



# **Mature Based for New Solutions Conference**

**Visegrád, 21 November 2013**

**Society of Petroleum Engineers**

# **Production increase for low pressure gas wells with liquid loading problems**

## **A Case Study**

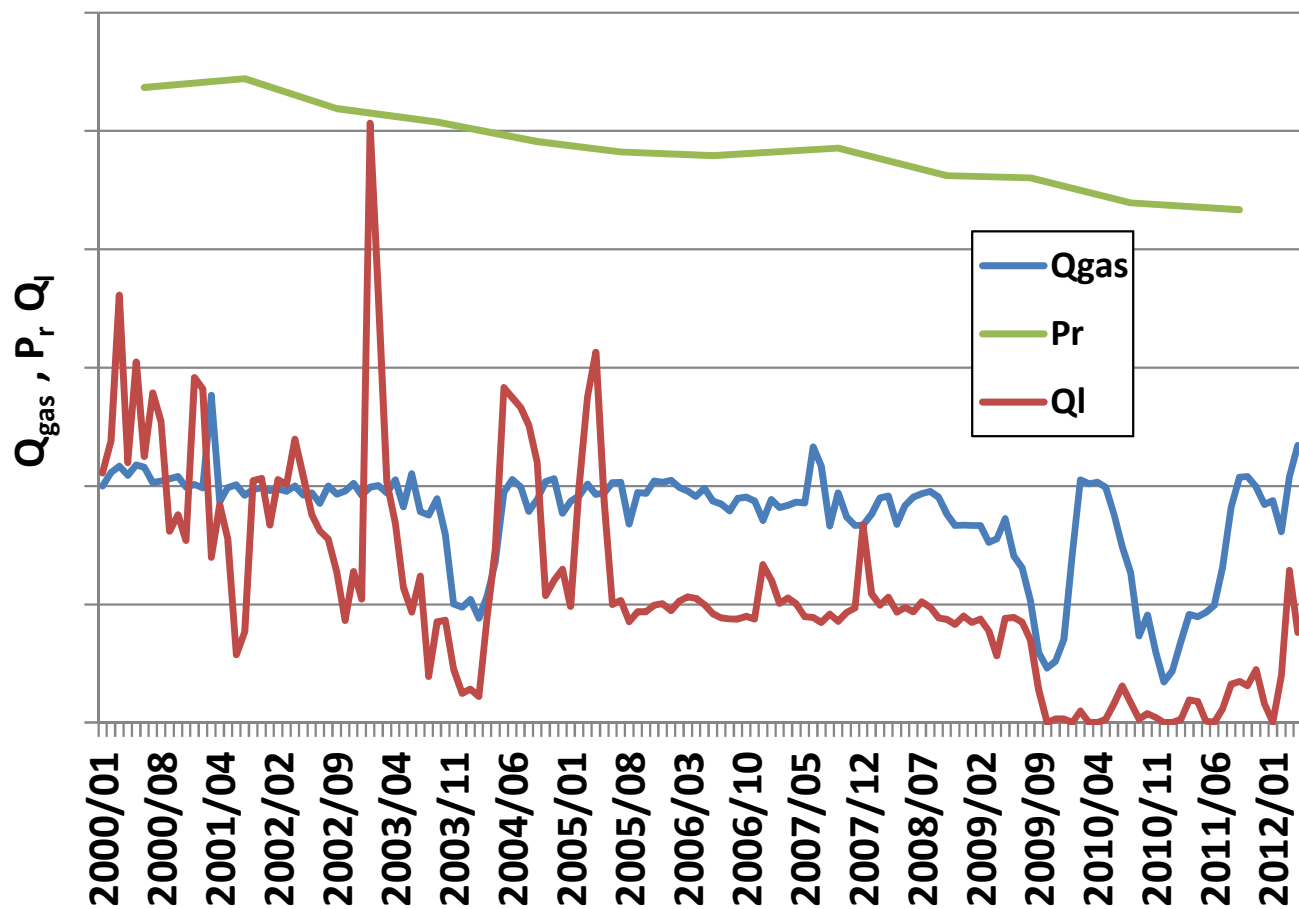
Zoltan Turzo, PhD. UoM

Mihaly Gyukics, Andras Filip, Sandor Puskas MOL NyRt.

(and many others)

# Recognition of fluid load

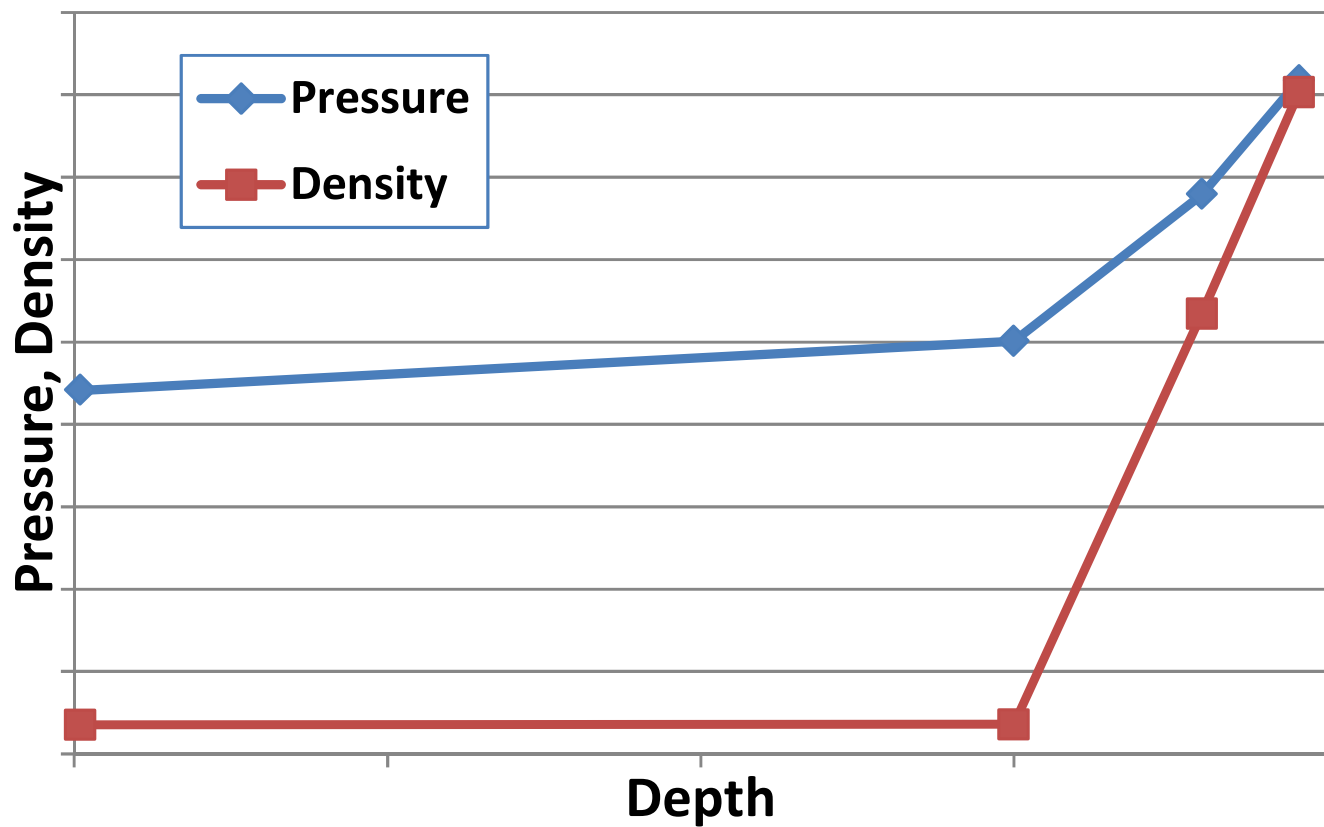
Well# - EN-87



# Recognition of fluid load

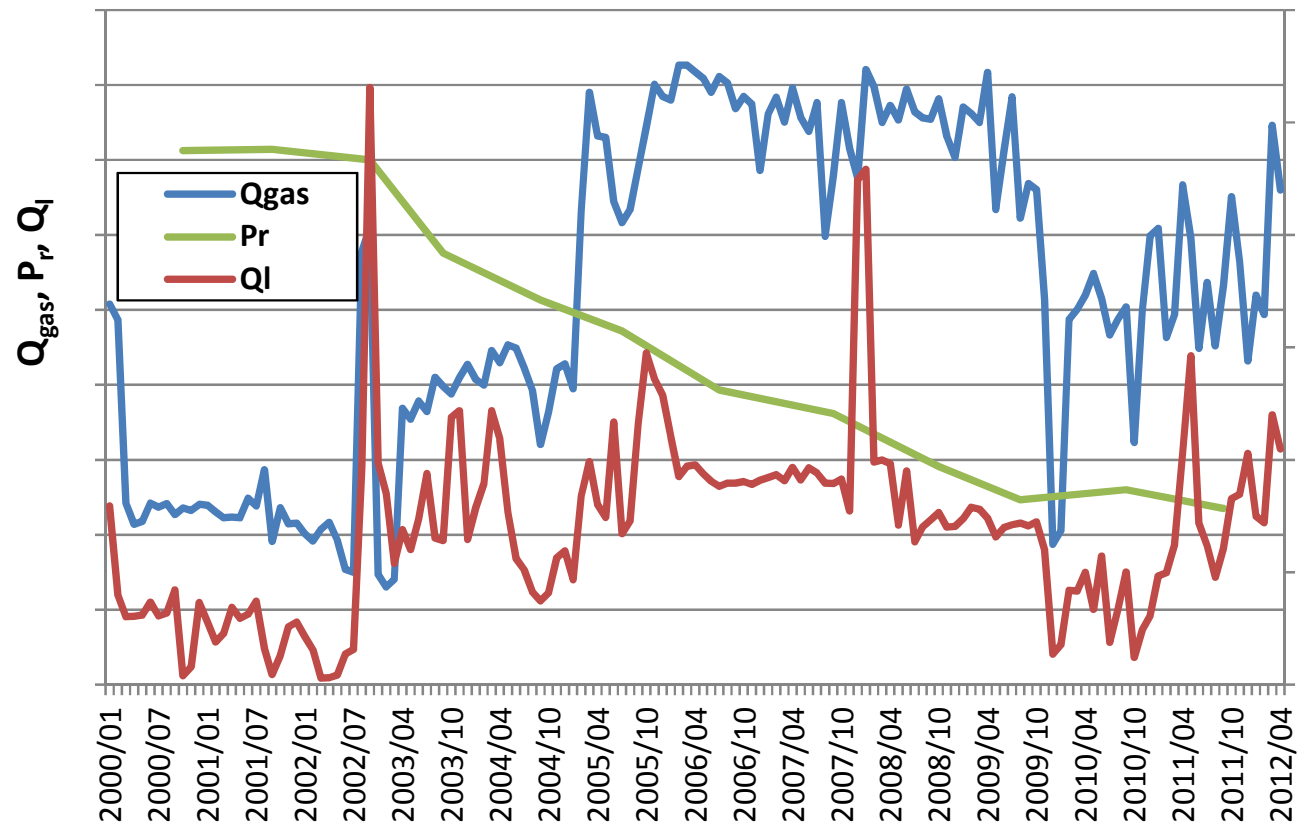
Date	Depth [m]	Pressure [Mpa]	$\Delta l$ [m]	$\Delta p$ [Mpa]	Density [kg/m <sup>3</sup> ]
<b>4/9/2009</b>	<b>10</b>	<b>6.641</b>			
	<b>1500</b>	<b>7.572</b>	<b>1490</b>	<b>0.931</b>	<b>62.5</b>
	<b>1800</b>	<b>7.866</b>	<b>300</b>	<b>0.294</b>	<b>98.0</b>
	<b>1955</b>	<b>8.793</b>	<b>155</b>	<b>0.927</b>	<b>598.1</b>
<b>31/08/2010</b>	<b>10</b>	<b>4.411</b>			
	<b>1500</b>	<b>5.009</b>	<b>1490</b>	<b>0.598</b>	<b>40.1</b>
	<b>1800</b>	<b>6.789</b>	<b>300</b>	<b>1.78</b>	<b>593.3</b>
	<b>1955</b>	<b>8.172</b>	<b>155</b>	<b>1.383</b>	<b>892.3</b>

# Recognition of fluid load



# Recognition of fluid load

Well# - EN-E - 14



# Recognition of fluid load

Date	Depth [m]	Pressure [Mpa]	$\Delta l$ [m]	$\Delta p$ [Mpa]	Density [kg/m <sup>3</sup> ]
<b>1/9/2010</b>	<b>10</b>	<b>4.405</b>			
	<b>1000</b>	<b>4.796</b>	<b>990</b>	<b>0.391</b>	<b>40.3</b>
	<b>1900</b>	<b>5.107</b>	<b>900</b>	<b>0.311</b>	<b>35.2</b>
	<b>2060</b>	<b>5.17</b>	<b>160</b>	<b>0.063</b>	<b>40.1</b>
<b>28/09/2011</b>	<b>10</b>	<b>3.996</b>			
	<b>1000</b>	<b>4.332</b>	<b>990</b>	<b>0.336</b>	<b>34.6</b>
	<b>1900</b>	<b>4.617</b>	<b>900</b>	<b>0.285</b>	<b>32.3</b>
	<b>2060</b>	<b>4.673</b>	<b>160</b>	<b>0.056</b>	<b>35.7</b>

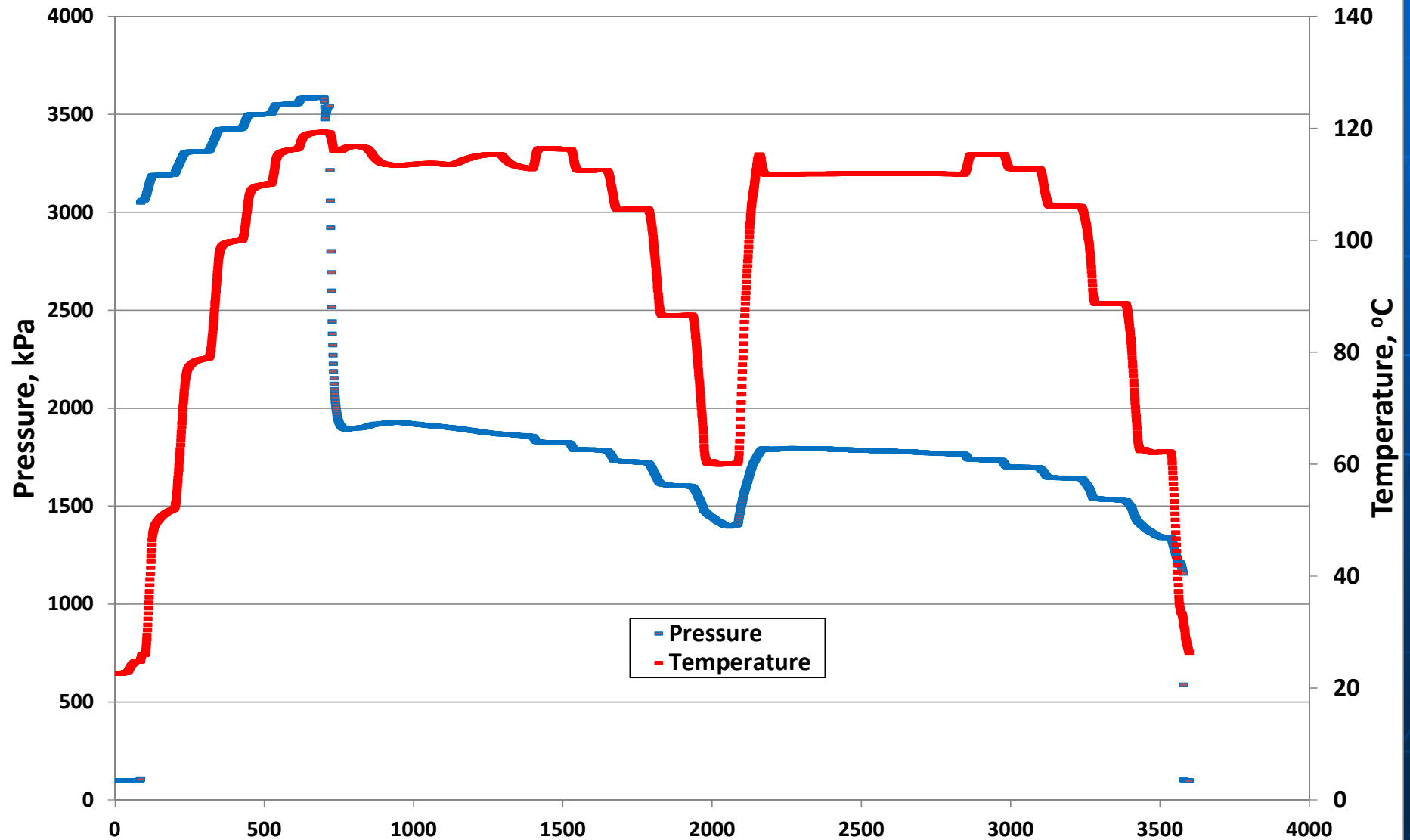
# Recognition of fluid load

Well #	Closed WHP	Producing WHP	WHT	CHP	Production type	Producing time
	[bar]	[bar]	[°C]	[bar]		
En-É-14	26	11	29	33	Intermittent	2-3 days
En-É-18	27	10	25	14	Intermittent	2-3 days
En-87	20	6	19	0	Continuous	cont.
En-88	20	7	16	0	Continuous	cont.
En-61	24	6	16	14	Intermittent	sensible for WHP
En-67	20	8	12	8	Intermittent	sensible for WHP
En-84	48	8	42	0	Intermittent	1-2 monthes
En-25	26	7	11	0	Intermittent	sensible for WHP



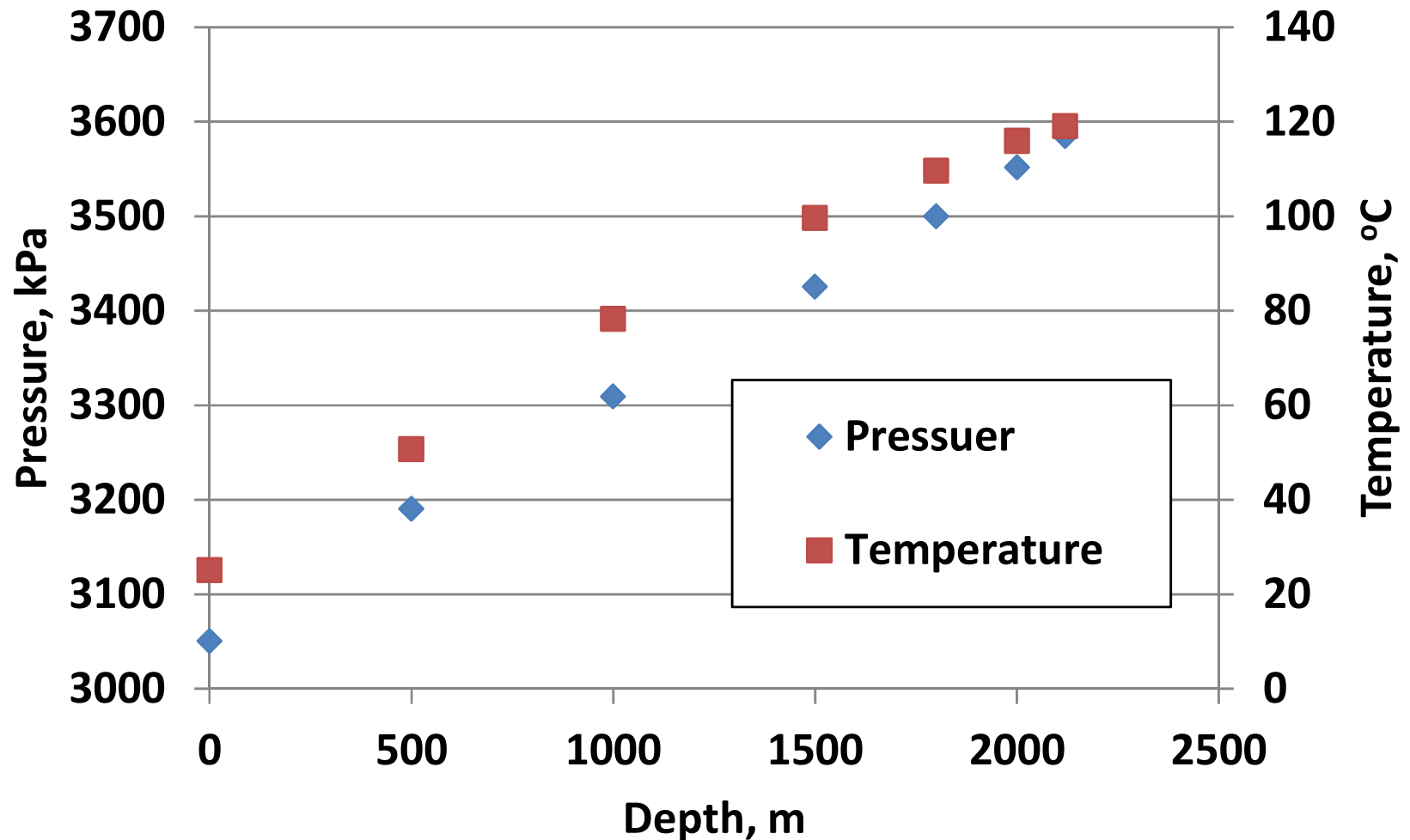
# Gradient measurements

Well# - EN-E-14 (1 closed, 2 producing)



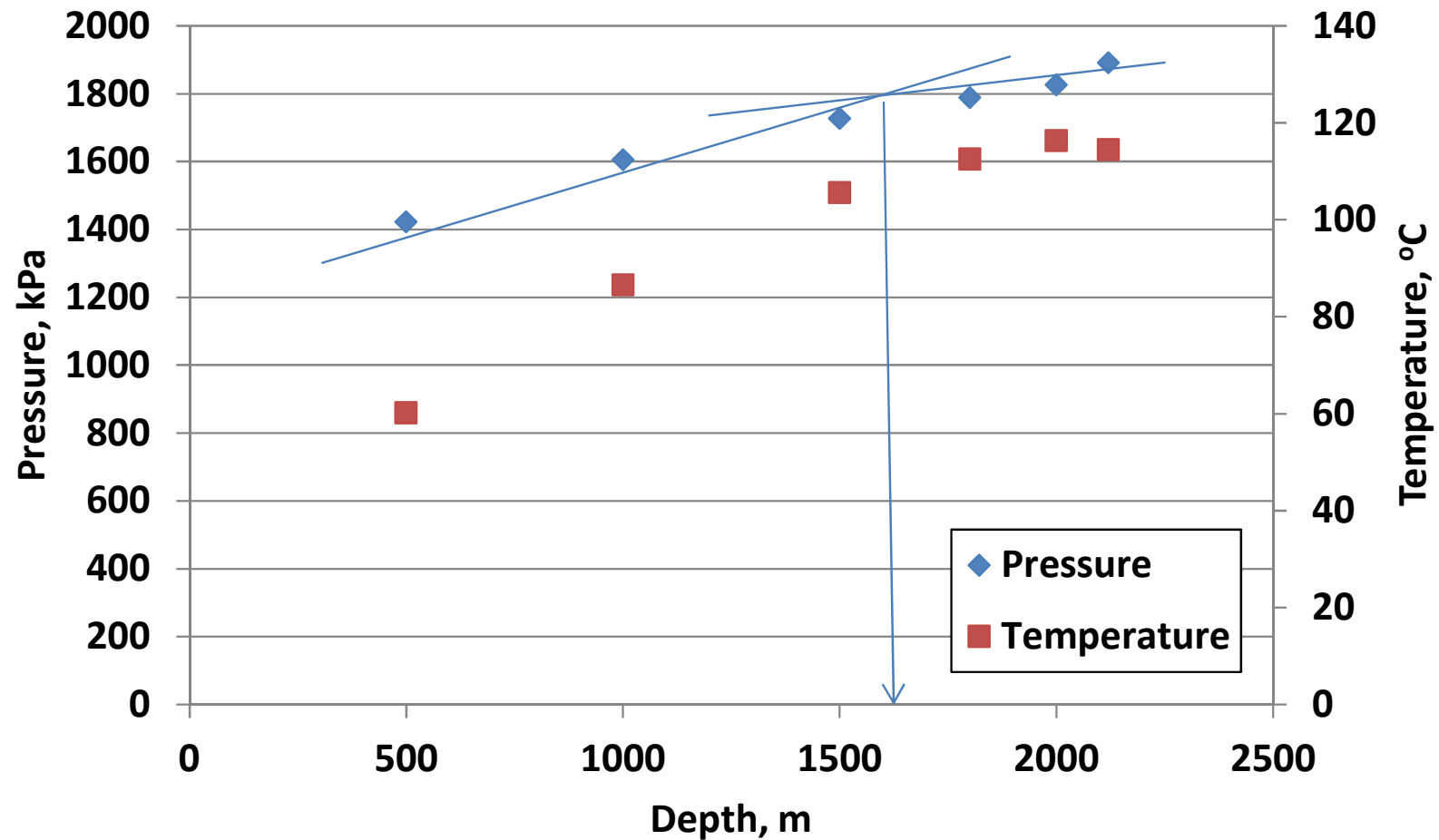
# Gradient measurements

Well# - EN-E-14, closed gradient



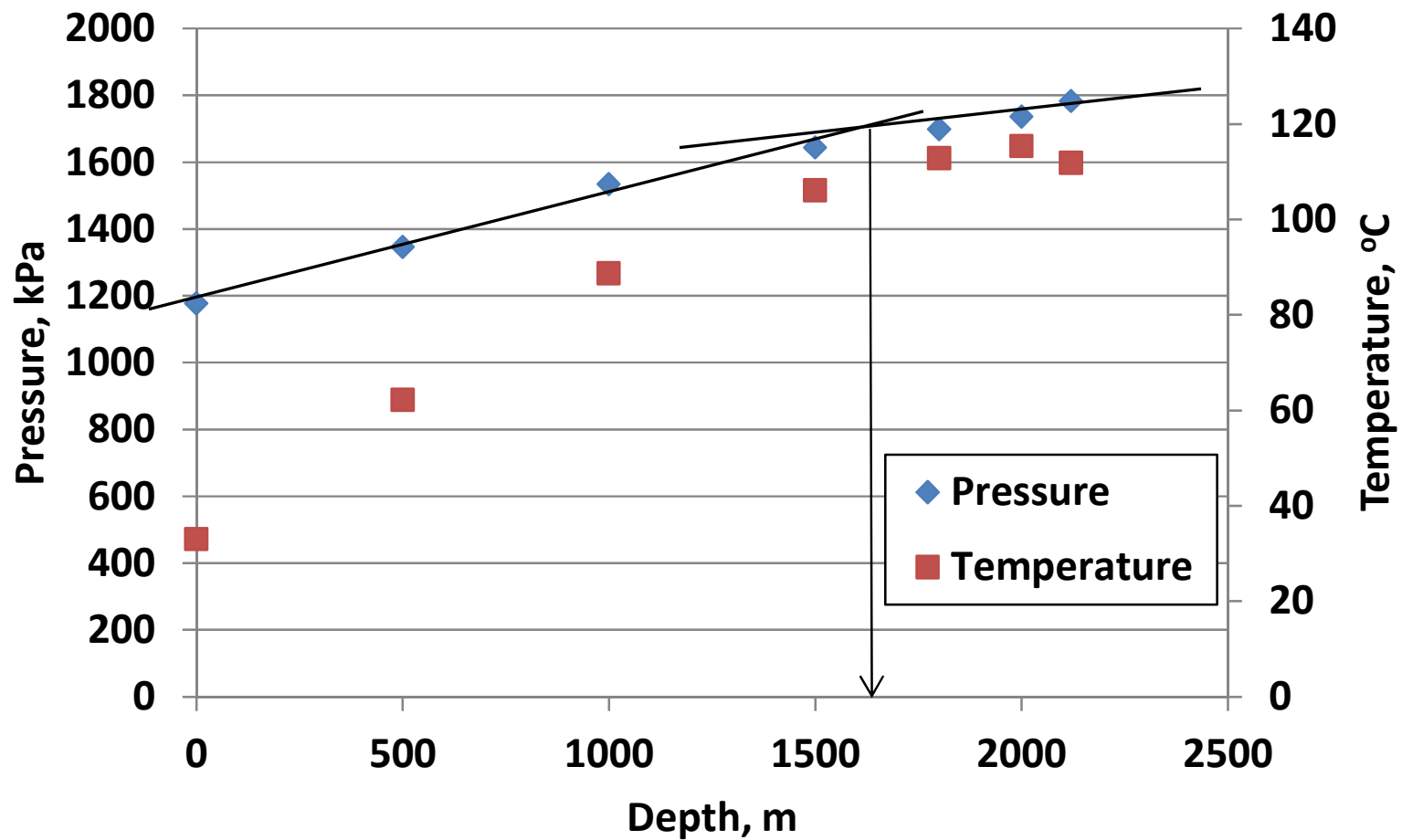
# Gradient measurements

Well# - EN-E-14, 1st producing gradient



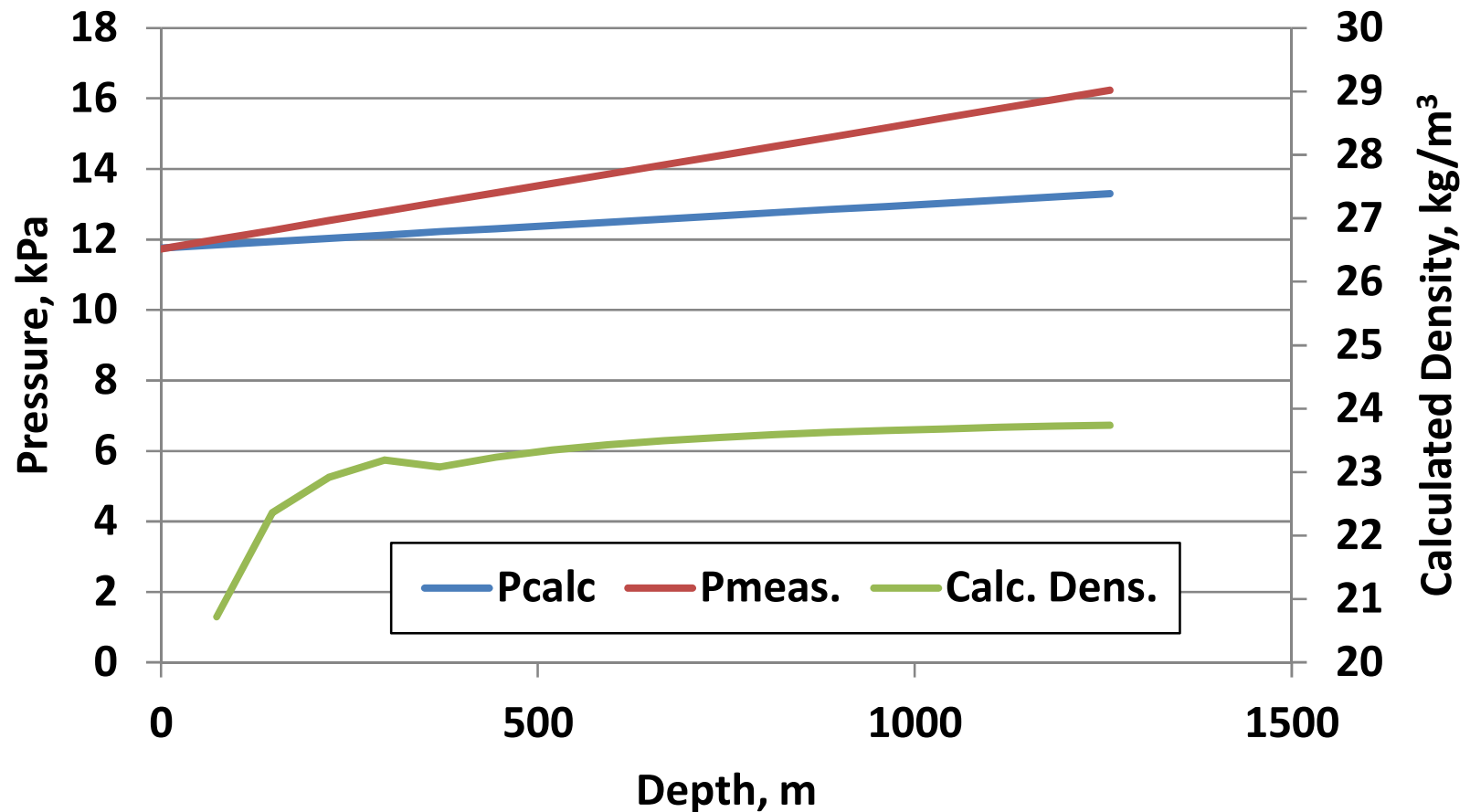
# Gradient measurements

Well# - EN-E-14, 2nd producing gradient

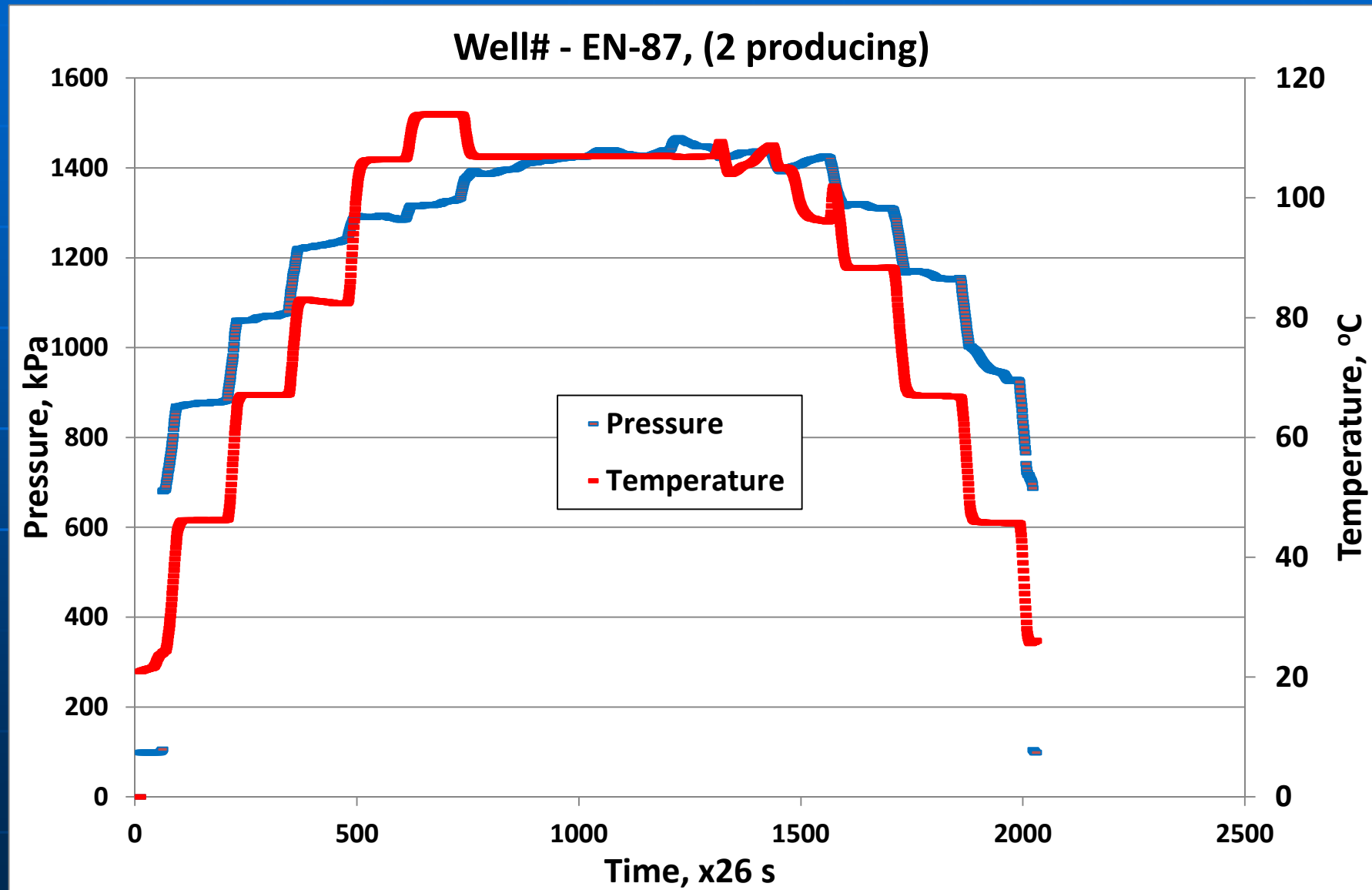


# Gradient measurements

Well# - EN-E-14, 2nd producing gradient

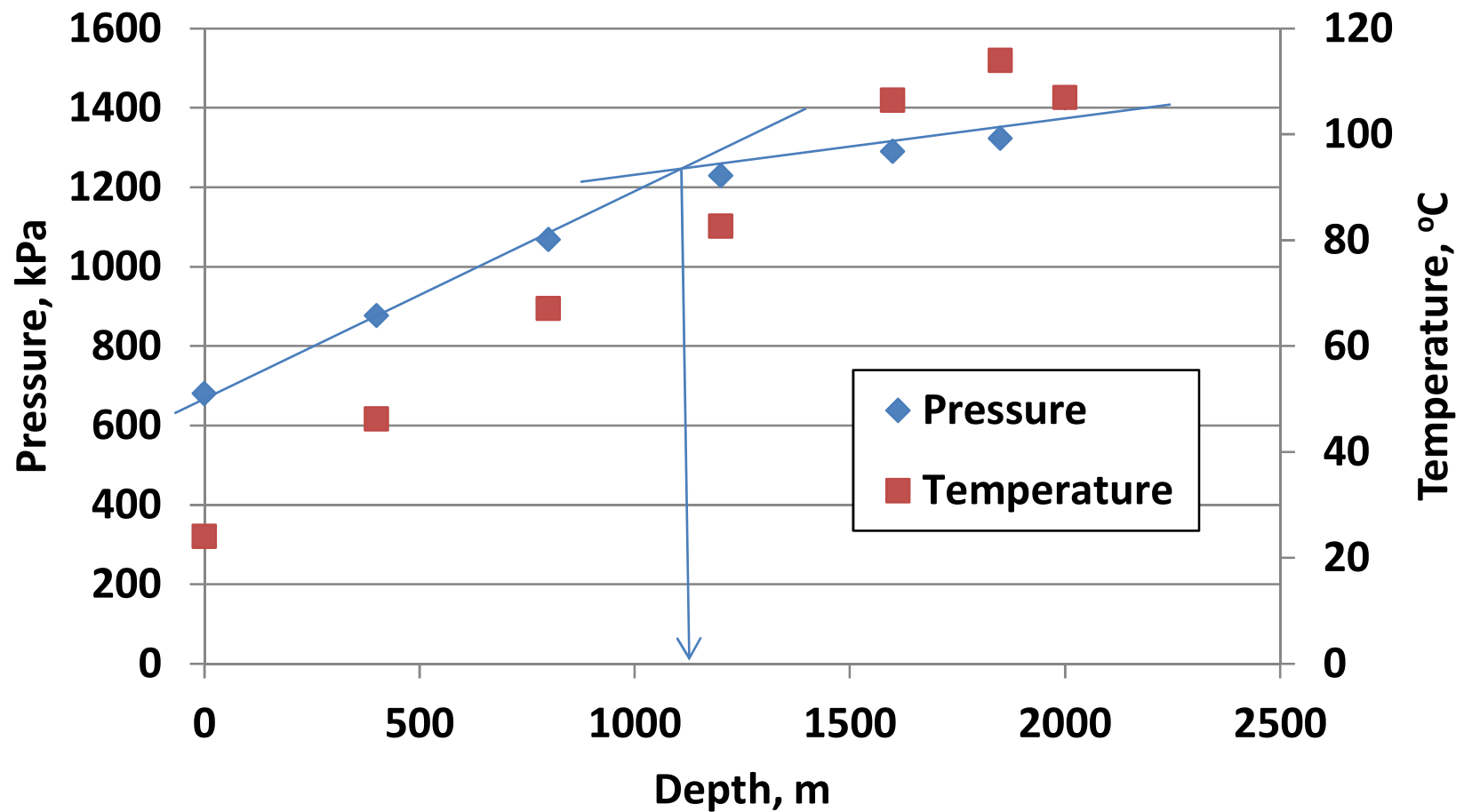


# Gradient measurements



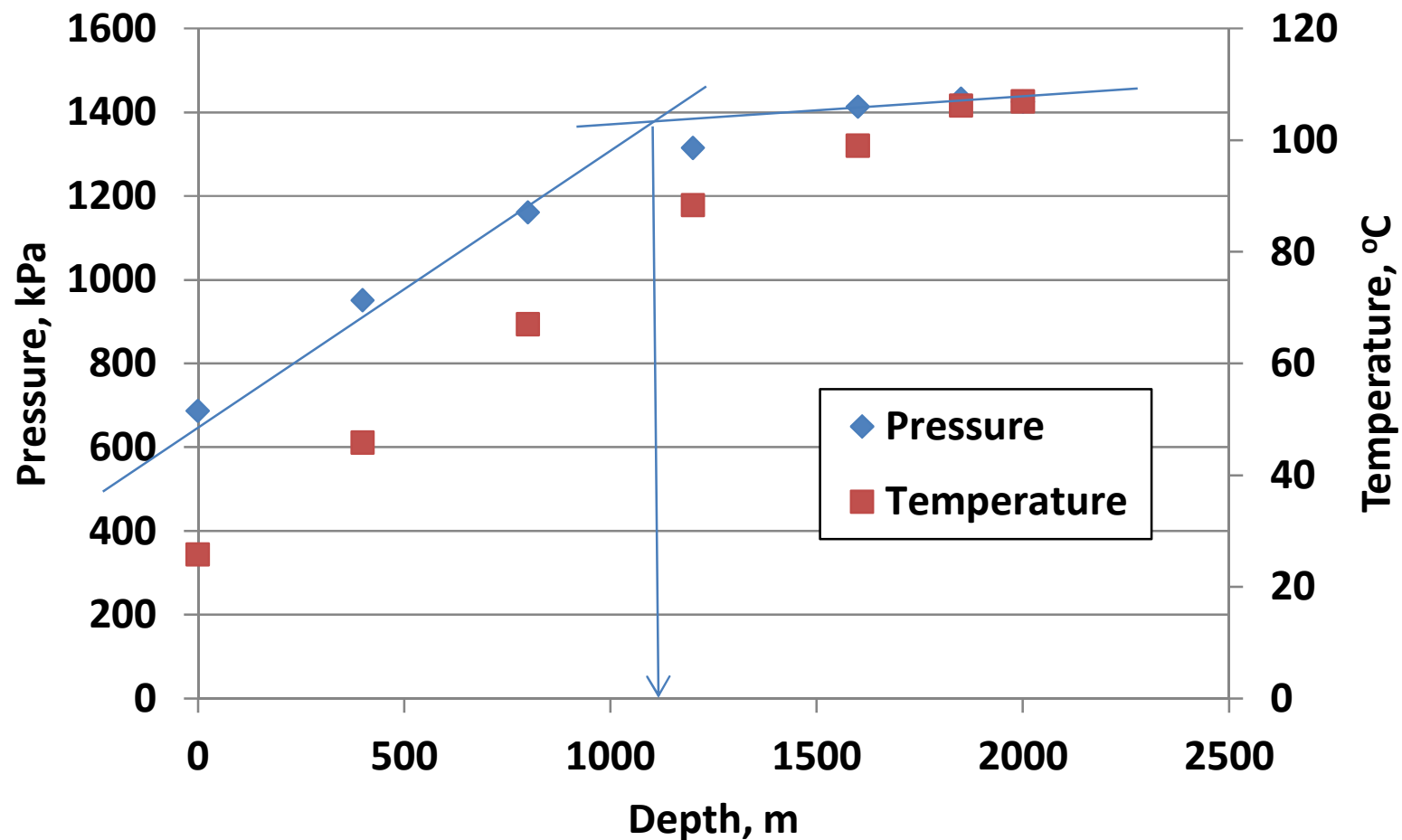
# Gradient measurements

Well# - EN-87, 1st producing gradient



# Gradient measurements

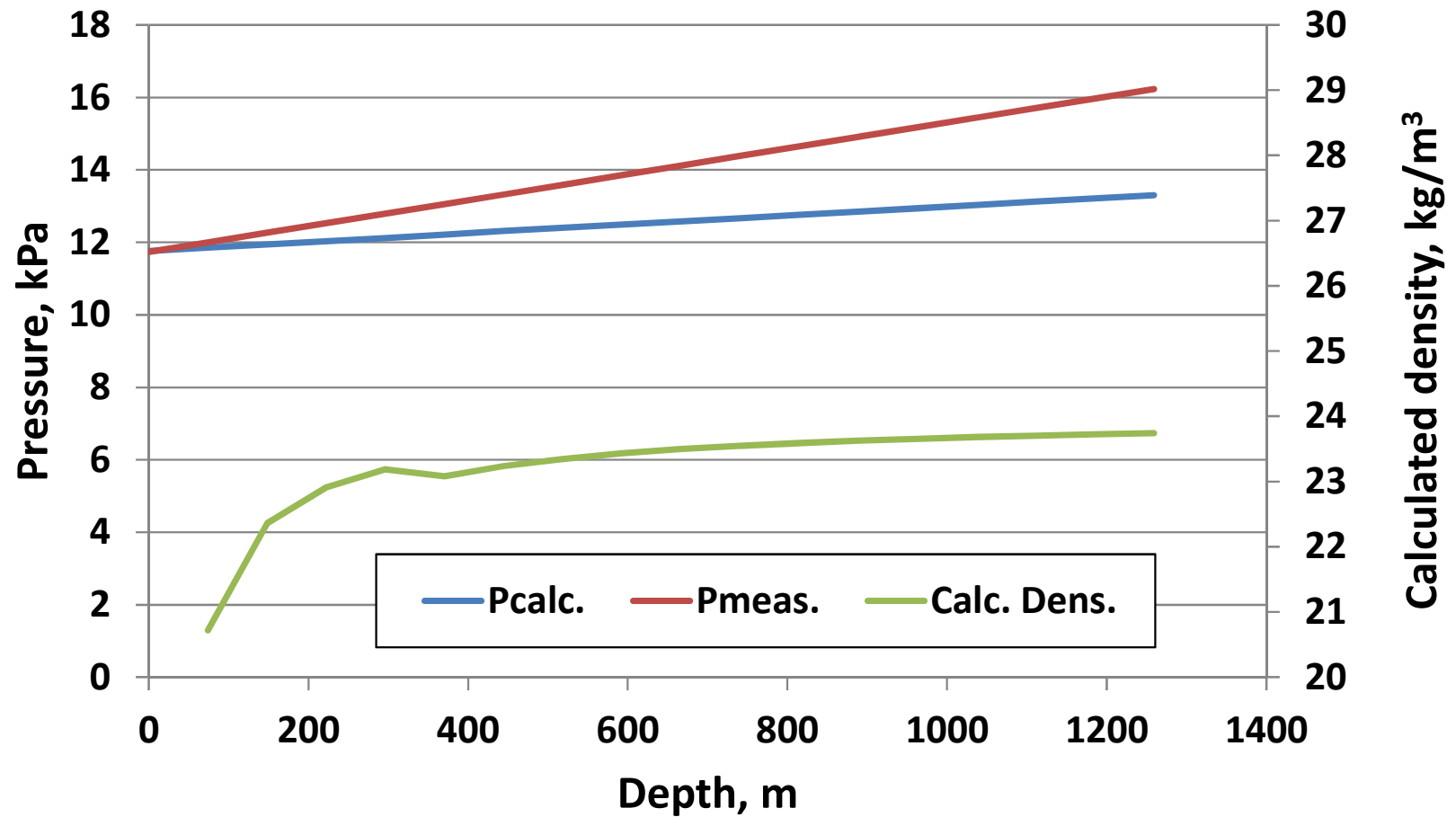
Well# - EN-87, 2nd producing gradient



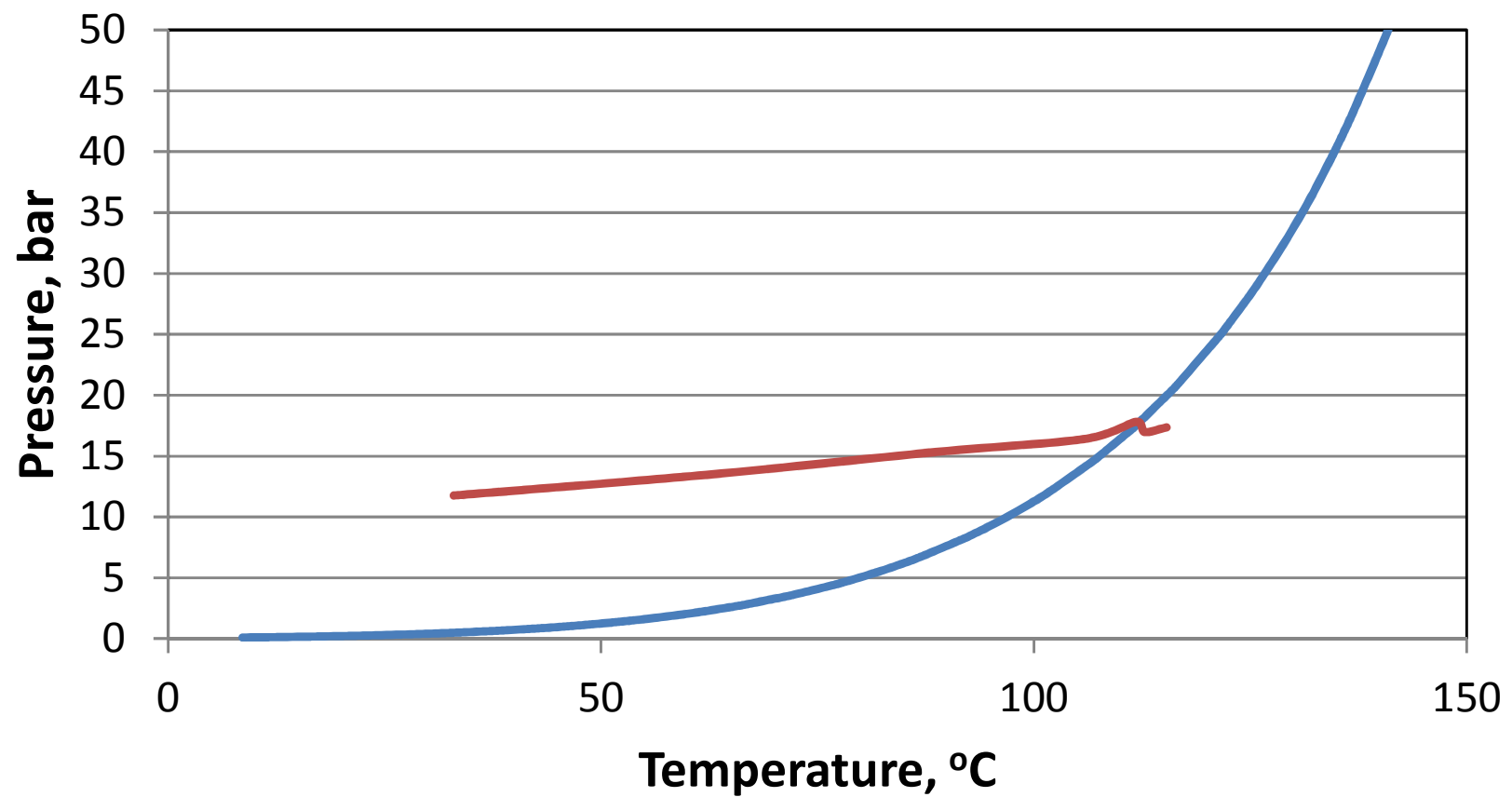


# Gradient measurements

Well# - EN-87, 2nd producing gradient



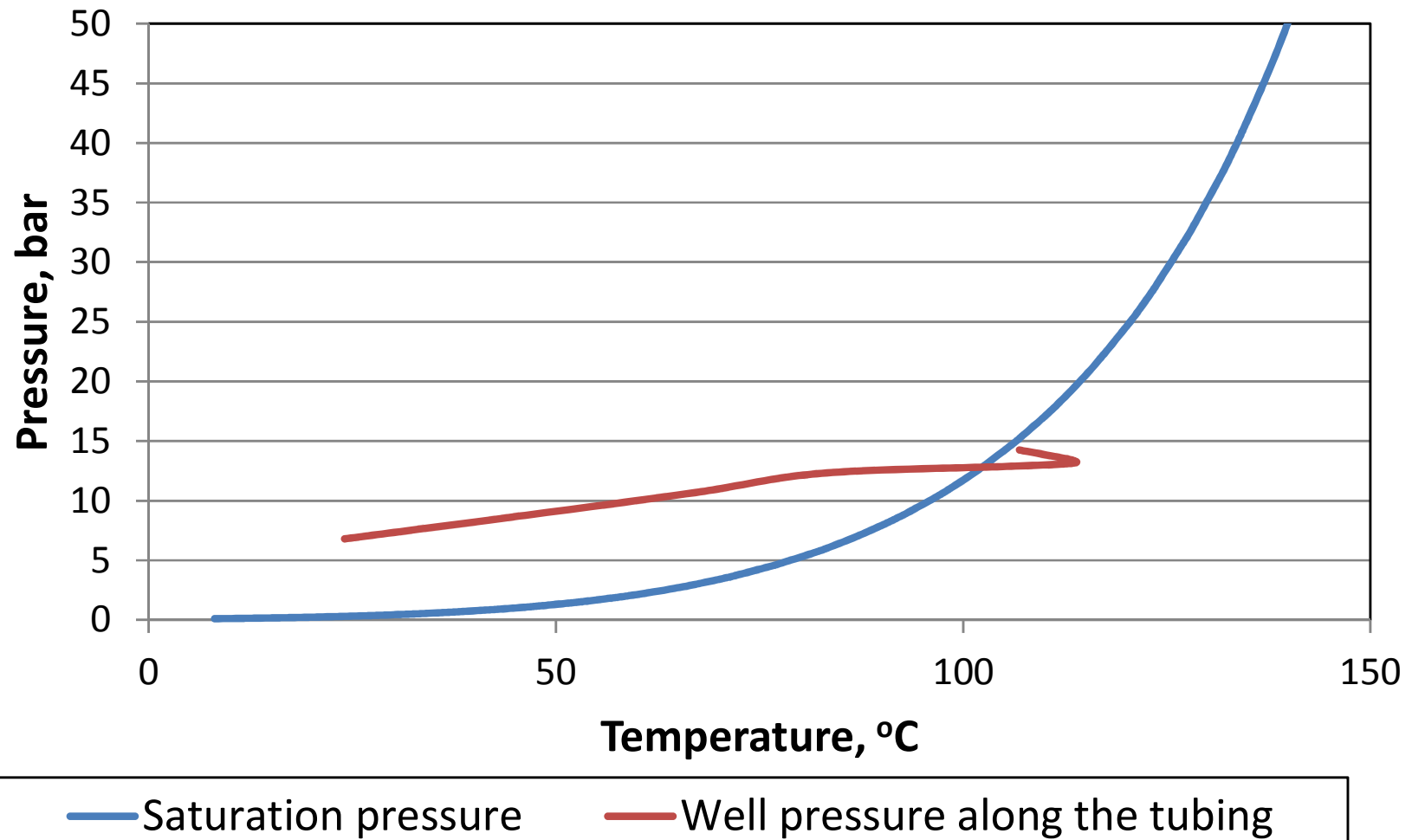
## Well# - EN-E-14, dew point curve



— Saturation pressurte

— Well presuere along the tubing

## Well# - EN-87, dew point curve



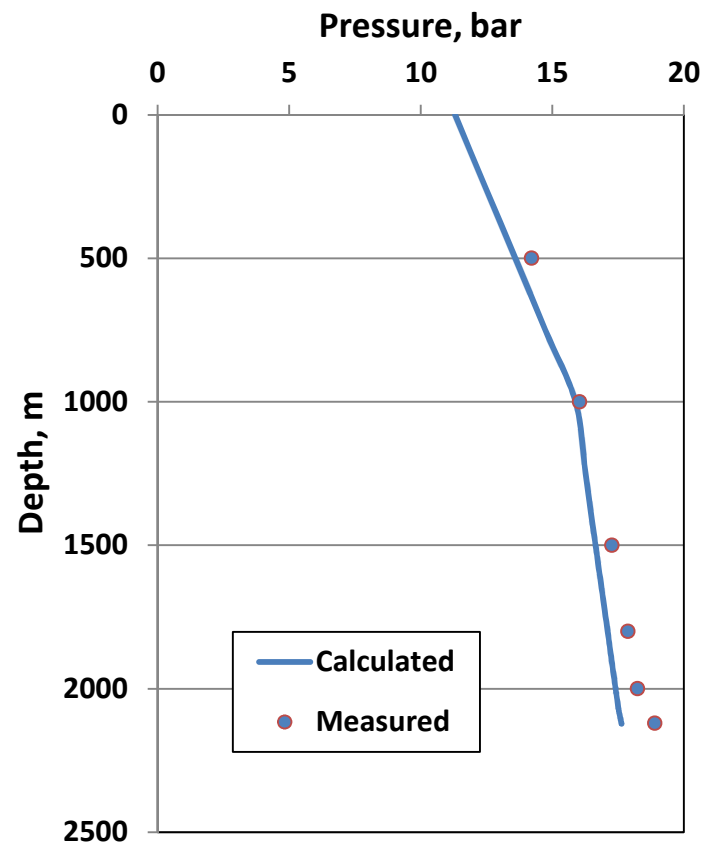
**Well# -EN-E-14, water content  
corrected wellstream composition**

<b>Component</b>	<b>mol%</b>
<b>C<sub>1</sub></b>	<b>78.509</b>
<b>C<sub>2</sub></b>	<b>3.328</b>
<b>C<sub>3</sub></b>	<b>1.713</b>
<b>i-C<sub>4</sub></b>	<b>0.65</b>
<b>n-C<sub>4</sub></b>	<b>0.522</b>
<b>i-C<sub>5</sub></b>	<b>0.253</b>
<b>n-C<sub>5</sub></b>	<b>0.186</b>
<b>C<sub>6</sub></b>	<b>0.193</b>
<b>C<sub>7</sub></b>	<b>0.135</b>
<b>C<sub>8</sub></b>	<b>0.067</b>
<b>CO<sub>2</sub></b>	<b>3.313</b>
<b>N<sub>2</sub> (+O<sub>2</sub>)</b>	<b>1.343</b>
<b>H<sub>2</sub>O</b>	<b>9.788</b>
<b>Total:</b>	<b>100.000</b>

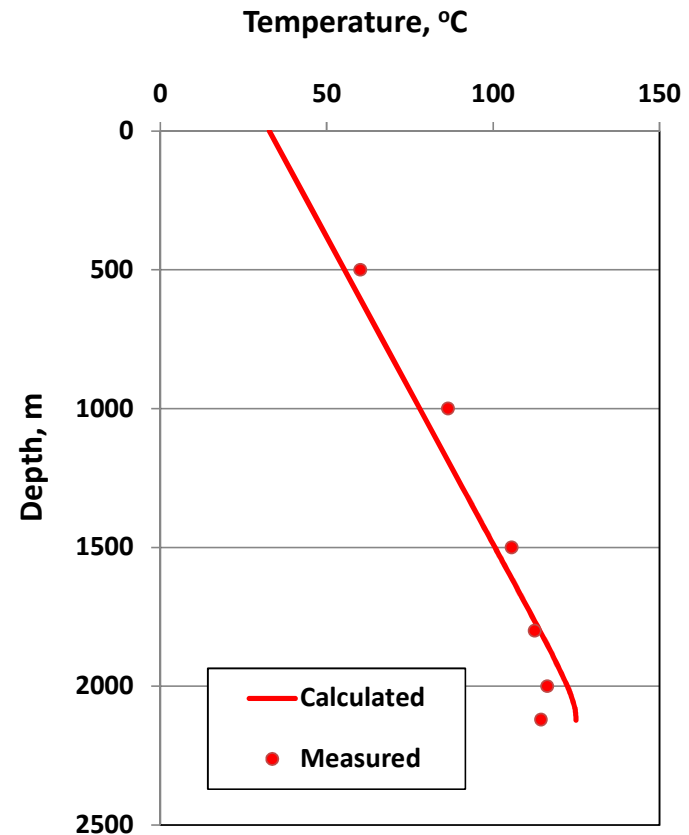
**Well-EN-87, water content corrected  
wellstream composition**

<b>Component</b>	<b>mol%</b>
<b>C1</b>	<b>75.669</b>
<b>C2</b>	<b>4.358</b>
<b>C3</b>	<b>2.122</b>
<b>i-C4</b>	<b>0.76</b>
<b>n-C4</b>	<b>0.635</b>
<b>i-C5</b>	<b>0.283</b>
<b>n-C5</b>	<b>0.207</b>
<b>C6</b>	<b>0.184</b>
<b>C7</b>	<b>0.111</b>
<b>C8</b>	<b>0.053</b>
<b>CO2</b>	<b>3.418</b>
<b>N<sub>2</sub> (+O<sub>2</sub>)</b>	<b>2.8</b>
<b>H<sub>2</sub>O</b>	<b>9.4</b>
<b>Total:</b>	<b>100.000</b>

# Well# - EN-E-14 kút

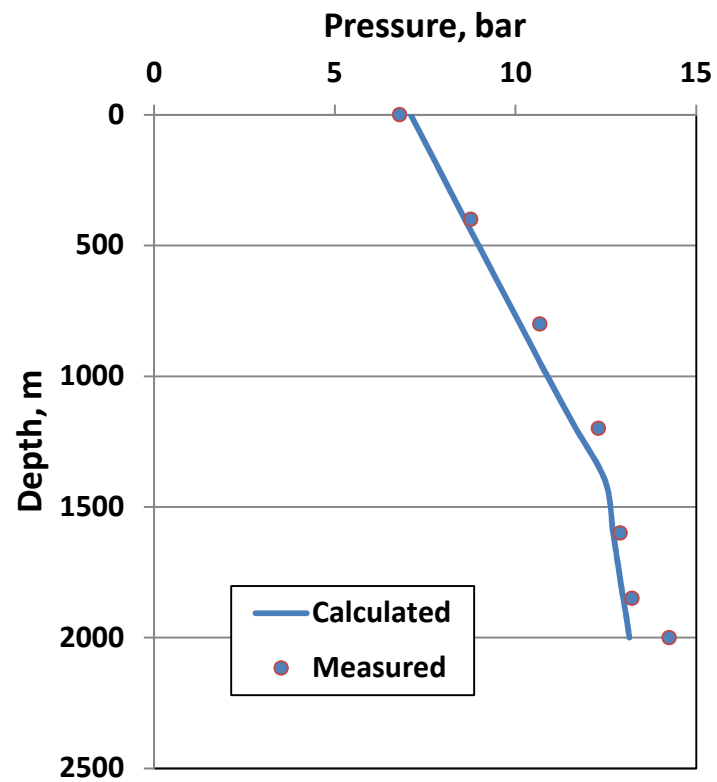


Well# - EN-E-14, Calculated and measured pressure

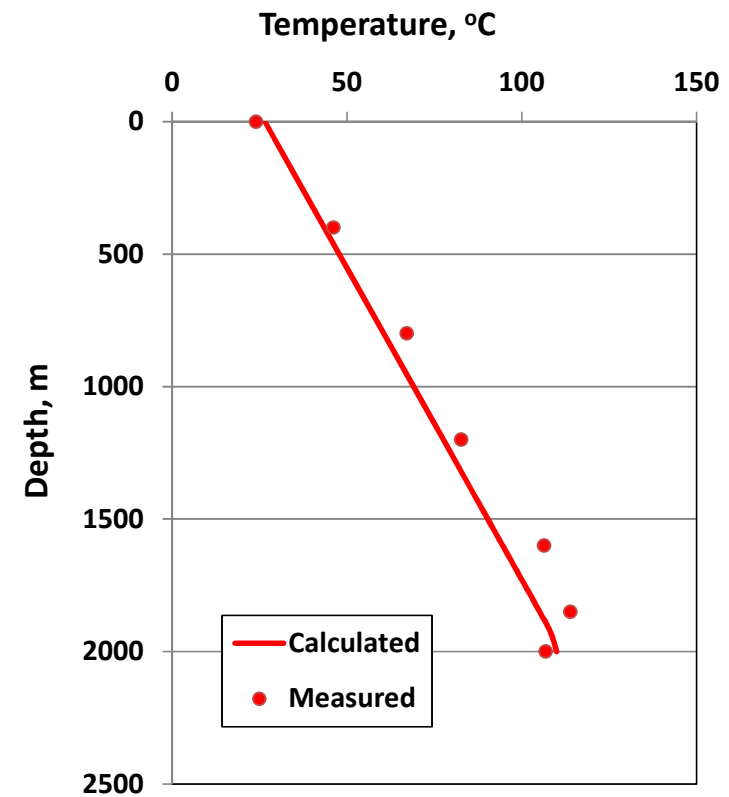


Well# -EN-E-14, Calculated and measured temperature

# Well# EN-87



Well# EN-87, Calculated and measured pressure



Well# EN-87, Calculated and measured temperature

**Well# - EN-E-14**  
**Echometer through tubing shots**

Time	$P_{to}$	$L_l$	$P_{tin}$
	kPa	m	kPa
11:04:33	1187	1266.0	3181
11:14:51	1286	1813.0	3381
11:24:36	1304	1864.0	2140
11:35:33	1407	1772.0	2417

**Well# - EN-87**  
**Echometer through tubing shots**

Time	P <sub>to</sub>	L <sub>i</sub>	P <sub>tin</sub>
	kPa	m	kPa
12:03:13	1572	544.6	4707
12:26:42	3098	1087.7	5365
12:44:17	4133	1853.4	5142
12:59:38	4423	1851.7	5536
13:13:22	4533	1872.2	5669



# **New measurements in Well EN-E-14 to detect fluid loading**

## **Planned:**

**I. Closed gradient measurement, immediately after complete fluid removal from the bottom, measurement frequency is 200 m, and 50 m near the bottom**

**II. FBHP measurement in 3 steps**

- 1. WHP is the usual 12 bar, until the stabilization of the flow**
- 2. WHP is 5 bar, until the stabilization of the flow**
- 3. WHP is the 12 bar again, duration 3-4 days**

**III. Production gradient measurement during pull-out**

# **New measurements in Well EN-E-14 to detect fluid loading**

**Performed:**

**(started: 2012. 12. 04. 07:30)**

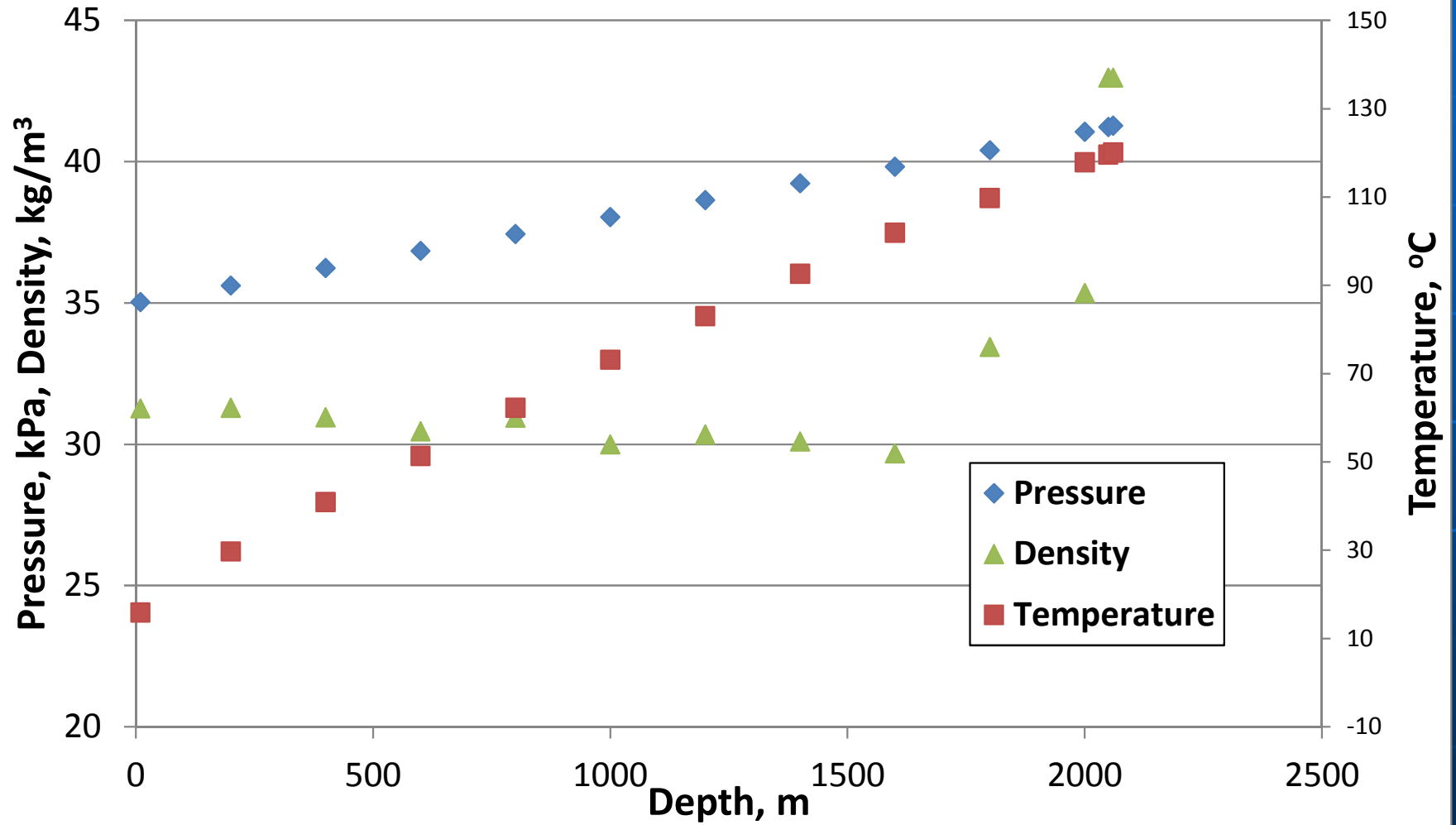
**I. Closed gradient measurement, immediately after complete fluid removal from the bottom, measurement frequency is 200 m, and 50 m near the bottom**

**II. FBHP measurement in 3 steps**

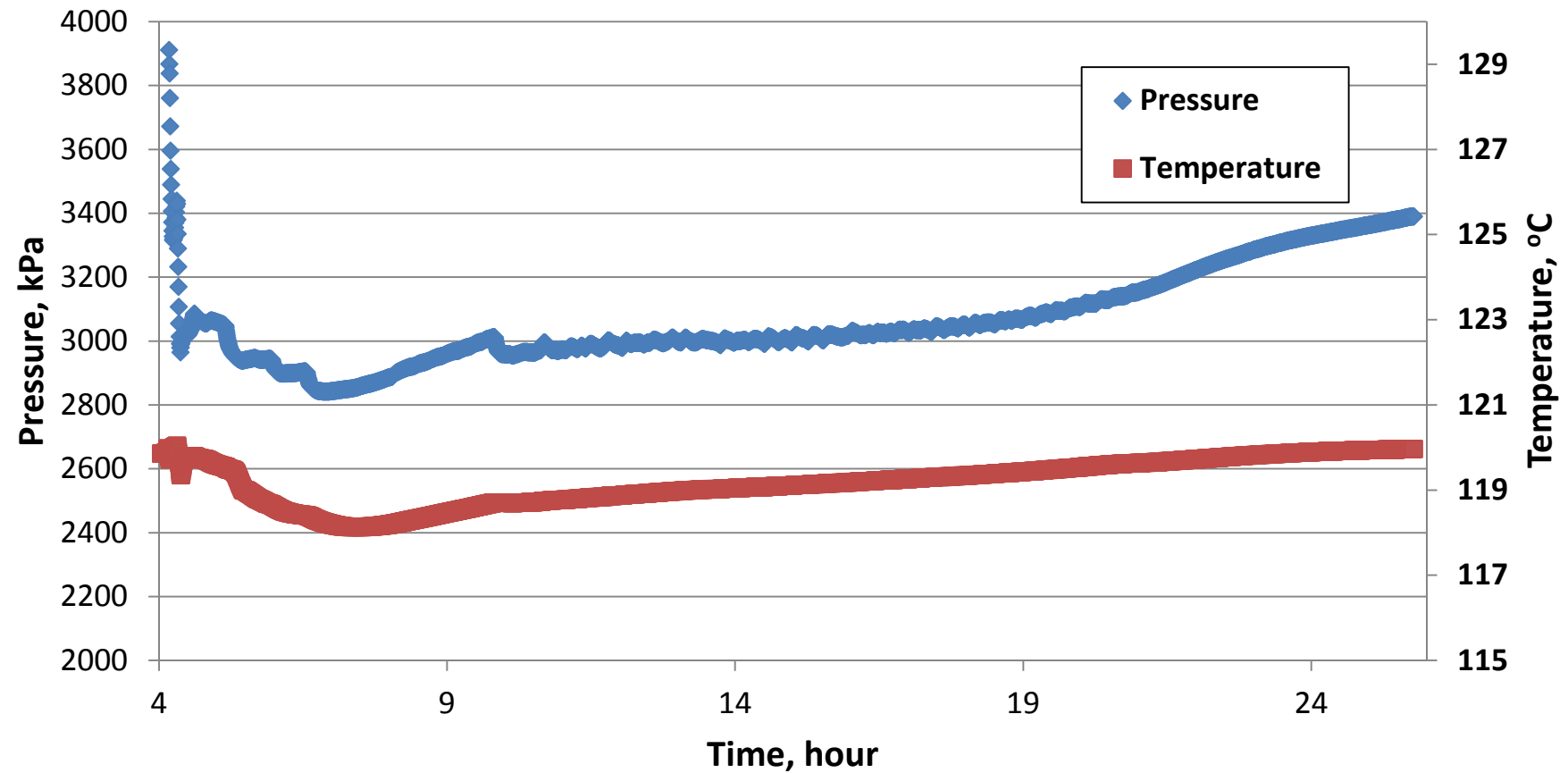
- 1. WHP is the usual 12 bar, until the stabilization of the flow**
- 2. WHP is 5 bar, until the stabilization of the flow**
- 3. WHP is 5 bar, duration hours**

**III. Production gradient measurement during pull-out  
(Finished: 2012. 12. 06. 12:30)**

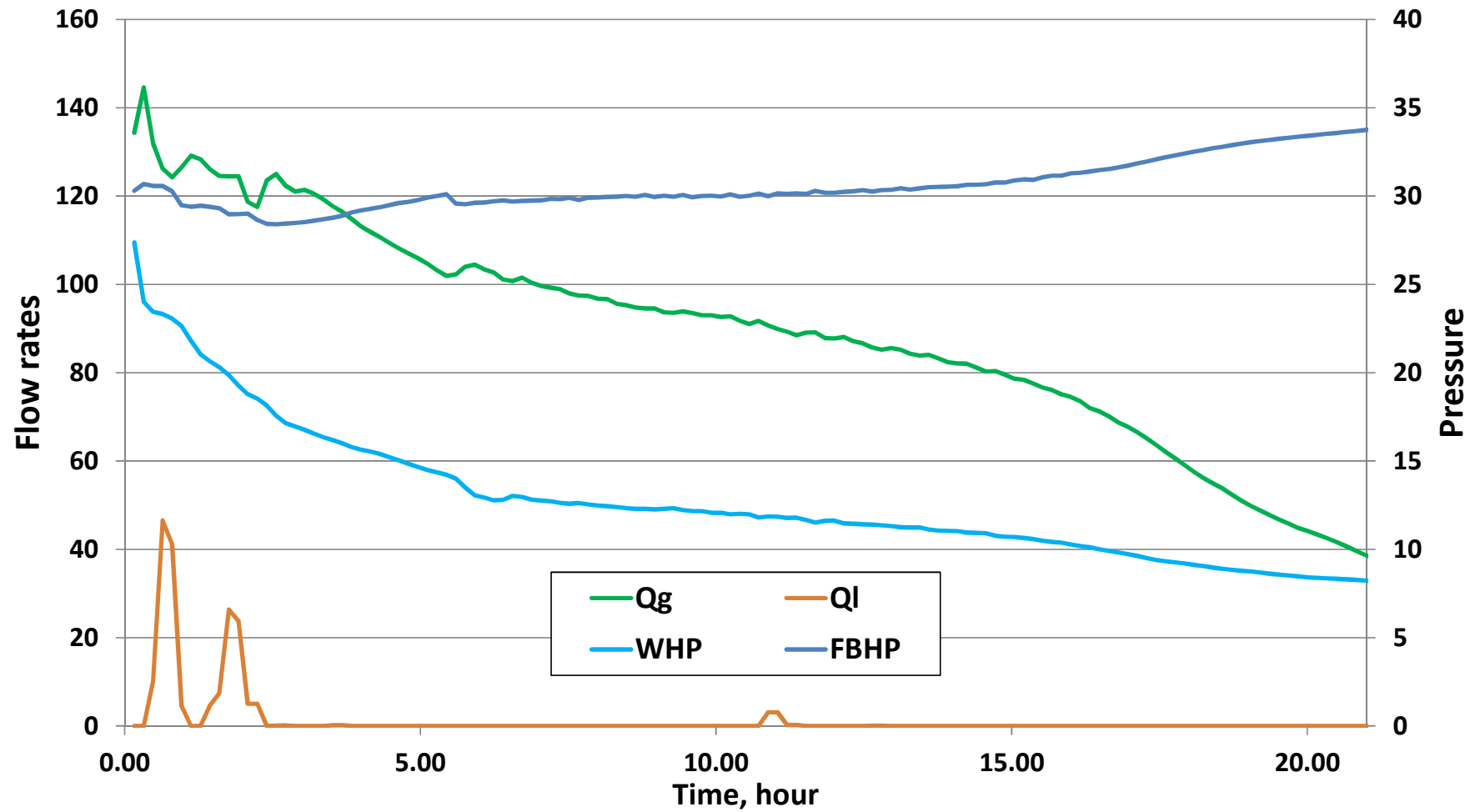
## Well# EN-E-14, closed gradient



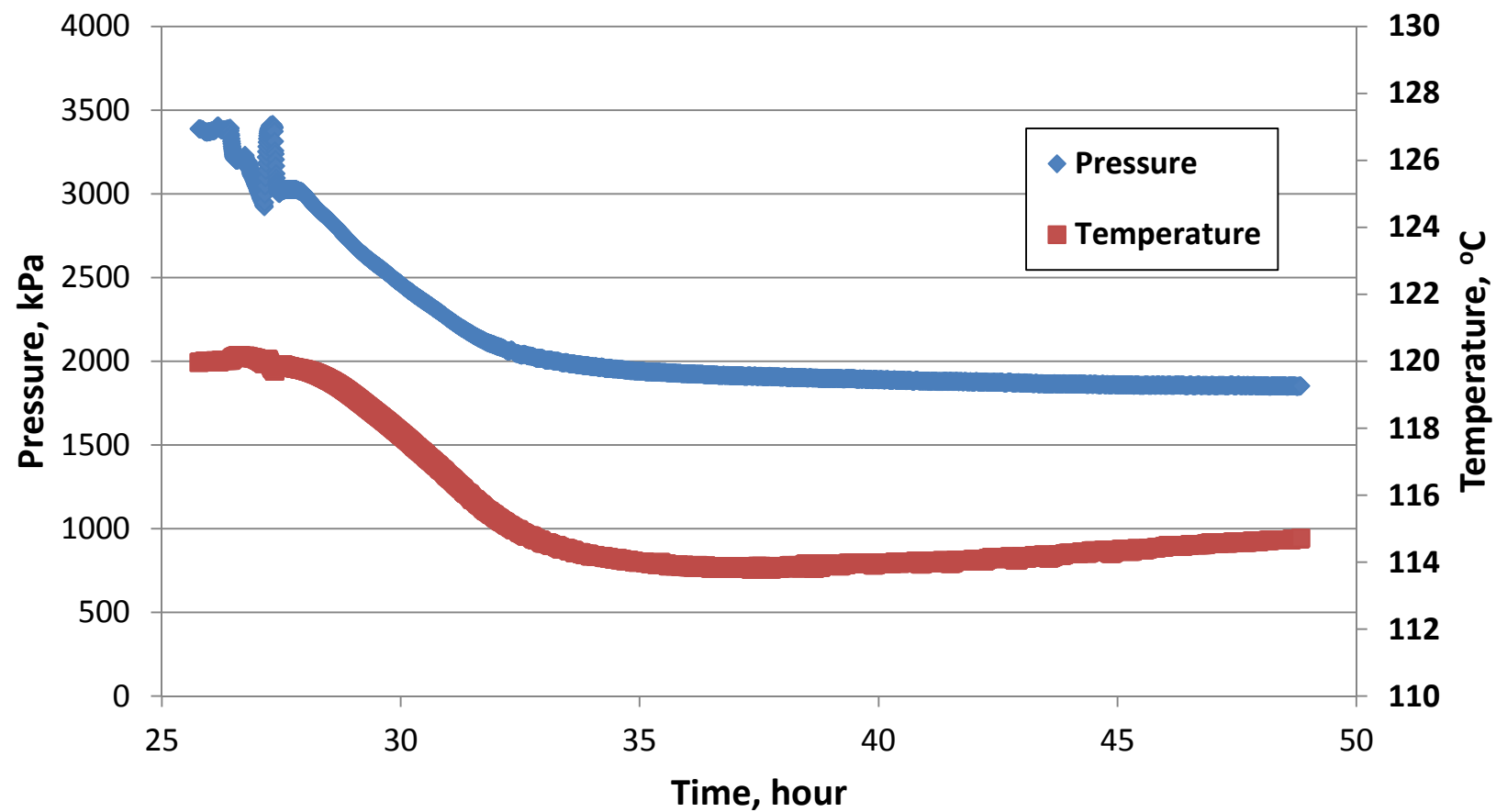
### Well# - EN-E-14, FBHP measurement, WHP: 10-12 bar



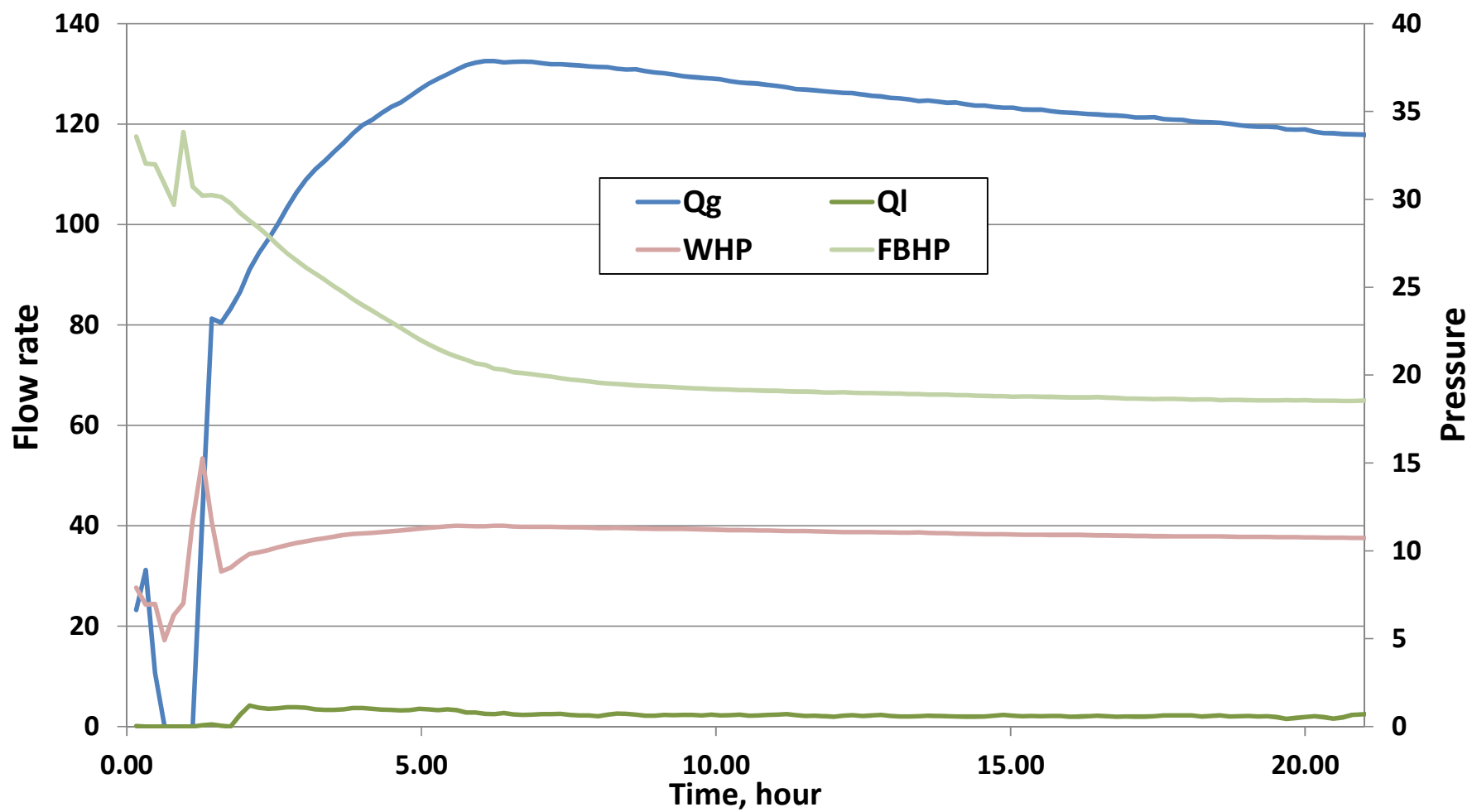
Well# - EN-E-14, Production data during FBHP measurement, WHP: 10-12 bar



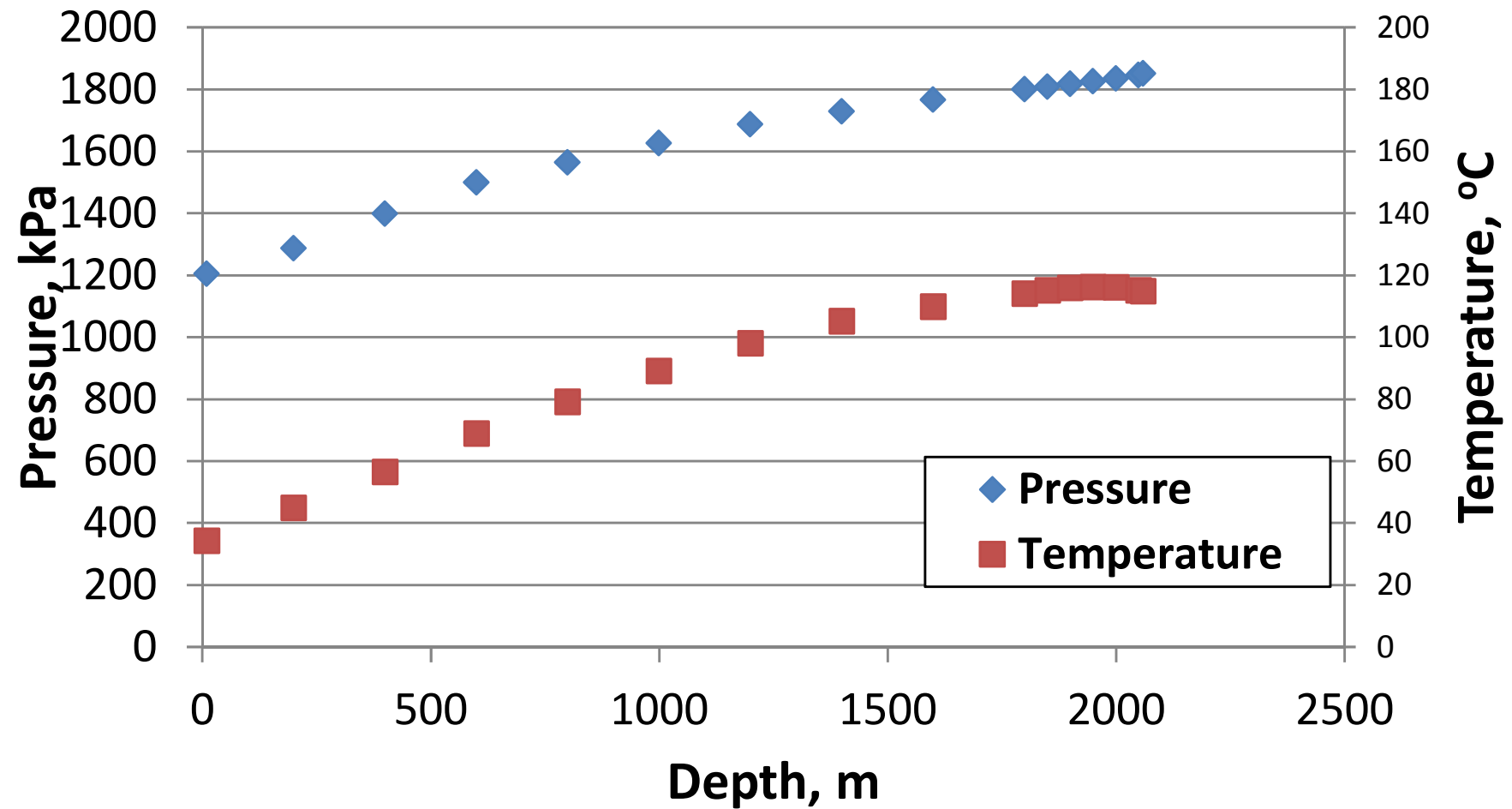
### Well# - EN-E-14, FBHP measurement, WHP: 5-8 bar



Well# - EN-E-14, Production data during FBHP measurement, WHP: 5-8 bar

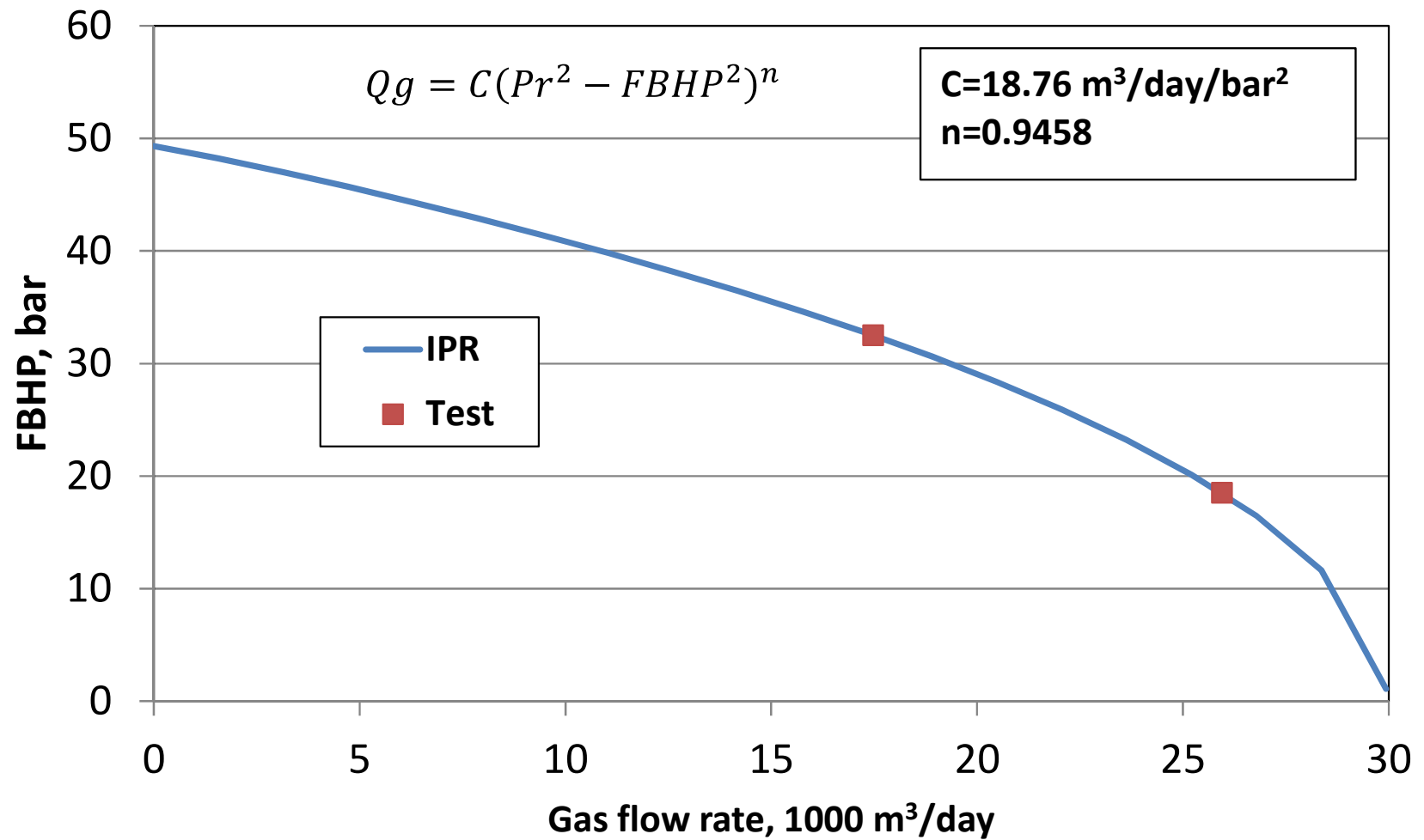


## Well# -EN-E-14, flowing gradient

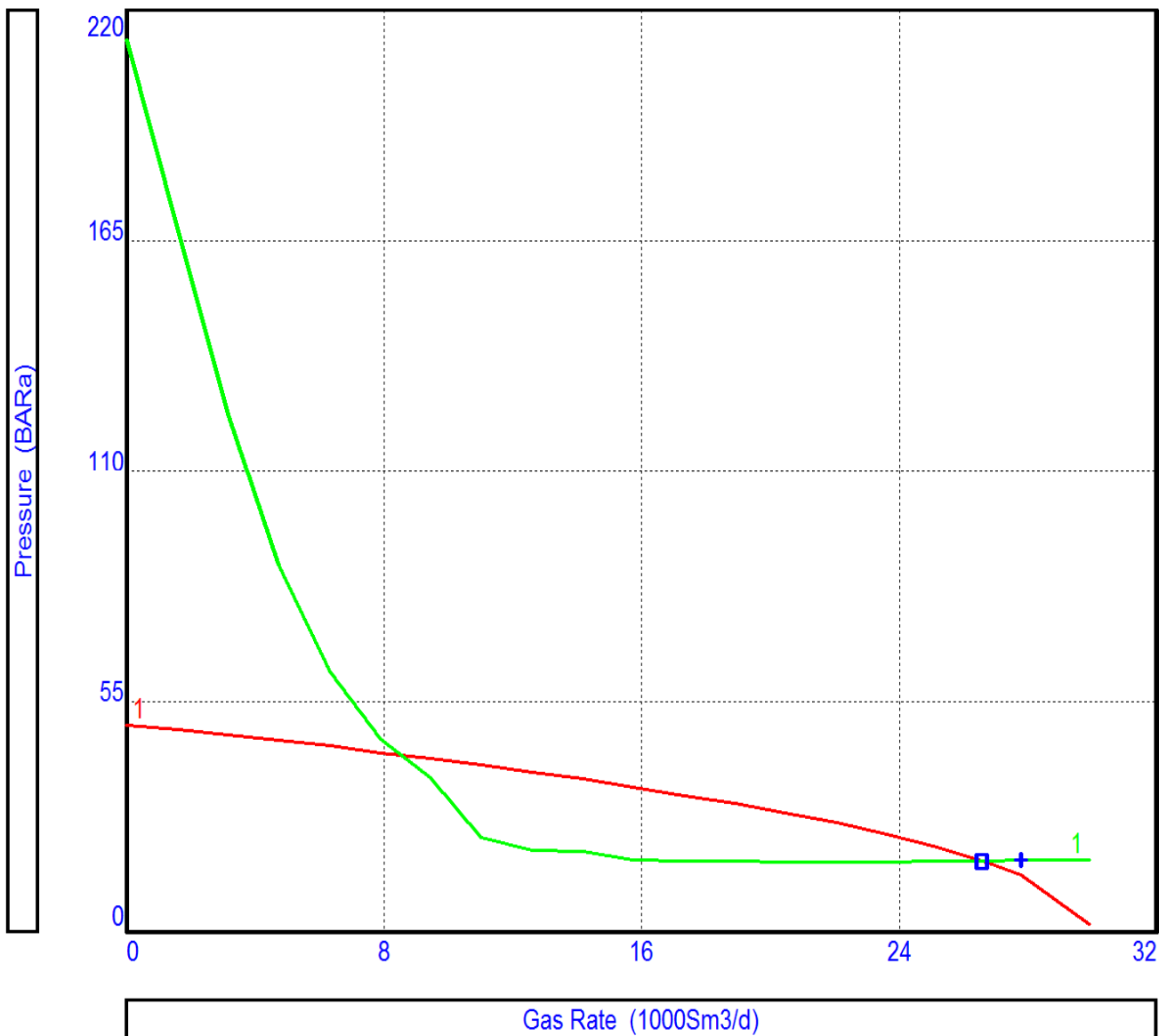




## IPR for Well# EN-E-14



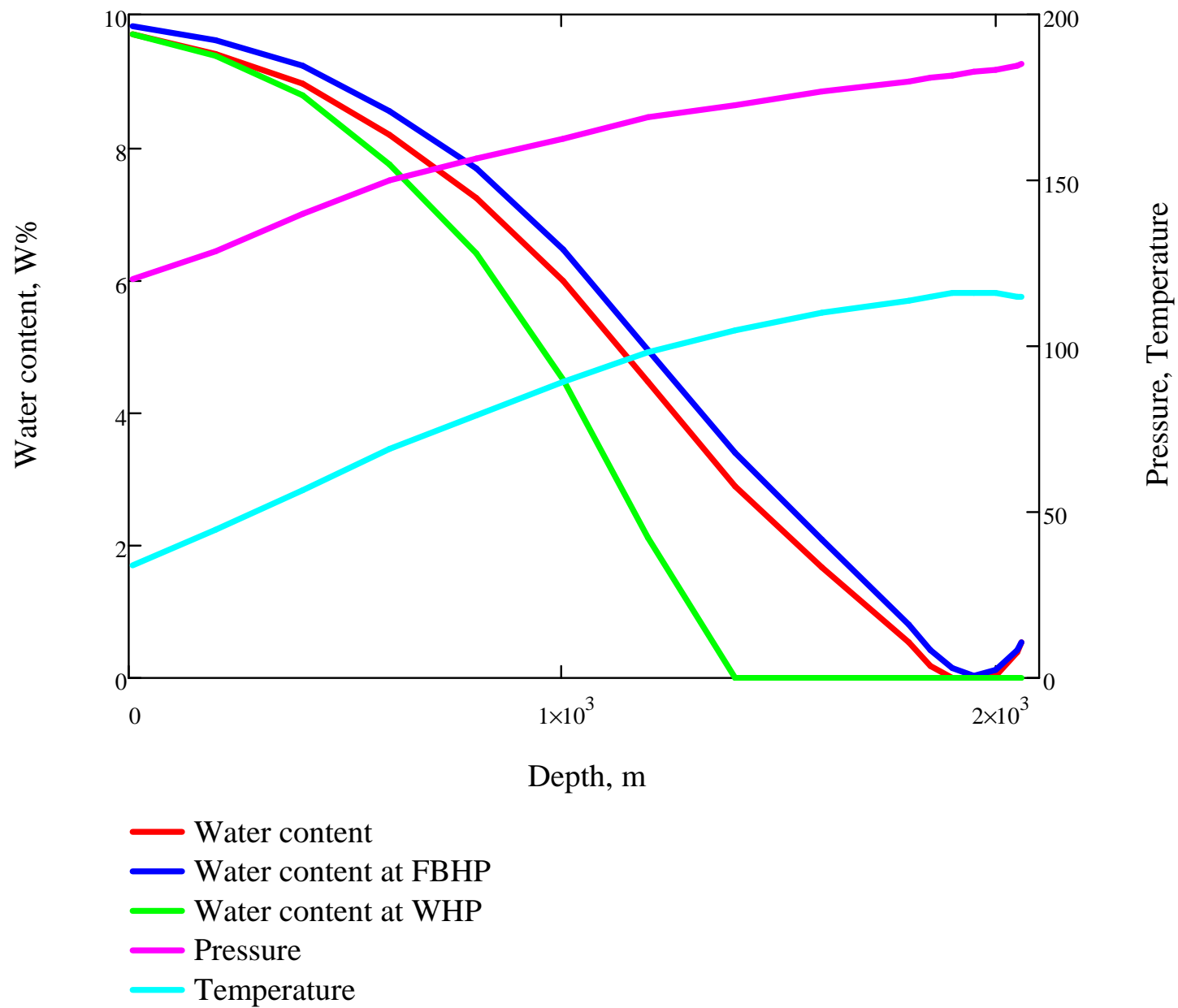
# VLP/IPR MATCHING ( 03/12/2013 - 22:26:30)



GAS RATE (1000Sm3/d)		
Measured	Calculated	% Difference
1 27.800	26.576	-4.40

BOTTOM HOLE PRESSURE (BARa)		
Measured	Calculated	% Difference
1 17.06	16.94	-0.78488

Well# EN-E-14, Calculated water saturation along the tubing



# **New program to show the water at the bottom**

**1.Closed gradient**

**2.Flowing gradient #1**

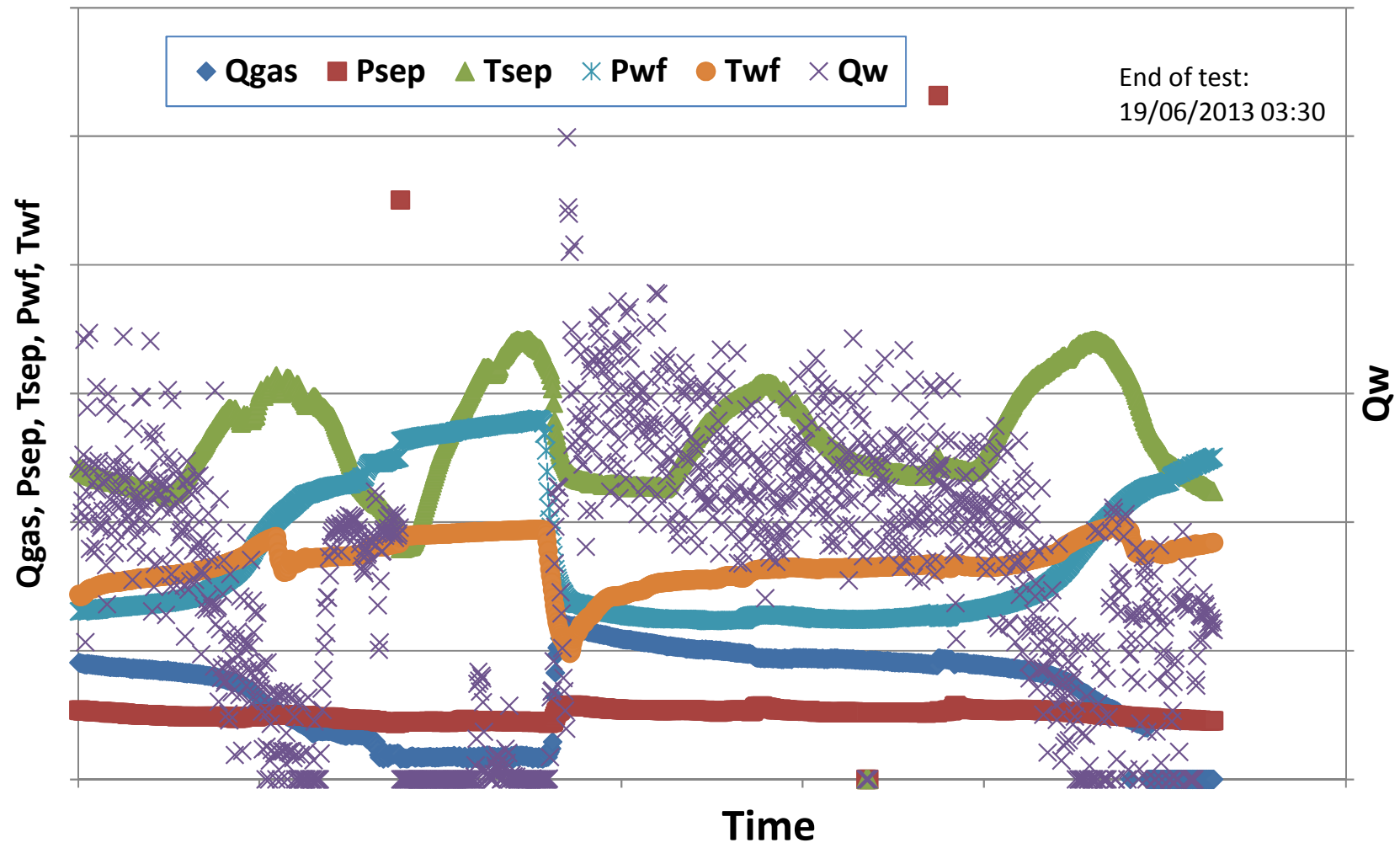
**3.Continuous FBHP measurement#1:**

**4.Flowing gradient#2**

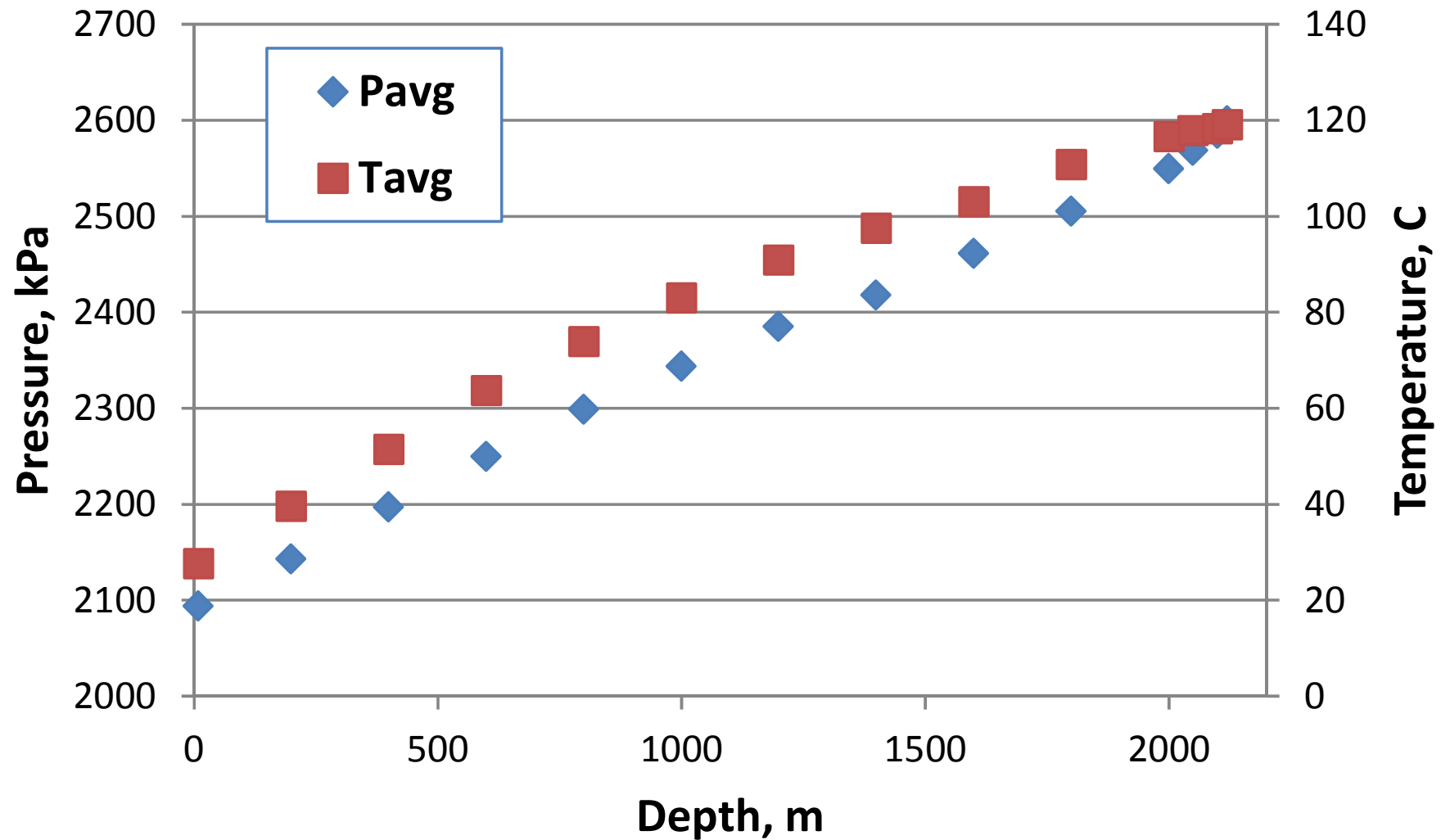
**1.Continuous FBHP measurement#2**

Until ceasing production or stabilisation of a minimal flow rate

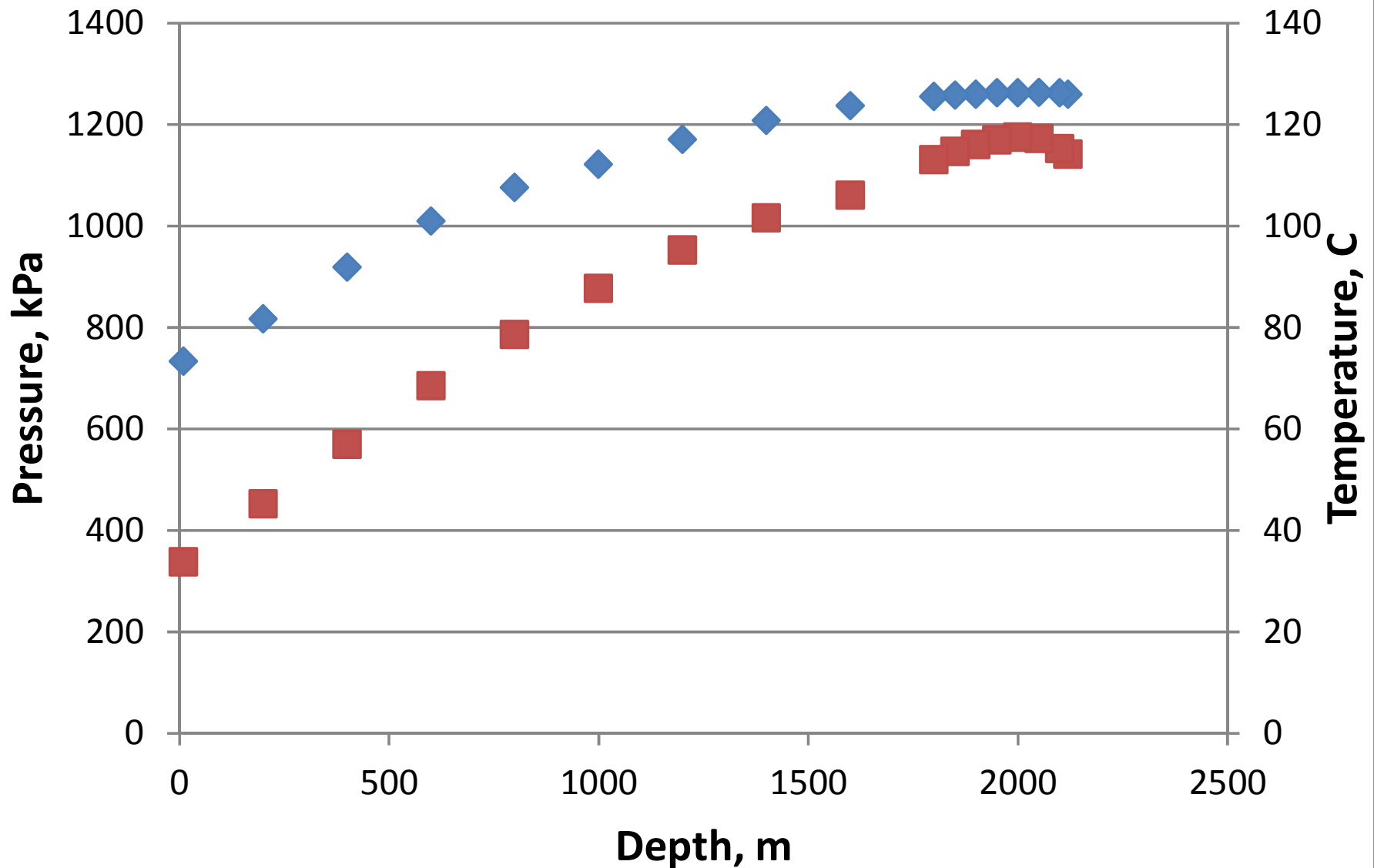
**5.Closed gradient**

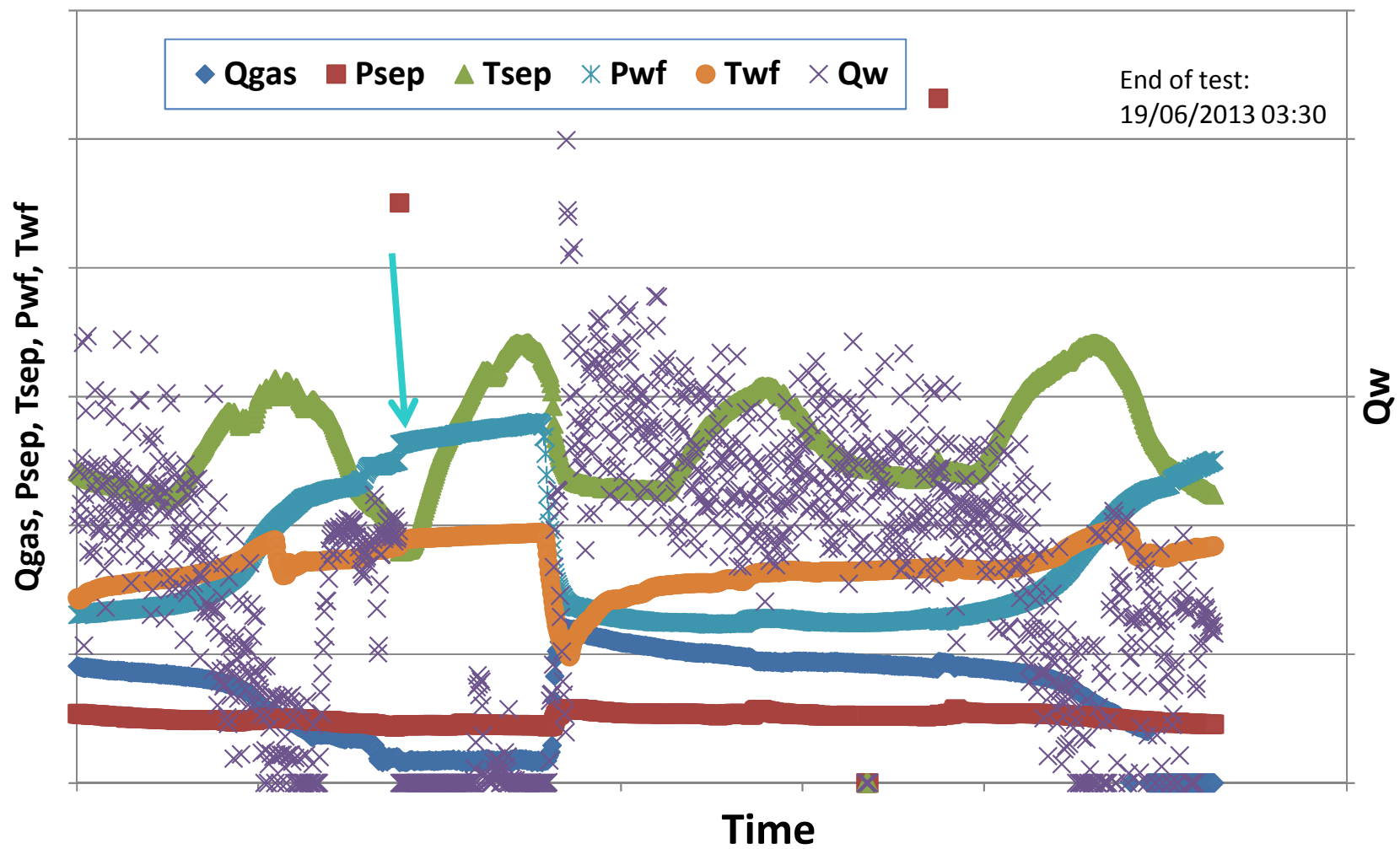


**13/06/2013 9:46 - 15:45, closed**



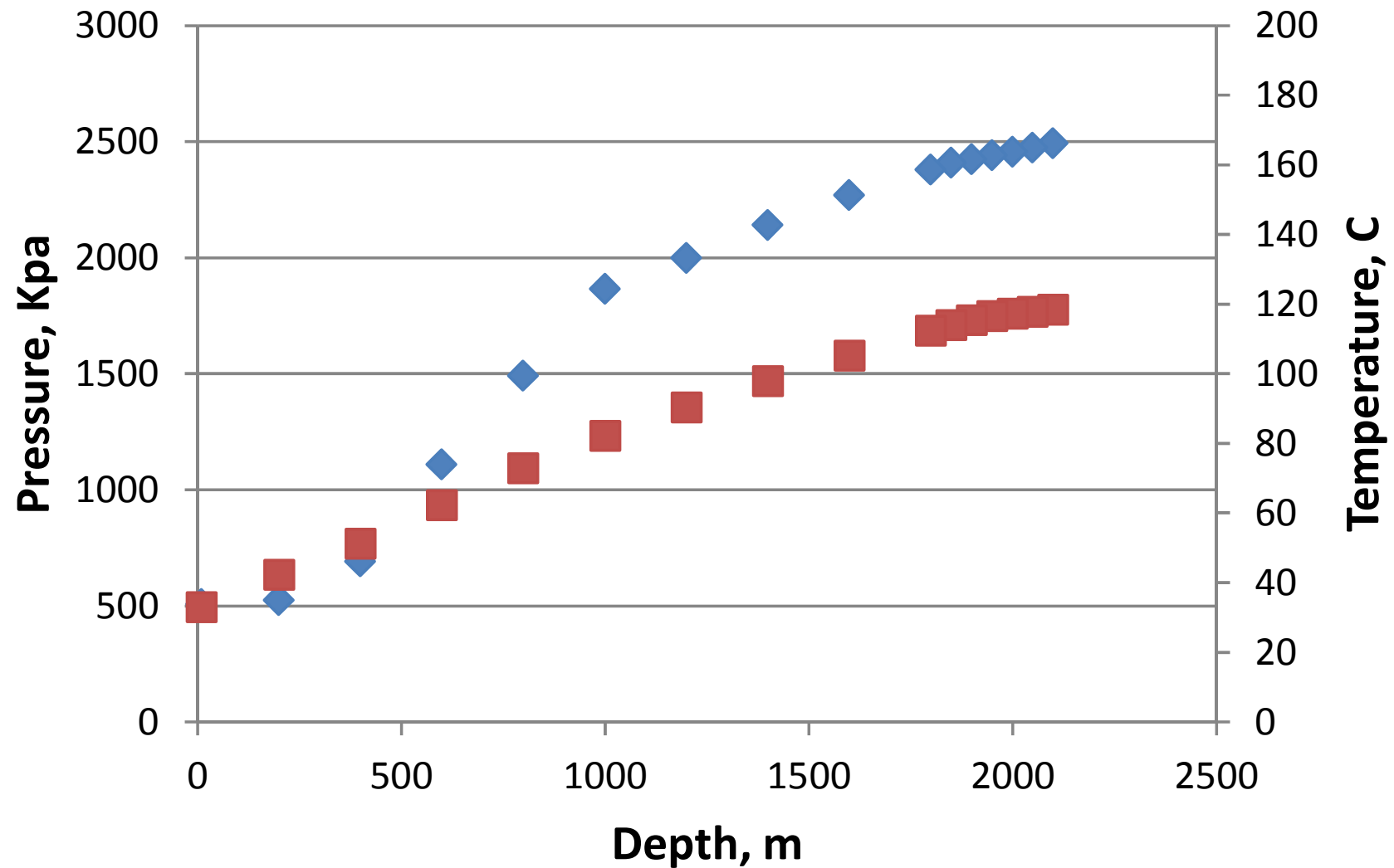
**13/06/2013 15:45-20:15, flowing**

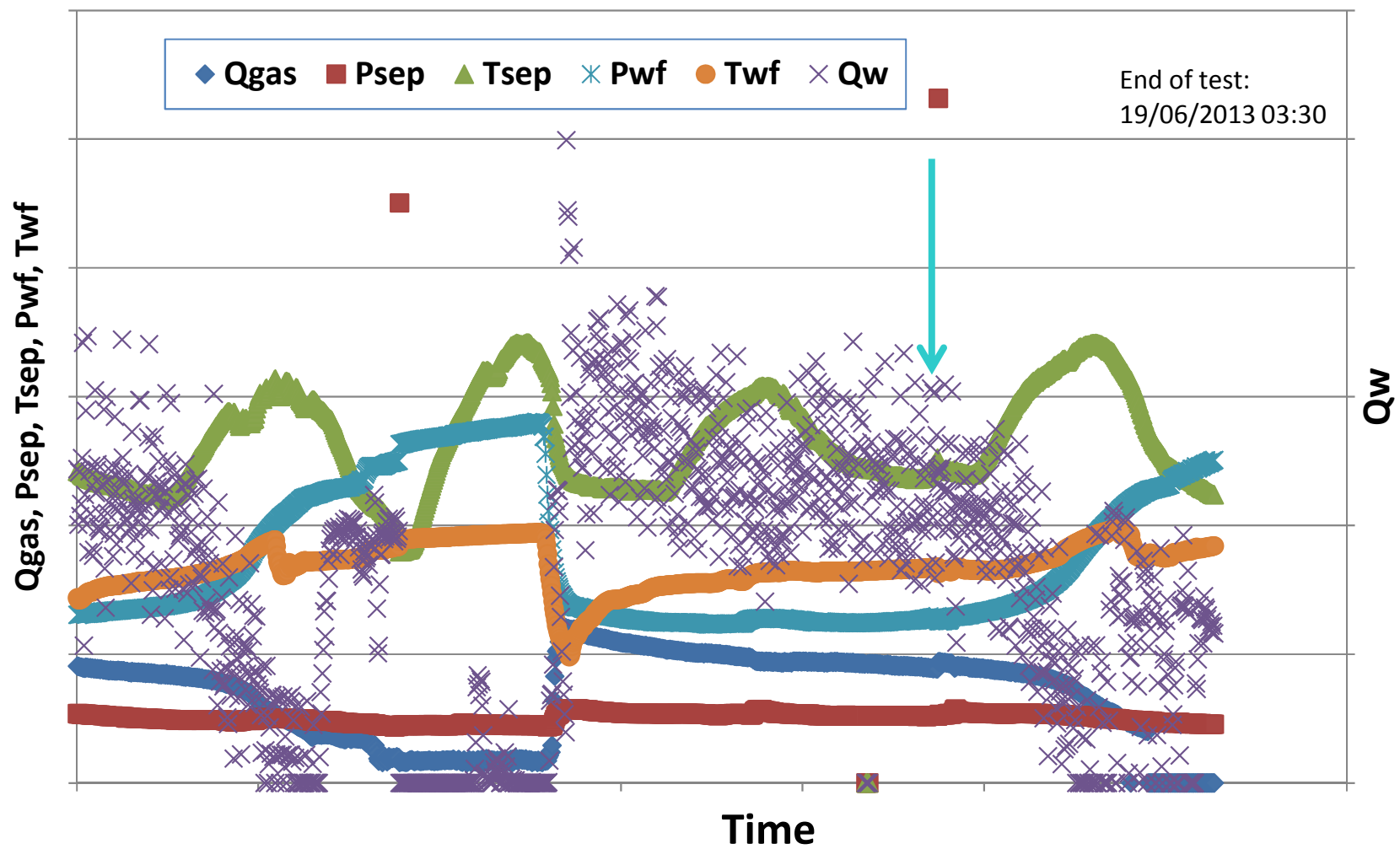




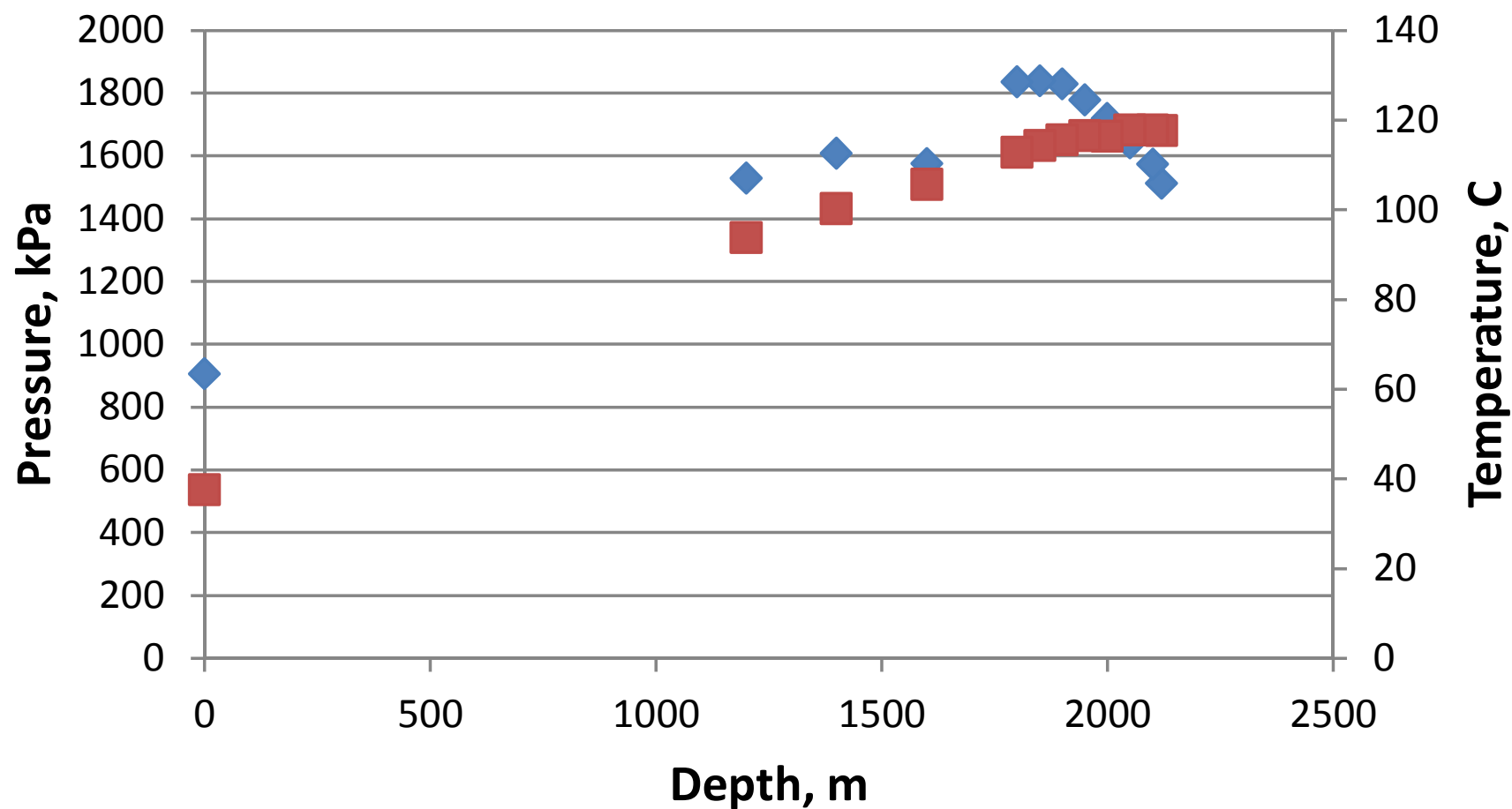


# 15/06/2013 01:01:-5:35, flowing

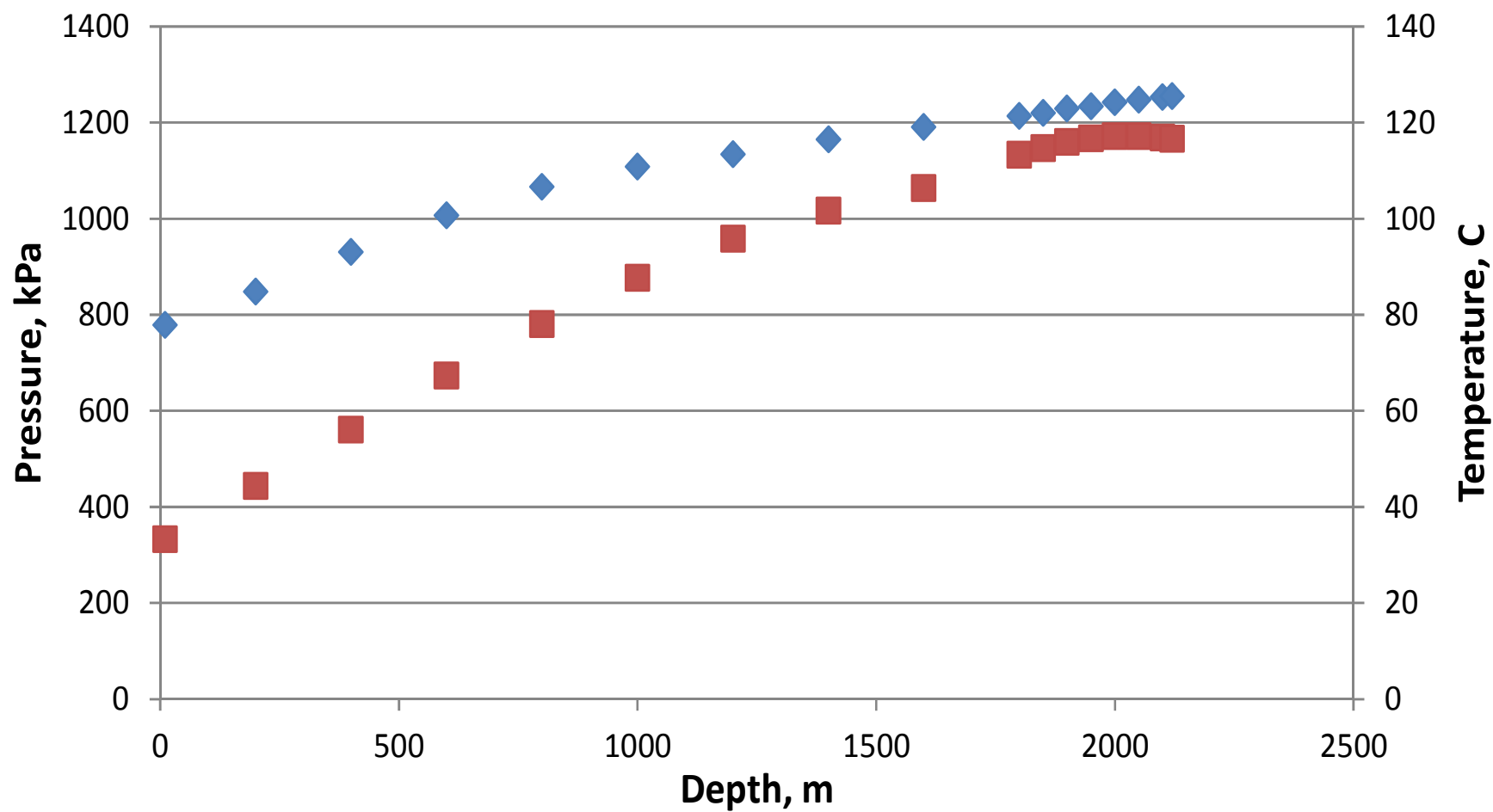


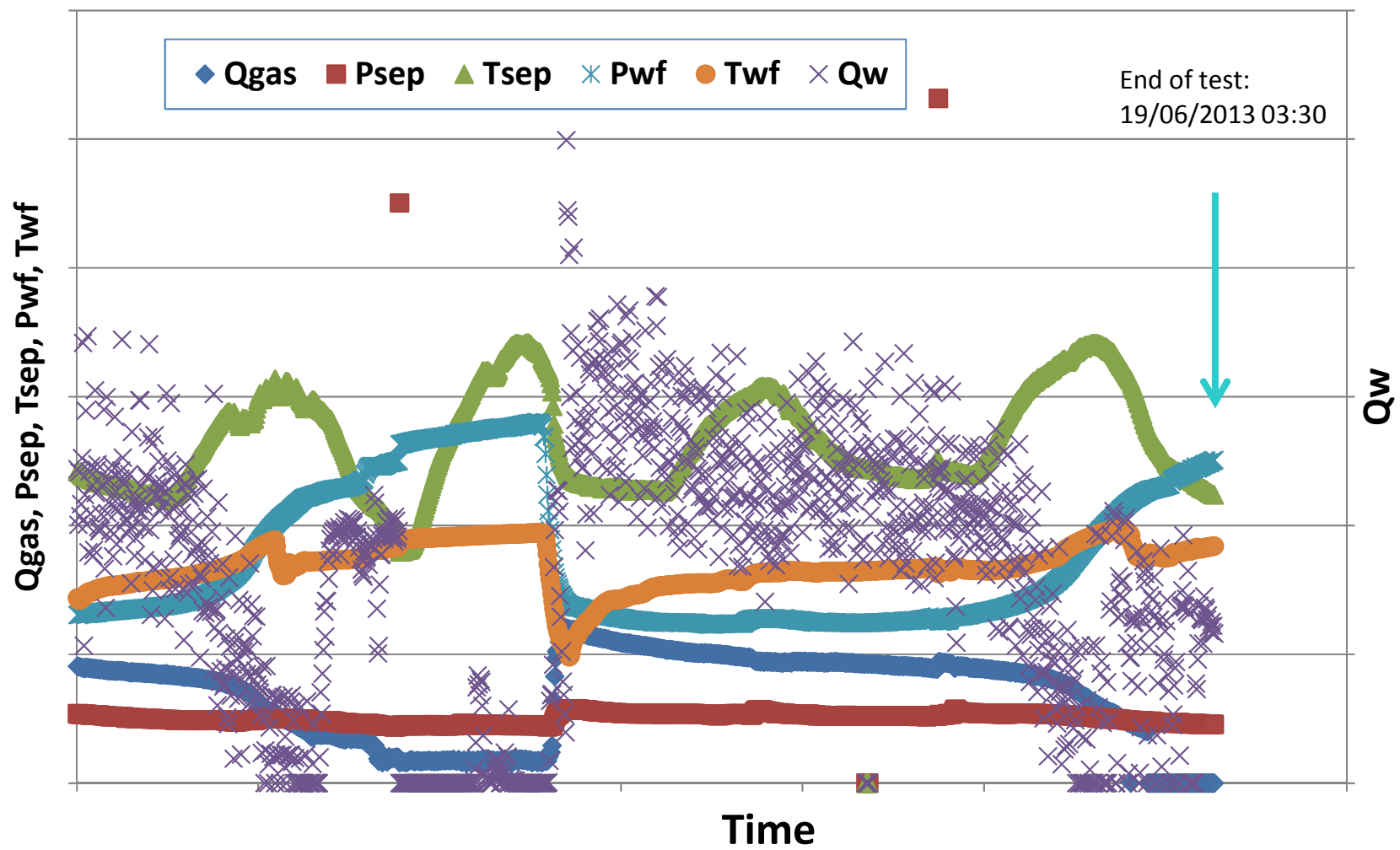


## 17/06/2013 7:50-11:00, after compressor problem

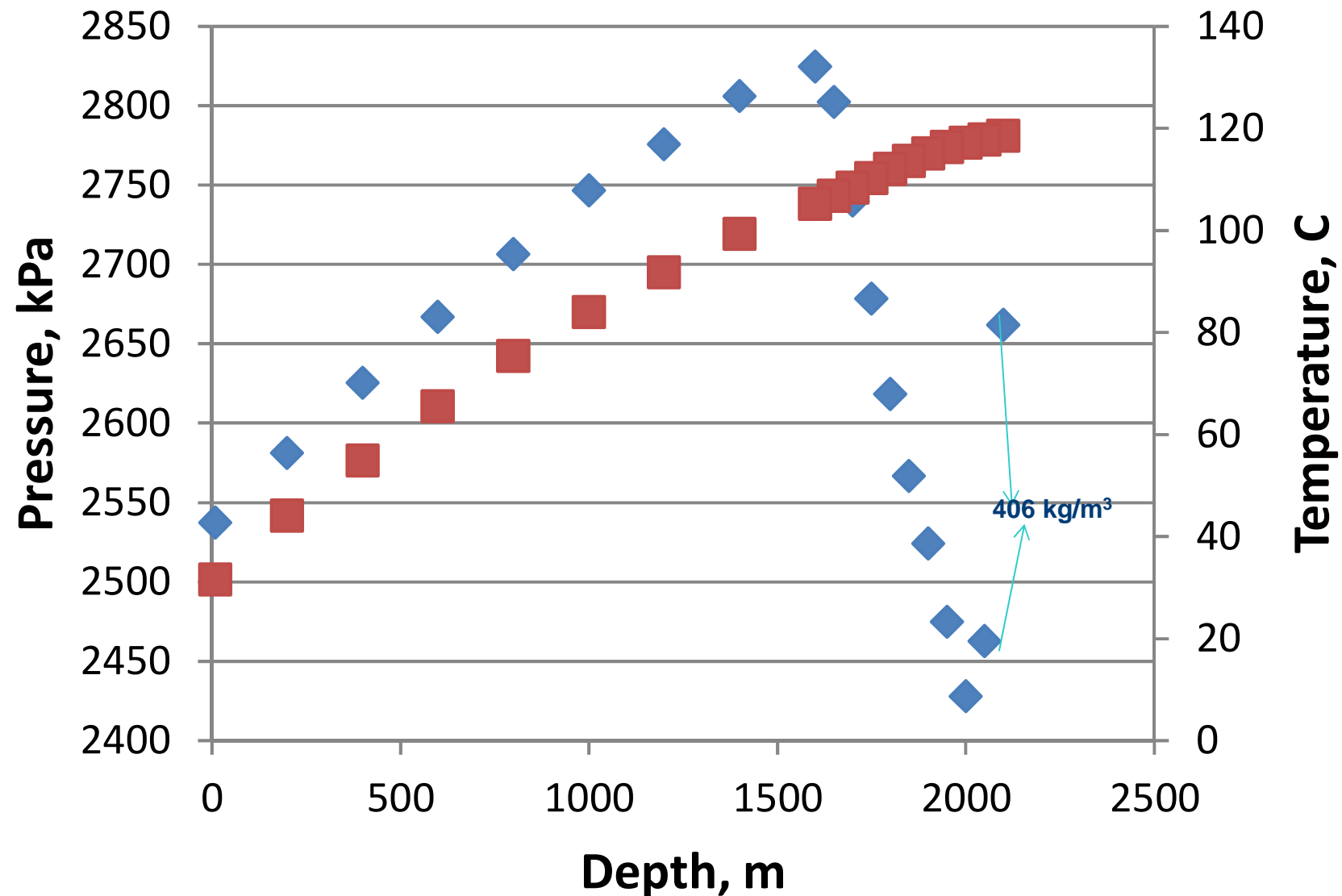


**17/06/2013 21:39-18/06/2013 02:09, flowing**





**19/06/2013 7:40-12:56, closed**



# Summary

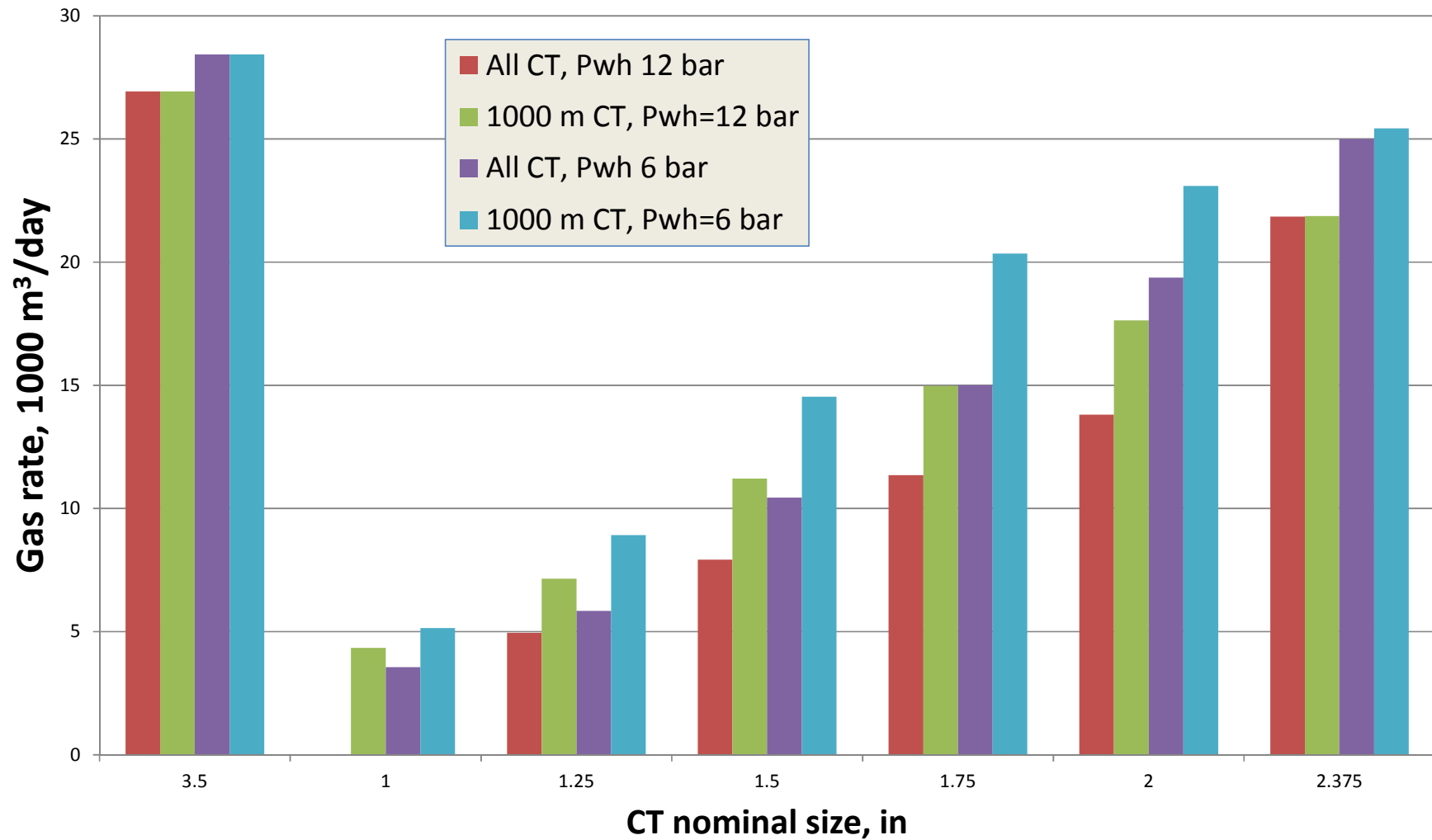
- Identification of liquid loading
  - Evaluate adequate data
- Measurements
- Identification of loading type
- Determination of the way of liquid removal

# Well# - EN – E- 14

- Loading is occurred at the upper part of tubing
- There are no possibilities to increase flow rate (from the terms of liquid removal)
- Possible solution#1: heating the upper part of the tubing (Insulation is not enough)
- Possible solution#2: Using CT at the upper 1000 m of the tubing.



## Well# EN-E-14, Gas flow rate vs. CT size and length



**Thank You for Your Attention!**