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Oskarshamn site investigation

Control of microorganism content in flushing water used for drilling of KAV04 and KLX03

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Abstract

A system for disinfection of flushing water and continuous dosage of tracer for drilling fluids has been developed. It comprises an ultra violet (UV) radiation unit and a flow controlled dosing pump attached on line in the flushing water system.

This activity aimed to control the effect from cleaning the drill water system during drilling of KAV04 and KLX03. A second aim was to control the efficiency of the drill water treatment during drilling of KLX03. The third aim was to control the disinfection efficiency of the UV-unit during both drilling campaigns.

The cleaning of the flushing system during drilling of KAV04 had a significant effect. The numbers of cultivable bacteria was within the range of approval after cleaning, but not before. The UV-unit was working properly. The flushing water was extremely dirty during drilling of KLX03, at least at the day of sampling. Both the number of cultivable bacteria and the ATP concentrations were much higher than during drilling of KAV04. Some disinfection effect was observed from the UV-unit, indicating that it was operative.

In conclusion, it is possible to keep flushing water systems clean. However, doing so is a continuous process that requires repeated cleaning and control.

Sammanfattning

Ett system för anti-mikrobiell behandling av spolvatten för borrning har utvecklats. Systemet omfattar en UV-enhet samt en flödeskontrollerad dosering av spårämne på spolvattensystemet ”in line”.

Denna aktivitet syftade på att kontrollera effektiviteten i rengöringsprocedurerna under borrning av KAV04 och KLX03. Ett annat syfte var att kontrollera effektiviteten i spolvattenbehandlingen under borrning av KLX03. Sista syftet var att kontrollera desinfektionsförmågan hos UV-enheten.

Rengöringen av spolvattensystemet under borrning av KAV04 hade en signifikant effekt. Antalet odlingsbara bakterier låg inom godkänt område efter, men inte före rengöringen. UV-enheten fungerade korrekt. Spolvattnet var däremot extremt smutsigt under borrning av KLX03, åtminstone under dagen för provtagning. Både antalet odlingsbara bakterier och ATP-koncentrationen var mycket högre än under borrning av KAV04. UV-enheten fungerade eftersom antalet bakterier var lägre efter, jämfört med före enheten.

Sammanfattningsvis kan det konstateras att det är möjligt att hålla spolvattnet på en acceptabel nivå vad gäller mikrobinnehåll. Men för att göra det krävs kontinuerlig rengöring och kontroll.

Contents

1 Introduction

A system for disinfection of flushing water and continuous dosage of tracer for drilling fluids has been developed (Figure 1-1). It comprises an ultra violet (UV) radiation unit and a flow controlled uranin dosing pump attached on line in the flushing water system. It is known since earlier investigations that flushing water may introduce large number of contaminating microbes into the aquifers /Pedersen et al. 1997/. This should be avoided because it may cause errors in the suceeding investigations of geochemistry and microbiology. The basic procedure to achieve a microbiologically approved flushing water system is to clean the drillwater system frequently. The UV-lamp should be kept clean and its proper efficiency should be continuously controlled. The uranin tank and mixture must be kept free from microbes. This is because some bacteria can grow on and degrade this tracer.

The drill water system was sampled at three points (Figure 1-1). The first was taken directly after the drill water is pumped up from the borehole. This point gives the microbial content in the borehole and the hygienic status of the borehole pump. The second point was located just after the UV-unit. This point should demonstrate the efficiency of the UV-unit and the numbers should be significantly lower compared to the first sampling point. The last point was located in the drilling machine. This point shows the hygienic status of the drill rig, mixing tank and of the uranin dosage system.

The results from a previous drill water investigation in Oskarshamn during drilling of KSH03B have been reported /Kalmus 2004/.

This document reports the results gained during drilling of KAV04 and KLX03. The drilling of KAV04 and KLX03 are reported in P-05-25 and P-05-167 respectively.

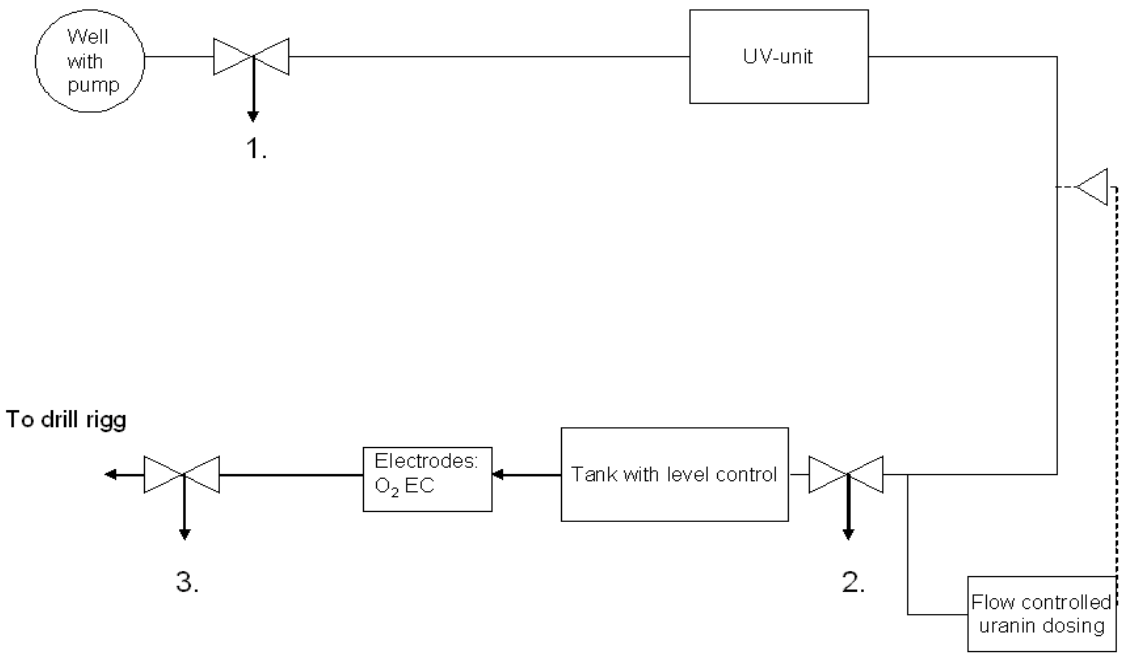

Figure 1-1. *Schematic drawing of the drill water system (1 = P1, 2 = P2 and 3 = P3).*

KAV04 was sampled 2004-11-15, before cleaning of the drill water system, and 2004-11-16, after cleaning of the drill water system. The drill water well was HSH03.

KLX03 was sampled 2004-06-04 after cleaning of the drill water system. The drill water well was HLX14.

The results are stored in the SICADA database.

2 Objective and scope

A washing/cleaning procedure and a disinfection UV-unit have been introduced to minimize the amount of microbes in the flushing water system during drilling. This activity aimed at:

1. Control of the effect from cleaning of the drill water system during drilling of KAV04. The performance of the flushing water treatment with reference to its ability to reduce potentially occurring microbes in the flushing water was analyzed before and after cleaning.
2. Control of the efficiency of cleaning the drill water treatment system during drilling of KLX03. The results should demonstrate significant decreases in the number of cultivable microbes along the flushing water line, from the flushing water borehole source to the water entering the drilling machine.
3. Control of the disinfection efficiency of the UV-unit.

3 Equipment

3.1 Description of equipment/interpretation tools

Standard cultivation equipment and procedures were employed as follows:

- Viable counts of microorganisms were analyzed in triplicates according to /Pedersen et al. 1997/, with R2A medium.
- ATP measurements were made in triplicates according to the method described in /Lundin 2000/ using firefly luciferase enzyme.

Sampling was performed in 1 L sterile glass bottles on 3 positions in the drill water line. Sampling was repeated once. This was done to understand the total variability over time included in the sampled water (short term fluctuations in water quality), and the sampling procedure.

4 Execution

4.1 General

Sterile 1 L bottles were sent in advance to the drill site.

4.2 Preparations

The samples were collected by personnel working at the drill site in the afternoon and sent by mail to the laboratory in Göteborg. The following morning the laboratory was prepared to analyse the samples as soon as they arrived. The inoculations and ATP measurements were finalized at noon the same day of arrival.

4.3 Execution of field work

Sampling was executed at different times as listed in Table 4-1.

4.4 Data handling/post processing

The numbers obtained are directly transferred to the results section, without post processing.

Table 4-1. Sampling times.

Sampling	Date	Sampling point					
		P1T1	P1T2	P2T1	P2T2	P3T1	P3T2
KAV04 before cleaning	040315	14:07	14:10	14:13	14:35	14:41	14:44
KAV04 after cleaning	040316	14:01	14:03	14:05	14:25	14:27	14:30
KLX03 after cleaning	040604	16:19	16:07	16:08	16:40	16:27	16:30

4.5 Analyses and interpretations

Samples for cultivation are diluted and distributed on R2A medium agar dishes in triplets. The number of colonies is counted on all dilutions and parallels. The average of the triplet that lies between 30 and 300 colonies is taken as the value. This value should correspond well with the other triplets when the dilutions are taken into account.

The average ATP content of one microbe in groundwater is about 10^{-18} mole. The ATP content can, therefore, be transferred to total amount of living microbes in the sample.

4.6 Nonconformities

Nonconformities did not appear in this activity.

5 Results

5.1 KAV04 drilling

There are yet no generally agreeded limits within the site investigations for the number of cultivable bacteria and ATP that should not be exceeded in the drill water during drilling. Obviously, zero values would be best, but that is far from achievable under full scale field conditions. The simple recommendation is “the lower numbers the better”. Based on earlier experiences, a level of 1000 cultivable bacteria can easily be achieved if the system is kept clean. This number is, therefore, taken as the limit for approval of a clean flushing water system. A red line denotes this limit in the result Figures 5-1 and 5-3.

The cleaning of the flushing system during drilling of KAV04 had a significant effect. The numbers of cultivable bacteria was above the limit of approval before cleaning, but did decrease below this limit after cleaning (Figure 5-1). The UV-unit was obviously working properly as the numbers after UV was significantly lower compared to before the unit before cleaning. But before cleaning, a new contamination was introduced after UV as the numbers were higher at the drill rig than after the UV-unit. This effect diminished after cleaning. The general pattern obtained for cultivable bacteria was repeated in the ATP measurements (Figure 5-2).

5.2 KLX03 drilling

The flushing water was extremely dirty during drilling of KLX03, at least at the day of sampling. Both the number of cultivable bacteria (Figure 5-3) and the ATP concentrations (Figure 5-4) were much higher than during drilling of KAV04. Some disinfection effect was observed from the UV-unit, indicating that it was operative.

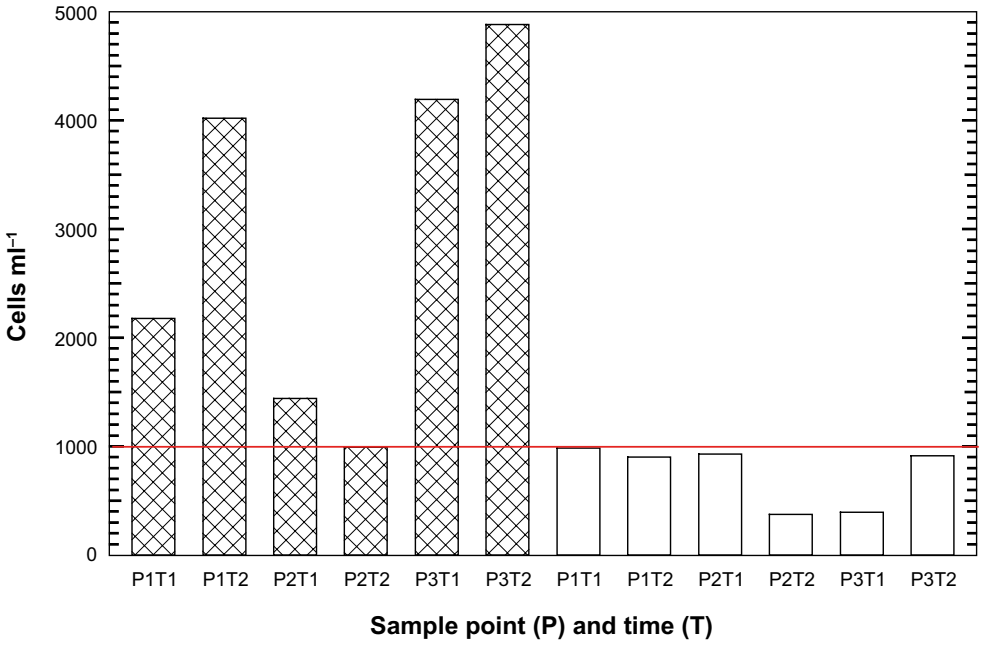

Figure 5-1. *Cultivable bacteria in the flushing water system during drilling of KAV04. Crosshatched bars show status before cleaning, open bars show status after cleaning. Sample points refer to Figure 1-1. Sampling times are given in Table 4-1. The red line denotes the maximum acceptable number.*

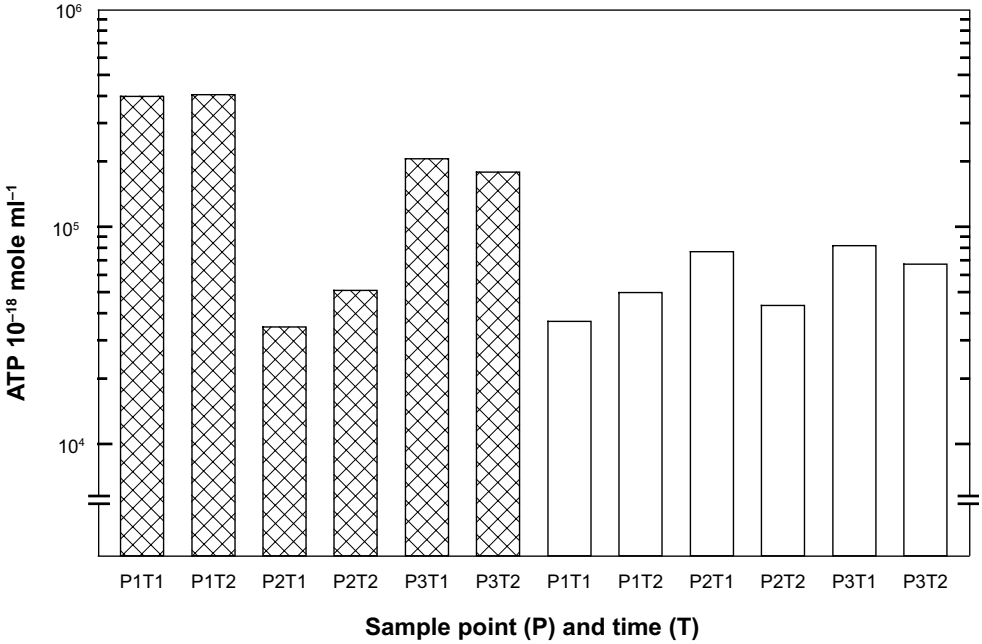

Figure 5-2. *The concentration of ATP in the flushing water system during drilling of KAV04. Crosshatched bars show status before cleaning, open bars show status after cleaning. Sample points refer to Figure 1-1. Sampling times are given in Table 4-1.*

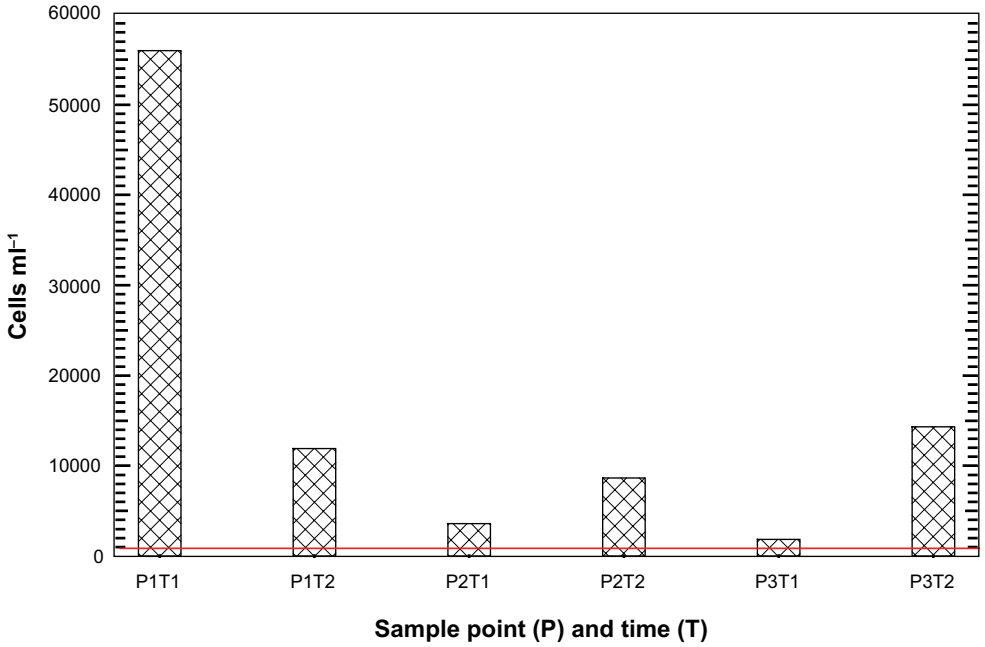

Figure 5-3. *The number of cultivable bacteria in the flushing water system during drilling of KLX03. Sample points refer to Figure 1-1. Sampling times are given in Table 4-1. The red line denotes the maximum acceptable number.*

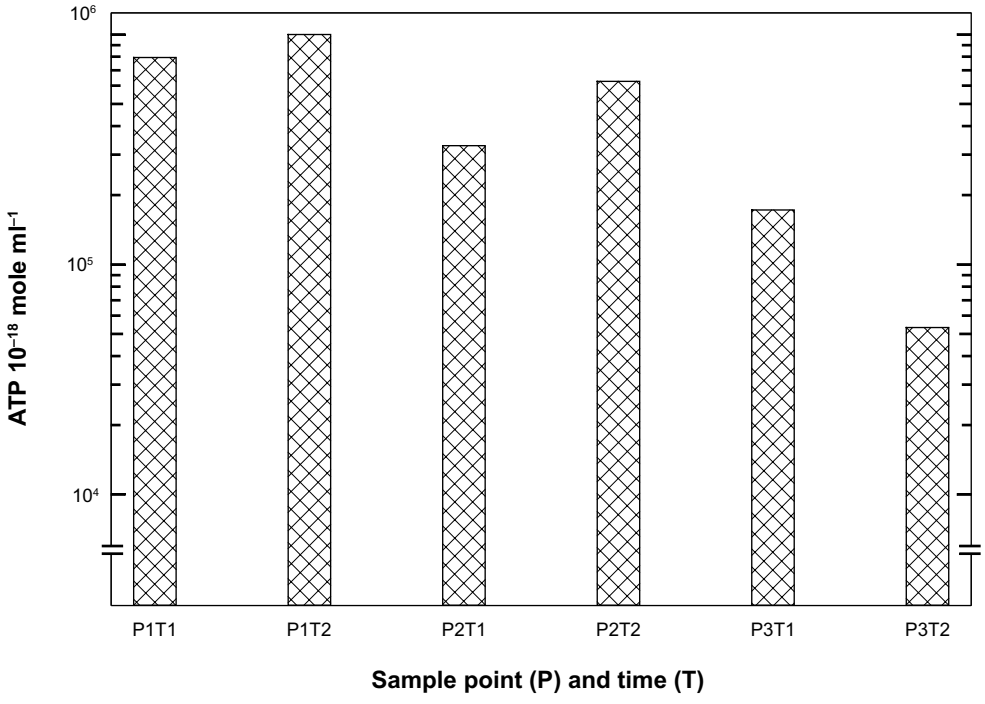

Figure 5-4. *The concentration of ATP in the flushing water system during drilling of KLX03 Sample points refer to Figure 1-1. Sampling times are given in Table 4-1.*

6 Summary and discussions

The possible sources of microbial contaminations to the flushing water system are several. The drill water well may have had dirty water. Fast pumping may stir up debris that can carry high numbers of bacteria. However, the cleaning procedure during KAV04 drilling decreased the numbers from the well significantly (Figure 5-1), which indicate that the source of contaminants was the flushing water system. This was also the case after the UV-unit. The numbers decreased after cleaning.

The very high numbers in KLX03 flushing water are probably caused by high particle concentrations in the system. This can be concluded based on the very high variability between sampling times. Particles are distributed unevenly in time in a flow system. Sudden variations in pump flow and discrete mechanical disturbance such as turning valves or fittings may cause peeks of debris.

All results indicate that the UV-unit was operative, as the numbers decreased significantly after UV-treatment.

In conclusion, it is possible to keep flushing water systems clean. However, doing so is a continuous process that requires repeated cleaning and control.

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