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Forsmark site investigation

Control of microorganism content in flushing water used for drilling of KFM05A

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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. In the present study, which refers to drilling of borehole KFM05A, continued control of flushing water showed that low numbers are generally maintained.

Sammanfattning

Ett system för TOC reduktion och anti-mikrobiell behandling av spolvatten för borrning har utvecklats. Systemet omfattar en UV-enhet ”in line” på spolvattensystemet samt ett automatiskt system för spårämnesdosering. Undersökningen som avser borrningen av KFM05A visar på fortsatt relativt låga halter av mikrober i spolvattnet.

Contents

1 Introduction

This document reports the results from control of microorganism content in flushing water used for core drilling of borehole KFM05A. The work was conducted according to the activity plan AP PF 400-03-09 (SKB internal controlling document).

A system for disinfection of flushing water and continuous dosage of tracer for drilling fluids has been developed. 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.

The first design included an ultra violet (UV) radiation unit, a carbon filter for reduction of high total organic carbon content in flushing water and manual labeling of the flushing water with the tracer Uranine. Later, a flow controlled dosing pump attached on line in the flushing water system replaced the manual labeling system.

During drilling of borehole KFM05A, the carbon filter was excluded due to a low content of organic constituents in the groundwater from the flushing water well, whereas the UV-unit and the dosing pump were at operation.

The results from previous flushing water investigations have been reported for KMF01A and for KMF02 and 04 in /Pedersen, 2003/ and /Pedersen and Kalmus, 2004/, respectively.

ATP measurements have been included in this investigation as a complement to the other two methods, total number of cells and viable count. ATP, adenosine tri-phosphate, is an indicator for viable and active cells since it is the key molecule in energy transformations in cells. The ATP concentrations can be recalculated to cell number with the formula; two amol ATP (2×10^{-18} moles) are equivalent to one cell /Lundin, 2000/.

2 Objectives

- This activity aimed at continuing control of the performance of the flushing water treatment with reference to its ability to reduce potentially occurring microbes in the flushing water. A washing/cleaning procedure has been included to further minimize the amount of microbes in the flushing water system.
- 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 Equipment and performance

Standard cultivation equipment and procedures were employed as follows:

Total numbers of microorganisms were analyzed in triplicates according to /Pedersen and Ekendahl, 1990/, using acridine orange direct counts.

Viable counts of microorganisms were analyzed in duplicates according to /Pedersen et al. 1997/, with R2A medium.

ATP measurements were made according to the method described in /Lundin, 2000/, using firefly luciferase enzyme.

Sampling was performed in 1 L sterile bottles on two positions in the flushing water line, 1) before the UV-unit and 2) after the UV-unit and after dosing of Uranine. Tubings were disconnected for sampling when valves were missing.

Sampling which was performed 2004-02-17, 2004-03-25, 2004-03-26 and 2004-04-14 during drilling of KFM05A was made in duplicates each time and are named A and B in the results. The samples from 25 and 26 of March represent sampling before (March 25) and after (March 26) cleaning of the system.

4 Results

4.1 Total number of microorganisms

Figure 4-1 shows the total numbers of microorganisms in drilling fluid from three sampling occasions during drilling of KFM05A. Samples were taken before and after UV-treatment and in duplicate, named A and B. The total numbers of cells were between 4×10^4 and 7.5×10^4 per ml and were comparable over all three measuring occasions. A small decrease was observed after the UV 2004-02-17 and for one of the two samples taken 2004-03-25 and 2004-03-26. The differences were small. UV killed microorganisms can still be visible as total number some time after sterilization. It is, therefore, not expected that the total number of microorganisms will decrease more than marginally, and this was also the case. Samples taken 2004-04-14 were not analysed for AODC.

No difference could be seen between the sampling before cleaning of the system the 25 of March and after, the 26 of March.

In comparison to samples taken during drilling of KFM02 and KFM04, the total numbers of cells from this drilling operation are in the same order of magnitude /Pedersen, 2003/ and /Pedersen and Kalmus, 2004/.

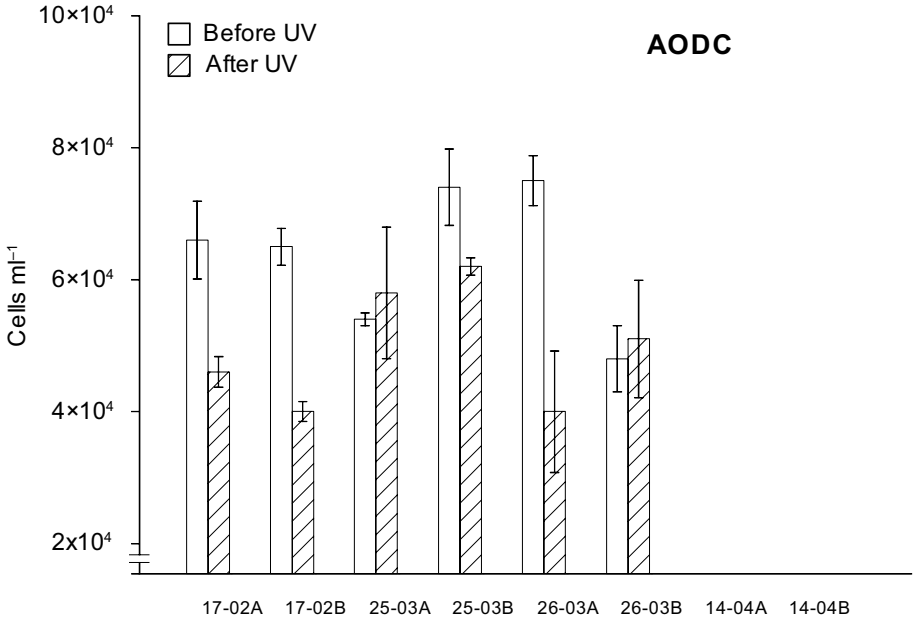

Figure 4-1. *Total number of microorganisms measured with AODC. Bars indicate standard deviation for three independent measurements. Samples from 2004-04-14 were not analysed.*

4.2 Number of cultivable microorganisms

The viable count showed a higher variability in this drilling operation (Figure 4-2) compared to KFM02 and KFM04. The highest numbers were found in samples from 2004-02-17 with a viable count close to 2,000 ml^{-1} before UV-treatment in the B-sample. The samples taken 25 and 26 of March were low both before and after UV but sample A from 2004-04-14 was very high compared to the one before the UV-unit.

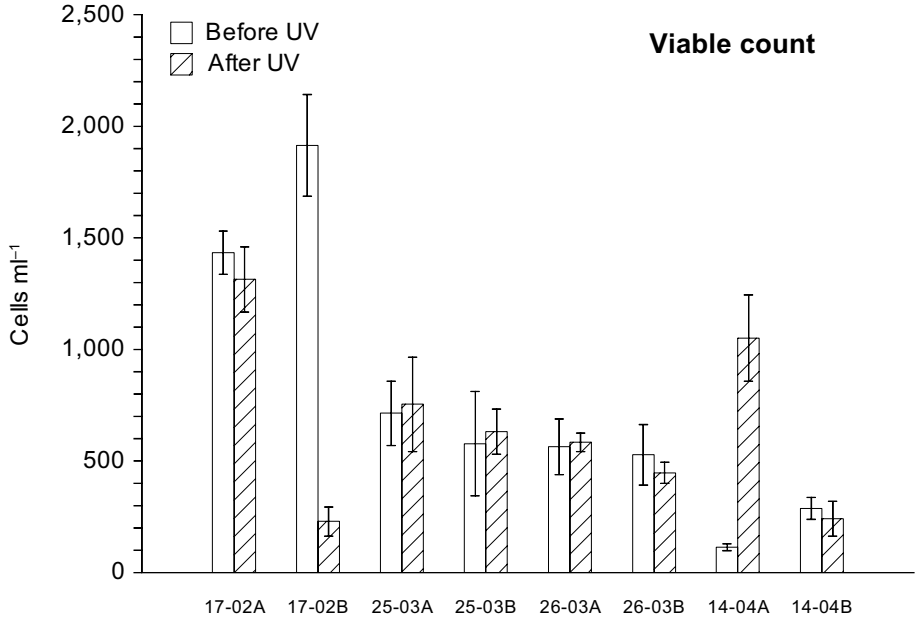

Figure 4-2. *Viable counts of microorganism in flushing water during drilling of KFM05, Forsmark. A and B stands for duplicate samples and bars indicate standard deviation for two independent measurements.*

4.3 ATP measurements

The ATP measurements in samples taken 2004-03-25 and 2004-03-26 showed values in accordance with the measured total number of cells and viable counts and are relatively low. The most remarkable values are the ones from 2004-04-14. The viable counts were here low except after UV in sample A but the ATP measurements showed high values.

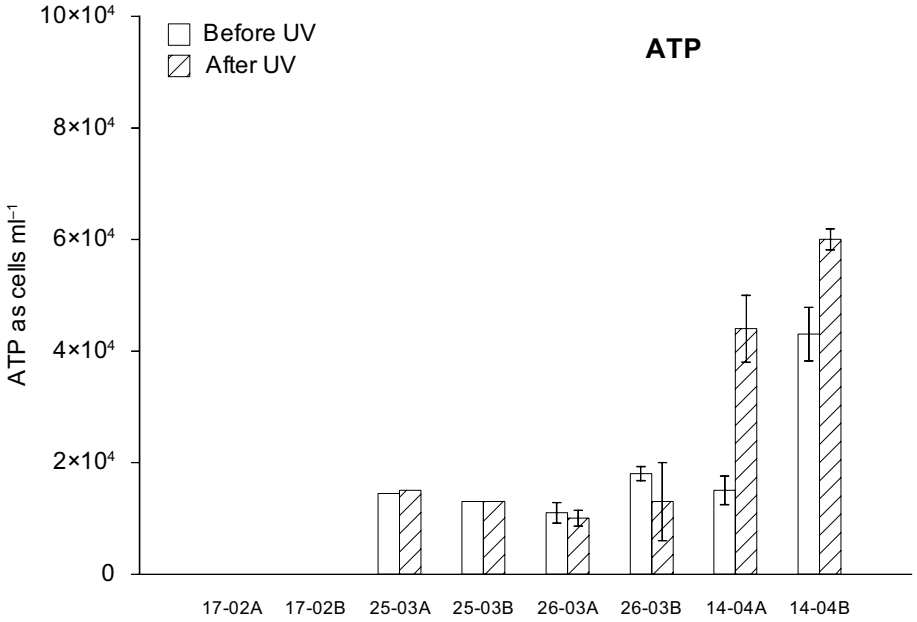

Figure 4-3. *ATP measurements recalculated as cells in drill fluid samples taken during drilling of borehole KFM05, Forsmark. ATP was not measured 2004-02-17.*

5 Conclusions and suggested improvements

Conclusions

- The samples from before and after cleaning, 25 and 26 of March, show that the number of cells in the system is low in general. It is important to maintain the cleaning procedure to keep the cell number low also in the future.
- Continue with the rinsing procedures for the tubing and tanks. Those procedures should be applied before every new drilling campaign. Use chemical disinfectants for disinfection and cleaning.
- Continue with the controls of proper UV-efficiency.
- Make sure that the drilling fluid trace solution is kept free from microorganisms. Do not store this solution for prolonged periods and mix tracer with sterile water in sterile tanks. This can be achieved by treatment with a disinfectant.

6 References

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