

## Natural Plant-derived Hop Acids in Drilling Fluids - Applications for Geothermal Energy Production

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### Introduction

Different microorganisms located in earth crust and soil can disrupt geothermal drilling processes by blocking pipelines due to slime formation or by promoting corrosion of metallic equipment by their metabolites. In addition, microbial activity may lead to polymer destruction and unpleasant smell formation. For prevention, aggressive biocides such as glutaraldehyde or triazine derivatives are used in process fluids [1]. Plant-derived hop acids could be an alternative to these harmful products to human health and environment. Hop acids, which are well-known from beer brewing, have been introduced in sugar industry in 1993 and since then have become the most important product worldwide after formaldehyde in sugar beet industry.



### Efficacy test

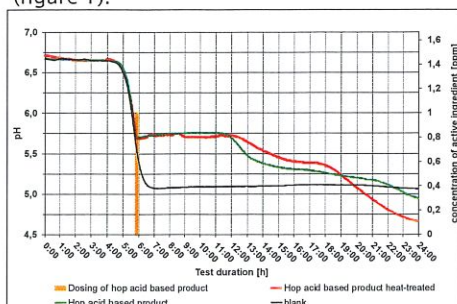
Products containing natural plant-based hop alpha or hop beta acids were tested for their minimum inhibitory concentration (MIC) against important Gram-positive bacteria occurring in drilling fluids such as *Haloanaerobium congolense* (DSM 11287), *Halolactibacillus miurensis* (DSM 17074) and *Halolactibacillus halophilus* (DSM 17073). Efficacy of tested products based on hop alpha or beta acids was comparable or even better than the reference product "Grotan OX" (table 1).

**Table 1:** Summary of MICs of hop alpha and beta acids and Grotan OX (reference product) for *H. congolense* (anaerobic), *H. miurensis* and *H. halophilus* (aerobic) [expressed in ppm active ingredient]

Antimicrobial products	<i>H. congolense</i>	<i>H. miurensis</i>	<i>H. halophilus</i>
Hop beta acids	10 ppm	10 ppm	50 ppm
Hop alpha acids	100 ppm	20 ppm	20 ppm
Grotan OX	20 ppm	100 ppm	50 ppm

### Temperature stability

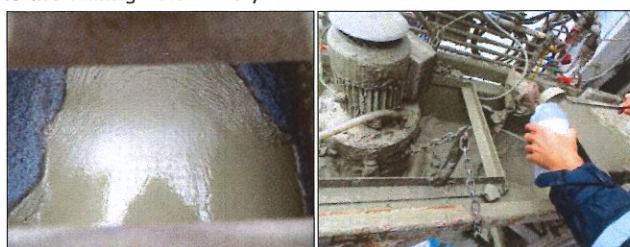
Due to the fact that drilling fluids are used in hot environment tests were carried out to evaluate temperature-stability of the products. Comparison of hop acid based product with and without heat-treatment showed the same antimicrobial activity (figure 1).



**Figure 1:** Microbiological efficacy comparison of hop acid based product with and without heat-treatment (20 min, 121 °C)

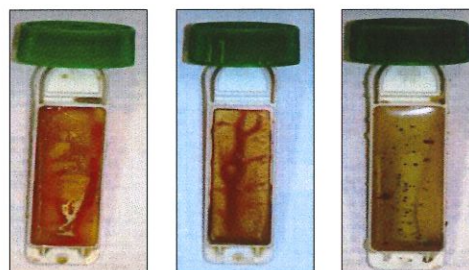
### Application at Drilling Sites

After promising laboratory results the hop products should be tested at a drilling site. After providing the product information to the mining authority, permission was granted and testing could be started. Since then, the product has been used at several drilling sites. The hop acid based products were added to the drilling fluid in very low concentrations.



**Figure 2:** Typical appearance of drilling fluid (left) sampling of the drilling fluid (right)

Upon addition of hop products, microbial contamination of drilling fluid could be reduced significantly. This could be demonstrated by analyzing microbial counts in ARIC's microbiology laboratory and with quick tests used on-site, respectively (figure 3). Additionally, development of unpleasant smell as well as problematic property changes of drilling fluid could be avoided.



**Figure 3:** Quick tests without (left & middle) & with hop acid addition (right)

### Conclusion

Plant-derived products such as hop acids, rosin acids and fatty acids are well-known antimicrobials in the sugar industry. The hop acid based products were tested extensively. Conclusively, they are promising alternatives to conventional chemicals to combat microbial activity in drilling fluids as they are well known from food industry and are non-hazardous to human health or environment. Bacterial contamination in drilling fluids can be reduced significantly, thus ensuring their stability & viscosity.

### Literature

1. M.A. Ashraf, S. Ullah, I. Ahmad, A.K. Qureshi, K.S. Balkhair, M.A. Rehamn, Green biocide, a promising technology: current and future applications to industry and industrial processes. *J Sci Food Agric*, 2014, 94: p. 388-403.
2. [https://www.t-online.de/leben/id\\_77858860/weissbier-weizenbier-tradition-mit-feinporigem-schaum.html](https://www.t-online.de/leben/id_77858860/weissbier-weizenbier-tradition-mit-feinporigem-schaum.html) (web page accessed: 14.01.2019)