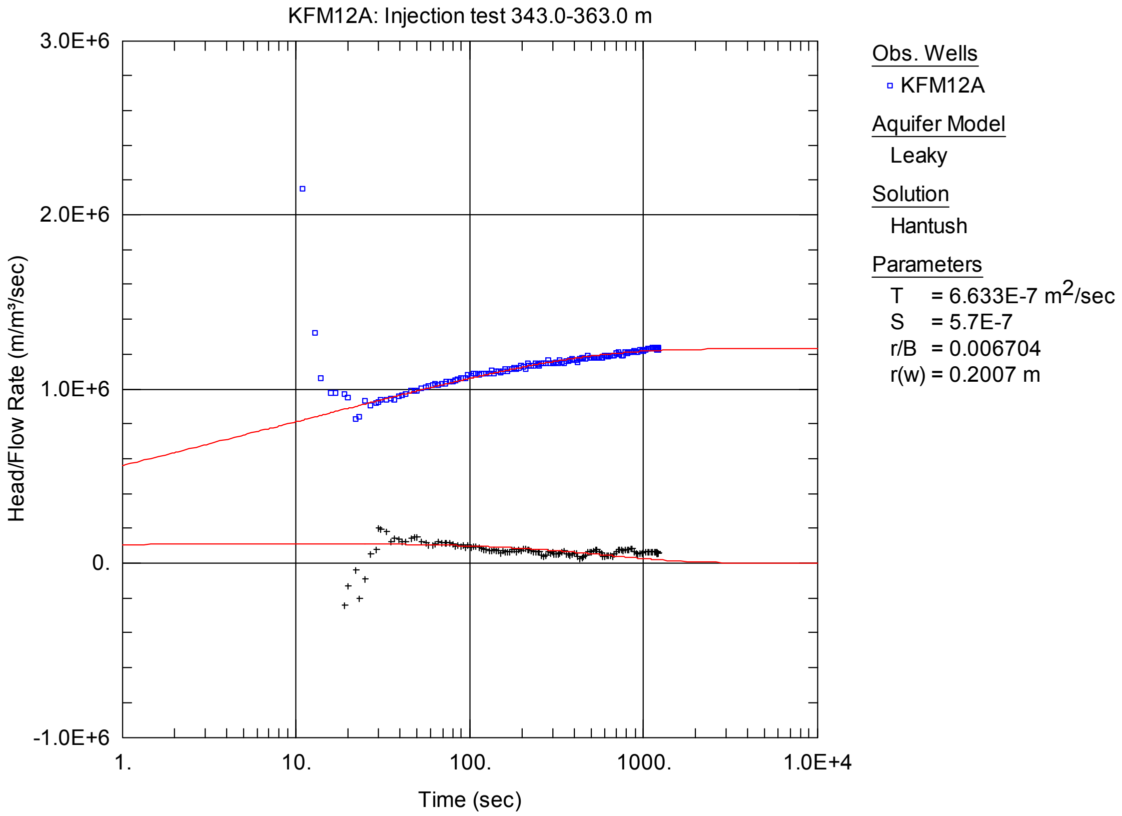


Figure A3-103. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 343.0-363.0 m in KFM12A.*

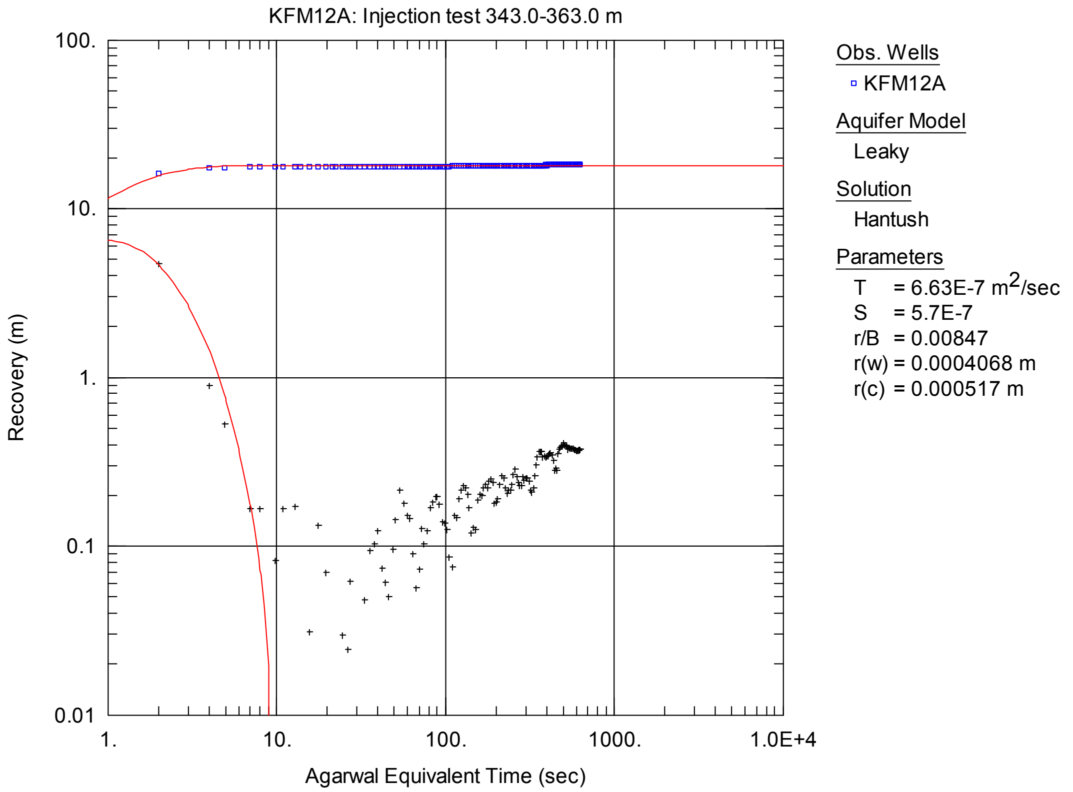


Figure A3-104. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 343.0-363.0 m in KFM12A. The type curve fit is showing a possible, however not unambiguous, evaluation.*

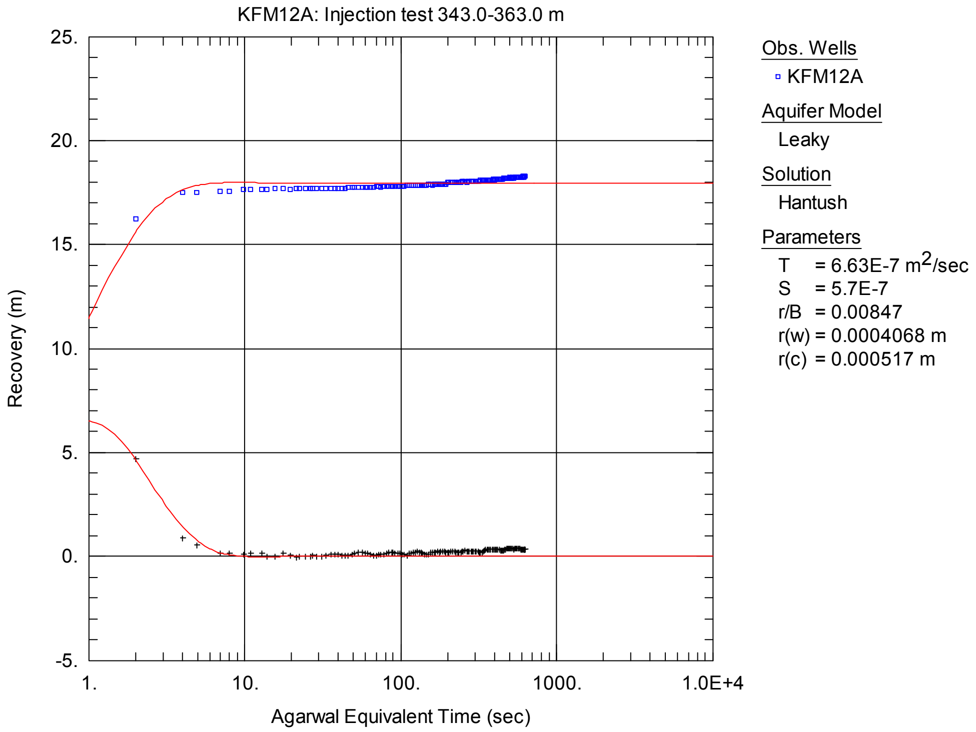


Figure A3-105. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 343.0-363.0 m in KFM12A. The type curve fit is showing a possible, however not unambiguous, evaluation.*

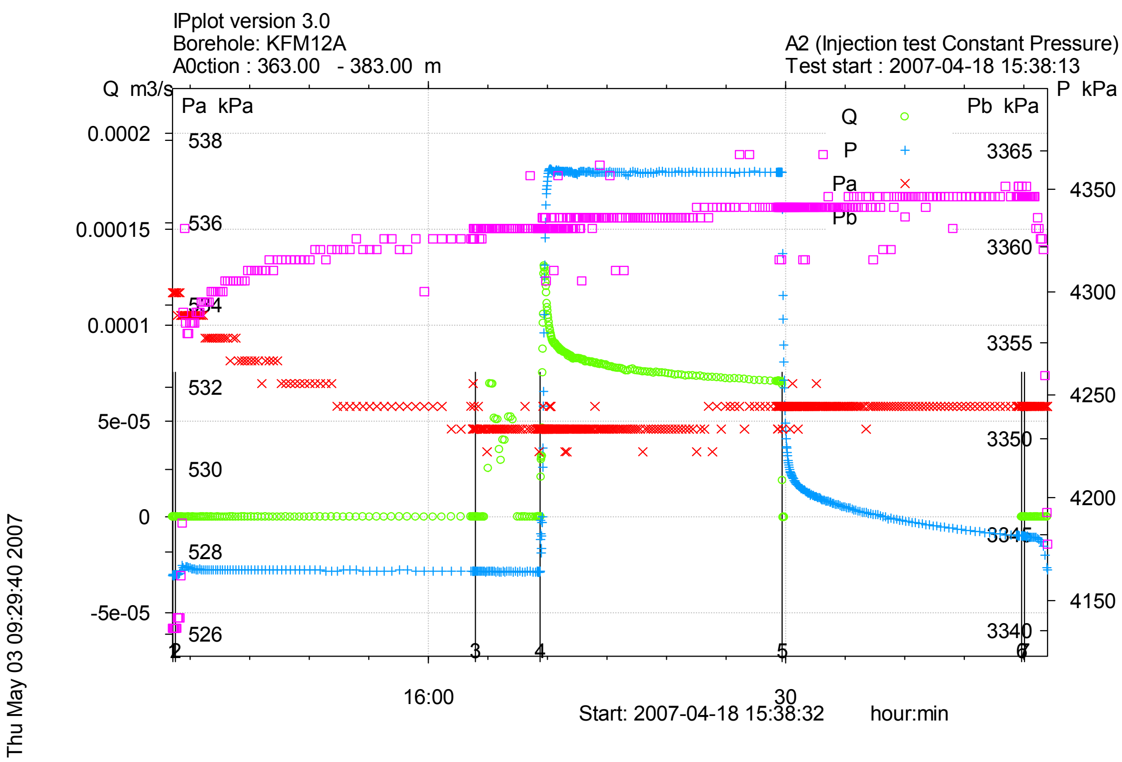


Figure A3-106. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 363.0-383.0 m in borehole KFM12A.*

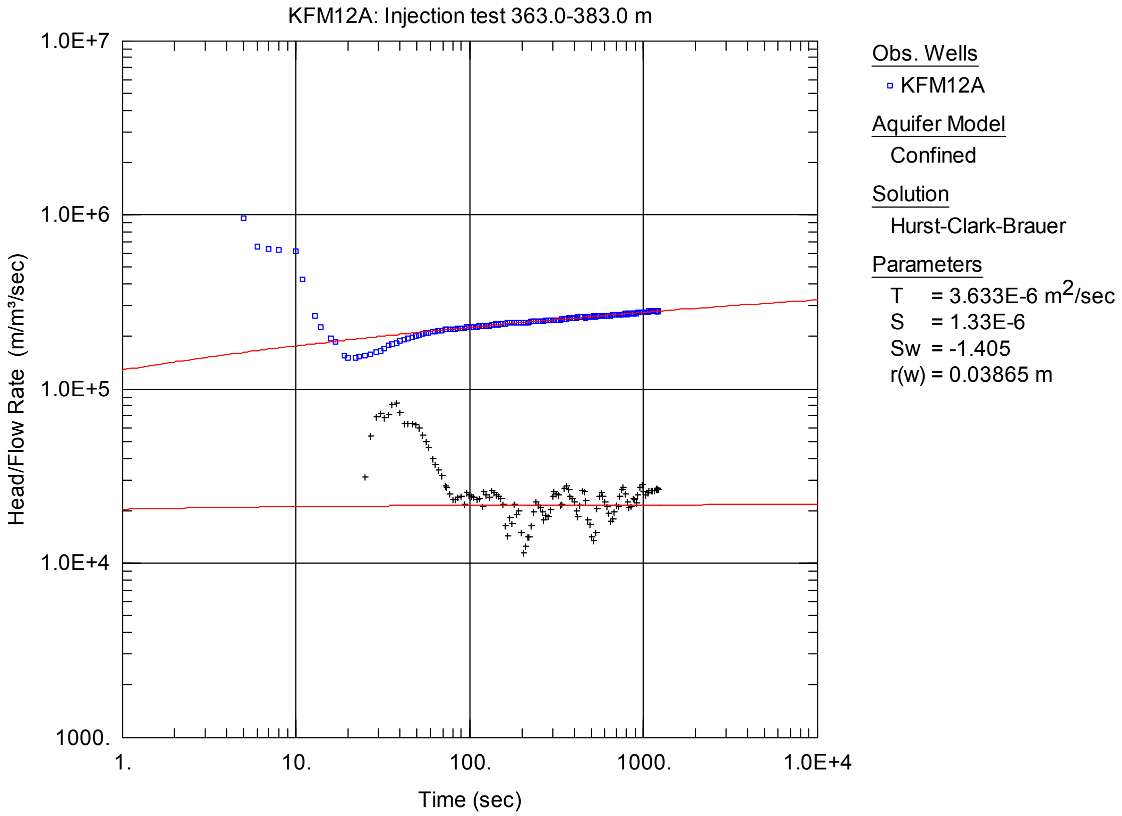


Figure A3-107. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 363.0-383.0 m in borehole KFM12A.*

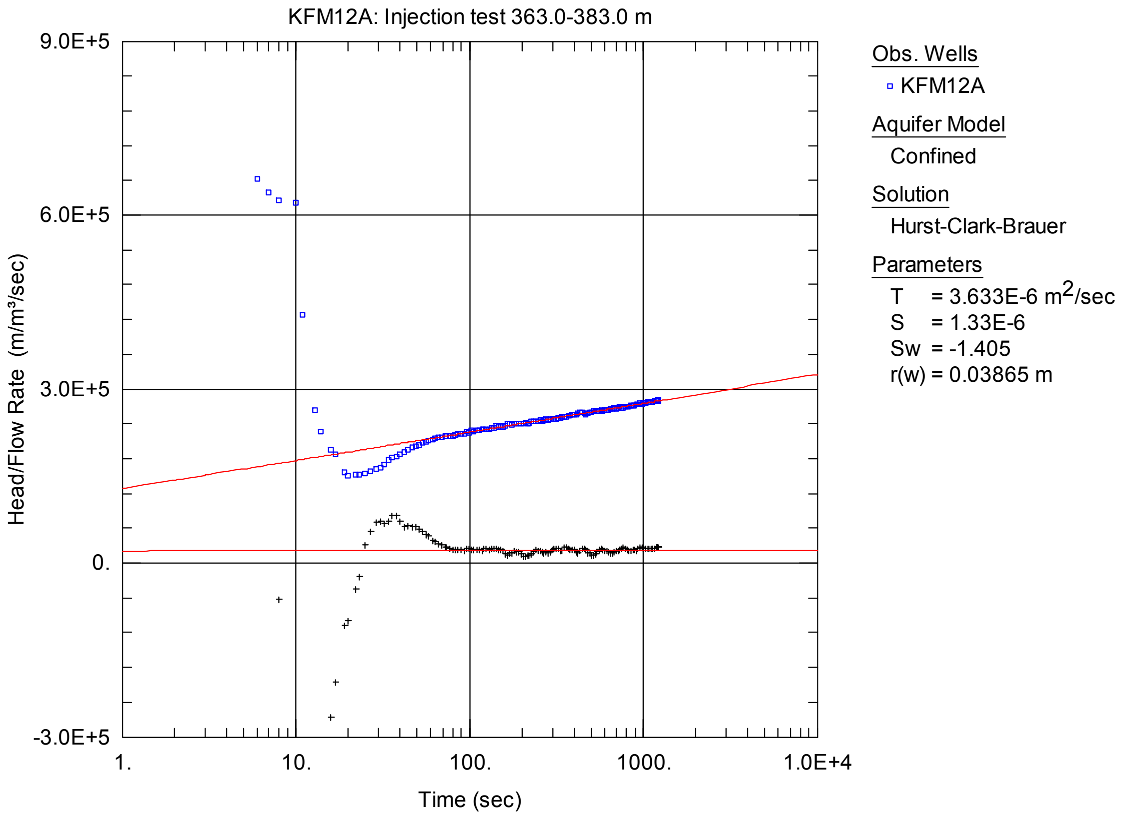


Figure A3-108. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 363.0-383.0 m in KFM12A.*

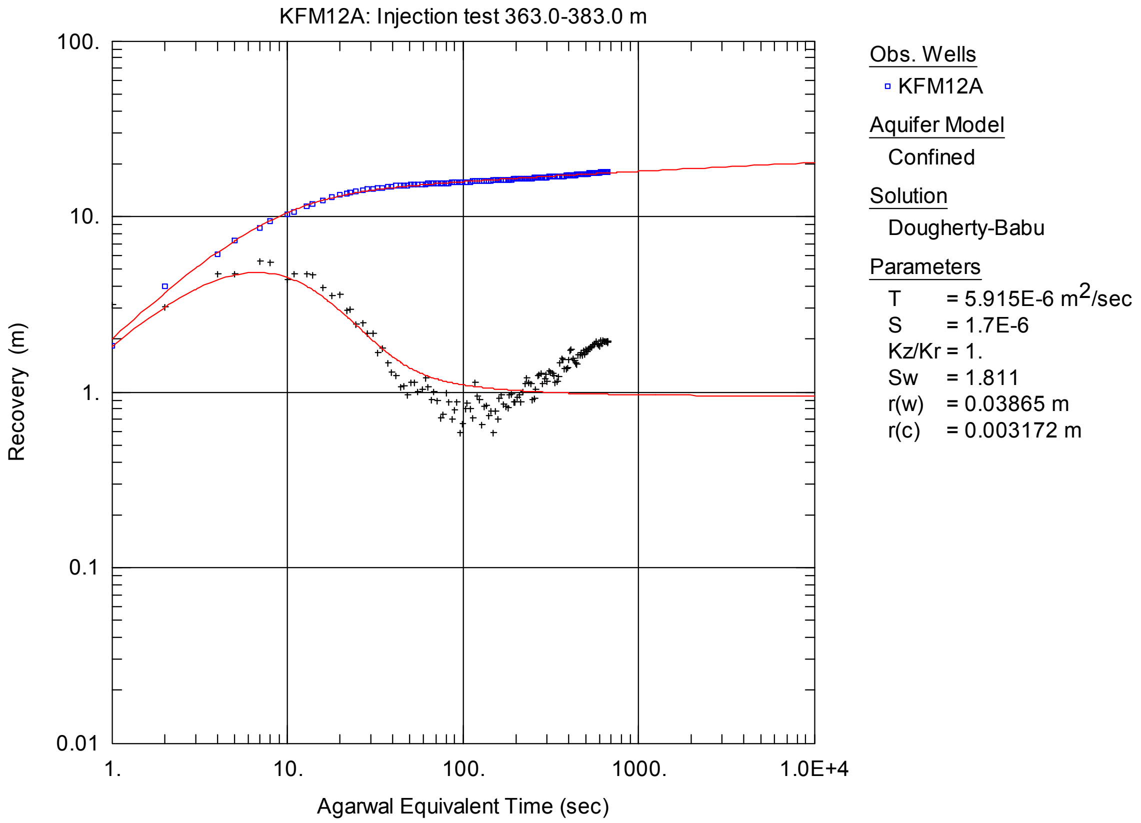


Figure A3-109. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 363.0-383.0 m in KFM12A.*

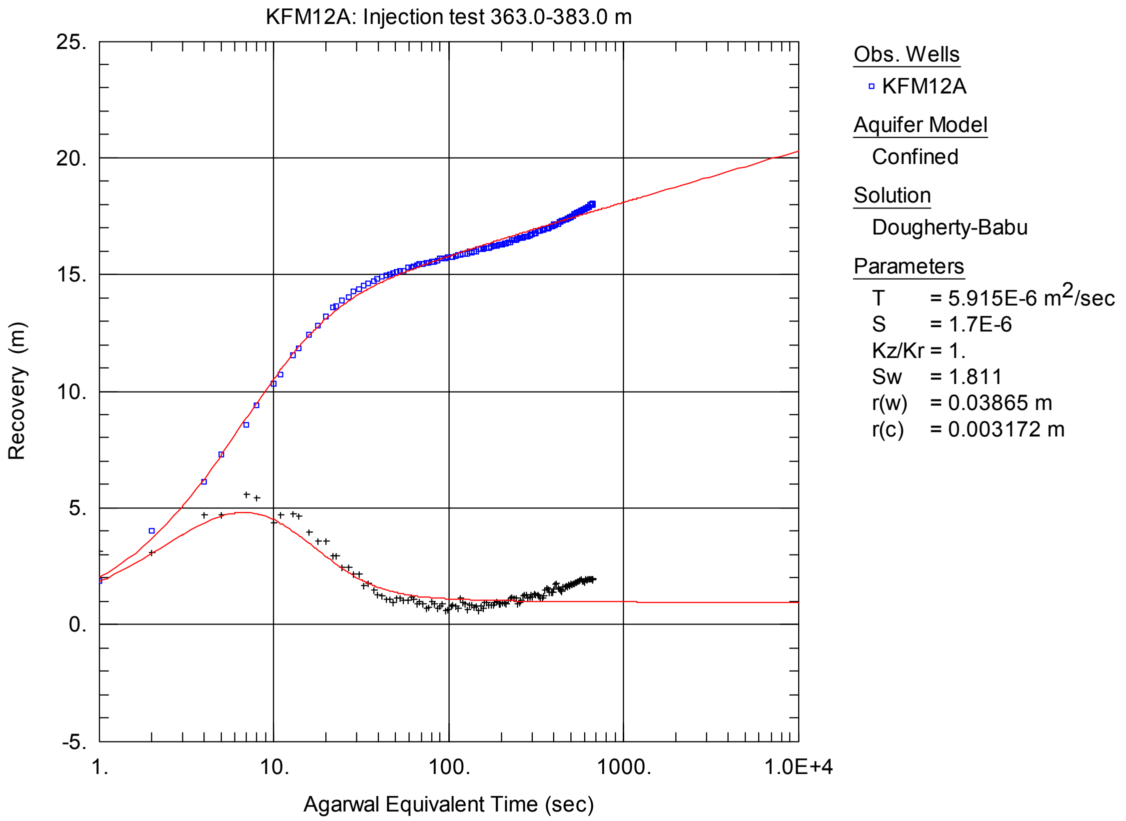


Figure A3-110. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 363.0-383.0 m in KFM12A.*

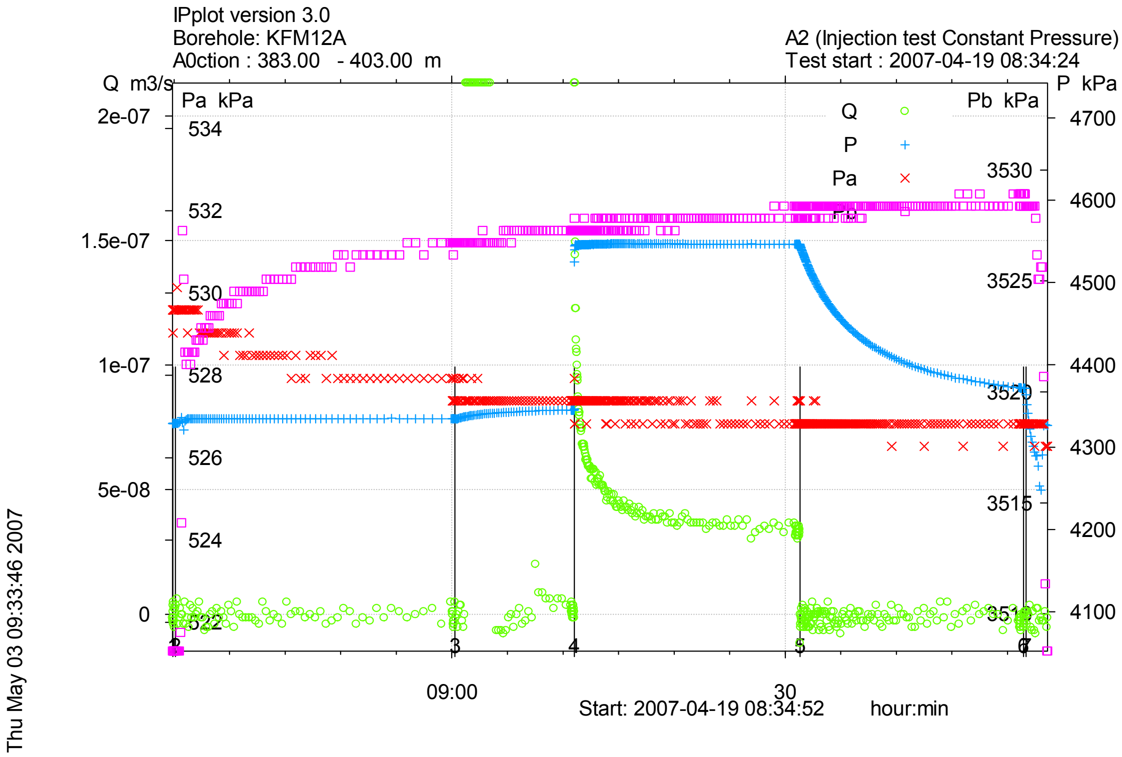


***Figure A3-111.** Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 383.0-403.0 m in borehole KFM12A.*

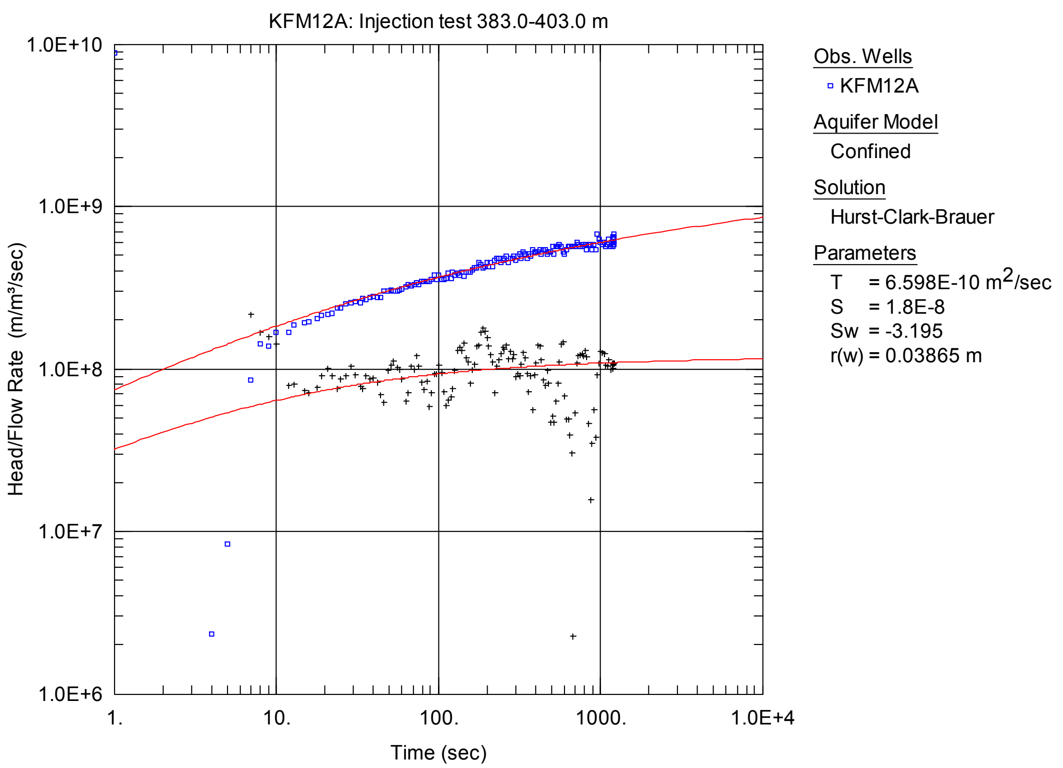


***Figure A3-112.** Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 383.0-403.0 m in KFM12A.*

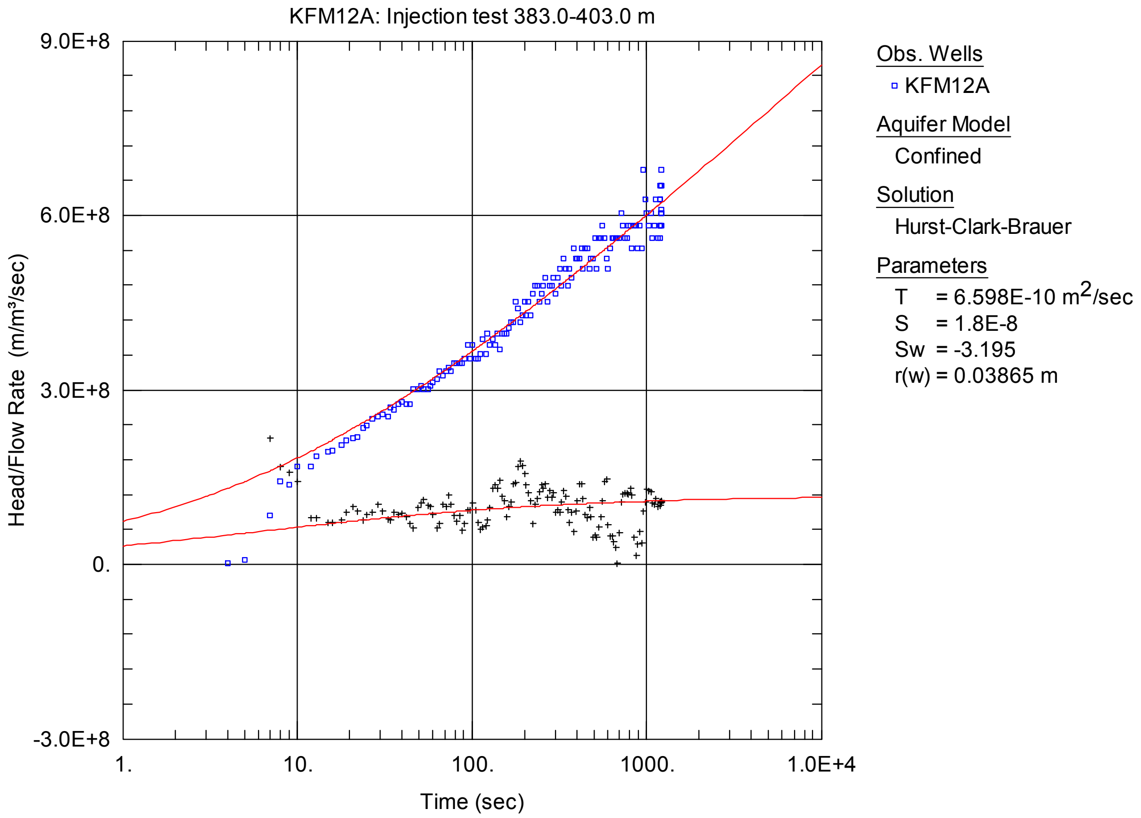


Figure A3-113. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 383.0-403.0 m in KFM12A.*

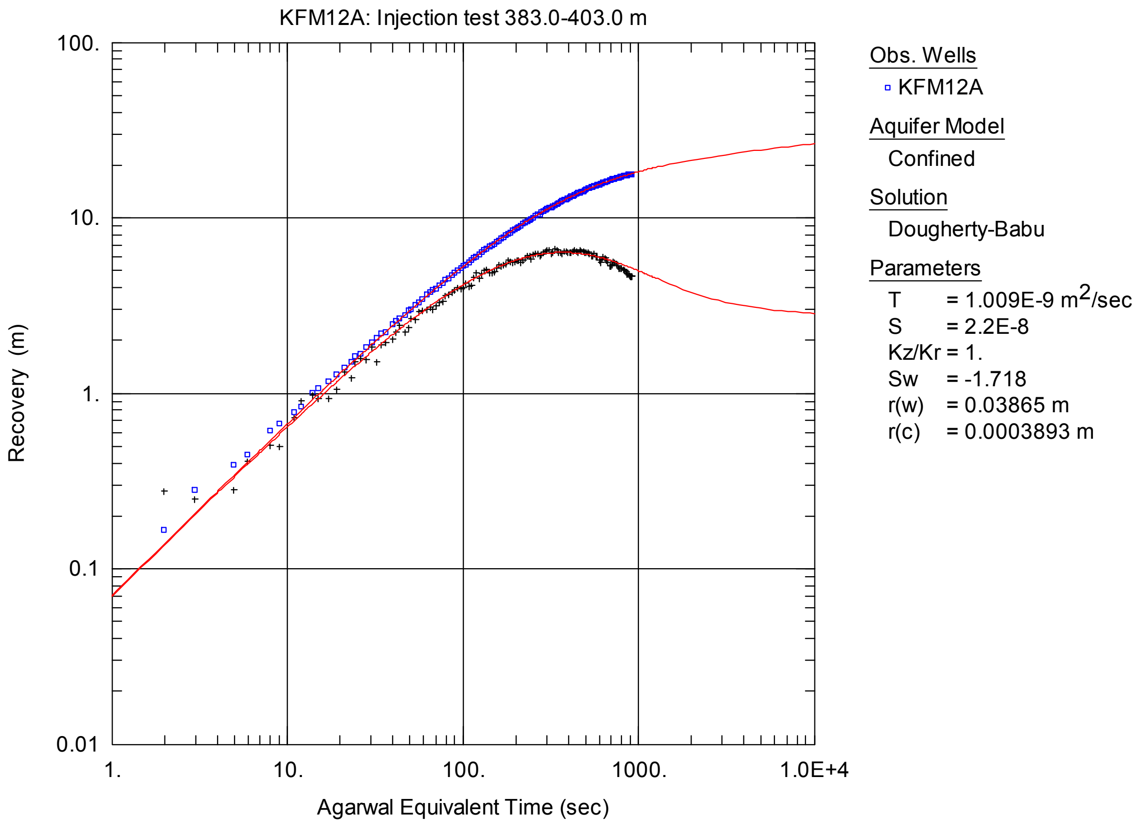


Figure A3-114. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 383.0-403.0 m in KFM12A.*

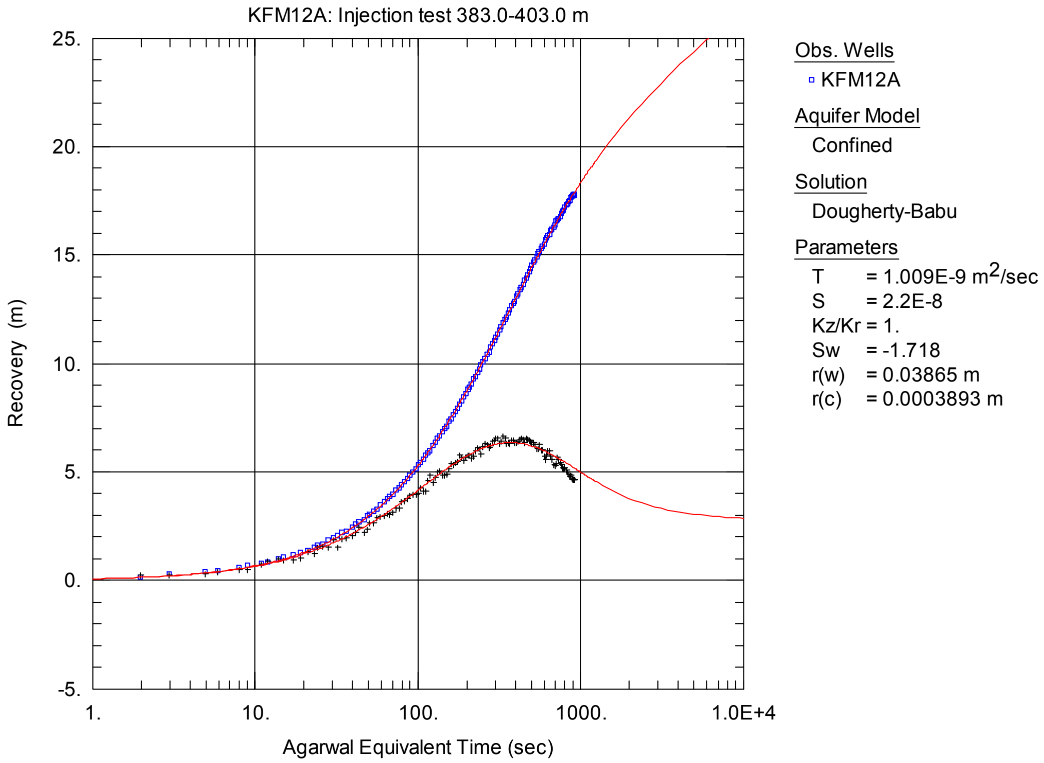


***Figure A3-115.** Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 383.0-403.0 m in KFM12A.*

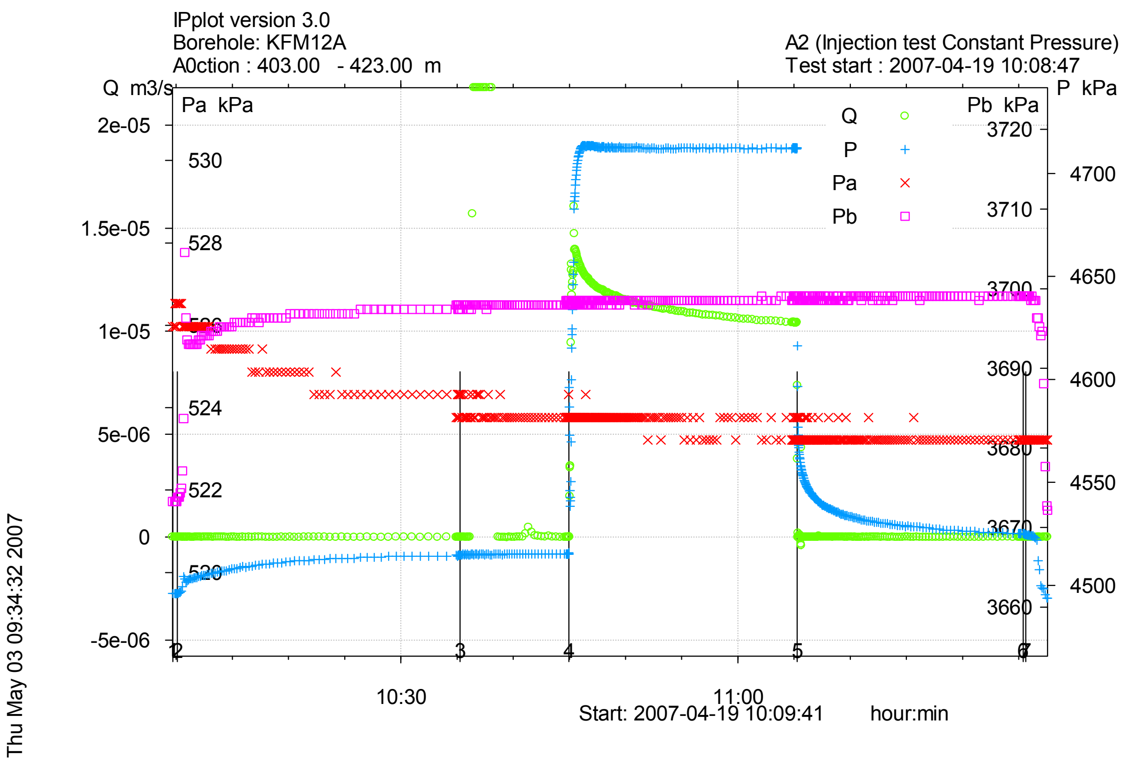


***Figure A3-116.** Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 403.0-423.0 m in borehole KFM12A.*

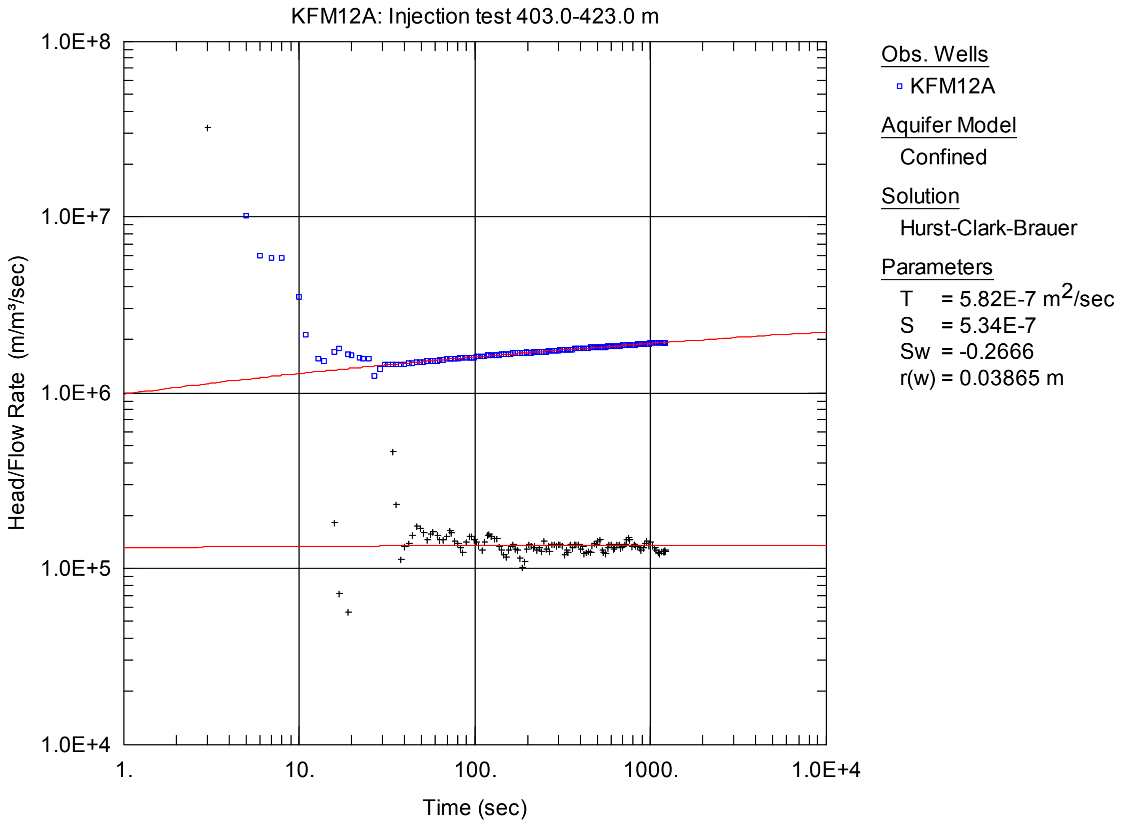


Figure A3-117. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 403.0-423.0 m in borehole KFM12A.*

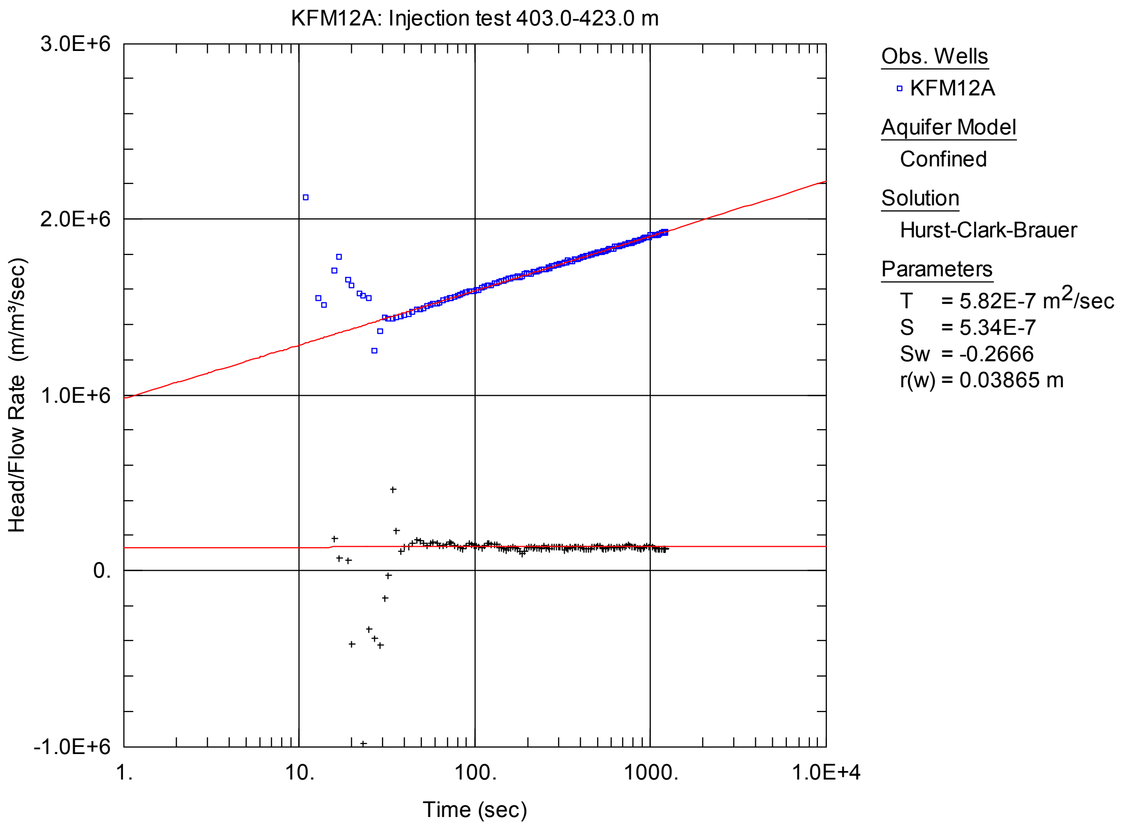


Figure A3-118. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 403.0-423.0 m in KFM12A.*

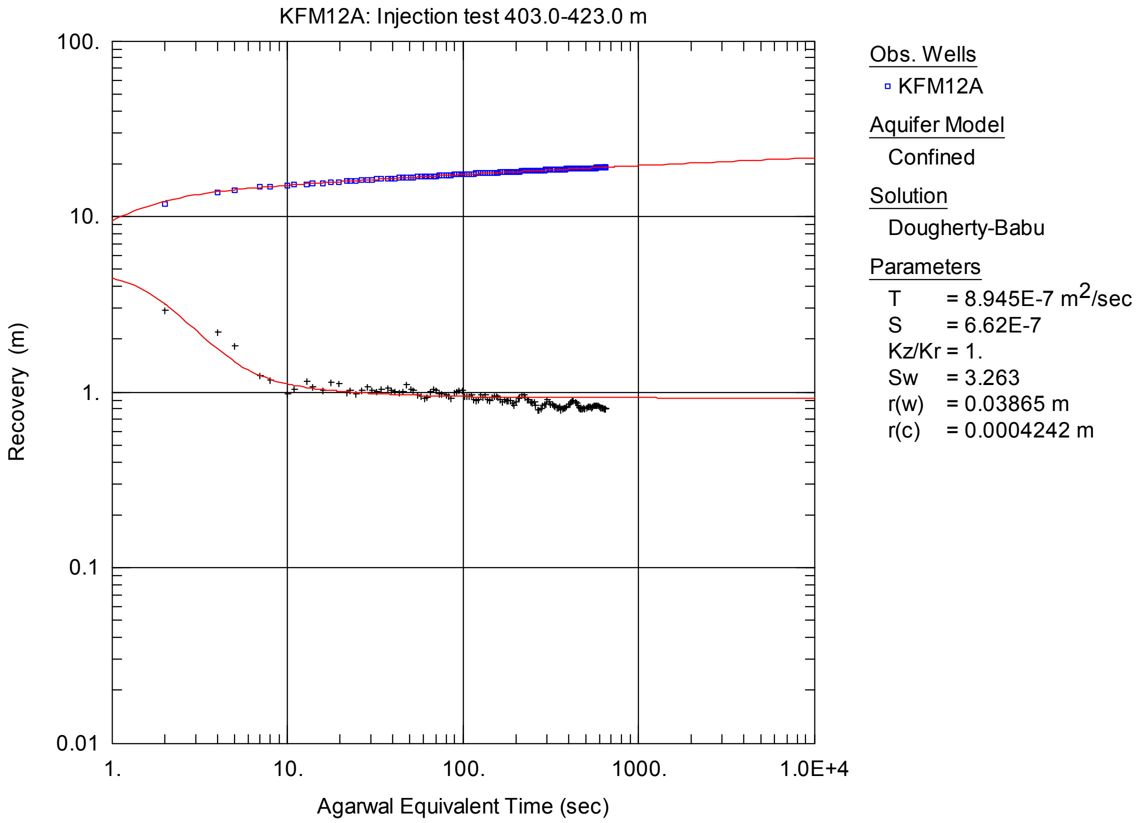


Figure A3-119. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 403.0-423.0 m in KFM12A.*

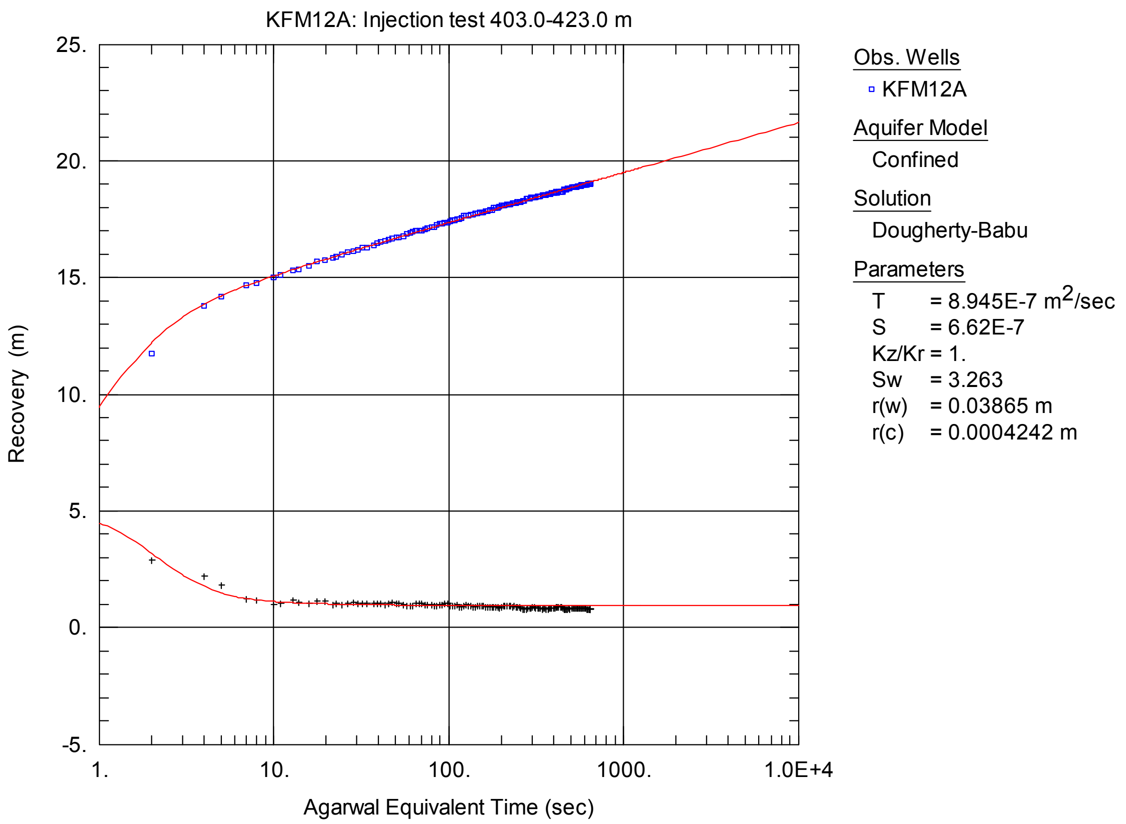


Figure A3-120. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 403.0-423.0 m in KFM12A.*

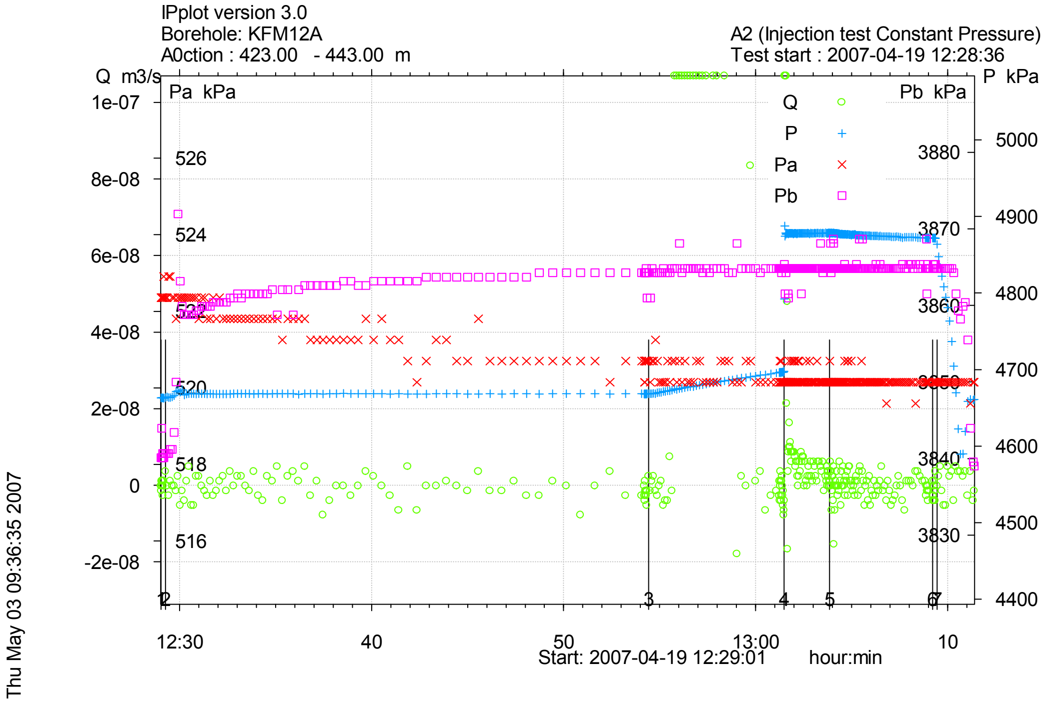


***Figure A3-121.** Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 423.0-443.0 m in borehole KFM12A.*

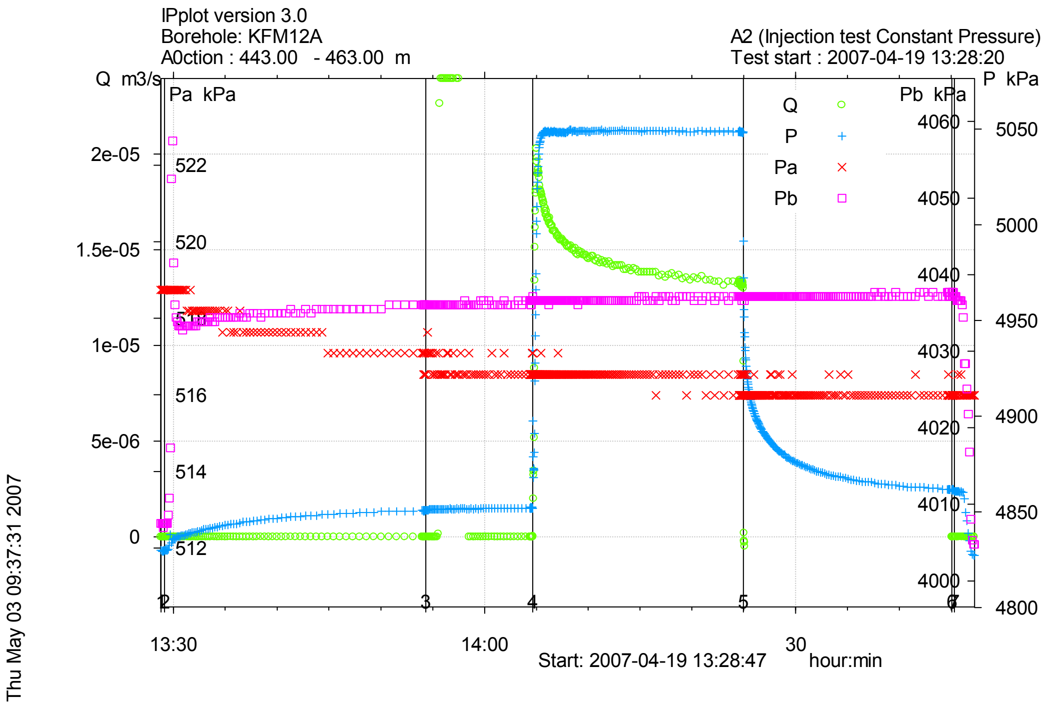


***Figure A3-122.** Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 443.0-463.0 m in borehole KFM12A.*

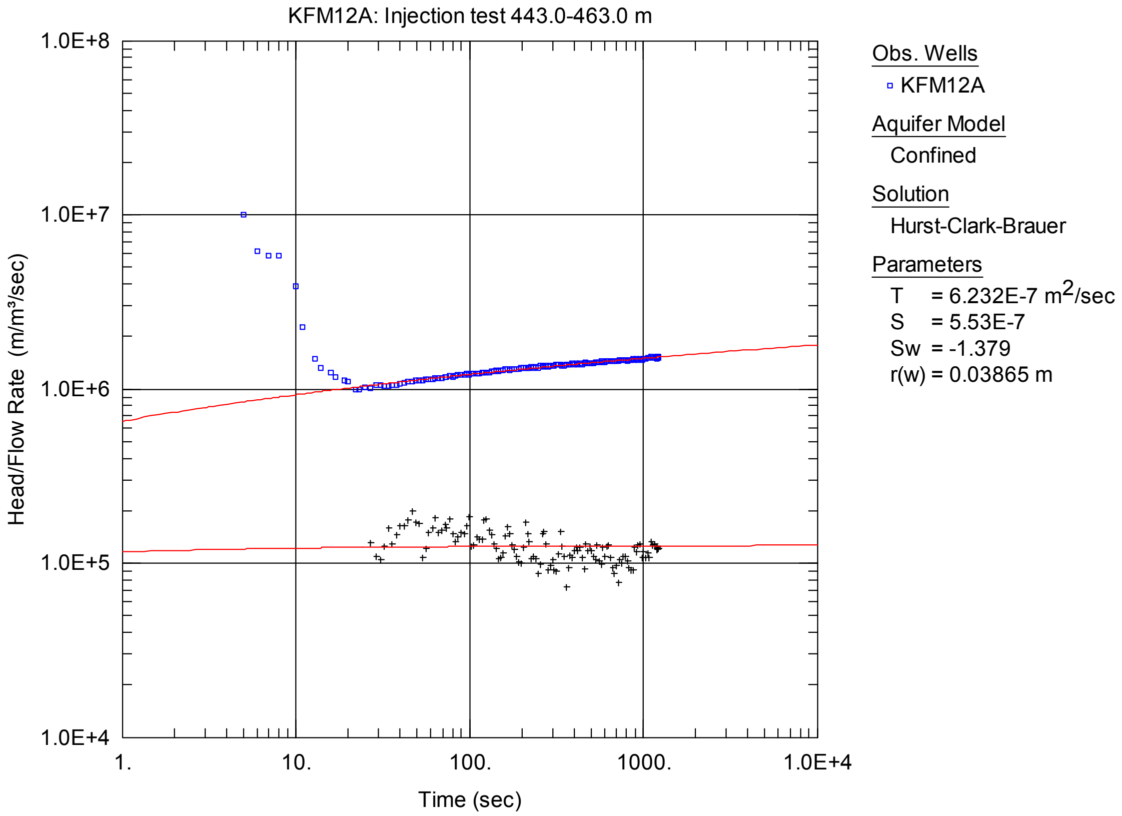


Figure A3-123. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 443.0-463.0 m in borehole KFM12A.*

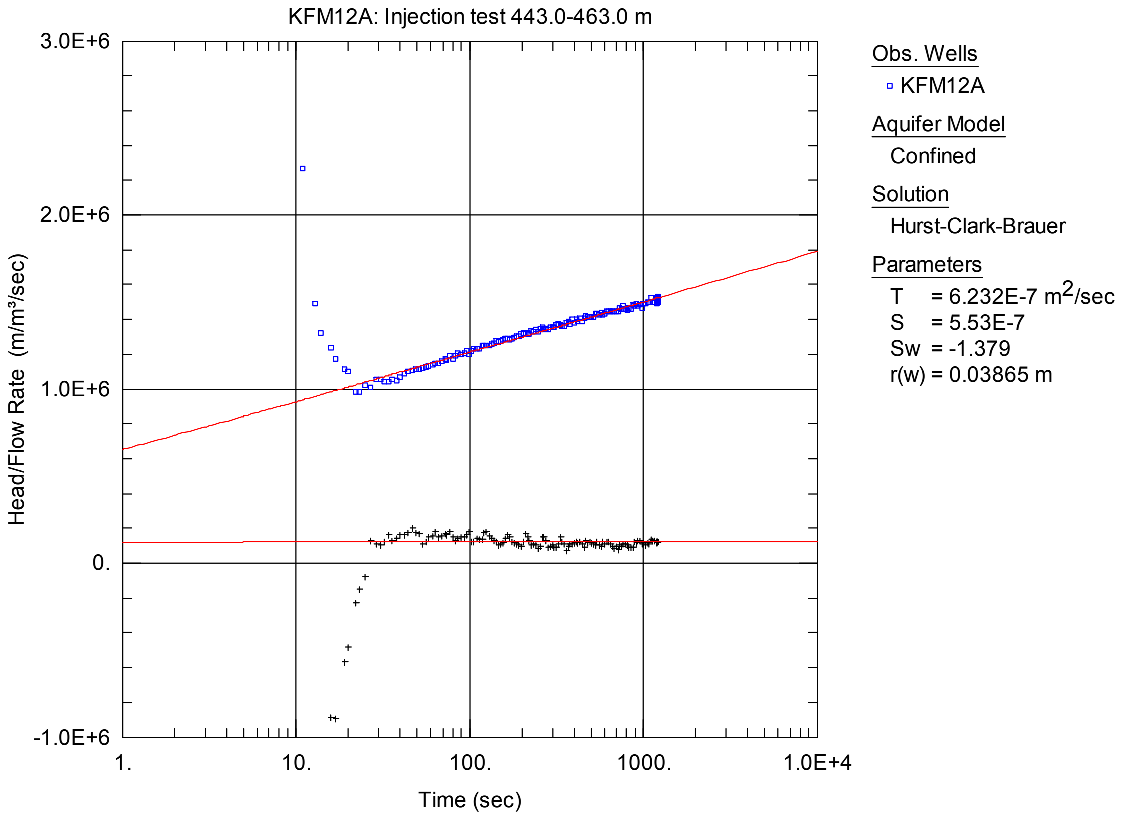


Figure A3-124. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 443.0-463.0 m in KFM12A.*

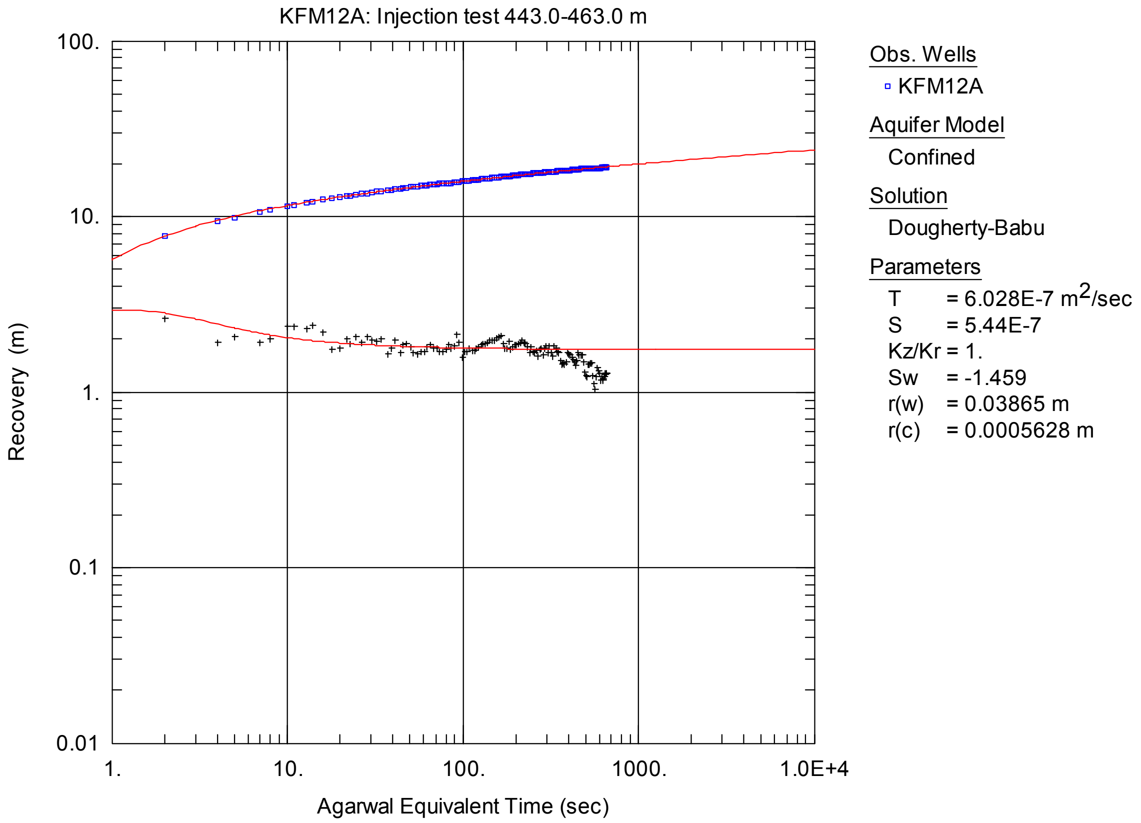


Figure A3-125. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 443.0-463.0 m in KFM12A.*

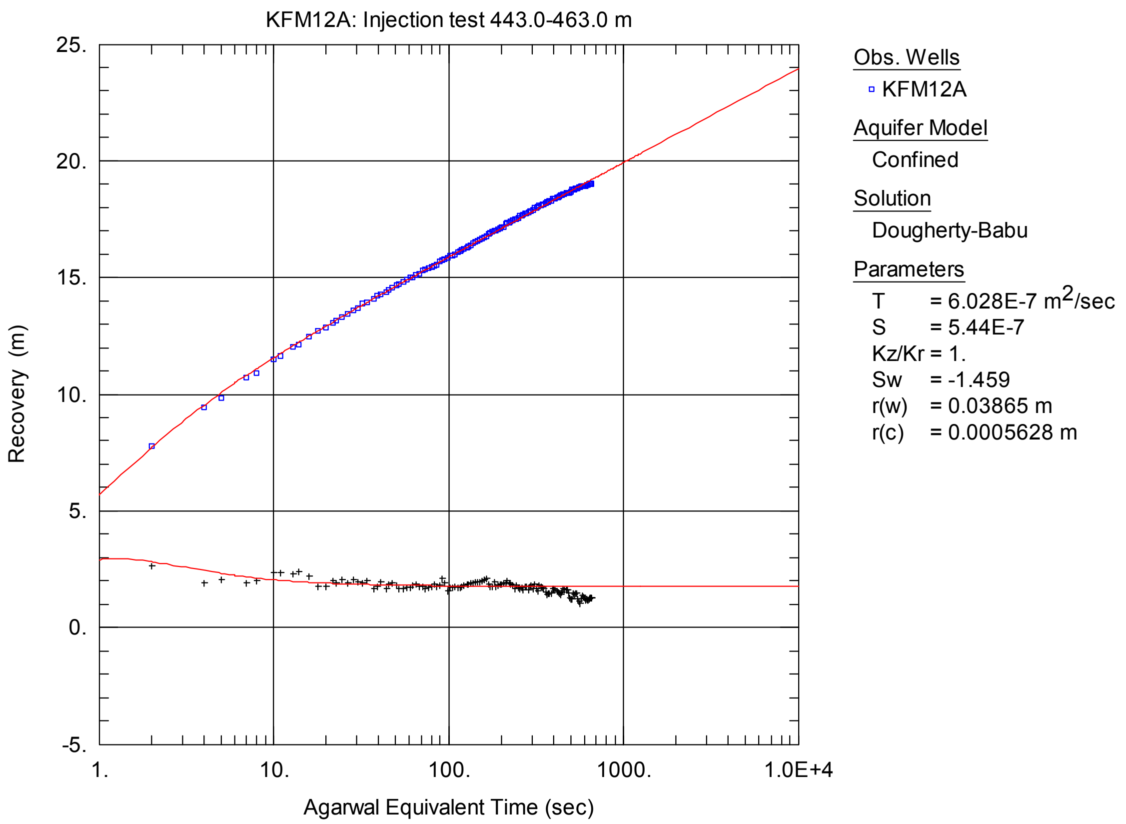


Figure A3-126. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 443.0-463.0 m in KFM12A.*

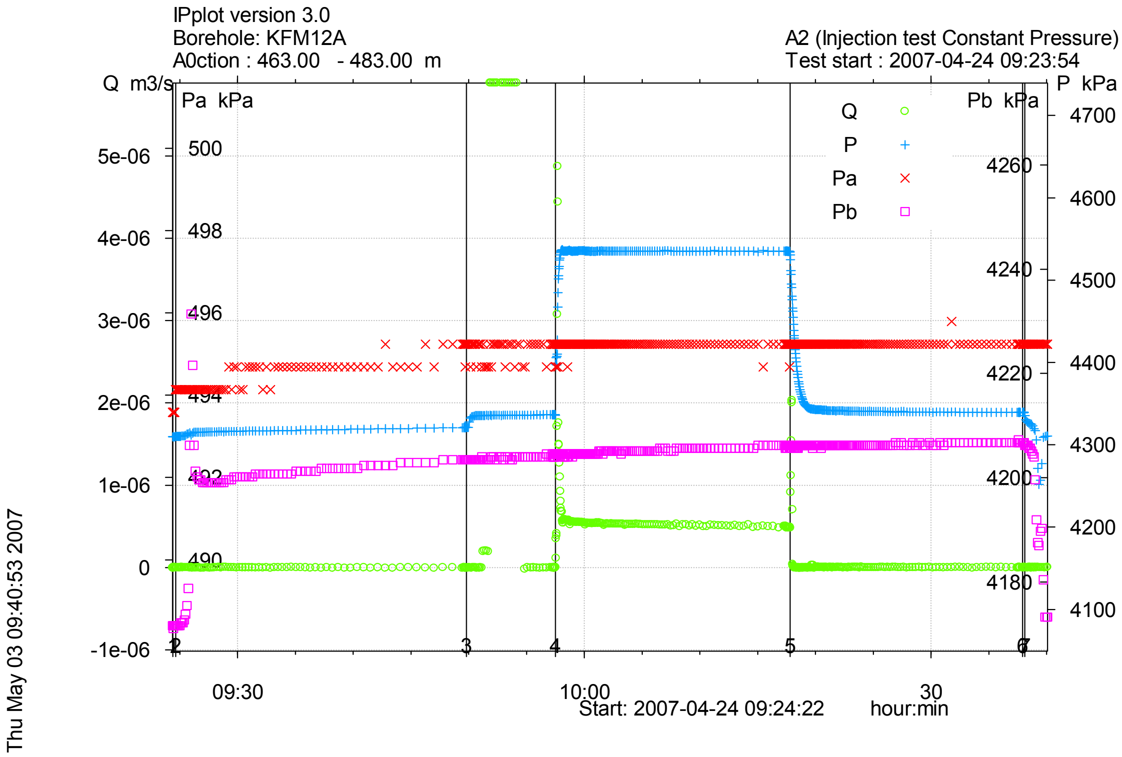


Figure A3-127. Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 463.0-483.0 m in borehole KFM12A.

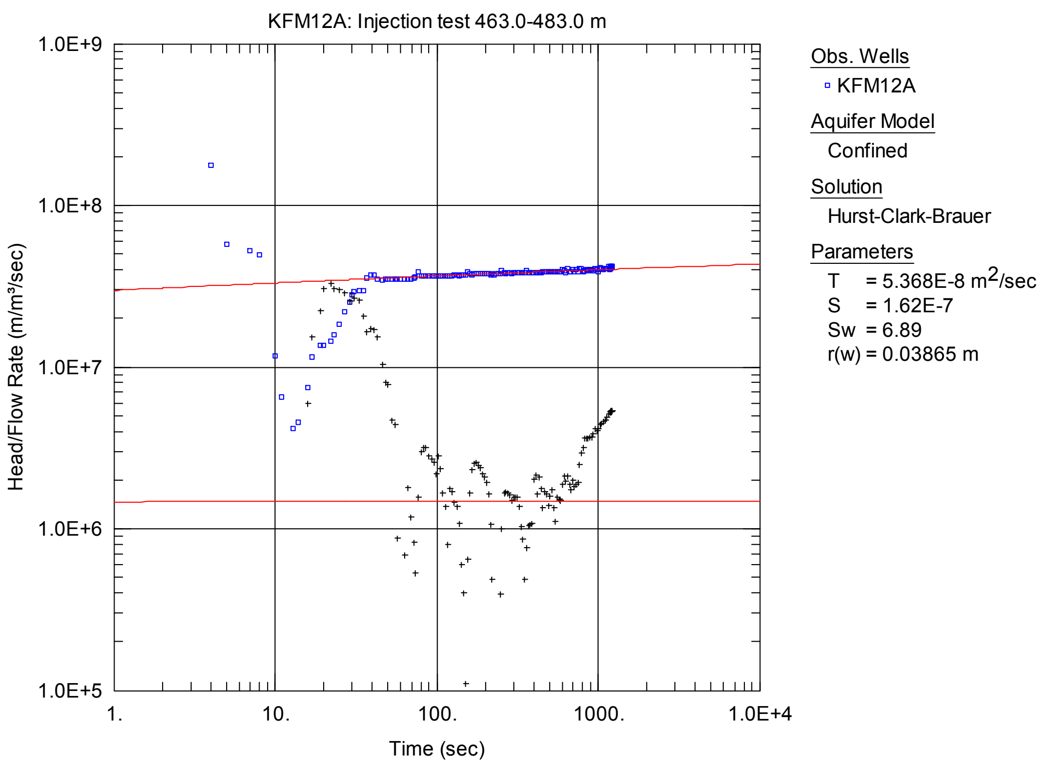


Figure A3-128. Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 463.0-483.0 m in borehole KFM12A.

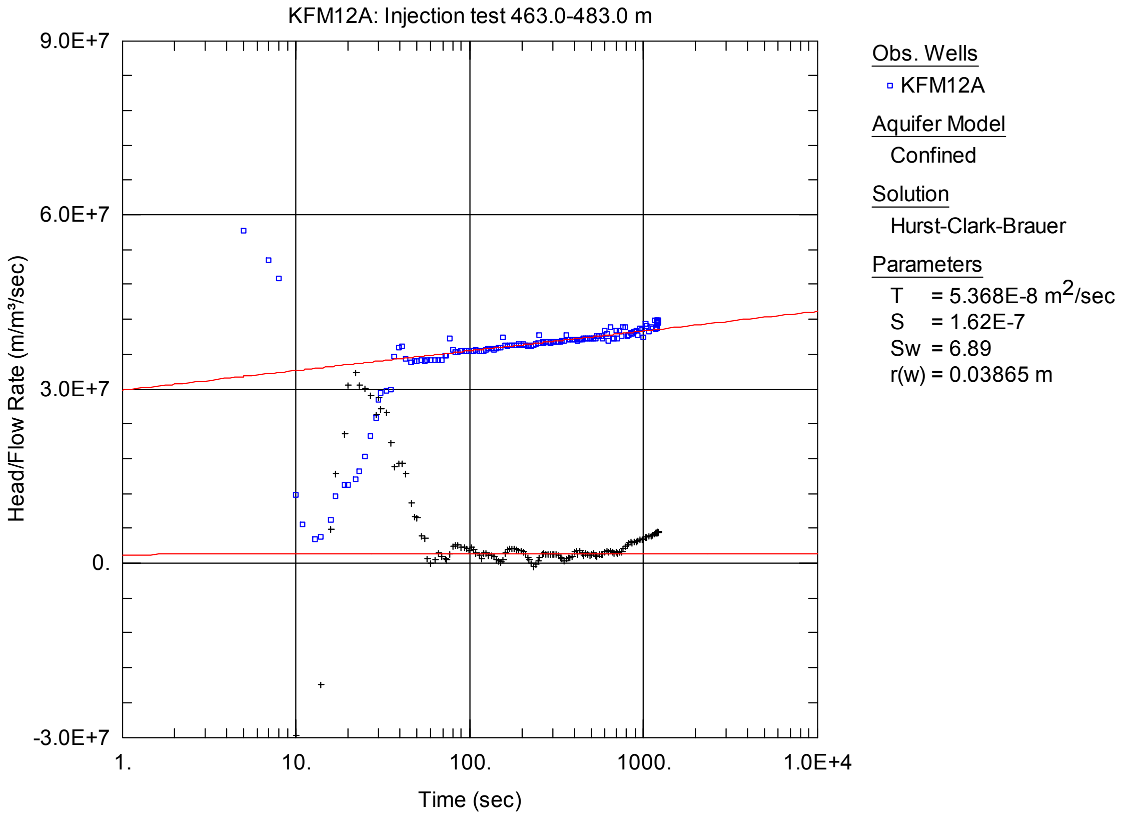


Figure A3-129. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 463.0-483.0 m in KFM12A.*

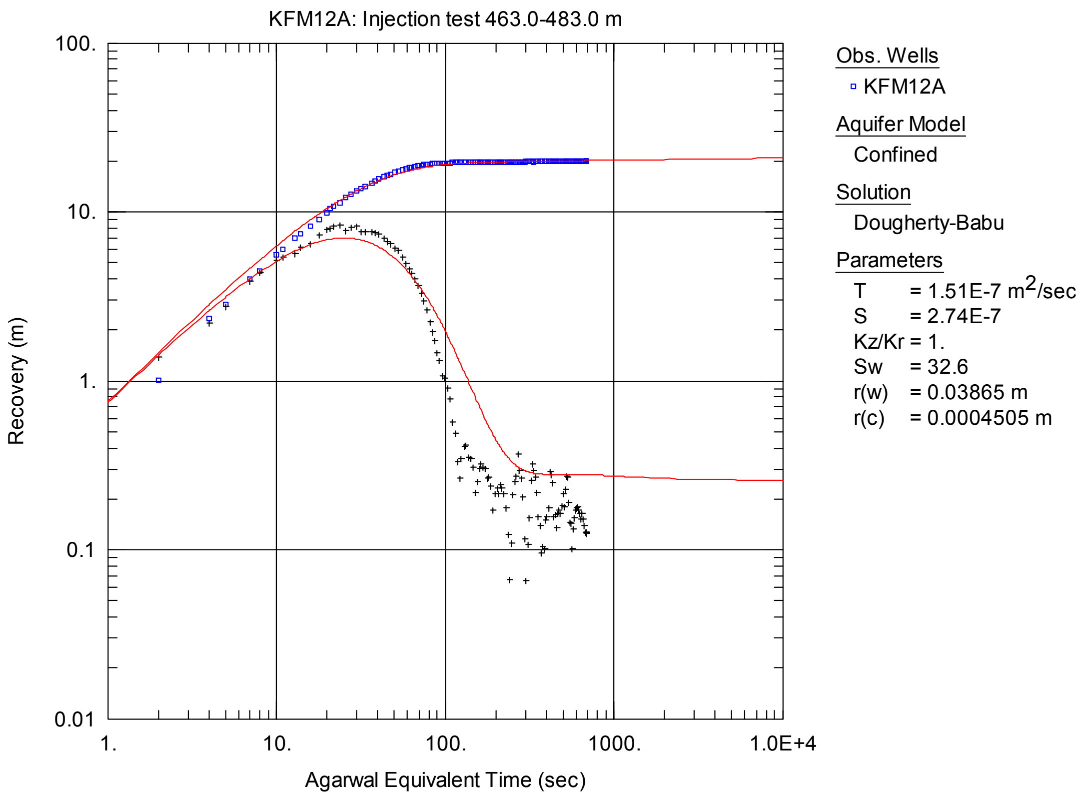


Figure A3-130. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 463.0-483.0 m in KFM12A. The type curve fit is showing a possible, however not unambiguous, evaluation.*

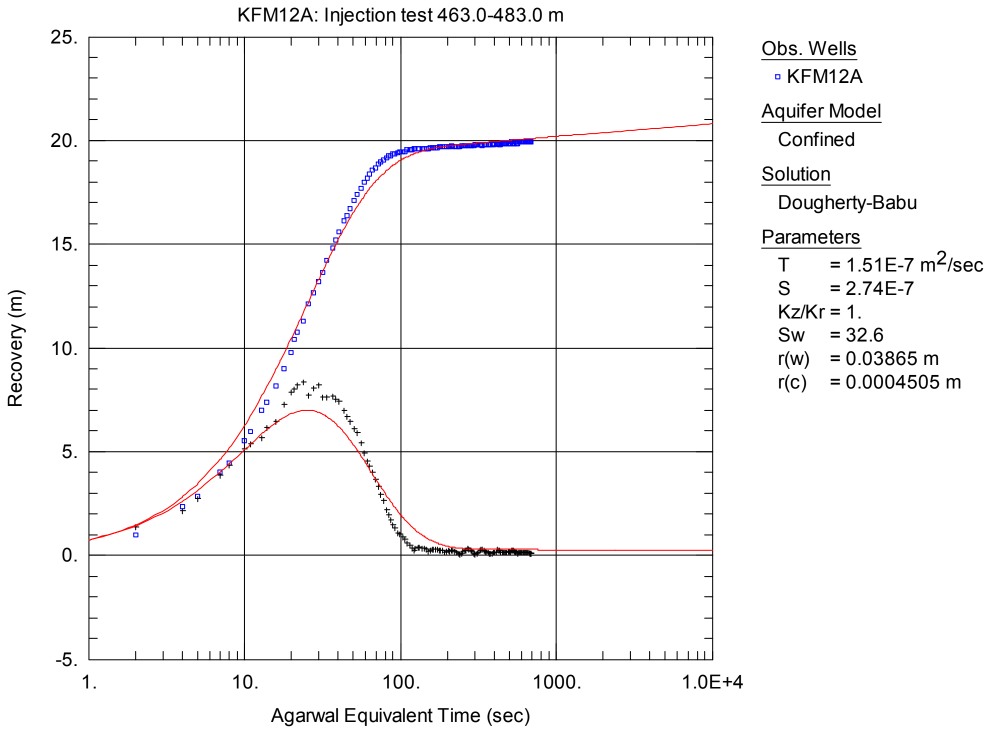


Figure A3-131. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 463.0-483.0 m in KFM12A. The type curve fit is showing a possible, however not unambiguous, evaluation.*

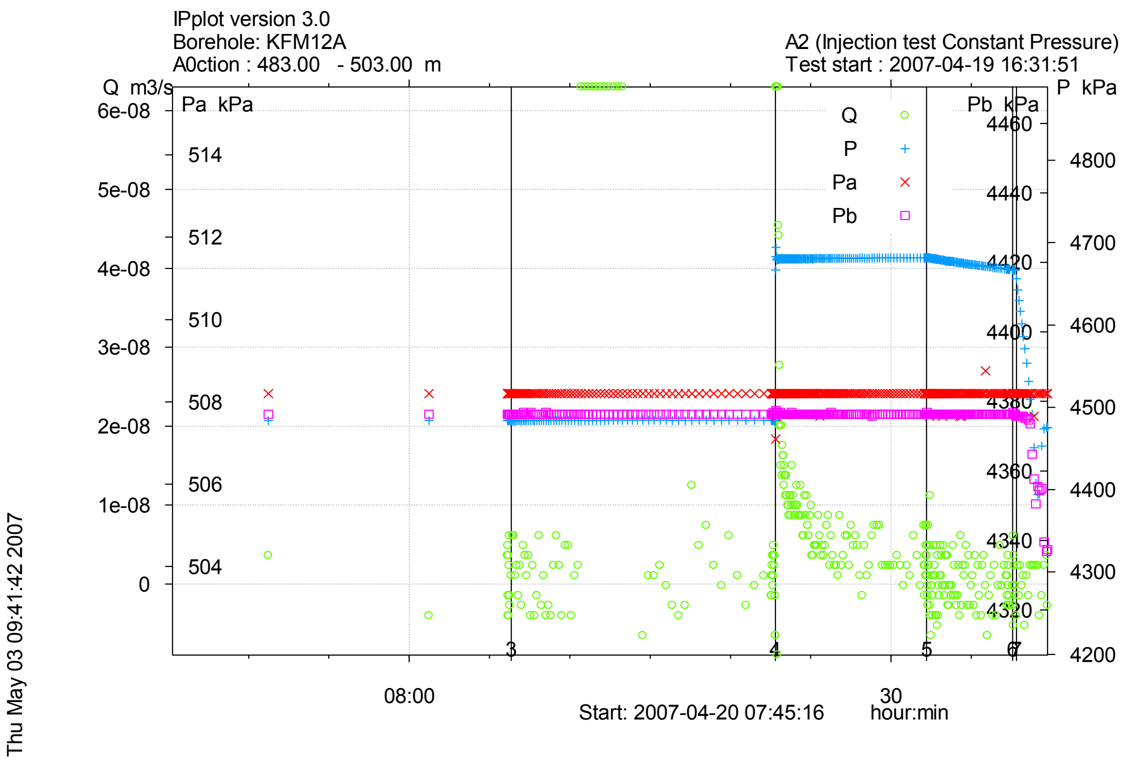


Figure A3-132. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 483.0-503.0 m in borehole KFM12A.*

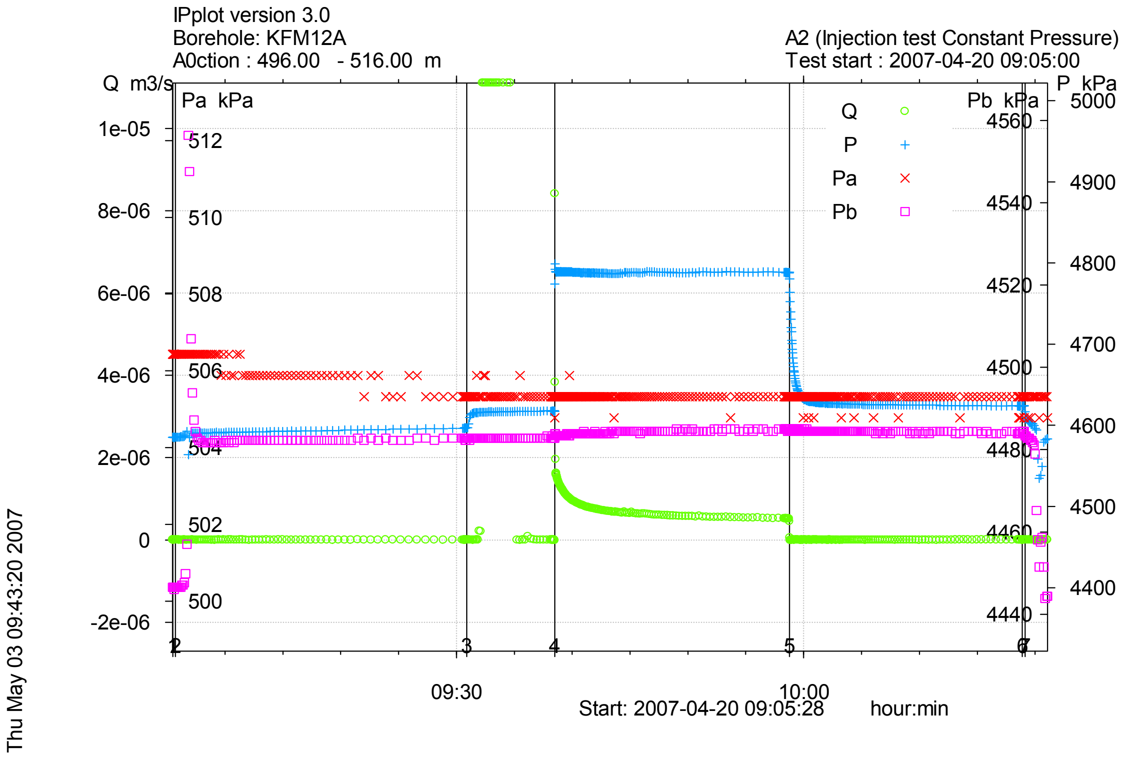


Figure A3-133. Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 496.0-516.0 m in borehole KFM12A.

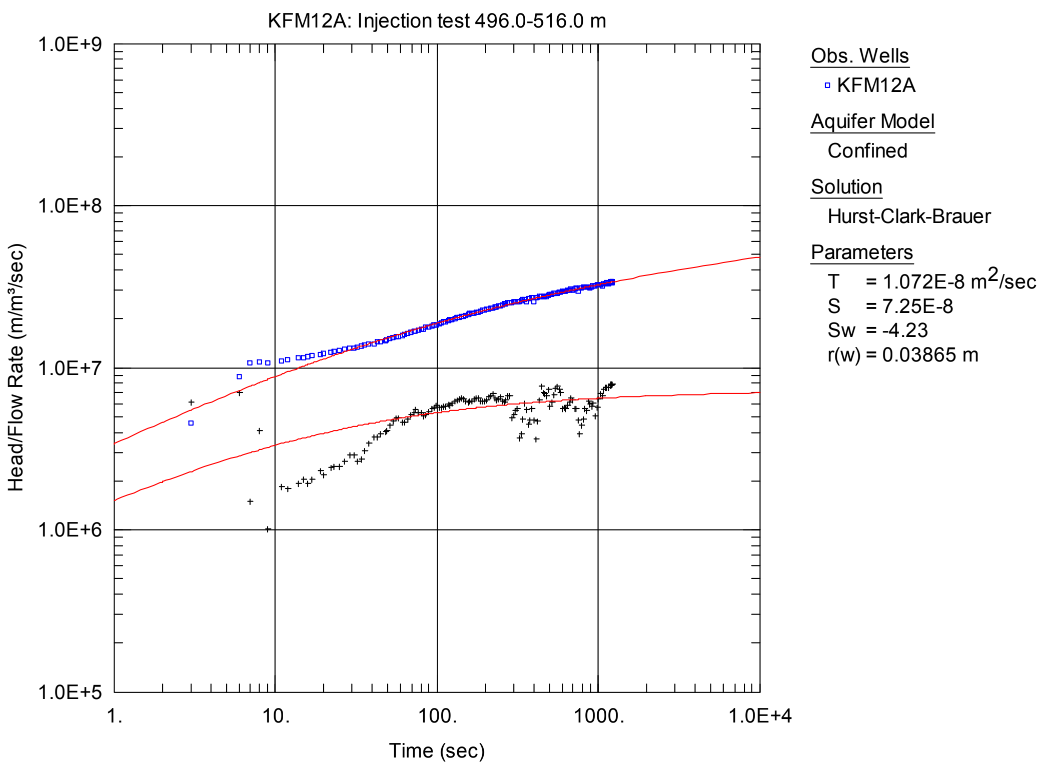


Figure A3-134. Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 496.0-516.0 m in borehole KFM12A.

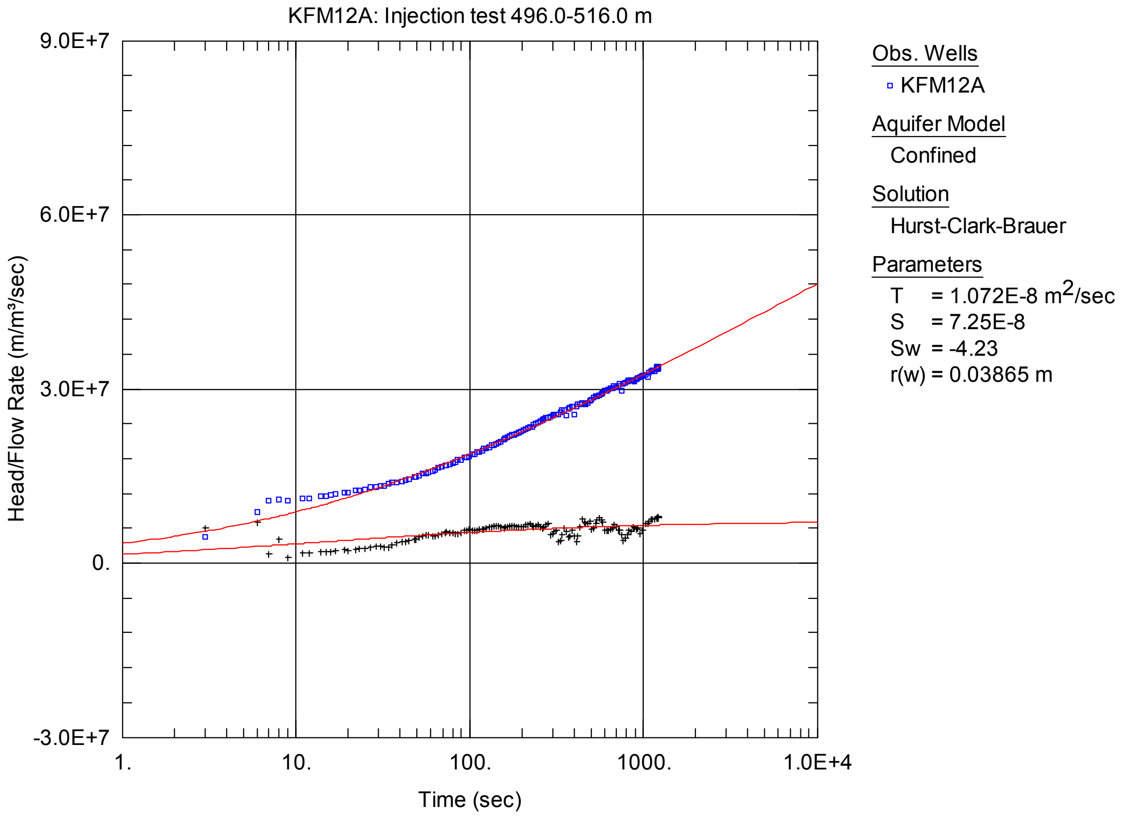


Figure A3-135. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 496.0-516.0 m in KFM12A.*

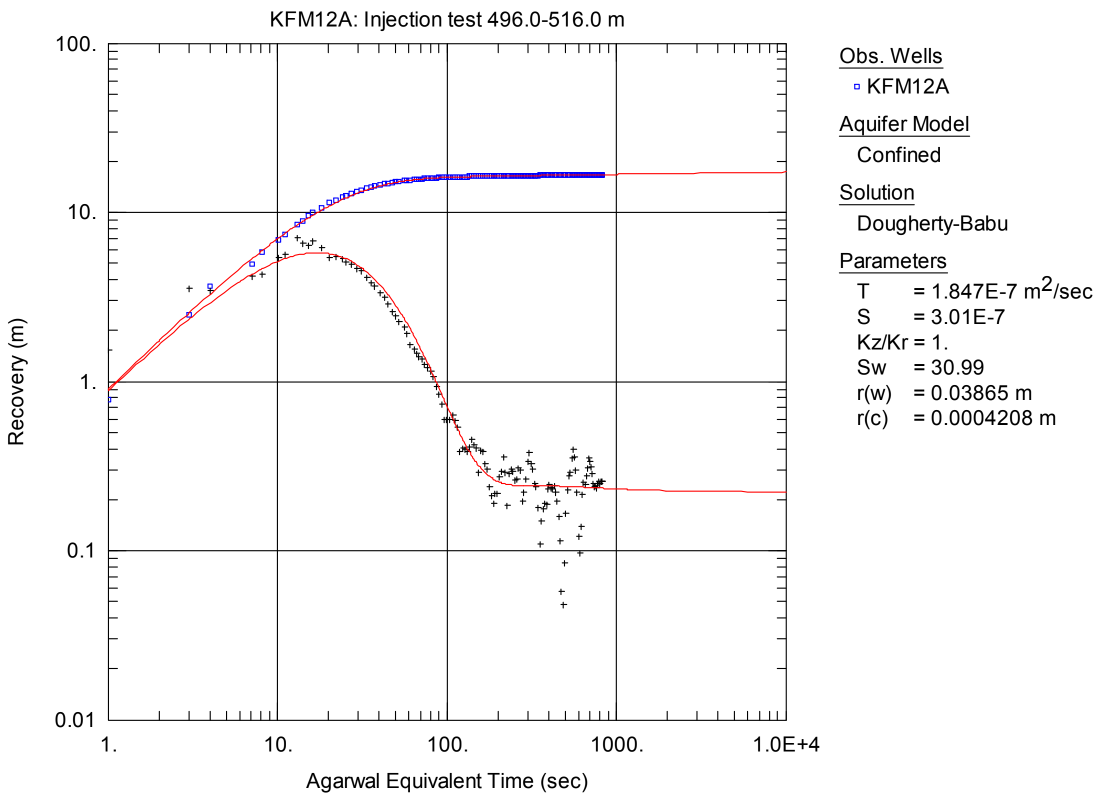


Figure A3-136. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 496.0-516.0 m in KFM12A. The type curve fit is showing a possible, however not unambiguous, evaluation.*

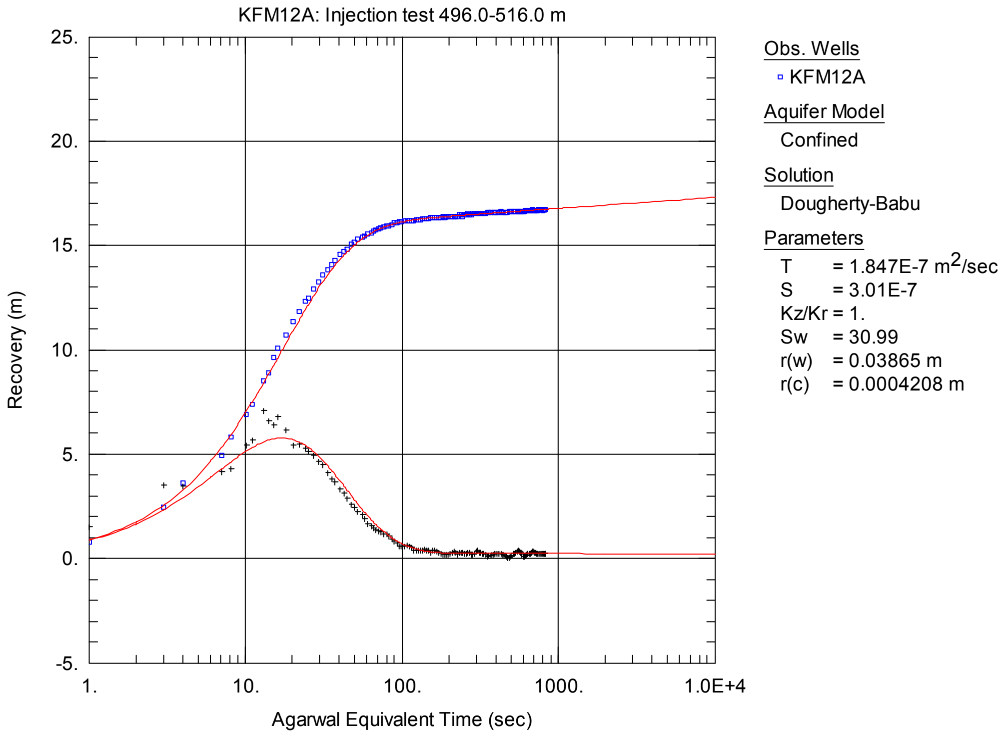


Figure A3-137. Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 496.0-516.0 m in KFM12A. The type curve fit is showing a possible, however not unambiguous, evaluation.

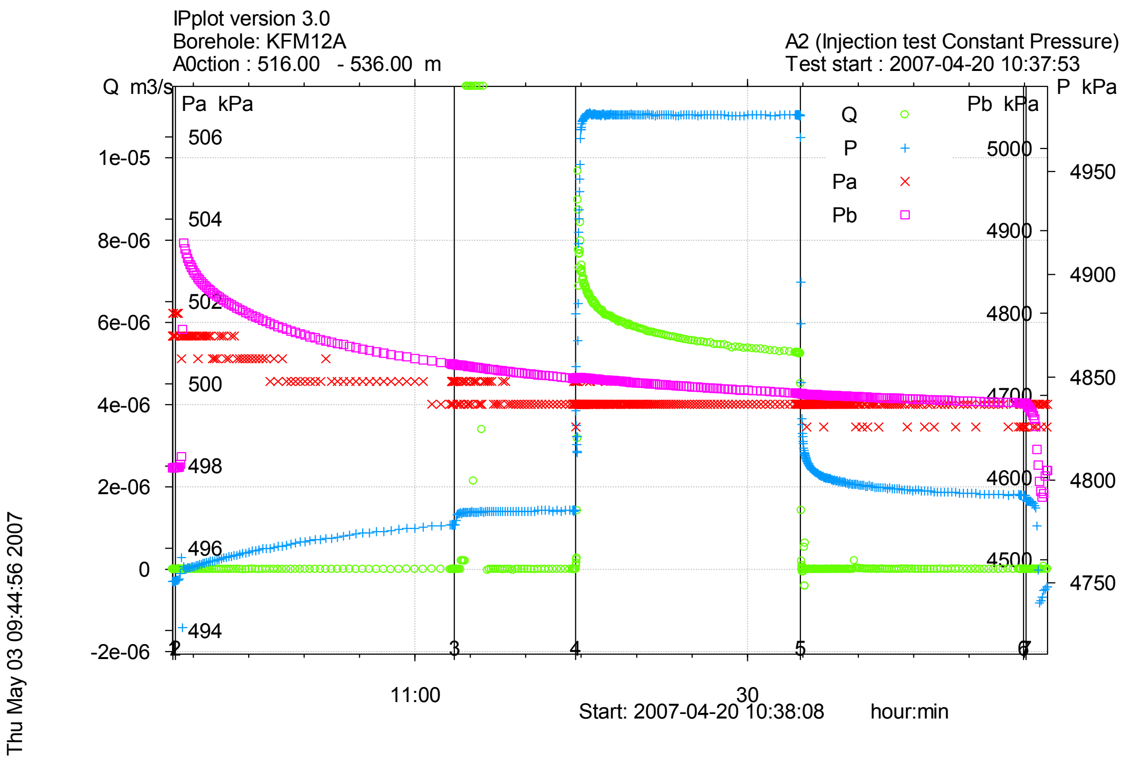


Figure A3-138. Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 516.0-536.0 m in borehole KFM12A.

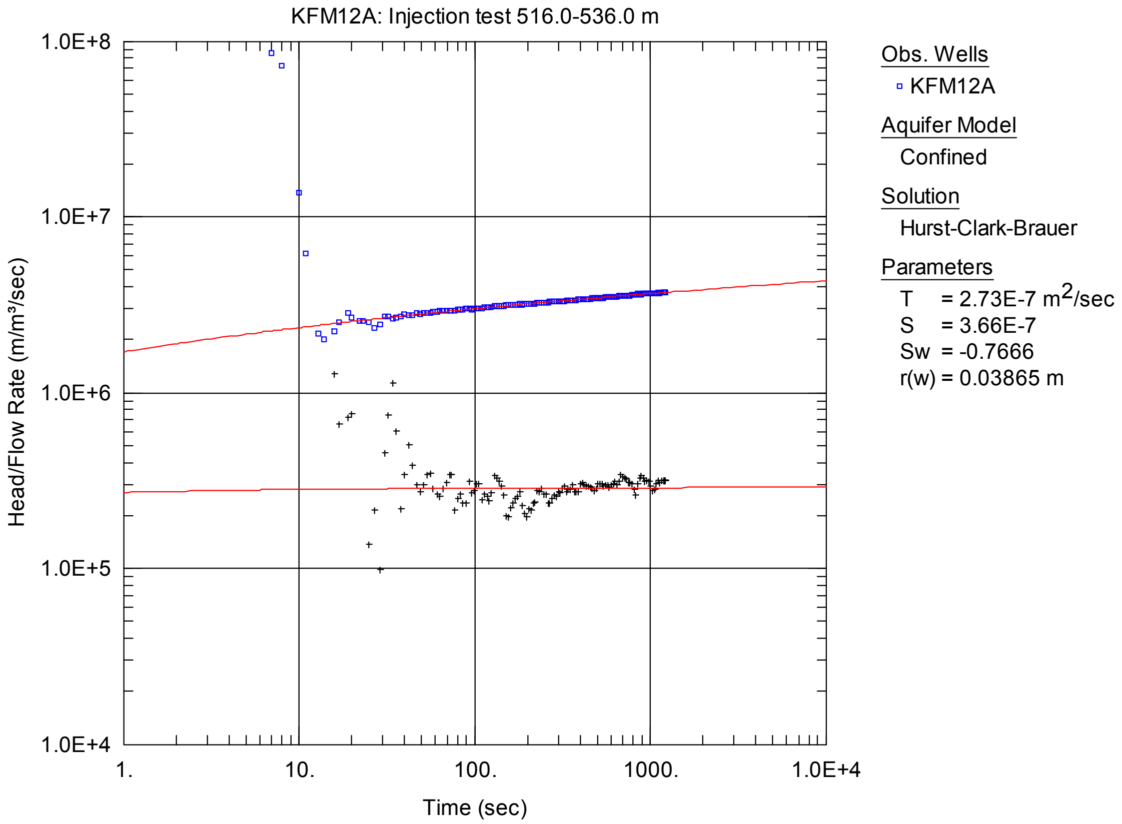


Figure A3-139. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 516.0-536.0 m in borehole KFM12A.*

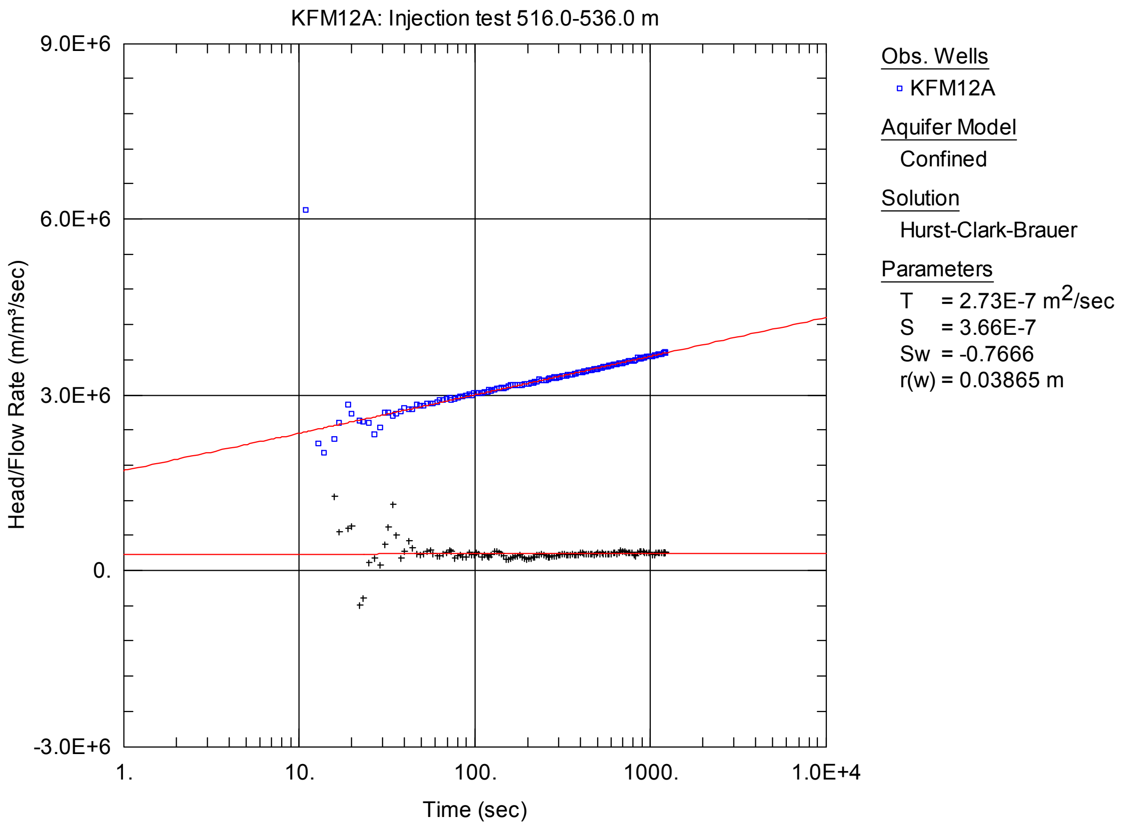


Figure A3-140. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 516.0-536.0 m in KFM12A.*

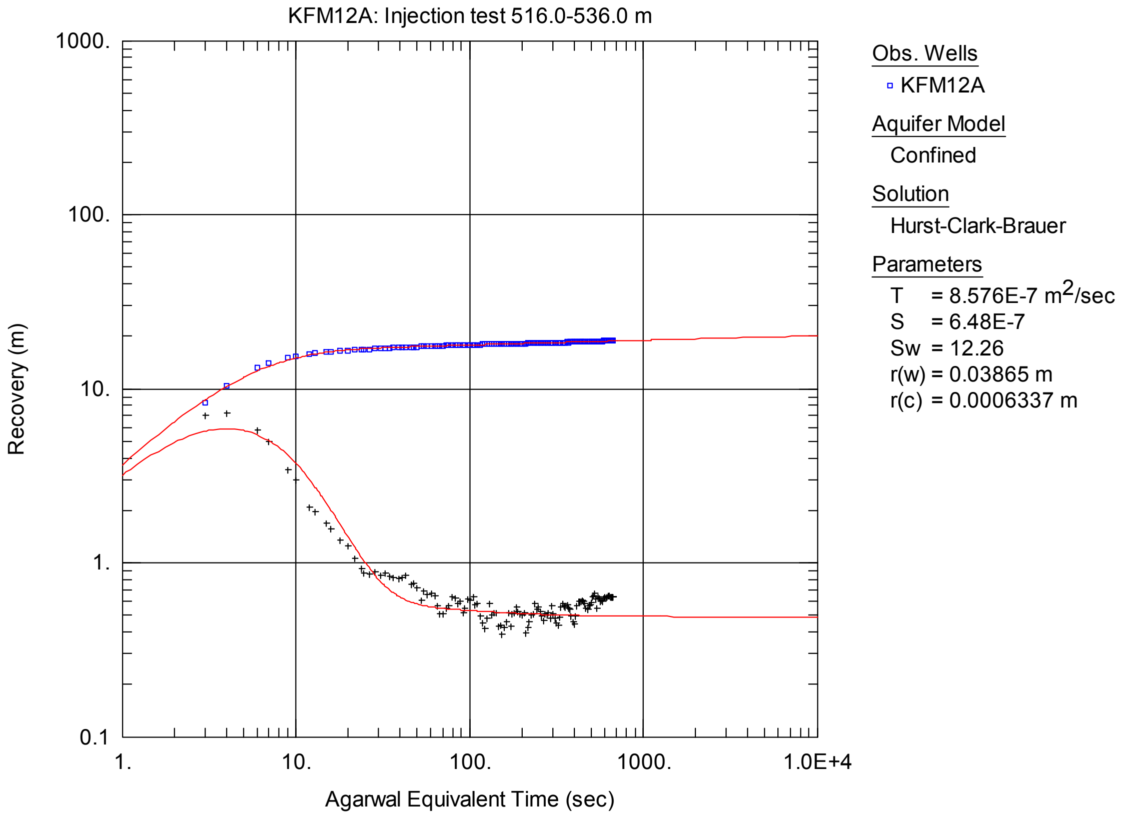


Figure A3-141. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 516.0-536.0 m in KFM12A.*

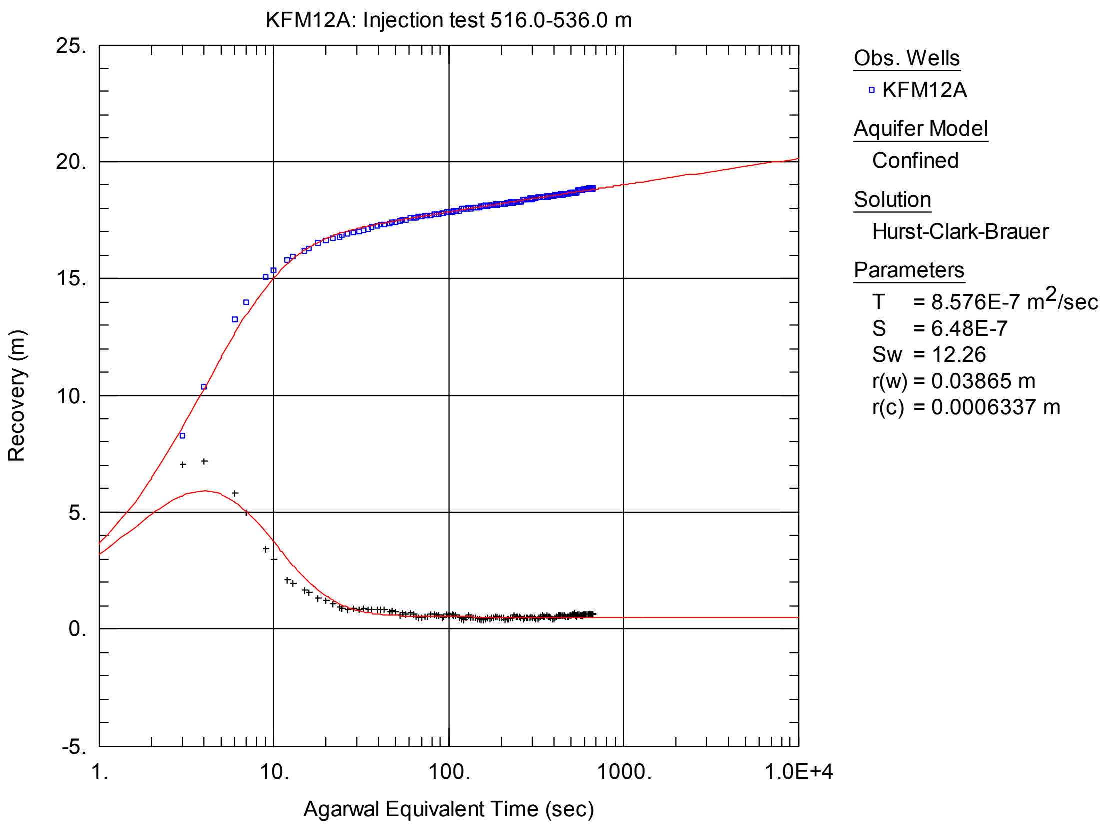


Figure A3-142. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 516.0-536.0 m in KFM12A.*

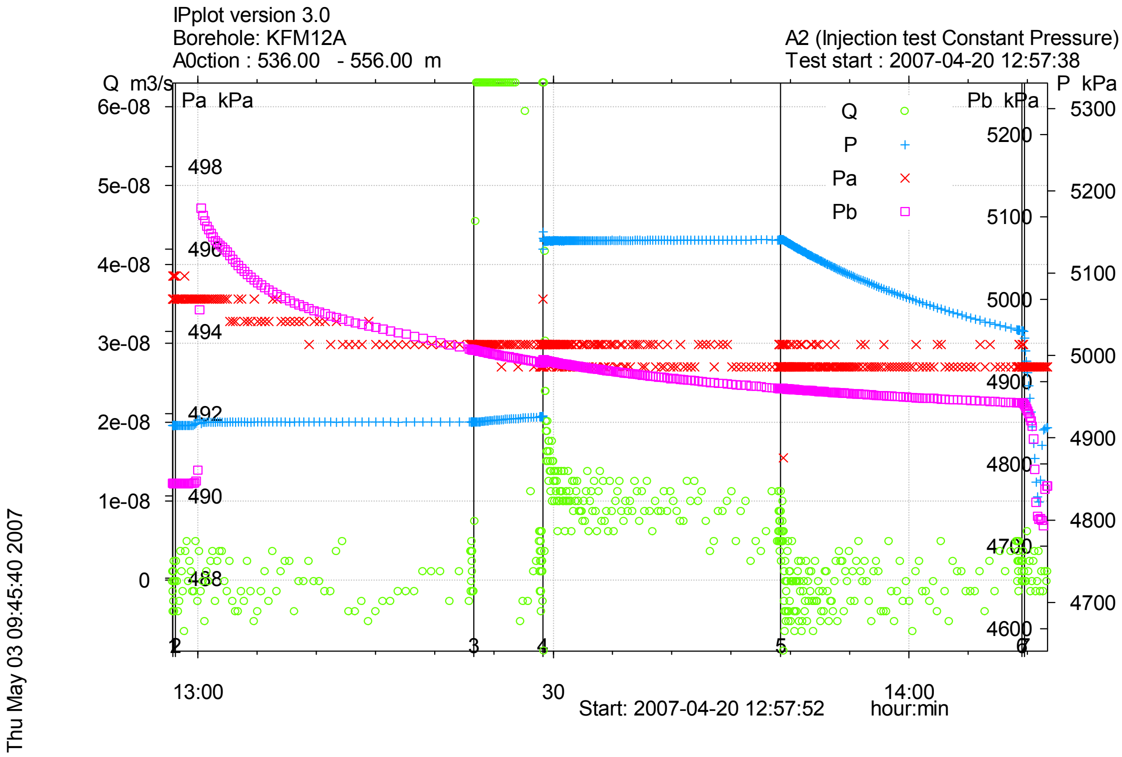


Figure A3-143. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 536.0-556.0 m in borehole KFM12A.*

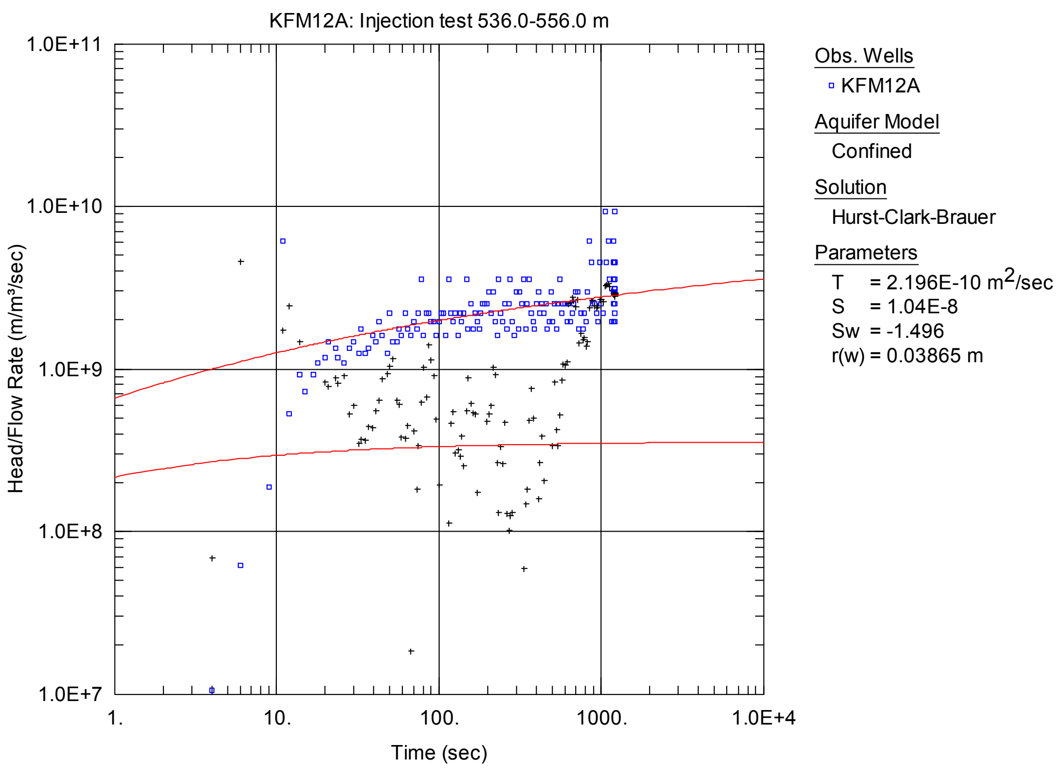


Figure A3-144. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 536.0-556.0 m in borehole KFM12A.*

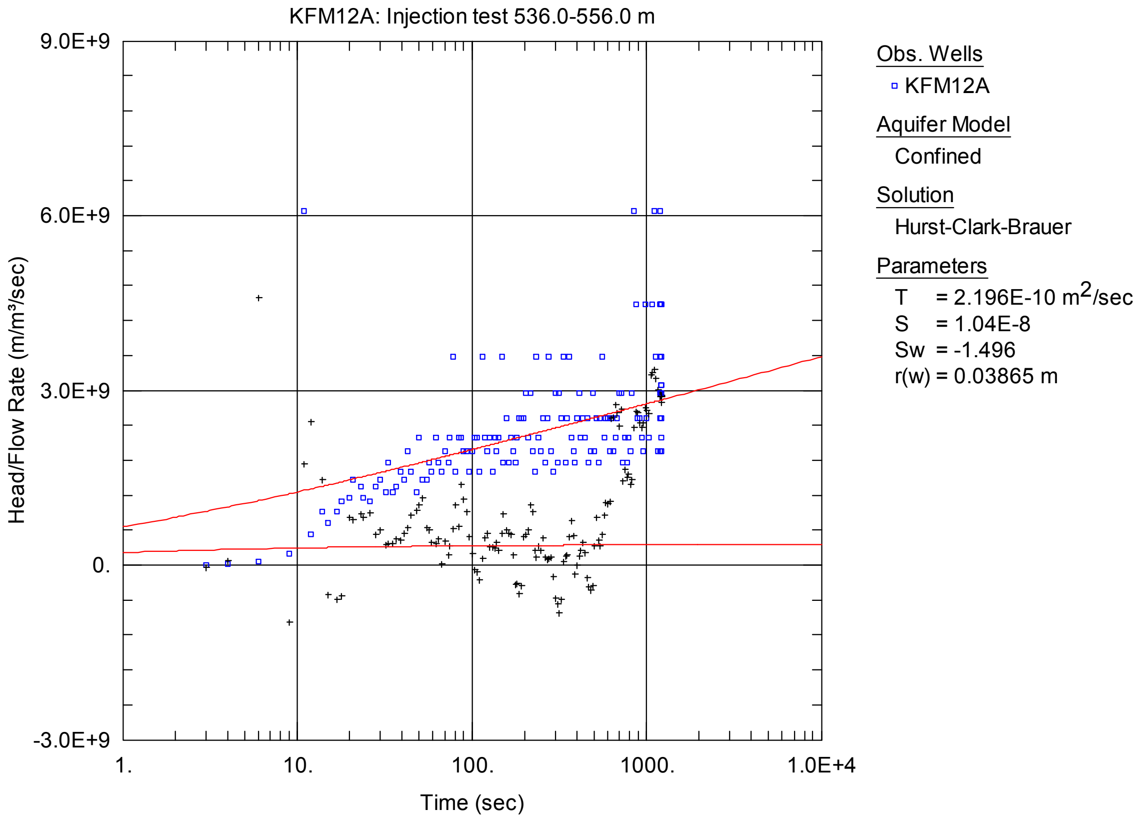


***Figure A3-145.** Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 536.0-556.0 m in KFM12A.*

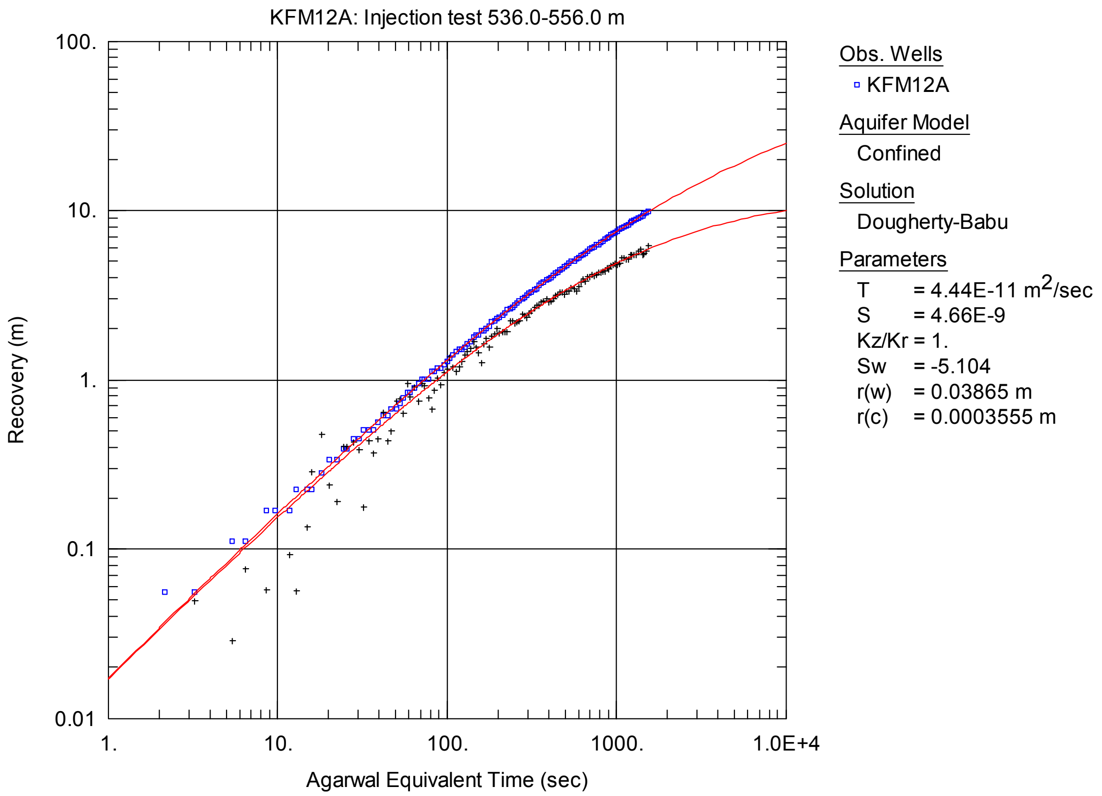


***Figure A3-146.** Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 536.0-556.0 m in KFM12A. The type curve fit is showing a possible, however not unambiguous, evaluation.*

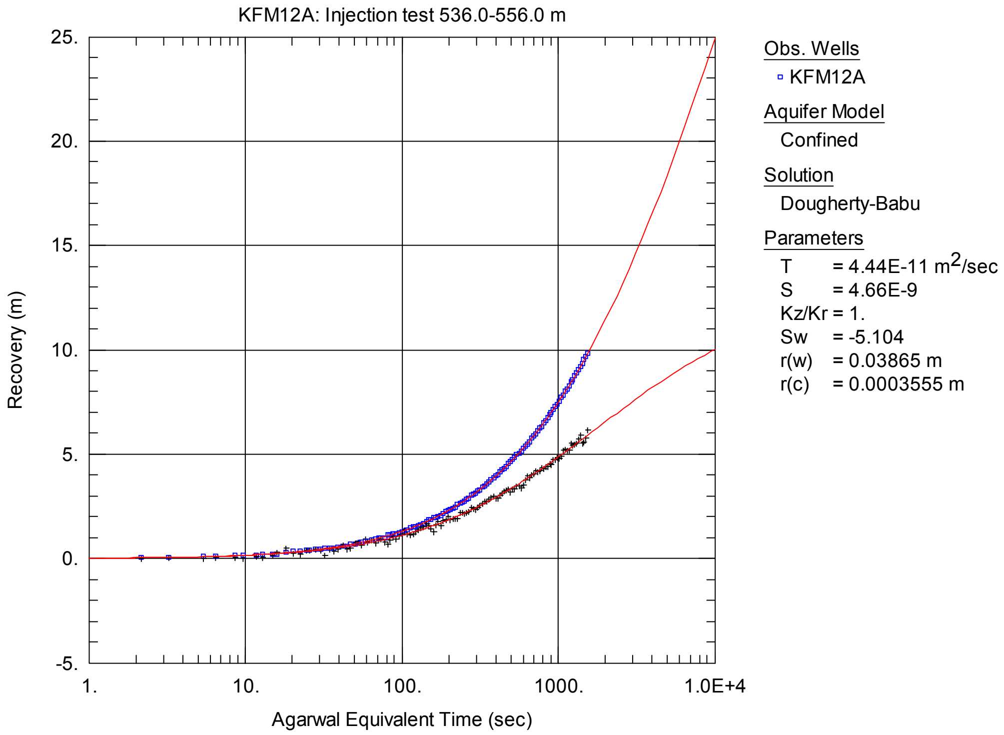


Figure A3-147. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 536.0-556.0 m in KFM12A. The type curve fit is showing a possible, however not unambiguous, evaluation.*

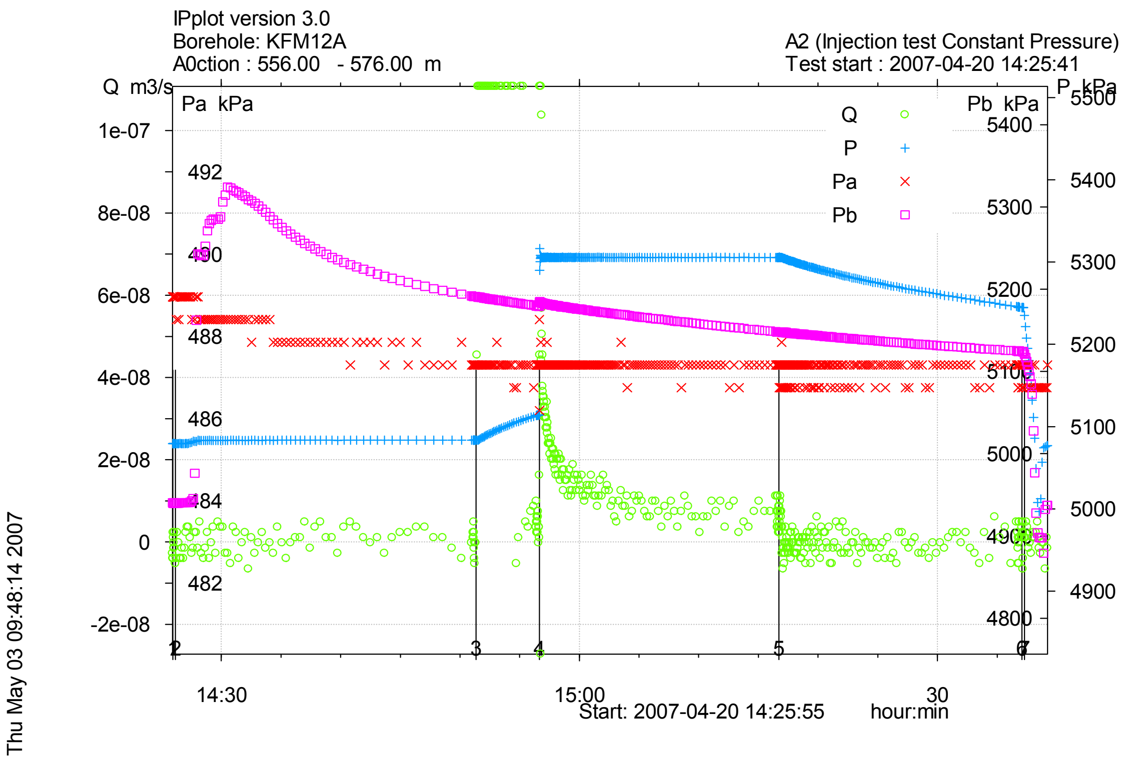


Figure A3-148. *Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 556.0-576.0 m in borehole KFM12A.*

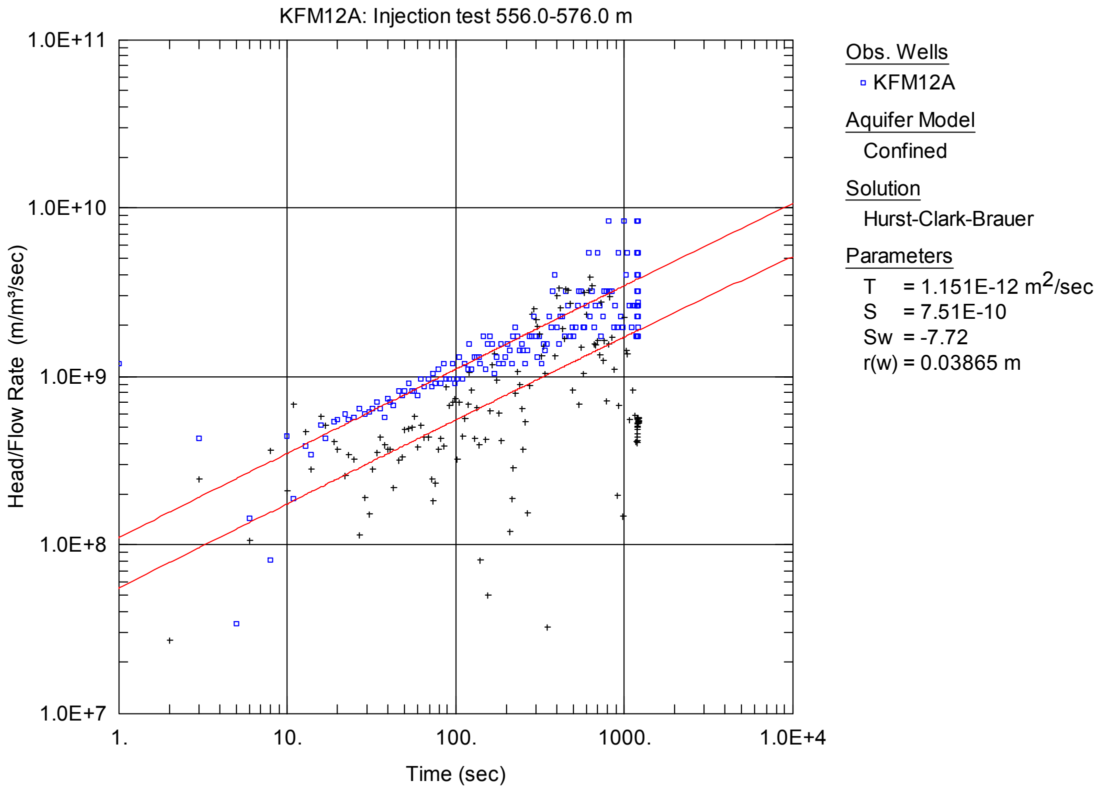


Figure A3-149. *Log-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 556.0-576.0 m in borehole KFM12A. The type curve fit is showing a possible, however not unambiguous, evaluation.*

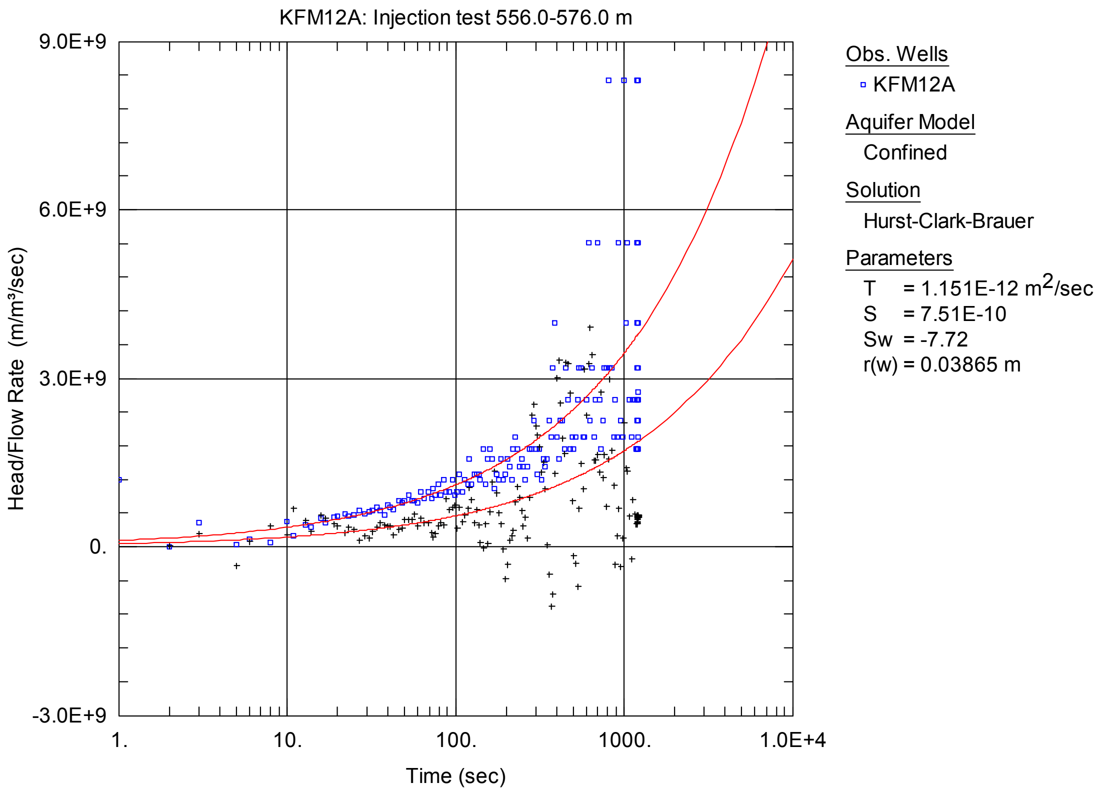


Figure A3-150. *Lin-log plot of head/flow rate (□) and derivative (+) versus time, from the injection test in section 556.0-576.0 m in KFM12A. The type curve fit is showing a possible, however not unambiguous, evaluation.*

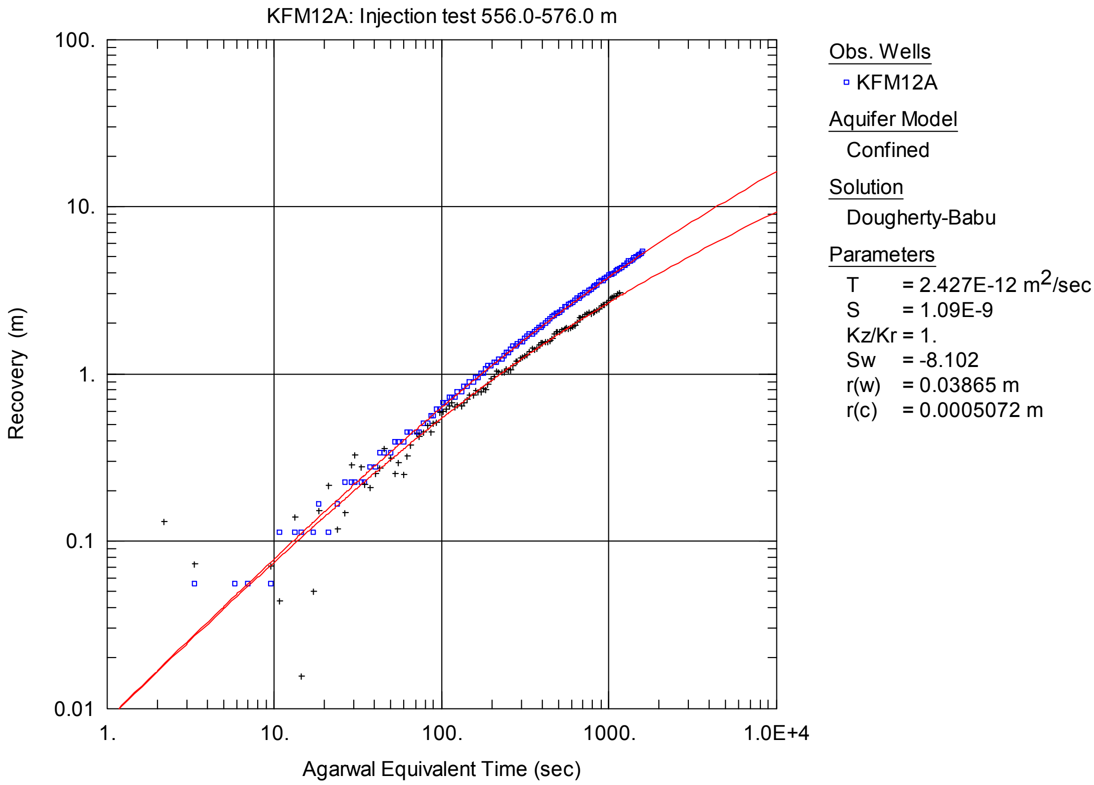


Figure A3-151. *Log-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 556.0-576.0 m in KFM12A. The type curve fit is showing a possible, however not unambiguous, evaluation.*

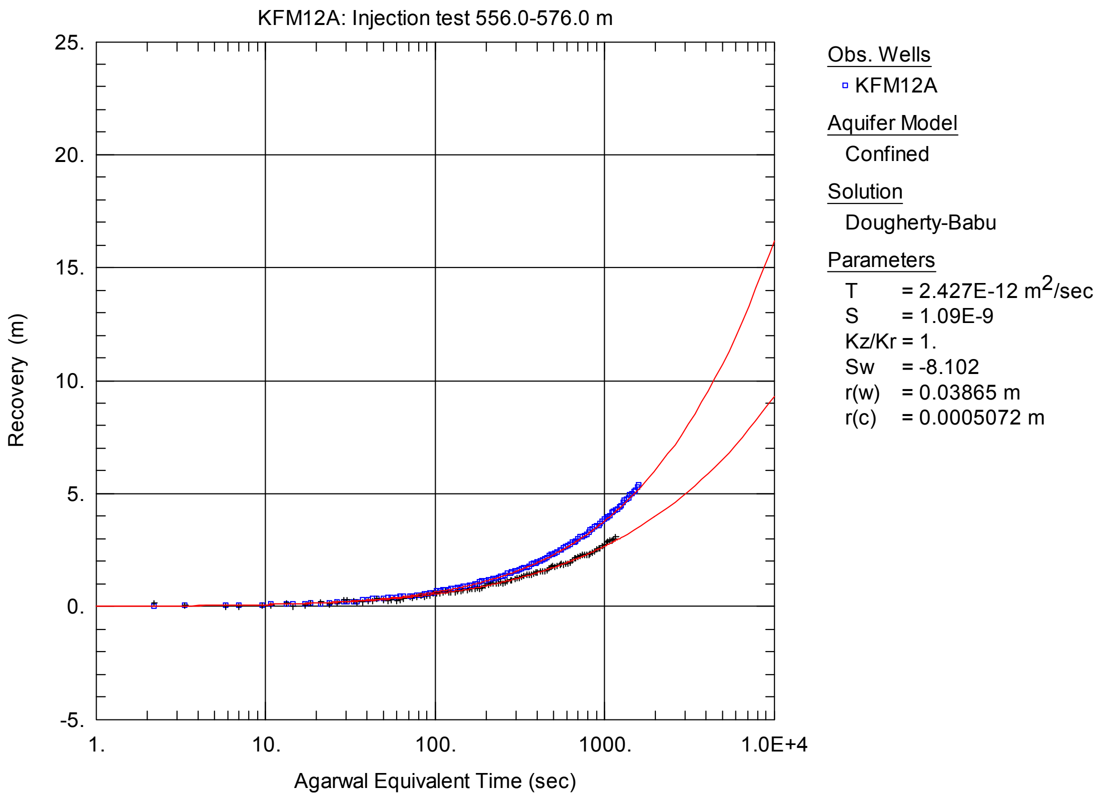


Figure A3-152. *Lin-log plot of recovery (□) and derivative (+) versus equivalent time, from the injection test in section 556.0-576.0 m in KFM12A. The type curve fit is showing a possible, however not unambiguous, evaluation.*

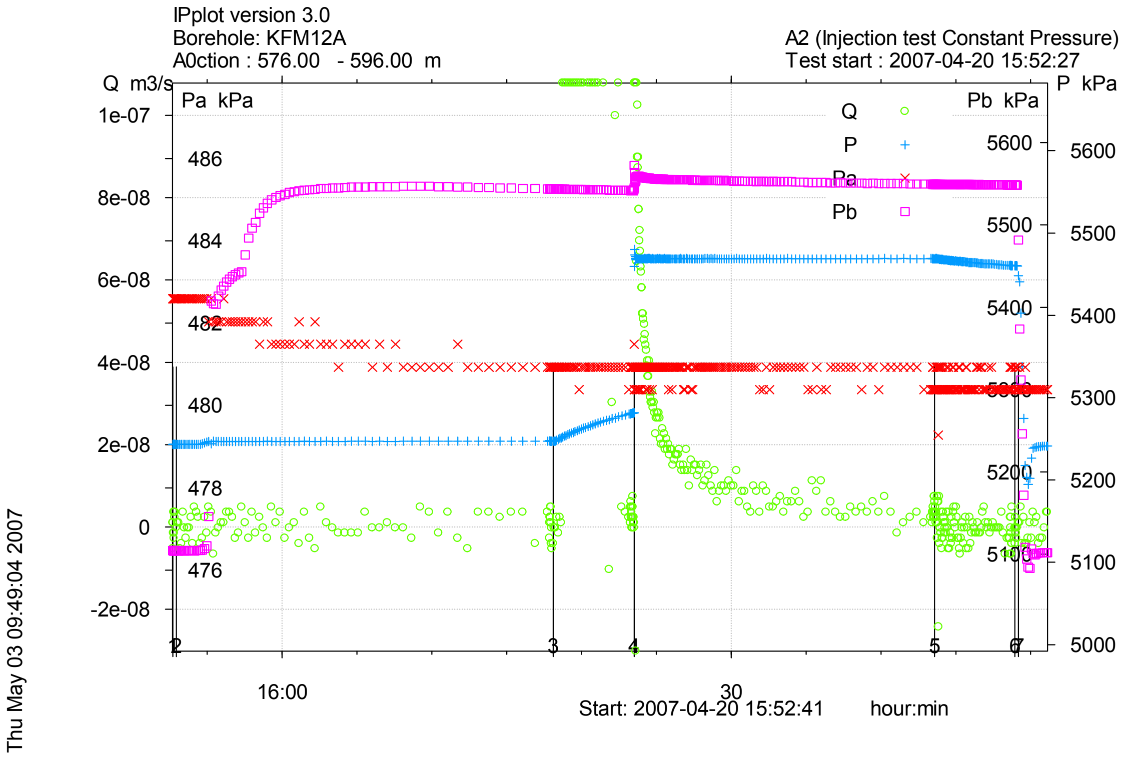
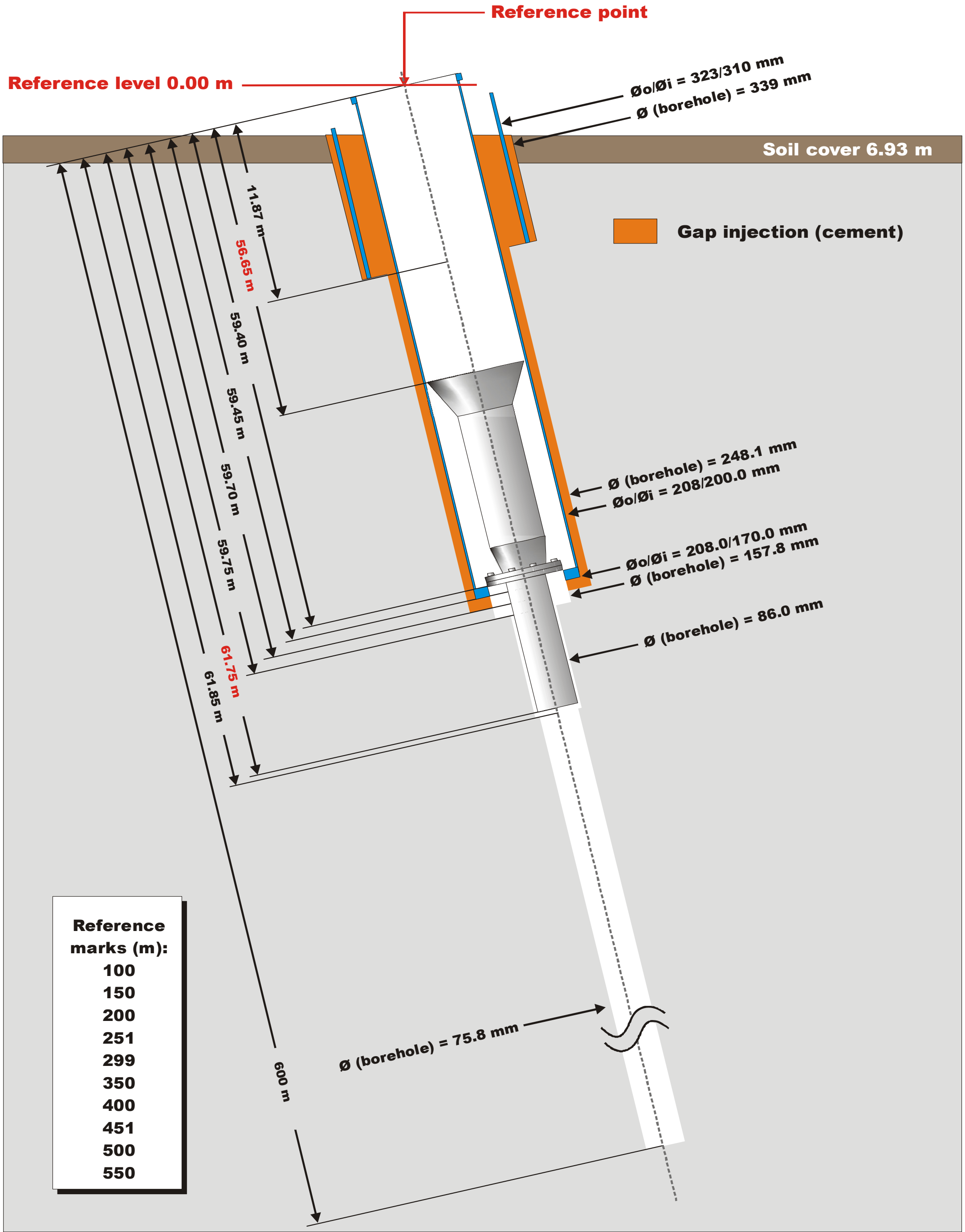


***Figure A3-153.** Linear plot of flow rate (Q), pressure (P), pressure above section (Pa) and pressure below section (Pb) versus time from the injection test in section 576.0-596.0 m in borehole KFM12A.*

Appendix 4. Borehole technical data

Technical data
Borehole KFM12A



Drilling reference point

Northing:	6696576.850 (m), RT90 2,5 gon V 0:-15
Easting:	1630051.636 (m), RT90 2,5 gon V 0:-15
Elevation:	10.737 (m), RHB 70

Orientation

Bearing (degrees):	36.20°
Inclination (degrees):	-60.67°

Borehole

Length:	600 m

Percussion drilling period

Drilling start date: 2006-09-04
Drilling stop date: 2006-09-18

Core drilling period

Drilling start date: 2007-02-26
Drilling stop date: 2007-03-10

2007-03-09

Appendix 5. Sicada tables

Nomenclature plu_s_hole_test_d

Column	Datatype	Unit	Column Description	Alt. Symbol
site	CHAR		Investigation site name	
activity_type	CHAR		Activity type code	
start_date	DATE		Date (yymmdd hh:mm:ss)	
stop_date	DATE		Date (yymmdd hh:mm:ss)	
project	CHAR		project code	
idcode	CHAR		Object or borehole identification code	
secup	FLOAT	m	Upper section limit (m)	
seclow	FLOAT	m	Lower section limit (m)	
section_no	INTEGER	number	Section number	
test_type	CHAR		Test type code (1-7), see table description	
formation_type	CHAR		1: Rock, 2: Soil (superficial deposits)	
start_flow_period	DATE	yyyymmdd	Date & time of pumping/injection start (YYYY-MM-DD hh:mm:ss)	
stop_flow_period	DATE	yyyymmdd	Date & time of pumping/injection stop (YYYY-MM-DD hh:mm:ss)	
flow_rate_end_qp	FLOAT	m**3/s	Flow rate at the end of the flowing period	
value_type_qp	CHAR		0:true value,-1<lower meas.limit1:>upper meas.limit	
mean_flow_rate_qm	FLOAT	m**3/s	Arithmetic mean flow rate during flow period	
Q_measl__l	FLOAT	m**3/s	Estimated lower measurement limit of flow rate	**Q-measl-L**
Q_measl__u	FLOAT	m**3/s	Estimated upper measurement limit of flow rate	Q-measl-U
tot_volume_vp	FLOAT	m**3	Total volume of pumped or injected water	
dur_flow_phase_tp	FLOAT	s	Duration of the flowing period of the test	
dur_rec_phase_tf	FLOAT	s	Duration of the recovery period of the test	
initial_head_hi	FLOAT	m	Hydraulic head in test section at start of the flow period	
head_at_flow_end_hp	FLOAT	m	Hydraulic head in test section at stop of the flow period.	
final_head_hf	FLOAT	m	Hydraulic head in test section at stop of recovery period.	
initial_press_pi	FLOAT	kPa	Groundwater pressure in test section at start of flow period	
press_at_flow_end_pp	FLOAT	kPa	Groundwater pressure in test section at stop of flow period.	
final_press_pf	FLOAT	kPa	Ground water pressure at the end of the recovery period.	
fluid_temp_tew	FLOAT	oC	Measured section fluid temperature, see table description	
fluid_elcond_ecw	FLOAT	mS/m	Measured section fluid el. conductivity,see table descr.	
fluid_salinity_tdsw	FLOAT	mg/l	Total salinity of section fluid based on EC,see table descr.	
fluid_salinity_tdswm	FLOAT	mg/l	Tot. section fluid salinity based on water sampling,see...	
reference	CHAR		SKB report No for reports describing data and evaluation	
comments	VARCHAR		Short comment to data	
error_flag	CHAR		If error_flag = "*" then an error occured and an error	
In_use	CHAR		If in_use = "*" then the activity has been selected as	
sign	CHAR		Signature for QA data accknowledge (QA - OK)	
Lp	FLOAT	m	Hydraulic point of application	

Nomenclature plu_s_hole_test_ed1

Column	Datatype	Unit	Column Description	Alt. Symbol
site	CHAR		Investigation site name	
activity_type	CHAR		Activity type code	
start_date	DATE		Date (yymmdd hh:mm:ss)	
stop_date	DATE		Date (yymmdd hh:mm:ss)	
project	CHAR		project code	
idcode	CHAR		Object or borehole identification code	
secup	FLOAT	m	Upper section limit (m)	
seclow	FLOAT	m	Lower section limit (m)	
section_no	INTEGER	number	Section number	
test_type	CHAR		Test type code (1-7), see table description!	
formation_type	CHAR		Formation type code. 1: Rock, 2: Soil (superficial deposits)	
Lp	FLOAT	m	Hydraulic point of application for test section, see descr.	
seclen_class	FLOAT	m	Planned ordinary test interval during test campaign.	
spec_capacity_q_s	FLOAT	m**2/s	Specific capacity (Q/s) of test section, see table descript.	Q/s
value_type_q_s	CHAR		0:true value,-1:Q/s<lower meas.limit,1:Q/s>upper meas.limit	
transmissivity_tq	FLOAT	m**2/s	Tranmissivity based on Q/s, see table description	
value_type_tq	CHAR		0:true value,-1:TQ<lower meas.limit,1:TQ>upper meas.limit.	
bc_tq	CHAR		Best choice code. 1 means TQ is best choice of T, else 0	
transmissivity_moye	FLOAT	m**2/s	Transmissivity,TM, based on Moye (1967)	T_M
bc_tm	CHAR		Best choice code. 1 means Tmoye is best choice of T, else 0	
value_type_tm	CHAR		0:true value,-1:TM<lower meas.limit,1:TM>upper meas.limit.	
hydr_cond_moye	FLOAT	m/s	K_M: Hydraulic conductivity based on Moye (1967)	K_M
formation_width_b	FLOAT	m	b:Aquifer thickness repr. for T(generally b=Lw) ,see descr.	b
width_of_channel_b	FLOAT	m	B:Inferred width of formation for evaluated TB	
Tb	FLOAT	m**3/s	TB:Flow capacity in 1D formation of T & width B, see descr.	
l_measl_tb	FLOAT	m**3/s	Estimated lower meas. limit for evaluated TB,see description	
U_measl_tb	FLOAT	m**3/s	Estimated upper meas. limit of evaluated TB,see description	
sb	FLOAT	m	SB:S=storativity,B=width of formation,1D model,see descript.	
assumed_sb	FLOAT	m	SB* : Assumed SB,S=storativity,B=width of formation,see...	
leakage_factor_lf	FLOAT	m	Lf:1D model for evaluation of Leakage factor	
transmissivity_tt	FLOAT	m**2/s	TT:Transmissivity of formation, 2D radial flow model,see...	T_T
value_type_tt	CHAR		0:true value,-1:TT<lower meas.limit,1:TT>upper meas.limit,	
bc_tt	CHAR		Best choice code. 1 means TT is best choice of T, else 0	
l_measl_q_s	FLOAT	m**2/s	Estimated lower meas. limit for evaluated TT,see table descr	Q/s-measl-L
U_measl_q_s	FLOAT	m**2/s	Estimated upper meas. limit for evaluated TT,see description	Q/s-measl-U
storativity_s	FLOAT		S:Storativity of formation based on 2D rad flow,see descr.	
assumed_s	FLOAT		Assumed Storativity,2D model evaluation,see table descr.	
bc_s	FLOAT		Best choice of S (Storativity) ,see descr.	
Ri	FLOAT	m	Radius of influence	
Ri_index	CHAR		ri index=index of radius of influence :-1,0 or 1, see descr.	
leakage_coeff	FLOAT	1/s	K'/b':2D rad flow model evaluation of leakage coeff,see desc	
hydr_cond_ksf	FLOAT	m/s	Ksf:3D model evaluation of hydraulic conductivity,see desc.	
value_type_ksf	CHAR		0:true value,-1:Ksf<lower meas.limit,1:Ksf>upper meas.limit,	
l_measl_ksf	FLOAT	m/s	Estimated lower meas.limit for evaluated Ksf,see table desc.	
U_measl_ksf	FLOAT	m/s	Estimated upper meas.limit for evaluated Ksf,see table descr	
spec_storage_ssf	FLOAT	1/m	Ssf:Specific storage,3D model evaluation,see table descr.	
assumed_ssf	FLOAT	1/m	Ssf*:Assumed Spec.storage,3D model evaluation,see table des.	

Column	Datatype	Unit	Column Description	Alt. Symbol
C	FLOAT	m**3/pa	C: Wellbore storage coefficient; flow or recovery period	C
cd	FLOAT		CD: Dimensionless wellbore storage coefficient	
skin	FLOAT		Skin factor;best estimate of flow/recovery period,see descr.	ξ
dt1	FLOAT	s	Estimated start time of evaluation, see table description	
dt2	FLOAT	s	Estimated stop time of evaluation. see table description	
t1	FLOAT	s	Start time for evaluated parameter from start flow period	t_1
t2	FLOAT	s	Stop time for evaluated parameter from start of flow period	t_2
dte1	FLOAT	s	Start time for evaluated parameter from start of recovery	dte_1
dte2	FLOAT	s	Stop time for evaluated parameter from start of recovery	dte_2
P_horner	FLOAT	kPa	p*:Horner extrapolated pressure, see table description	
transmissivity_t_nlr	FLOAT	m**2/s	T_NLR Transmissivity based on None Linear Regression...	
storativity_s_nlr	FLOAT		S_NLR=storativity based on None Linear Regression,see..	
value_type_t_nlr	CHAR		0:true value,-1:T_NLR<lower meas.limit,1:>upper meas.limit	
bc_t_nlr	CHAR		Best choice code. 1 means T_NLR is best choice of T, else 0	
C_nlr	FLOAT	m**3/pa	Wellbore storage coefficient, based on NLR, see descr.	
cd_nlr	FLOAT		Dimensionless wellbore storage constant, see table descrip.	
skin_nlr	FLOAT		Skin factor based on Non Linear Regression,see desc.	
transmissivity_t_grf	FLOAT	m**2/s	T_GRF:Transmissivity based on Genelized Radial Flow,see...	
value_type_t_grf	CHAR		0:true value,-1:T_GRF<lower meas.limit,1:>upper meas.limit	
bc_t_grf	CHAR		Best choice code. 1 means T_GRF is best choice of T, else 0	
storativity_s_grf	FLOAT		S_GRF:Storativity based on Generalized Radial Flow, see des.	
flow_dim_grf	FLOAT		Inferred flow dimesion based on Generalized Rad. Flow model	
comment	VARCHAR	no_unit	Short comment to the evaluated parameters	
error_flag	CHAR		If error_flag = "*" then an error occured and an error	
In_use	CHAR		If in_use = "*" then the activity has been selected as	
sign	CHAR		Signature for QA data accknowledge (QA - OK)	

Nomenclature plu_s_hole_test_obs

Column	Datatype	Unit	Column Description
site	CHAR		Investigation site name
activity_type	CHAR		Activity type code
idcode	CHAR		Object or borehole identification code
start_date	DATE		Date (yymmdd hh:mm:ss)
secup	FLOAT	m	Upper section limit (m)
seclow	FLOAT	m	Lower section limit (m)
obs_secup	FLOAT	m	Upper limit of observation section
obs_seclow	FLOAT	m	Lower limit of observation section
pi_above	FLOAT	kPa	Groundwater pressure above test section,start of flow period
pp_above	FLOAT	kPa	Groundwater pressure above test section,at stop flow period
pf_above	FLOAT	kPa	Groundwater pressure above test section at stop recovery per
pi_below	FLOAT	kPa	Groundwater pressure below test section at start flow period
pp_below	FLOAT	kPa	Groundwater pressure below test section at stop flow period
pf_below	FLOAT	kPa	Groundwater pressure below test section at stop recovery per
comments	VARCHAR		Comment text row (unformatted text)

KFM12A plu_s_hole_test_d. Left (This result table to SICADA includes more columns which are empty, these columns are not presented here.)

idcode	start_date	stop_date	secup	seclow	test_type	Formation_type	start_flow_period	stop_flow_period	flow_rate_end_qp	Value_type_qp	mean_flow_rate_qm
KFM12A	20070410 10:27	20070410 12:23	63.00	163.00	3	1	20070410 11:20:35	20070410 11:50:51	1.64E-04	0	1.94E-04
KFM12A	20070410 15:15	20070410 17:32	163.00	263.00	3	1	20070410 16:29:31	20070410 16:59:48	3.28E-05	0	3.61E-05
KFM12A	20070411 09:30	20070411 11:20	263.00	363.00	3	1	20070411 10:17:38	20070411 10:47:48	2.32E-04	0	2.54E-04
KFM12A	20070411 13:26	20070411 15:15	363.00	463.00	3	1	20070411 14:12:54	20070411 14:43:10	6.37E-05	0	7.01E-05
KFM12A	20070411 16:05	20070412 09:28	463.00	563.00	3	1	20070412 08:26:01	20070412 08:56:19	4.83E-06	0	5.13E-06
KFM12A	20070412 10:02	20070412 11:50	496.00	596.00	3	1	20070412 10:47:57	20070412 11:18:07	4.82E-06	0	5.34E-06
KFM12A	20070413 15:53	20070413 17:09	63.00	83.00	3	1	20070413 16:26:58	20070413 16:47:15	1.81E-05	0	1.84E-05
KFM12A	20070416 08:40	20070416 09:55	83.00	103.00	3	1	20070416 09:12:35	20070416 09:32:53	4.77E-05	0	4.87E-05
KFM12A	20070416 10:12	20070416 11:25	103.00	123.00	3	1	20070416 10:43:18	20070416 11:03:36	4.37E-06	0	4.61E-06
KFM12A	20070416 12:23	20070416 13:37	123.00	143.00	3	1	20070416 12:54:37	20070416 13:14:54	5.15E-05	0	5.57E-05
KFM12A	20070416 13:55	20070416 15:11	143.00	163.00	3	1	20070416 14:29:22	20070416 14:49:32	8.90E-05	0	1.16E-04
KFM12A	20070416 15:31	20070416 16:52	163.00	183.00	3	1	20070416 16:09:32	20070416 16:29:48	7.21E-07	0	7.78E-07
KFM12A	20070417 08:26	20070417 09:41	183.00	203.00	3	1	20070417 08:58:56	20070417 09:19:13	6.21E-07	0	7.16E-07
KFM12A	20070417 09:58	20070417 11:14	203.00	223.00	3	1	20070417 10:32:13	20070417 10:52:29	2.22E-06	0	2.48E-06
KFM12A	20070417 12:17	20070417 13:40	223.00	243.00	3	1	20070417 12:57:27	20070417 13:17:44	3.06E-05	0	3.37E-05
KFM12A	20070417 14:03	20070417 15:17	243.00	263.00	3	1	20070417 14:34:46	20070417 14:55:03	2.88E-07	0	3.13E-07
KFM12A	20070417 15:34	20070417 16:48	263.00	283.00	3	1	20070417 16:05:54	20070417 16:26:09	8.66E-05	0	1.03E-04
KFM12A	20070418 08:33	20070418 09:49	283.00	303.00	3	1	20070418 09:06:33	20070418 09:26:51	2.49E-05	0	2.72E-05
KFM12A	20070418 10:05	20070418 11:23	303.00	323.00	3	1	20070418 10:40:54	20070418 11:01:08	9.96E-05	0	1.02E-04
KFM12A	20070418 12:24	20070418 13:40	323.00	343.00	3	1	20070418 12:57:36	20070418 13:17:53	5.90E-05	0	6.30E-05
KFM12A	20070418 13:59	20070418 15:13	343.00	363.00	3	1	20070418 14:30:50	20070418 14:51:08	1.53E-05	0	1.60E-05
KFM12A	20070418 15:38	20070418 16:51	363.00	383.00	3	1	20070418 16:09:24	20070418 16:29:42	7.05E-05	0	7.66E-05
KFM12A	20070419 08:34	20070419 09:53	383.00	403.00	3	1	20070419 09:11:01	20070419 09:31:21	3.37E-08	0	5.17E-08
KFM12A	20070419 10:08	20070419 11:27	403.00	423.00	3	1	20070419 10:44:58	20070419 11:05:16	1.04E-05	0	1.11E-05
KFM12A	20070419 12:28	20070419 13:11	423.00	443.00	3	1	20070419 13:01:29	20070419 13:03:52		-1	
KFM12A	20070419 13:28	20070419 14:47	443.00	463.00	3	1	20070419 14:04:38	20070419 14:24:56	1.32E-05	0	1.42E-05
KFM12A	20070424 09:23	20070424 10:40	463.00	483.00	3	1	20070424 09:57:29	20070424 10:17:47	4.87E-07	0	5.41E-07

idcode	start_date	stop_date	secup	seclow	test_type	Formation_type	start_flow_period	stop_flow_period	flow_rate_end_qp	Value_type_qp	mean_flow_rate_qm
KFM12A	20070419 16:31	20070420 08:39	483.00	503.00	3	1	20070420 08:22:48	20070420 08:32:14		-1	
KFM12A	20070420 09:05	20070420 10:21	496.00	516.00	3	1	20070420 09:38:29	20070420 09:58:47	5.15E-07	0	6.70E-07
KFM12A	20070420 10:37	20070420 11:57	516.00	536.00	3	1	20070420 11:14:29	20070420 11:34:46	5.25E-06	0	5.67E-06
KFM12A	20070420 12:57	20070420 14:11	536.00	556.00	3	1	20070420 13:29:06	20070420 13:49:25	6.45E-09	0	1.99E-08
KFM12A	20070420 14:25	20070420 15:39	556.00	576.00	3	1	20070420 14:56:39	20070420 15:16:59	7.09E-09	0	1.84E-08
KFM12A	20070420 15:52	20070420 16:51	576.00	596.00	3	1	20070420 16:23:31	20070420 16:43:36		-1	
KFM12A[1)]	20070419 15:02	20070419 16:16	463.00	483.00	3	1	20070419 15:34:06	20070419 15:54:24	3.41E-07	0	3.92E-07

[1)] Incomplete test, interrupted and re-performed later.

KFM12A plu_s_hole_test_d. Right (This result table to SICADA includes more columns which are empty, these columns are not presented here.)

idcode	secup	seclow	q_measl__l	q_measl__u	tot_volume_vp	dur_flow_phase_tp	dur_rec_phase_tf	initial_press_pi	press_at_flow_end_pp	final_press_pf	fluid_temp_tew
KFM12A	63.00	163.00	1.7E-08	1.0E-03	3.53E-01	1816	1806	2288.70	2454.01	2303.53	9.39
KFM12A	163.00	263.00	1.7E-08	1.0E-03	6.58E-02	1817	1806	3143.30	3339.10	3156.48	7.20
KFM12A	263.00	363.00	1.7E-08	1.0E-03	4.61E-01	1810	1815	3990.22	4139.61	3997.36	8.12
KFM12A	363.00	463.00	1.7E-08	1.0E-03	1.27E-01	1816	1806	4834.39	4957.41	4845.92	9.10
KFM12A	463.00	563.00	1.7E-08	1.0E-03	9.34E-03	1818	1806	5693.39	5890.69	5699.42	10.42
KFM12A	496.00	596.00	1.7E-08	1.0E-03	9.67E-03	1810	1816	5963.34	6162.97	5972.40	10.70
KFM12A	63.00	83.00	1.7E-08	1.0E-03	2.25E-02	1217	1206	926.41	1113.69	926.95	6.49
KFM12A	83.00	103.00	1.7E-08	1.0E-03	5.94E-02	1218	1206	1093.37	1268.79	1092.82	6.63
KFM12A	103.00	123.00	1.7E-08	1.0E-03	5.63E-03	1218	1206	1270.08	1479.93	1277.91	6.84
KFM12A	123.00	143.00	1.7E-08	1.0E-03	6.78E-02	1217	1208	1441.03	1631.62	1447.08	6.73
KFM12A	143.00	163.00	1.7E-08	1.0E-03	1.40E-01	1210	1214	1610.61	1779.12	1633.82	7.04
KFM12A	163.00	183.00	1.7E-08	1.0E-03	9.47E-04	1216	1208	1785.95	1998.78	1784.31	7.51
KFM12A	183.00	203.00	1.7E-08	1.0E-03	8.73E-04	1217	1206	1952.65	2152.01	1968.29	7.73
KFM12A	203.00	223.00	1.7E-08	1.0E-03	3.02E-03	1216	1208	2121.25	2320.90	2124.28	7.91
KFM12A	223.00	243.00	1.7E-08	1.0E-03	4.11E-02	1217	1208	2290.14	2482.79	2302.23	7.80
KFM12A	243.00	263.00	1.7E-08	1.0E-03	3.81E-04	1217	1208	2461.78	2692.73	2469.75	8.32
KFM12A	263.00	283.00	1.7E-08	1.0E-03	1.26E-01	1215	1209	2630.81	2835.54	2650.44	7.96
KFM12A	283.00	303.00	1.7E-08	1.0E-03	3.32E-02	1218	1206	2799.97	2996.59	2810.27	8.49
KFM12A	303.00	323.00	1.7E-08	1.0E-03	1.23E-01	1214	1210	2970.65	3167.41	2973.38	8.36
KFM12A	323.00	343.00	1.7E-08	1.0E-03	7.68E-02	1217	1208	3138.71	3319.69	3139.81	8.69
KFM12A	343.00	363.00	1.7E-08	1.0E-03	1.95E-02	1218	1206	3315.29	3500.32	3320.51	9.14
KFM12A	363.00	383.00	1.7E-08	1.0E-03	9.34E-02	1218	1206	3480.20	3674.21	3497.36	9.05
KFM12A	383.00	403.00	1.7E-08	1.0E-03	6.31E-05	1220	1206	3661.58	3863.06	3687.94	9.68
KFM12A	403.00	423.00	1.7E-08	1.0E-03	1.35E-02	1218	1206	3831.42	4028.19	3841.17	9.78
KFM12A	423.00	443.00	4.9E-09	1.0E-03		143	322	4013.09	4194.34	4187.75	10.06
KFM12A	443.00	463.00	1.7E-08	1.0E-03	1.73E-02	1218	1206	4168.11	4364.42	4177.86	10.12
KFM12A	463.00	483.00	1.7E-08	1.0E-03	6.60E-04	1218	1206	4336.44	4534.72	4339.33	10.36
KFM12A	483.00	503.00	5.1E-09	1.0E-03		566	321	4484.19	4681.50	4667.77	10.55

idcode	secup	seclow	q_measl__l	q_measl__u	tot_volume_vp	dur_flow_phase_tp	dur_rec_phase_tf	initial_press_pi	press_at_flow_end_pp	final_press_pf	fluid_temp_tew
KFM12A	496.00	516.00	1.7E-08	1.0E-03	8.16E-04	1218	1208	4617.65	4788.19	4623.84	10.72
KFM12A	516.00	536.00	1.7E-08	1.0E-03	6.91E-03	1217	1208	4785.31	4977.12	4792.44	10.90
KFM12A	536.00	556.00	4.9E-09	1.0E-03	2.40E-05	1219	1221	4925.90	5140.66	5030.81	11.11
KFM12A	556.00	576.00	3.6E-09	1.0E-03	2.22E-05	1220	1221	5114.29	5305.43	5245.01	11.30
KFM12A	576.00	596.00	4.9E-09	1.0E-03		1205	322	5281.40	5468.55	5460.31	11.49
KFM12A[1)]	463.00	483.00	1.7E-08	1.0E-03	4.78E-04	1218	1206	5020.03	5258.47	5022.23	10.41

[1)] Incomplete test, interrupted and re-performed later.

KFM12A plu_s_hole_test_ed1. Left (This result table to SICADA includes more columns which are empty, these columns are not presented here.)

idcode	start_date	stop_date	secup	seclow	test_type	formation_type	spec_capacity_q_s	value_type_q_s	transmissivity_moye	value_type_tm	bc_tm	hydr_cond_moye	formation_width_b
KFM12A	20070410 10:27	20070410 12:23	63.00	163.00	3	1	9.71E-06	0	1.26E-05	0	0	1.26E-07	100.00
KFM12A	20070410 15:15	20070410 17:32	163.00	263.00	3	1	1.64E-06	0	2.14E-06	0	0	2.14E-08	100.00
KFM12A	20070411 09:30	20070411 11:20	263.00	363.00	3	1	1.52E-05	0	1.98E-05	0	0	1.98E-07	100.00
KFM12A	20070411 13:26	20070411 15:15	363.00	463.00	3	1	5.08E-06	0	6.62E-06	0	0	6.62E-08	100.00
KFM12A	20070411 16:05	20070412 09:28	463.00	563.00	3	1	2.40E-07	0	3.13E-07	0	0	3.13E-09	100.00
KFM12A	20070412 10:02	20070412 11:50	496.00	596.00	3	1	2.37E-07	0	3.09E-07	0	0	3.09E-09	100.00
KFM12A	20070413 15:53	20070413 17:09	63.00	83.00	3	1	9.48E-07	0	9.93E-07	0	0	4.96E-08	20.00
KFM12A	20070416 08:40	20070416 09:55	83.00	103.00	3	1	2.67E-06	0	2.79E-06	0	0	1.40E-07	20.00
KFM12A	20070416 10:12	20070416 11:25	103.00	123.00	3	1	2.04E-07	0	2.14E-07	0	0	1.07E-08	20.00
KFM12A	20070416 12:23	20070416 13:37	123.00	143.00	3	1	2.65E-06	0	2.77E-06	0	0	1.39E-07	20.00
KFM12A	20070416 13:55	20070416 15:11	143.00	163.00	3	1	5.18E-06	0	5.43E-06	0	0	2.71E-07	20.00
KFM12A	20070416 15:31	20070416 16:52	163.00	183.00	3	1	3.32E-08	0	3.48E-08	0	0	1.74E-09	20.00
KFM12A	20070417 08:26	20070417 09:41	183.00	203.00	3	1	3.05E-08	0	3.20E-08	0	0	1.60E-09	20.00
KFM12A	20070417 09:58	20070417 11:14	203.00	223.00	3	1	1.09E-07	0	1.14E-07	0	0	5.72E-09	20.00
KFM12A	20070417 12:17	20070417 13:40	223.00	243.00	3	1	1.56E-06	0	1.63E-06	0	0	8.16E-08	20.00
KFM12A	20070417 14:03	20070417 15:17	243.00	263.00	3	1	1.22E-08	0	1.28E-08	0	0	6.40E-10	20.00
KFM12A	20070417 15:34	20070417 16:48	263.00	283.00	3	1	4.15E-06	0	4.34E-06	0	0	2.17E-07	20.00
KFM12A	20070418 08:33	20070418 09:49	283.00	303.00	3	1	1.24E-06	0	1.30E-06	0	0	6.50E-08	20.00
KFM12A	20070418 10:05	20070418 11:23	303.00	323.00	3	1	4.97E-06	0	5.20E-06	0	0	2.60E-07	20.00
KFM12A	20070418 12:24	20070418 13:40	323.00	343.00	3	1	3.20E-06	0	3.35E-06	0	0	1.67E-07	20.00
KFM12A	20070418 13:59	20070418 15:13	343.00	363.00	3	1	8.11E-07	0	8.49E-07	0	0	4.25E-08	20.00
KFM12A	20070418 15:38	20070418 16:51	363.00	383.00	3	1	3.57E-06	0	3.73E-06	0	0	1.87E-07	20.00
KFM12A	20070419 08:34	20070419 09:53	383.00	403.00	3	1	1.64E-09	0	1.72E-09	0	0	8.59E-11	20.00
KFM12A	20070419 10:08	20070419 11:27	403.00	423.00	3	1	5.19E-07	0	5.43E-07	0	0	2.72E-08	20.00
KFM12A	20070419 12:28	20070419 13:11	423.00	443.00	3	1	2.44E-10	-1	2.55E-10	-1	0	1.28E-11	20.00
KFM12A	20070419 13:28	20070419 14:47	443.00	463.00	3	1	6.61E-07	0	6.92E-07	0	0	3.46E-08	20.00
KFM12A	20070424 09:23	20070424 10:40	463.00	483.00	3	1	2.41E-08	0	2.52E-08	0	0	1.26E-09	20.00
KFM12A	20070419 16:31	20070420 08:39	483.00	503.00	3	1	2.54E-10	-1	2.65E-10	-1	0	1.33E-11	20.00
KFM12A	20070420 09:05	20070420 10:21	496.00	516.00	3	1	2.96E-08	0	3.10E-08	0	0	1.55E-09	20.00
KFM12A	20070420 10:37	20070420 11:57	516.00	536.00	3	1	2.69E-07	0	2.81E-07	0	0	1.41E-08	20.00

idcode	start_date	stop_date	secup	seclow	test_type	formation_type	spec_capacity_q_s	value_type_q_s	transmissivity_moye	value_type_tm	bc_tm	hydr_cond_moye	formation_width_b
KFM12A	20070420 12:57	20070420 14:11	536.00	556.00	3	1	2.95E-10	0	3.08E-10	0	0	1.54E-11	20.00
KFM12A	20070420 14:25	20070420 15:39	556.00	576.00	3	1	3.64E-10	0	3.81E-10	0	1	1.90E-11	20.00
KFM12A	20070420 15:52	20070420 16:51	576.00	596.00	3	1	2.44E-10	-1	2.55E-10	-1	0	1.28E-11	20.00
KFM12A[1]	20070419 15:02	20070419 16:16	463.00	483.00	3	1	1.41E-08	0	1.47E-08	0	0	7.35E-10	20.00

[1] Incomplete test, interrupted and re-performed later.

KFM12A plu_s_hole_test_ed1. Right (This result table to SICADA includes more columns which are empty, these columns are not presented here.)

idcode	secup	seclow	transmissivity_tt	value_type_tt	bc_tt	l_measl_q_s	u_measl_q_s	assumed_s	bc_s	ri	ri_index	c	skin	t1	t2	dte1	dte2
KFM12A	63.00	163.00	2.60E-06	0	1	9.9E-10	5.0E-04	1.13E-06	1.13E-06	97.00	-1		-6.04				
KFM12A	163.00	263.00	1.46E-06	0	1	8.4E-10	5.0E-04	8.46E-07	8.46E-07	83.60	0		-2.19	150	1800		
KFM12A	263.00	363.00	1.01E-05	0	1	1.1E-09	5.0E-04	2.22E-06	2.22E-06	135.60	0		-4.07	200	1800		
KFM12A	363.00	463.00	3.98E-06	0	1	1.3E-09	5.0E-04	1.40E-06	1.40E-06	107.46	0		-3.15	300	1800		
KFM12A	463.00	563.00	3.41E-07	0	1	8.3E-10	5.0E-04	4.09E-07	4.09E-07	58.14	0		1.54	200	1800		
KFM12A	496.00	596.00	2.32E-07	0	1	8.2E-10	5.0E-04	3.37E-07	3.37E-07	52.77	0		-1.22	60	1800		
KFM12A	63.00	83.00	3.11E-06	0	1	8.7E-10	5.0E-04	1.23E-06	1.23E-06	82.48	0		12.89	25	1200		
KFM12A	83.00	103.00	2.85E-06	0	1	9.3E-10	5.0E-04	1.18E-06	1.18E-06	81.30	-1		-0.31				
KFM12A	103.00	123.00	3.56E-07	0	1	7.8E-10	5.0E-04	4.18E-07	4.18E-07	48.33	0		3.75				
KFM12A	123.00	143.00	2.21E-06	0	1	8.6E-10	5.0E-04	1.04E-06	1.04E-06	76.23			-2.06				
KFM12A	143.00	163.00	1.89E-06	0	1	9.7E-10	5.0E-04	9.61E-07	9.61E-07	73.07			-5.52				
KFM12A	163.00	183.00	4.62E-08	0	1	7.7E-10	5.0E-04	1.50E-07	1.50E-07	28.98	-1		2.21				
KFM12A	183.00	203.00	2.11E-08	0	1	8.2E-10	5.0E-04	1.02E-07	1.02E-07	23.85	0	4.60E-11	-2.22	20	1217		
KFM12A	203.00	223.00	6.40E-08	0	1	8.2E-10	5.0E-04	1.77E-07	1.77E-07	31.45	-1		-2.80				
KFM12A	223.00	243.00	1.33E-06	0	1	8.5E-10	5.0E-04	8.07E-07	8.07E-07	66.70	0		-2.18	40	1200		
KFM12A	243.00	263.00	5.33E-09	0	1	7.1E-10	5.0E-04	5.11E-08	5.11E-08	16.90	-1	3.91E-11	-2.93				
KFM12A	263.00	283.00	1.78E-06	0	1	8.0E-10	5.0E-04	9.34E-07	9.34E-07	71.73	0		-5.02	50	1200		
KFM12A	283.00	303.00	1.16E-06	0	1	8.3E-10	5.0E-04	7.54E-07	7.54E-07	64.44	0		-1.62	200	1200		
KFM12A	303.00	323.00	1.23E-05	0	1	8.3E-10	5.0E-04	2.45E-06	2.45E-06	75.00	-1		7.60	100	500		
KFM12A	323.00	343.00	3.80E-06	0	1	9.0E-10	5.0E-04	1.37E-06	1.37E-06	86.73	0		-0.35	30	1200		
KFM12A	343.00	363.00	6.63E-07	0	1	8.8E-10	5.0E-04	5.70E-07	5.70E-07	56.46	1		-1.67				
KFM12A	363.00	383.00	3.63E-06	0	1	8.4E-10	5.0E-04	1.33E-06	1.33E-06	86.38	0		-1.41	70	1218		
KFM12A	383.00	403.00	6.60E-10	0	1	8.1E-10	5.0E-04	1.80E-08	1.80E-08	10.04	0	4.68E-11	-3.20	20	1220		
KFM12A	403.00	423.00	5.82E-07	0	1	8.3E-10	5.0E-04	5.34E-07	5.34E-07	54.65	0		-0.27	30	1218		
KFM12A	423.00	443.00		-1	0	2.4E-10	5.0E-04										
KFM12A	443.00	463.00	6.23E-07	0	1	8.3E-10	5.0E-04	5.53E-07	5.53E-07	55.18	0		-1.38	30	1200		
KFM12A	463.00	483.00	5.37E-08	0	1	8.2E-10	5.0E-04	1.62E-07	1.62E-07	27.29	1	9.45E-11	6.89	100	1000		
KFM12A	483.00	503.00		-1	0	2.5E-10	5.0E-04										

idcode	secup	seclow	transmissivity_tt	value_type_tt	bc_tt	l_measl_q_s	u_measl_q_s	assumed_s	bc_s	ri	ri_index	c	skin	t1	t2	dte1	dte2
KFM12A	496.00	516.00	1.07E-08	0	1	9.6E-10	5.0E-04	7.25E-08	7.25E-08	19.98	0		-4.23	20	1200		
KFM12A	516.00	536.00	2.73E-07	0	1	8.5E-10	5.0E-04	3.66E-07	3.66E-07	44.89	0		-0.77	20	1200		
KFM12A	536.00	556.00	2.20E-10	0	1	2.2E-10	5.0E-04	1.04E-08	1.04E-08	5.77	1	4.49E-11	-1.50	20	700		
KFM12A	556.00	576.00		0	0	1.8E-10	5.0E-04	1.37E-08	1.37E-08	8.75		1.14E-10					
KFM12A	576.00	596.00		-1	0	2.4E-10	5.0E-04										
KFM12A[1)]	463.00	483.00		0	0	6.9E-10	5.0E-04										

[1)] Incomplete test, interrupted and re-performed later.

KFM12A plu_s_hole_test_obs. Injection tests (This result table to SICADA includes more columns which are empty, these columns are not presented here.)

idcode	start_date	stop_date	secup	seclow	obs_secup	obs_seclow	pi_above	pp_above	pf_above	pi_below	pp_below	pf_below	comments
KFM12A	20070410 10:27	20070410 12:23	63.00	163.00	59.70	62.00	545.96	550.38	548.17				
KFM12A	20070410 10:27	20070410 12:23	63.00	163.00	164.00	601.04				1472.56	1472.97	1472.97	
KFM12A	20070410 15:15	20070410 17:32	163.00	263.00	59.70	162.00	541.43	540.74	540.60				
KFM12A	20070410 15:15	20070410 17:32	163.00	263.00	264.00	601.04				2322.30	2322.57	2322.57	
KFM12A	20070411 09:30	20070411 11:20	263.00	363.00	59.70	262.00	537.45	536.34	535.80				
KFM12A	20070411 09:30	20070411 11:20	263.00	363.00	364.00	601.04				3174.92	3187.54	3181.51	
KFM12A	20070411 13:26	20070411 15:15	363.00	463.00	59.70	362.00	532.78	532.64	532.64				
KFM12A	20070411 13:26	20070411 15:15	363.00	463.00	464.00	601.04				4039.33	4040.30	4040.43	
KFM12A	20070411 16:05	20070412 09:28	463.00	563.00	59.70	462.00	516.78	516.64	517.34				
KFM12A	20070411 16:05	20070412 09:28	463.00	563.00	564.00	601.04				4864.52	4865.62	4864.25	
KFM12A	20070412 10:02	20070412 11:50	496.00	596.00	59.70	495.00	508.78	508.23	508.64				
KFM12A	20070412 10:02	20070412 11:50	496.00	596.00	597.00	601.04				5506.53	5552.35	5549.20	
KFM12A	20070413 15:53	20070413 17:09	63.00	83.00	59.70	62.00	550.38	550.38	549.84				
KFM12A	20070413 15:53	20070413 17:09	63.00	83.00	84.00	601.04				795.15	795.15	795.15	
KFM12A	20070416 08:40	20070416 09:55	83.00	103.00	59.70	82.00	546.23	545.67	545.12				
KFM12A	20070416 08:40	20070416 09:55	83.00	103.00	104.00	601.04				963.64	963.09	963.09	
KFM12A	20070416 10:12	20070416 11:25	103.00	123.00	59.70	102.00	543.16	541.51	540.96				
KFM12A	20070416 10:12	20070416 11:25	103.00	123.00	124.00	601.04				1133.37	1133.23	1133.23	
KFM12A	20070416 12:23	20070416 13:37	123.00	143.00	59.70	122.00	542.31	540.79	540.10				
KFM12A	20070416 12:23	20070416 13:37	123.00	143.00	144.00	601.04				1303.37	1309.00	1305.02	
KFM12A	20070416 13:55	20070416 15:11	143.00	163.00	59.70	142.00	542.42	543.95	544.23				
KFM12A	20070416 13:55	20070416 15:11	143.00	163.00	164.00	601.04				1474.06	1474.06	1474.06	
KFM12A	20070416 15:31	20070416 16:52	163.00	183.00	59.70	162.00	543.23	542.40	541.71				
KFM12A	20070416 15:31	20070416 16:52	163.00	183.00	184.00	601.04				1644.20	1644.20	1644.20	
KFM12A	20070417 08:26	20070417 09:41	183.00	203.00	59.70	182.00	540.31	539.75	539.21				
KFM12A	20070417 08:26	20070417 09:41	183.00	203.00	204.00	601.04				1813.24	1813.24	1813.24	
KFM12A	20070417 09:58	20070417 11:14	203.00	223.00	59.70	202.00	539.32	538.36	537.80				

idcode	start_date	stop_date	secup	seclow	obs_secup	obs_seclow	pi_above	pp_above	pf_above	pi_below	pp_below	pf_below	comments
KFM12A	20070417 09:58	20070417 11:14	203.00	223.00	224.00	601.04				1982.83	1983.11	1982.83	
KFM12A	20070417 12:17	20070417 13:40	223.00	243.00	59.70	222.00	537.50	536.95	536.39				
KFM12A	20070417 12:17	20070417 13:40	223.00	243.00	244.00	601.04				2152.97	2152.97	2152.97	
KFM12A	20070417 14:03	20070417 15:17	243.00	263.00	59.70	242.00	537.89	537.20	536.65				
KFM12A	20070417 14:03	20070417 15:17	243.00	263.00	264.00	601.04				2323.67	2323.67	2323.67	
KFM12A	20070417 15:34	20070417 16:48	263.00	283.00	59.70	262.00	537.04	535.80	535.80				
KFM12A	20070417 15:34	20070417 16:48	263.00	283.00	284.00	601.04				2494.36	2495.45	2495.45	
KFM12A	20070418 08:33	20070418 09:49	283.00	303.00	59.70	282.00	536.05	536.05	535.50				
KFM12A	20070418 08:33	20070418 09:49	283.00	303.00	304.00	601.04				2663.81	2663.95	2664.50	
KFM12A	20070418 10:05	20070418 11:23	303.00	323.00	59.70	302.00	534.93	534.10	534.10				
KFM12A	20070418 10:05	20070418 11:23	303.00	323.00	324.00	601.04				2834.36	2846.16	2837.38	
KFM12A	20070418 12:24	20070418 13:40	323.00	343.00	59.70	322.00	534.35	536.00	534.89				
KFM12A	20070418 12:24	20070418 13:40	323.00	343.00	344.00	601.04				3008.07	3009.17	3009.71	
KFM12A	20070418 13:59	20070418 15:13	343.00	363.00	59.70	342.00	532.94	532.40	532.40				
KFM12A	20070418 13:59	20070418 15:13	343.00	363.00	364.00	601.04				3178.89	3188.10	3183.15	
KFM12A	20070418 15:38	20070418 16:51	363.00	383.00	59.70	362.00	530.98	531.54	531.54				
KFM12A	20070418 15:38	20070418 16:51	363.00	383.00	384.00	601.04				3360.96	3361.38	3362.62	
KFM12A	20070419 08:34	20070419 09:53	383.00	403.00	59.70	382.00	527.38	526.96	526.82				
KFM12A	20070419 08:34	20070419 09:53	383.00	403.00	404.00	601.04				3527.27	3527.96	3528.92	
KFM12A	20070419 10:08	20070419 11:27	403.00	423.00	59.70	402.00	523.90	523.35	523.21				
KFM12A	20070419 10:08	20070419 11:27	403.00	423.00	424.00	601.04				3698.37	3698.92	3699.05	
KFM12A	20070419 12:28	20070419 13:11	423.00	443.00	59.70	422.00	520.14	520.14	520.14				
KFM12A	20070419 12:28	20070419 13:11	423.00	443.00	444.00	601.04				3864.80	3864.80	3864.80	
KFM12A	20070419 13:28	20070419 14:47	443.00	463.00	59.70	442.00	516.81	516.12	515.99				
KFM12A	20070419 13:28	20070419 14:47	443.00	463.00	464.00	601.04				4036.60	4037.14	4037.14	
KFM12A	20070424 09:23	20070424 10:40	463.00	483.00	59.70	462.00	495.24	495.10	495.24				
KFM12A	20070424 09:23	20070424 10:40	463.00	483.00	484.00	601.04				4204.26	4206.04	4206.73	
KFM12A	20070419 16:31	20070420 08:39	483.00	503.00	59.70	482.00	508.20	508.20	508.20				
KFM12A	20070419 16:31	20070420 08:39	483.00	503.00	504.00	601.04				4376.32	4376.32	4376.32	
KFM12A	20070420 09:05	20070420 10:21	496.00	516.00	59.70	495.00	505.33	505.33	504.77				
KFM12A	20070420 09:05	20070420 10:21	496.00	516.00	517.00	601.04				4482.80	4484.72	4483.90	
KFM12A	20070420 10:37	20070420 11:57	516.00	536.00	59.70	515.00	499.78	499.50	499.50				

idcode	start_date	stop_date	secup	seclow	obs_secup	obs_seclow	pi_above	pp_above	pf_above	pi_below	pp_below	pf_below	comments
KFM12A	20070420 10:37	20070420 11:57	516.00	536.00	537.00	601.04				4720.31	4702.33	4690.82	
KFM12A	20070420 12:57	20070420 14:11	536.00	556.00	59.70	535.00	493.95	493.27	493.14				
KFM12A	20070420 12:57	20070420 14:11	536.00	556.00	557.00	601.04				4922.83	4891.55	4874.13	
KFM12A	20070420 14:25	20070420 15:39	556.00	576.00	59.70	555.00	487.58	487.30	487.30				
KFM12A	20070420 14:25	20070420 15:39	556.00	576.00	577.00	601.04				5179.28	5147.99	5124.40	
KFM12A	20070420 15:52	20070420 16:51	576.00	596.00	59.70	575.00	481.07	480.38	480.38				
KFM12A	20070420 15:52	20070420 16:51	576.00	596.00	597.00	601.04				5542.88	5549.74	5548.64	
KFM12A	20070419 15:02	20070419 16:16	463.00	483.00	59.70	462.00	512.92	512.92	512.92				Incomplete test, interrupted and re-performed later.
KFM12A	20070419 15:02	20070419 16:16	463.00	483.00	484.00	601.04				4203.99	4204.67	4205.08	Incomplete test, interrupted and re-performed later.