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Estimation and Chemical Analysis of the Solid Depositions for Geothermal Water from Well 4777 Madaras - Romania

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ABSTRACT

Geothermal water from well 4777 Mădăras has experienced severe scaling due to utilization. Based on analysis of the chemical composition by the use of simulation computer programs, the temperature of the geothermal reservoir was assessed, and there were estimated scaling problems which could appear during the well utilization. Chemical analysis of solid depositions was also performed. The solid depositions collected from wells were analyzed using the X-Ray diffraction.

1. INTRODUCTION

Geothermal energy has been used for heating, industry, and generation of electricity. In Romania, the geothermal reservoirs are mainly located in the western part. The chemical composition of geothermal waters depends on the mineralogical structure of the geological formations of the reservoir. Due to the pressure drop at the wellhead and temperature changes during utilization, scaling problems can occur. Geothermal water from well 4777 in Mădăras contains dissolved gases and tends to be subject to carbonate deposition. Deposition samples from the geothermal well were collected and analyzed. The mineral deposits of geothermal waters can be estimated with the WATCH simulator. The program can be used to predict the behavior of geothermal fluid under different conditions, as well as the reservoir temperature and lower temperatures that occur in the distribution of geothermal water. WATCH uses the chemical composition of geothermal fluid as input data.

2 .EXPERIMENTAL DATA

Geothermal water from well 4777 Madaras was analyzed by using standard analytical methods. Based on the chemical composition, possible mineral precipitation during production of the studied well was estimated using the WATCH simulator.

The methods of analysis are presented as follows:

- sodium and potassium were determined with a flame-photometric detector to be λ=589 nm and 767 nm, respectively;
- calcium and magnesium were determined using complexometric titration;
- ferrum – spectrophotometric determination at λ=510 nm, using o-phenantroline;
- silica – spectrophotometric determination at λ=410 nm
- chloride was determined using Mohr method;
- sulphate concentration was determined by titration with barium perchlorate; thorin was used as indicator;
- total carbonate was analyzed by titration with HCl solution with metilorange as indicator;
- total dissolved solids – gravimetric analysis.

The results are presented in table 1.

Table 1: Chemical composition of geothermal water from well 4777 in mg/l.

Chemical characteristics	2007	2008
PH	7,6	7,4
Cl^-	72,0	70,9
SO_4^{2-}	13	16,5
HCO_3^-	740,0	834,0
Na^+	241	340,0
K^+	3,8	3,5
Ca^+	6,0	5,8
Mg^2	4,1	2,9
SiO_2	28,8	30,0
Fe^{2+}	0,52	0,40
H_2S	0,11	-
$C0_2$	15	47
Mineralization	1650	1290

2.1 Scaling Prediction and Solid Deposition Analysis

The results of the laboratory analyses have been calculated in the WATCH simulation program at production temperature and at cooling steps of 15º C.

In this way, it is possible to predict the scaling potential. By the use of the program the ionic activity Q corresponding to different minerals in the brine was calculated and compared to the theoretical solubility, K, of the respective minerals. When Q < K, the saturation index is negative, and the solution is undersaturated with respect to the mineral considered.

When Q >K, the solution is supersaturated, and when Q = K the solution is exactly saturated or in equilibrium with the mineral of interest.

Changes in water due to cooling within the system during utilization can by modeled, and subsequent changes in chemistry can be evaluated. This is an important tool for the assessment of scaling problems.

The results obtained by the WATCH program are presented in Tables 2 and 3. Representations of the saturation indices calculated for minerals depending on temperature are shown in the Figures 1 and 2.

Table 2: Values of log Solubility products of minerals in deep water at different temperatures in 2007 for well 4777.

Temp °C	Log.Q/K Anh.	Log. Q/K Calcit	Log. Q/K Calc.	Log. Q/K Goetit	Log .Q/K Magn.
51°C	-3.313	-0.061	0.02	0.517	4.809
40°C	-3.359	-0.122	0.08	0.334	4.251
25°C	-3.474	-0.27	0.26	-0.162	2.742
Temp °C	Log.Q/K Cuarț	Log.Q/K Talc	Log. Q/K Wolls.	Log.Q/K Cris.	Log. Q/K Sil.am.
51°C	0.357	0.05	26.312	-2.58	-0.774
40°C	0.427	-0.35	28.423	-3.16	-0.731
25°C	0.611	-1.37	34.267	-4.67	-0.611

Table 3: Values of log-solubility products of minerals in deep water at different temperatures in 2008 for well 4777.

Temp °C	Log.Q/K Anh.	Log.Q/K Calcit	Log.Q/K Calced.	Log.Q/K Cuarț
50°C	-4.644	-0.232	0.017	0.354
40°C	-4.706	-0.318	0.101	0.446
25°C	-4.822	-0.472	0.280	0.63
Temp °C	Log.Q/K Talc	Log.Q/K Wollas.	Log Q/K Crisotil	Log.Q/K Sil.am.
50°C	-5.479	-1.315	-3.926	-0.768
40°C	-5.756	-1.874	-4.715	-0.712
25°C	-6.31	-2.924	-6.266	0.592

Geothermal water is a surfeit of talc, magnetite, goetit, chalcedony and quartz, but there were a suprasaturation with calcite. Curves for calcite and chalcedony are near equilibrium. Other minerals are represented by dispersed curved lines below saturation.

The solid sample was then analyzed by X-ray diffraction, the results of which are shown in Figure 3.

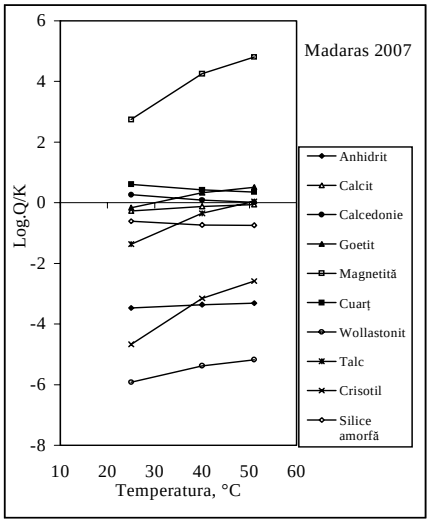

Figure 1: Log.Q/K vs. temperature for selected water in well 4777 (2007).

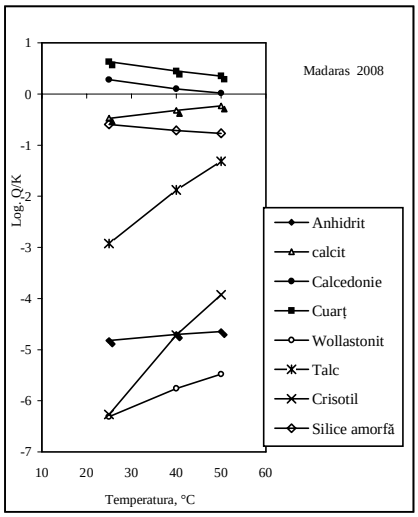

Figure 2: Log.Q/K vs. temperature for selected water in well 4777 (2008).

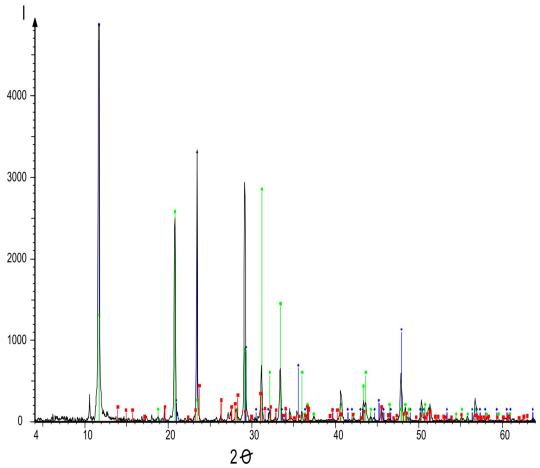

Figure 3: XRD diagram of the solid deposits from well 4777 in Madaras (-00-011-0293(N) - $CaPO_3(OH).2H_2O$-Y:56,25%; -00-021-0816(*)-Ghips – $CaSO_4.2H_2O$-Y:14,58%; -00-034-0148(I) - $Ca_2Fe(PO_4).2H_2O$ -Y:2.08%).

Analysis by X-ray diffraction presented information about the existence of $CaPO_3(OH).2H_2O$ crystals, $Ca_2Fe(PO_4).2H_2O$ crystals and ghips ($CaSO_4$) in solid depositions from Mădăras. This registered the importance of problems of incrustation demonstrated in exploitation by the substitution of the metallic column after each winter.

3. CONCLUSIONS

Major problems have arisen in heating services due to mineral depositions.The potential scaling problems of geothermal utilization depend on water type. Therefore, chemical analysis of geothermal water from a well in Mădăras was performed in order to predict possible scaling. A simulation program was used to estimate the depositions which can be formed at different temperatures reached during geothermal water utilization.

It is better to avoid scales before they occur. In the case of mineral depositions inside the pipes, a mechanical removal is not convenient. Geothermal water with scaling tendency must be chemically treated in order to prevent deposition. Simulation programs exist to estimate deposition that can occur at different temperatures reached during geothermal water utilization.

The scale deposits in the pipeline are more voluminous inside the well towards the surface and at the degassing entry. This could be due to variation of flow, pressure or temperature during exploitation of the well.

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