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Our ref: 2016-07154
Edition: 1
Date: 30.des.2016
Page: 1 of 9
Your ref: 4503461077

Laboratory Report

Objective: Analysis of water samples from 7121/4-G-4 H Snøhvit
Sampling location: n/a
Sampled by: Statoil Petroleum AS
Received date: 26.okt.2016
Tested: Nov.- Dec. 2016
Attachment: Alkalinity titration curve, transfer sheets and Isotope report from IFE. (Pages=13)

If you should have any questions to the report, please do not hesitate to contact us.

Regards
Intertek West Lab AS

Technical responsible

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Laboratory Report

Sample marking 7121/4-G-4 H Snøhvit

Chamber no: 4036
Bottle no: WFL-02013-14NO

Sampled Date 22.sep.2016

Sample type Formation water

Sample depth 3617,32 m MD RKB

Results for sample 2016-07154-001

Parameter	Results	Unit	PQL		Method/standard	Uncertainty	
			Lower	Upper		Rel	Abs
Gas/water ratio (GWR), "single flash"							
Gas water ratio GWR @15°C, 1atm	0,832	-			Single flash		
Volume gas @15°C 1atm	333	ml					
Volume liquid @15°C	400	ml					
Natural gas properties							
Compressibility factor, 15°C	0,9975	-			NS-EN-ISO 6976		
Inferior Calorific Value, ISO	29533,6	KJ/m ³					
Superior Calorific Value, ISO	32778,3	KJ/m ³					
Real relative Density, 15 °C	0,7105	-					
Real density of mixture	0,8707	kg/Sm ³					
Moleweight	20,5	kg/kmol					
Critical Pressure	4970,2	kPa					
Critical Temperature	208,0	K					
Composition of gas C1-C7+ incl. Nitrogene and CO2, GC							
Nitrogene	1,63	mol%	0,1	10	Mod. ASTM D 1945	10% ±0,05	
Carbondioxide	13,87	mol%	0,05	10		5% ±0,05	
Methane	82,63	mol%	35	100		1,4%	
Ethane	1,46	mol%	0,1	28		3% ±0,1	
Propane	0,14	mol%	0,1	21		3% ±0,1	
i-Butane	0,01	mol%	0,01	4		3% ±0,03	
n-Butane	0,03	mol%	0,01	8		3% ±0,03	
Cyclopentane	0,01	mol%	0,01	2		7%	
i-Pentane	0,02	mol%	0,01	2		5% ±0,03	
Neopentane	<0.01	mol%	0,01	2			
n-Pentane	0,03	mol%	0,01	3		5% ±0,03	
Hexanes	0,09	mol%					
Heptanes+	0,08	mol%					
H2S in water, "purge & trap"							
H2S dissolved in water	<0.02	mg/l	0,02		K-156	20% ±0,05	
Suspended solids in water, gravimetric							
Suspended solids	57	mg/l	15		NACE TM01-73	40% ±15	

Laboratory Report

Sample marking 7121/4-G-4 H Snøhvit
 Chamber no: 4036
 Bottle no: WFL-02013-14NO
 Sampled Date 22.sep.2016
 Sample type Formation water
 Sample depth 3617,32 m MD RKB

Results for sample 2016-07154-001

Parameter	Results	Unit	PQL		Method/standard	Uncertainty	
			Lower	Upper		Rel	Abs
Elements on filter, XRF (calculated as oxides)							
Aluminum, Al	1,1	wt%	0,1		a-s-002		Semikvantitativ
Barium, Ba	2,0	wt%	0,1				Semikvantitativ
Calcium, Ca	1,4	wt%	0,1				Semikvantitativ
Chromium, Cr	0,9	wt%	0,1				Semikvantitativ
Copper, Cu	<0.1	wt%	0,1				Semikvantitativ
Iron, Fe	41	wt%	0,1				Semikvantitativ
Potassium, K	0,4	wt%	0,1				Semikvantitativ
Magnesium, Mg	0,6	wt%	0,1				Semikvantitativ
Manganese, Mn	<0.1	wt%	0,1				Semikvantitativ
Sodium, Na	<0.1	wt%	0,1				Semikvantitativ
Nickel, Ni	<0.1	wt%	0,1				Semikvantitativ
Phosphorus, P	0,4	wt%	0,1				Semikvantitativ
Lead, Pb	<0.1	wt%	0,1				Semikvantitativ
Silicon, Si	14	wt%	0,1				Semikvantitativ
Strontium, Sr	<0.1	wt%	0,1				Semikvantitativ
Titanium, Ti	<0.1	wt%	0,1				Semikvantitativ
Zinc, Zn	<0.1	wt%	0,1				Semikvantitativ
Sulphur, S	0,6	wt%	0,1				Semikvantitativ
Chlorine, Cl	0,3	wt%	0,1				Semikvantitativ
Crystalline phases in solids, XRD							
- -Minerals, XRD- -			See comment -		X-031 (XRD)		

Explanation: PQL = Practical Quantification limit. # = The analysis is performed by sub contractor.

The uncertainty is expressed at 95% confidence level. If both a relative and an absolute uncertainty argument is stated, it is the argument that represents the highest uncertainty that applies.

Analysis comments

XRF/XRD is performed on suspended solids which are deposited on a filter and dried at 105°C.

The elements (XRF) are calculated as oxides and normalized to 100%, but reported as elements (WT%).

XRD: Identification is uncertain due to small amounts of inorganic material on the filter. The main peak for Quartz (SiO₂) is visible but the identification is uncertain.

The water was: Colored (brown-yellow)

Laboratory Report

Sample marking 7121/4-G-4 H Snøhvit
 Chamber no: 4788
 Bottle no: WFL-02014-14NO
 Sampled Date 22.sep.2016
 Sample type Formation water
 Sample depth 3617,32 m MD RKB

Results for sample 2016-07154-002

Parameter	Results	Unit	PQL		Method/standard	Uncertainty	
			Lower	Upper		Rel	Abs
Gas/water ratio (GWR), "single flash"							
Gas water ratio GWR @15°C, 1atm	0,809	-			Single flash		
Volume gas @15°C 1atm	324	ml					
Volume liquid @15°C	400	ml					
Natural gas properties							
Compressibility factor, 15°C	0,9973	-			NS-EN-ISO 6976		
Inferior Calorific Value, ISO	29571,4	KJ/m ³					
Superior Calorific Value, ISO	32808,0	KJ/m ³					
Real relative Density, 15 °C	0,7318	-					
Real density of mixture	0,8968	kg/Sm ³					
Moleweight	21,2	kg/kmol					
Critical Pressure	5014,1	kPa					
Critical Temperature	211,2	K					
Composition of gas C1-C7+ incl. Nitrogene and CO2, GC							
Nitrogene	1,21	mol%	0,1	10	Mod. ASTM D 1945	10% ±0,05	
Carbondioxide	15,43	mol%	0,05	10		5% ±0,05	
Methane	81,02	mol%	35	100		1,4%	
Ethane	1,47	mol%	0,1	28		3% ±0,1	
Propane	0,25	mol%	0,1	21		3% ±0,1	
i-Butane	0,05	mol%	0,01	4		3% ±0,03	
n-Butane	0,15	mol%	0,01	8		3% ±0,03	
Cyclopentane	<0.01	mol%	0,01	2		7%	
i-Pentane	0,07	mol%	0,01	2		5% ±0,03	
Neopentane	<0.01	mol%	0,01	2			
n-Pentane	0,09	mol%	0,01	3		5% ±0,03	
Hexanes	0,13	mol%	0,01	0,2		6% ±0,03	
Heptanes+	0,13	mol%	0,01	2			
7-ion, Na,Ca,Mg,Ba,Fe,Sr,K							
Sodium, Na	61100	mg/l	100	75000	a-v-026	10% ±25	
Calcium, Ca	4620	mg/l	5	35000		10% ±5	
Magnesium, Mg	529	mg/l	0,1	3000		10% ±0,1	
Barium, Ba	3,35	mg/l	0,05	1500		10% ±0,05	
Iron, Fe	1,4	mg/l	0,1	2000		15% ±0,2	
Strontium, Sr	220	mg/l	0,05	1600		10% ±0,1	
Potassium, K	481	mg/l	10	26000		15% ±10	
Sulphur, S	193	mg/l	1	1100		10% ±1	
Chloride in water, titration							
Chloride, Cl-	103000	mg/l	1000	300000	Mod. NS 4756	10%	
Bromide in chemical							
Bromide, Br-	86	mg/l	10		NS-EN ISO 10304-1	15% ±10	
Sulphate in chemicals, IC							
Sulphate	550	mg/l	20		NS-EN ISO 10304-1	10% ±20	
Sulphate in water, calculated from sulphur by ICP							
Sulphate from sulphur, ICP	580	mg/l	2		ICP-OES		
Alkalinity of water, titration til pH 2,5							
Total alkalinity	7,20	mmol/l	0,33		NS 4754	15%	

Laboratory Report

Sample marking 7121/4-G-4 H Snøhvit
 Chamber no: 4788
 Bottle no: WFL-02014-14NO
 Sampled Date 22.sep.2016
 Sample type Formation water
 Sample depth 3617,32 m MD RKB

Results for sample 2016-07154-002

Parameter	Results	Unit	PQL		Method/standard	Uncertainty	
			Lower	Upper		Rel	Abs
Determination of ion balance for 11-ion (12-ion)							
Ionbalance (cation/anion)	0,2	%					
TDS (Sum ions)							
Total dissolved salt	171000	mg/l					
pH in water							
pH at 20°C	5,6	pH	0	14	NS 4720 (Mod.)		±0,3
Specific density in water, Anton Paar							
Specific gravity at 15°C	1,118	-			Mod. ASTM D-4052		0,2% ±0,002
Resistivity of water at 25°C							
Resistivity at 25°C	0,054	Ohm*m	0,030	0,8	NS-ISO 7888		10%
Suspended solids in water, gravimetric							
Suspended solids	17	mg/l		15	NACE TM01-73		40% ±15
BTEX, organic acids in seawater HS/GC/MS							
Benzene	<0.1	mg/l	0,01		M-047		24% ±0,01
Toluene	<0.2	mg/l	0,02				28% ±0,02
Ethylbenzene	<0.2	mg/l	0,02				27% ±0,02
p-Xylene	<0.2	mg/l	0,02				28% ±0,02
m-Xylene	<0.2	mg/l	0,02				26% ±0,02
o-Xylene	<0.2	mg/l	0,02				23% ±0,02
Xylene (sum)	n.a	mg/l					n.a n.a
BTEX (sum)	n.a	mg/l					n.a n.a
Ethanoic acid	76	mg/l		2			15% ±2,2
Propionic acid	<20	mg/l		2			22% ±2
n-Butanoic acid	<20	mg/l		2			14% ±2
n-Pentanoic acid	<20	mg/l		2			19% ±2
n-Hexanoic acid	<20	mg/l		2			16% ±2
# Tritium in water, scintillation counter (Institutt for Energiteknikk)							
Tritium	50	bq/l		10	Scintillasjon (beta), IFE		5%
# Isotopes in water (Institutt for Energiteknikk)							
dD VSMOW	- 50,69	-			IFE		
d18O VSMOW	- 5,47	-					
87Sr / 86Sr	0,713433	-					

Explanation: PQL = Practical Quantification limit. # = The analysis is performed by sub contractor.

The uncertainty is expressed at 95% confidence level. If both a relative and an absolute uncertainty argument is stated, it is the argument that represents the highest uncertainty that applies.

Analysis comments

Bromide by IC is reported with increased uncertainty due to chemical interferens.
 Organic acids and BTEX have increased LOQ due to dilution of sample
 The water was: Colourless / light yellow.

Laboratory Report

Sample marking 7121/4-G-4 H Snøhvit
 Chamber no: 30288
 Bottle no: WFL-02015-14NO
 Sampled Date 22.sep.2016
 Sample type Formation water
 Sample depth 3617,32 m MD RKB

Results for sample 2016-07154-003

Parameter	Results	Unit	PQL		Method/standard	Uncertainty	
			Lower	Upper		Rel	Abs
Gas/water ratio (GWR), "single flash"							
Gas water ratio GWR @15°C, 1atm	0,825	-			Single flash		
Volume gas @15°C 1atm	330	ml					
Volume liquid @15°C	400	ml					
Natural gas properties							
Compressibility factor, 15°C	0,9975	-			NS-EN-ISO 6976		
Inferior Calorific Value, ISO	29254,7	KJ/m ³					
Superior Calorific Value, ISO	32473,3	KJ/m ³					
Real relative Density, 15 °C	0,7063	-					
Real density of mixture	0,8655	kg/Sm ³					
Moleweight	20,4	kg/kmol					
Critical Pressure	4979,7	kPa					
Critical Temperature	207,6	K					
Composition of gas C1-C7+ incl. Nitrogene and CO2, GC							
Nitrogene	1,45	mol%	0,1	10	Mod. ASTM D 1945	10% ±0,05	
Carbondioxide	14,06	mol%	0,05	10		5% ±0,05	
Methane	82,90	mol%	35	100		1,4%	
Ethane	1,39	mol%	0,1	28		3% ±0,1	
Propane	0,13	mol%	0,1	21		3% ±0,1	
i-Butane	0,02	mol%	0,01	4		3% ±0,03	
n-Butane	0,02	mol%	0,01	8		3% ±0,03	
Cyclopentane	<0.01	mol%	0,01	2		7%	
i-Pentane	0,01	mol%	0,01	2		5% ±0,03	
Neopentane	<0.01	mol%	0,01	2			
n-Pentane	0,01	mol%	0,01	3		5% ±0,03	
Hexanes	<0.01	mol%	0,01	0,2		6% ±0,03	
Heptanes+	0,01	mol%	0,01	2			
# Isotopes in produced water (Institutt for Energiteknikk)							
Ra (226)	4,6 ± 0,7	bq/l			IFE, Gammaspektrometri		
Ra (228)	2,66 ± 0,29	bq/l					
Pb (210)	<= 0,6	bq/l					

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Analysis comments

The water was: Colored (brown-yellow)

Laboratory Report

Sample marking 7121/4-G-4 H Snøhvit
 Chamber no: 3961
 Bottle no: WFL-02016-14NO
 Sampled Date 22.sep.2016
 Sample type Formation water
 Sample depth 3617,32 m MD RKB

Results for sample 2016-07154-004

Parameter	Results	Unit	PQL		Method/standard	Uncertainty	
			Lower	Upper		Rel	Abs
Gas/water ratio (GWR), "single flash"							
Gas water ratio GWR @15°C, 1atm	0,827	-			Single flash		
Volume gas @15°C 1atm	331	ml					
Volume liquid @15°C	400	ml					
Natural gas properties							
Compressibility factor, 15°C	0,9978	-			NS-EN-ISO 6976		
Inferior Calorific Value, ISO	32298,7	KJ/m³					
Superior Calorific Value, ISO	35848,6	KJ/m³					
Real relative Density, 15 °C	0,6277	-					
Real density of mixture	0,7691	kg/Sm³					
Moleweight	18,2	kg/kmol					
Critical Pressure	4729,2	kPa					
Critical Temperature	198,0	K					
Composition of gas C1-C7+ incl. Nitrogene and CO2, GC							
Nitrogene	1,93	mol%	0,1	10	Mod. ASTM D 1945	10% ±0,05	
Carbondioxide	5,29	mol%	0,05	10		5% ±0,05	
Methane	90,89	mol%	35	100		1,4%	
Ethane	1,56	mol%	0,1	28		3% ±0,1	
Propane	0,14	mol%	0,1	21		3% ±0,1	
i-Butane	0,01	mol%	0,01	4		3% ±0,03	
n-Butane	0,02	mol%	0,01	8		3% ±0,03	
Cyclopentane	<0.01	mol%	0,01	2		7%	
i-Pentane	0,01	mol%	0,01	2		5% ±0,03	
Neopentane	<0.01	mol%	0,01	2			
n-Pentane	0,01	mol%	0,01	3		5% ±0,03	
Hexanes	0,06	mol%	0,01	0,2		6% ±0,03	
Heptanes+	0,08	mol%	0,01	2			

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Analysis comments

The water was: Colourless / light yellow.

Laboratory Report

Sample marking 7121/4-G-4 H Snøhvit

Mudreport 038 Check #
2 (22:30) Baradril-n 8
1/2 section

Sampled Date 20.sep.2016 Mudfiltrate

Sample type

Results for sample 2016-07154-005

Parameter	Results	Unit	PQL		Method/standard	Uncertainty	
			Lower	Upper		Rel	Abs
9-ion, Na,Ca,Mg,Ba,Fe,Sr,K,Cl,S							
Sodium, Na	65900	mg/l	100	75000	a-v-026	10%	±25
Calcium, Ca	60,6	mg/l	5	35000		10%	±5
Magnesium, Mg	218	mg/l	0,1	3000		10%	±0,1
Barium, Ba	1,10	mg/l	0,05	1500		10%	±0,05
Iron, Fe	1,7	mg/l	0,1	2000		15%	±0,2
Strontium, Sr	0,84	mg/l	0,05	1600		10%	±0,1
Potassium, K	1610	mg/l	10	26000		15%	±10
Sulphur, S	187	mg/l	1	1100		10%	±1
Bromide in water, IC							
Bromide, Br-	19000	mg/l	10		NS-EN ISO 10304-1	15%	±10
# Tritium in water, scintillation counter (Institutt for Energiteknikk)							
Tritium	72100	bq/l	10		Scintilasjon (beta), IFE	5%	
BTEX, organic acids in seawater HS/GC/MS							
Benzene	<0.3	mg/l	0,01		M-047	24%	±0,01
Toluene	<0.6	mg/l	0,02			28%	±0,02
Ethylbenzene	<0.6	mg/l	0,02			27%	±0,02
p-Xylene	<0.6	mg/l	0,02			28%	±0,02
m-Xylene	<0.6	mg/l	0,02			26%	±0,02
o-Xylene	<0.6	mg/l	0,02			23%	±0,02
Xylene (sum)	n.a	mg/l				n.a	n.a
BTEX (sum)	n.a	mg/l				n.a	n.a
Etanoic acid	170	mg/l	2			15%	±2,2
Propionic acid	<60	mg/l	2			22%	±2
n-Butanoic acid	<60	mg/l	2			14%	±2
n-Pentanoic acid	<60	mg/l	2			19%	±2
n-Hexanoic acid	<60	mg/l	2			16%	±2

Explanation: PQL = Practical Quantification limit. # = The analysis is performed by sub contractor.

The uncertainty is expressed at 95% confidence level. If both a relative and an absolute uncertainty argument is stated, it is the argument that represents the highest uncertainty that applies.

Analysis comments

Organic acids and BTEX have increased LOQ due to dilution of sample

Laboratory Report

Sample marking 7121/4-G-4 H Snøhvit
 Baradriil-n 8 1/2 section
 Mudfiltrate (Weatherford)

Sampled Date
 Sample type Mudfiltrate

Results for sample 2016-07154-006

Parameter	Results	Unit	PQL		Method/standard	Uncertainty
			Lower	Upper		Rel Abs
Specific density in water, Anton Paar Density @15°C	1,119	g/cm ³	0,99	1,4	Mod. ASTM D-4052	0,2% ±0,002

Explanation: PQL = Practical Quantification limit. # = The analysis is performed by sub contractor.

The uncertainty is expressed at 95% confidence level. If both a relative and an absolute uncertainty argument is stated, it is the argument that represents the highest uncertainty that applies.