Buletinul Ştiinţific al Universităţii "Politehnica" din Timisoara, ROMÂNIA
Seria CHIMIE ŞI INGINERIA MEDIULUI
Chem. Bull. "POLITEHNICA" Univ. (Timişoara) *Volume 53(67), 1-2, 2008*

Chemical Modelling Programs for Predicting Scaling of Geothermal Water

M. Sebeşan[*], G. Gavriş[*], R. Sebeşan[**]

[*] University of Oradea, Faculty of Sciences, Department of Chemistry, Oradea, Universitatii 1, Romania
Phone: (040)0259-408 640, E-Mail: msebesan@uoradea.ro, ggavris@uoradea.ro

[**] University of Oradea, Faculty of Electrical Engineering and Information Technology,Street Universităţii, Nr.1, 410087, Oradea
Phone: (040)0259-408438, E-Mail: rsebesan@uoradea.ro

Abstract: This paper presents the analysis made in order to get the chemical composition of geothermal waters from well 4777 Mădăras and well 4699 Cighid. The aim of this work was to establish the chemical data of the water for geothermal well from Mădăras in the period 2005-2006 and for geothermal well from Cighid in 2007. Based on the chemical composition by the use of Watch simulation pogram, they were estimated the minerals which can precipitate during production of the studied wells.

Keywords: watch simulation program, geothermal drillings, chemical composition, geothermal waters

1. Introduction

The geothermal drillings studied was: well 4699 Cighid and well 4777 Mădăras.The geothermal energy has been used for heating, for industry, and for generation of electricity. Geothermal water from wells, 4699 Cighid and 4777 Mădăras contents dissolved gases and presents a tendency to form carbonates deposition. In our country these geothermal reservoirs are located in the western part. 4699 geothermal well is situated in the yard of the hospital for children with severe handicap from CIGHID, located at about 3,5 km south-west from GHIORAC town and 4 km far from CIUMEGHIU village.Starting 1998 geothermal energy from Cighid was used to heat up water and for heating the hospital. A part of the water has balnear use in a small, open swimmng pool.
Geothermal water from 4669 well content dissolved gases and presents a tendency to form carbonates deposition.Well 4777 from Mădăras is situated in the northern part of village, near swimming place. Water extracted is drived in thermal swimming place.

The chemical composition of geothermal waters depend on the mineralogical structure of the geological formations of the reservoir. Due to the pressure drop at the wellhead and due to temperature changes during utilization there could appear scaling problems.

2. Experimental data

Geothermal waters from the studied geothermal wells were analysed by using standard analytical methods. Based on the chemical composition by the use of Watch simulation pogram, they were estimated the minerals which can precipitate during production of the studied well.

The methods of analysis are presented as follows:
- sodium and potassium were flamephotometric determined at λ=589 nm, respectively 767 nm;
- calcium and magnesium – complexonometric titration;
- ferrum – spectrophotometric determination at λ=510 nm, using o-phenantroline;
- silica – spectrophotometric determination at λ=410 nm
- chloride was determined by using Mohr method;
- sulphate concentration was determined by titration with barium perchlorate; thorin was used as indicator;
- total carbonate was analysed by titration with HCl solution with metilorange as indicator;
- total dissolved solids – gravimetric analysis.

The results are presented in tables 1-3.

TABLE 1. Characteristics of geothermal water from Cighid, well 4 699 in mg/L, in 2007

Depth [m]	1500-2000	Anions [mg/L]		Cations [mg/L]	
pH	6.5	Cl^-	154.2	Na^+	1042.0
Mineralization	4264.6	SO_4^{2-}	18	K^+	53.2
		HCO_3^-	2641.0	Ca^{2+}	15.41
Total dissolved solids	1036.0			Mg^{2+}	6.33
Dissolved gases [mg/L]		O_2	2.90	SiO_2	36
		CO_2	2100	Phe-nols	0.032

TABLE 2. Characteristics of geothermal water from Mădăras, well 4777 in mg/L, in 2005

Depth [m]	1400-1500	Anions [mg/L]		Cations [mg/L]	
pH	7.2	Cl^-	58.2	Na^+	339.0
Mineralization	1320.0	SO_4^{2-}	9.42	K^+	5.0
		HCO_3^-	844.2	Ca^{2+}	5.4
Total dissolved solids	849.0			Mg^{2+}	3.5
Dissolved gases [mg/L]		O_2		SiO_2	32.1
		CO_2	80	Phenols	0.002

TABLE 3. Characteristics of geothermal water from Mădăras, well 4777 in mg/L, in 2006.

Depthl [m]	1400-1500	Anions [mg/L]		Cations [mg/L]	
pH	8.0	Cl^-	78.0	Na^+	355
Mineralization	1410.0	SO_4^{2-}	11.8	K^+	3.80
		HCO_3^-	830.4	Ca^{2+}	5.9
Total dissolved solids	910.5			Mg^{2+}	4.6
				Fe^{2+}	0.687
Dissolved gases [mg/L]		O_2		SiO^{2+}	66.5
		CO_2	25	NH_4^+	3.22

3. Results and discussion

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

In this way it is possible to predict the scaling potential. By the use of the program it was calculated the ionic activity Q corresponding to different minerals in the brine and it was compared with 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 in respect.

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

The results obtained by the Watch program are presented in table 4-6 and figures 1-3.

TABLE 4. Values of log. solubility products of minerals in deep water at different temperatures in 2005 for 4777 well

Log Q/K	Temperature. °C		
	52°C	40°C	25°C
Anhydrite	-4.799	-4.887	-5.003
Calcite	-0.408	-0.531	-0.687
Chalcedony	0.014	0.132	0.310
Goetit	-0.437	-0.792	-1.303
Magnetite	2.138	1.053	-0.505
Quartz	0.348	0.477	0.66
Wollastonite	-5.762	-6.154	-6.712
Talc	-1.902	-2.699	-3.762
Chrysotile	-4.488	-5.601	-7.164
Amorph. silica	-0.759	0.681	-0.562

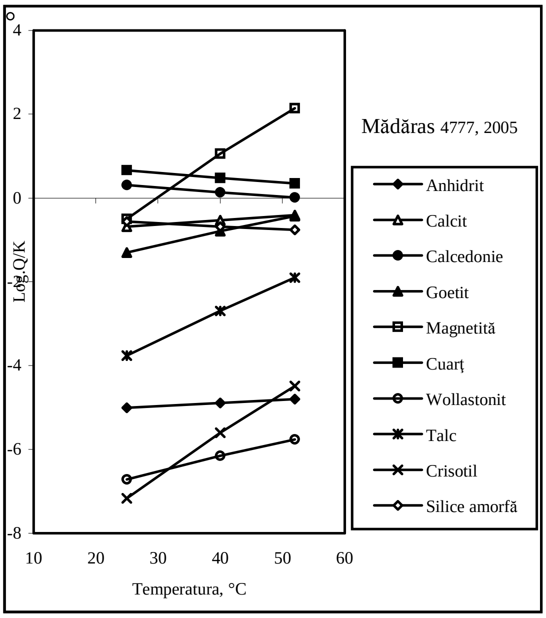

Figure 1. Log.Q/K vs temperature for selected water from well 4777 Mădăras in 2005

TABLE 5. Values of log. solubility products of minerals in deep water at different temperatures in 2006 for 4777 wel

Log Q/K	Temperature, °C		
	50°C	40°C	25°C
Anhydrite	-4.25	-4.592	-4.703
Calcite	0.614	0.239	0.126
Chalcedony	-0.005	0.44	0.62
Quartz	0.281	0.785	0.97
Wollastonite	-3.082	-4.304	-4.778
Talc	5.843	3.421	2.604
Chrysotile	3.452	-0.097	-1.42
Amorph. silica	-0.673	-0.373	-0.252

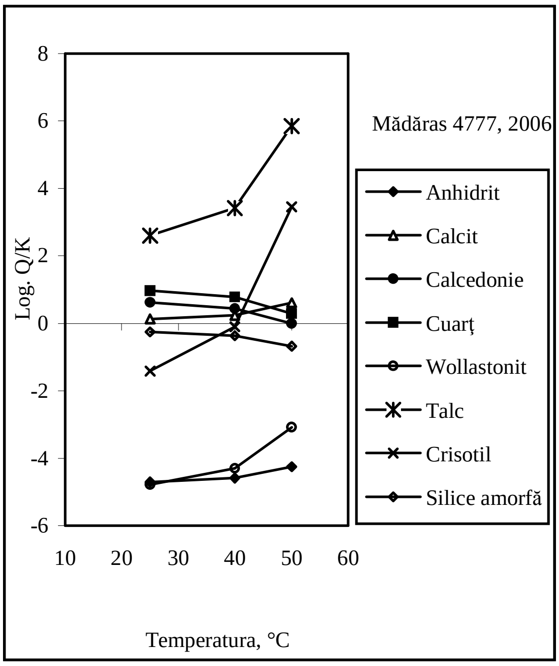

Figure 2. Log.Q/K vs temperature for selected water from well 4777 Mădăras in 2006

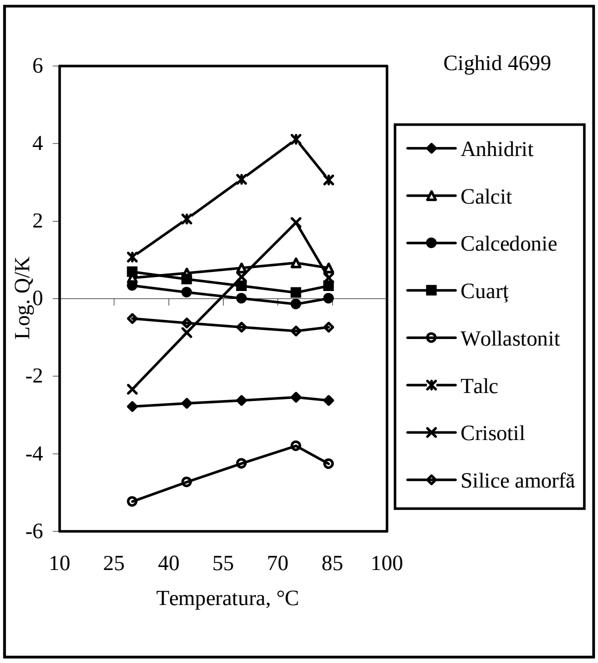

Figure 3.Log.Q/K vs temperature for selected water from well 4669 from CIGHID

TABLE 6. Values of log. solubility products of minerals in deepwater at different temperatures in 2007, for 4699 well

Log Q/K	Temperature, °C				
	84°C	75°C	60°C	45°C	30°C
Anhydrite	2.622	2.544	-2.621	-2.701	2.783
Calcite	0.789	0.928	0.791	0.660	0.540
Chalcedony	0.008	-0.043	0.006	0.166	0.340
Quartz	0.331	0.157	0.328	0.506	0.690
Wollastonite	-4.258	-3.794	-4.250	-4.729	-5.231
Talc	3.059	4.112	3.076	2.058	1.075
Chrysotile	-0.734	1.964	0.563	-0.872	-2.334
Amorph. silica	-0.734	-0.837	-0.736	-0.629	-0.512

The saturation indexes were calculated for the following minerals: calcite, chalcedony, quartz talc chrysotile amorphus silica.

4. Conclusions

Major problems have arisen in heating services due to mineral depositions.

The potential scaling problems of a geothermal utilization depend on the type of water.

Therefore chemical analysis of geothermal water from wells from Cighid and Mădăras were made 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 case of mineral depositions inside the pipes a mechanical removal is not convenient. Geothermal waters with a scaling tendency must be treated by chemical method in order to prevent the deposits. It is recommended to inject chemical inhibitors into the well.

REFERENCES

1 . Arnorsson, S., *J.Volc.Geotherm.Res*., **1985,** Vol. 2.3, pp. 145.

2. Giggenbach W.F., *Geochim.Cosmochim.Acta*, **1988,** Vol. 52, pp. 2749.

3. Keenan, J.H., et.al., Steam Tables-Thermodynamic properties of water including vapor, liquid and solid phases, International Edition-metric units, Wiley, New York, **1969**.

4. Mackenzie, W.S., Guilford, C., Atlas of rock-forming minerals in thin section, Longman U.K., **1982**.
5. Sebeşan M., Stănăşel, O., Sebeşan, R., Proceedings of the World Geothermal Congress, Atalya-Turkey, **2005**, pp. 2040.
6. Arnorsson S., Stefansson A., Proceedings of the World Geothermal Congress, Atalya-Turkey, 2005, pp. 870.
7. Stănăşel O, Sebeşan M., Bota M., Gilău L., Iovi A., *Analele Universităţii din Oradea, Fascicola Chimie XI*, Oradea, **2004,** pp. 46.
8. Keenan J.H., etal., Steam Tables-Thermodynamic properties of water including vapor, liquid and solid phases, International Edition – metric units, Wiley, New York, **1969.**
9. Hauksdottir S., Tulinius, H., Kristjansson, B.R., Proceedings of the World Geothermal Congress, Atalya-Turkey, **2005**, pp. 1718.
10. Stănăşel O., Monitorizarea chimică a sondelor geotermale de producţie, Ed.Univ. din Oradea, Oradea, **2003**.