PREDICTING MINERAL DEPOSITS THAT IS FORMED IN INSTALLATIONS WITH GEOTHERMAL FLUIDS BY PHYSICO-CHEMICAL STUDY

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Abstract - In this paper we study the relationship between **the chemical composition, the temperature and the types of mineral deposits which can appear when geothermal waters are used for heating.**
Are presents the physico-chemical data of the water, produced by 1704 well from Sacuieni, in 2011 and 2012. With Watch simulation pogram, that use the chemical composition, we estimated the minerals which can precipitate during production of the studied well.

Keywords: geothermal water, Watch program, mineral deposits, chemical composition

1. INTRODUCTION

Well 1704 from Sacuieni is situated in Bihor county, at about 80 km from Oradea. Energy of geothermal water is energy available as heat emitted from within the earth and is energy recoverable. The geothermal energy has been used for heating, for industry, and for generation of electricity. The geothermal industry worldwide grew rapidly in the later half of the last century. In our country the geothermal reservoirs are mainly located in the western part. The aim of this work was to establish the physico- chemical data [1], of the water produced by 1704 geothermal well from Sacuieni, in the period 2011-2012.
\Geothermal water's chemical composition depends 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.
By means of chemical composition, Watch simulation program estimates the minerals which are precipitated by cooling.
Interpretation of geothermal water compositions using a special program [2], we allows evaluation of how changes in the temperature of geothermal waters affect mineral saturation and appearance of crusts.

2. EXPERIMENTAL DATA

Geothermal water resulting from the studied well were analysed.

The analysis were made using analytical methods, that indicated the major anions and cations contained in the geothermal fluid.
Chemical composition of water is processed with a simulation program that displays logarithms saturation indices for minerals [3], which can form in geothermal water by cooling.
The analytical methods used are as follows::
- we determine cations the sodium and potassium flamephotometric, [4];
- ferrum is determined spectrophotometric [5];
- calcium is determined complexonometric titration;
- magnesium is determined complexonometric titration;
- silica – spectrophotometric determination [6];
- sulphate anion was determined by titration used as indicator;
- chloride anion is determined by means of Mohr method;
- total carbonate is determined by titration;
- total dissolved solids is determined gravimetric.

In tables 1-4 are presented the results.

Table 1. Physico-chemical characteristics of geothermal water from Sacuieni, in march 2011, in mg/l

pH	8,5	Anions [mg/l]		Cations [mg/l]	
Mineraliz -ation	4451	Cl^-	474	Na^+	1018
		SO_4^{2-}	14	K^+	160
		HCO_3	2506	Ca^{2+}	20,2
Total dissolved solids		2220		Mg^{2+}	13,3
Dissolved gases [mg/l]		O_2		SiO_2	54
		CO_2	1890	Phenol	11

Table 2. Physico-chemical characteristics of geothermal water from Sacuieni, in november 2011, in mg/l.

pH	8,0	Anions [mg/l]		Cations [mg/l]	
Mineraliz -ation	4390	Cl^-	460	Na^+	1202
		SO_4^{2-}	16	K^+	148
		HCO_3	2930	Ca^{2+}	10,2
Total dissolved solids		2170		Mg^{2+}	12
Dissolved gases [mg/l]		O_2	1,7	SiO_2	49
		CO_2	2200	Phenol	9,2

Table 3. Physico-chemical characteristics of geothermal water from Sacuieni, in april 2012, in mg/l

pH	8,3	Anions [mg/l]		Cations [mg/l]	
Mineraliz -ation	4420	Cl^-	506	Na^+	1030
		SO_4^{2-}	17	K^+	155
		HCO_3	2460	Ca^{2+}	19
Total dissolved solids		3180		Mg^{2+}	13,6
Dissolved gases [mg/l]		O_2	3,10	SiO_2	55
		CO_2	1980	Phenol	10,4

Table 4. Physico-chemical characteristics of geothermal water from Sacuieni, in otober 2012, in mg/l.

pH	**8,0**	**Anions [mg/l]**		**Cations [mg/l]**	
Mineraliz -ation	5040	Cl^-	618	Na^+	1130
		SO_4^{2-}	22	K^+	155
		HCO_3	2340	Ca^{2+}	14,2
Total dissolved solids		2910		Mg^{2+}	3,6
Dissolved gases [mg/l]		O_2		SiO_2	56
		CO_2	1880	Phenol	10,1

3. RESULTS AND DISCUSSIONS

Laboratory test findings were calculated [7.8] with the simulation program at output temperature and at cooling, in steps of 20 ° C.

Watch a simulation program calculates ionic activities, Q for different minerals in geothermal water [9].

The Q-values were compared with the theoretical solubility, K, for these minerals.

If the saturation index is negative, when Q <K, the solution is unsaturated or mineral.

If Q> K, the saturation index is pozitiv, the solution is supersaturated with mineral and whether Q = K solution is saturated or in equilibrium with mineral analysed.

Cooling the system, ie geothermal fluid during operation or use can be modeled in this way. We can estimated with Watch program, scaling problems., [11,12].

In tables 5-8 and in figures 1-4 we are presented the results obtained:

Table 5. The values of saturation indices of minerals may be separated by cooling the geothermal water in the 1704 well at different temperatures in Sacuieni, march-2011.

Temp. °C	Log.Q/K (Anhyd.)	Log.Q/K (Calcite)	Log.Q/K (Chalc.)	Log.Q/K (Quartz)
87°C	-3,641	1,953	- 0,342	-0,027
60°C	-2,629	1,174	- 0,390	0,690
40°C	-3,359	1,122	0,182	0,427
25°C	-3,411	1,062	0,867	1,171
87°C	11,593	-1,29	5,775	-1,084
60°C	9,802	-2,124	4,016	-0,904
40°C	5,353	-3,423	3,156	-0,731
25°C	3,452	-4,808	-1,428	-0,119

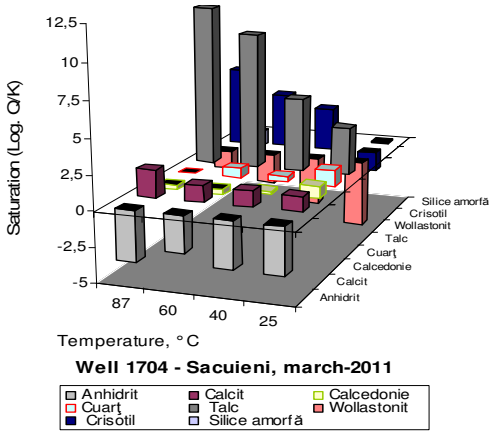

Fig. 1. Log.Q/K vs temperature for selected water from well 1704 - Sacuieni, march-2011

The saturation indexes were calculated for the following minerals: calcite, quartz, talc, chrysotile and wollastonite. Geothermal water that coming from well 1704 of Sacuieni in march 2011, shows a saturation with talc and chrysotile, and supersaturation with calcite occurs at low temperatures. The remaining minerals are located below the saturation.

TABLE 6. The values of saturation indices of minerals may be separated by cooling the geothermal water in the 1704 well at different temperatures in Sacuieni, november-2011.

Temp. °C	Log.Q/K (Anhyd.)	Log.Q/K (Calcite)	Log.Q/K (Chalc.)	Log.Q/K (Quartz)
87°C	-4,014	-0,232	0,017	0,354
60°C	-3,851	0,357	0,351	0,651
40°C	-3,706	-0,318	0,101	0,446
25°C	-2,322	-0,472	0,280	0,63
Temp. °C	Log.Q/K (Talc)	Log.Q/K (Wollast.)	Log.Q/K (Chrysot.)	Log.Q/K (Amorph. Silica.)
87°C	5,315	-1,479	3,926	-0,768
60°C	4,44	- 2,088	2,049	-0,343
40°C	3,874	-3,756	1,715	-0,712
25°C	2,924	-4,31	0,266	0,592

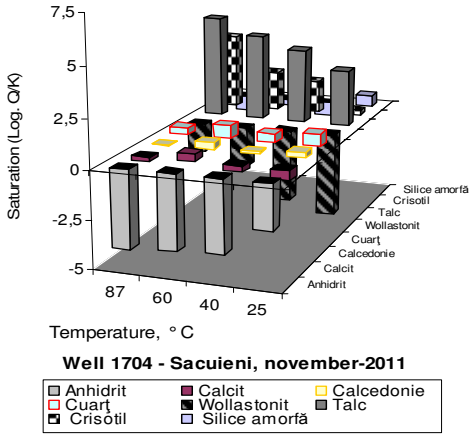

Fig. 2. Log.Q/K vs temperature for selected water from well 1704 - Sacuieni, november-2011

In november 2011 the largest supersaturation is with talc and chrysotile, these shows a saturation and at temperatures above 20 ° C.
Calcite saturation index is > 1 at any temperature, showing a saturation above the equilibrium line which means that we have calcite deposition.

TABLE 7. The values of saturation indices of minerals may be separated by cooling the geothermal water in the 1704 well at different temperatures in Sacuieni, april – 2012.

Temp. °C	Log.Q/K (Anhyd.)	Log.Q/K (Calcite)	Log.Q/K (Chalc.)	Log.Q/K (Quartz)
88°C	-3,799	-0,408	0,014	0,348
60°C	-2,482	0,568	0,37	0,67
40°C	-1,887	-0,531	0,132	0,477
25°C	0,003	-0,687	0,310	0,66
Temp. °C	Log.Q/K (Talc)	Log.Q/K (Wollast.)	Log.Q/K (Chrysot.)	Log.Q/K (Amorph. Silica.)
88°C	1,902	-2,762	4,488	-0,759
60°C	2,877	-2,202	4,122	-0,324
40°C	2,990	-1,154	3,601	0,681
25°C	3,762	-0,712	2,164	0,862

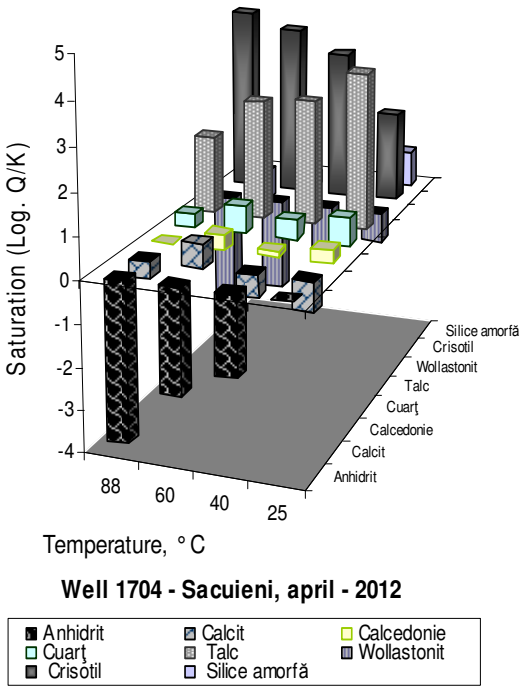

Fig 3. Log.Q/K vs temperature for selected water from well 1704 - Sacuieni, april – 2012

In April 2012 geothermal water, coming from the well 1704 from Săcuieni is supersaturated with talc, quartz and chrysotile but there are a small supersaturation with calcite only at 60 ° C.

TABLE 8. The values of saturation indices of minerals may be separated by cooling the geothermal water in the 1704 well at different temperatures in Sacuieni, in october – 2012.

Temp. °C	Log.Q/K (Anhyd.)	Log.Q/K (Calcite)	Log.Q/K (Chalc.)	Log.Q/K (Quartz)
86	-3,336	0,898	0,012	0,034
60	-3,503	0,847	-0,039	0,319
40	-3,618	0,750	0,178	0,546
25	-3,838	0,654	0,358	0,711
Temp. °C	Log.Q/K (Talc)	Log.Q/K (Wollast.)	Log.Q/K (Chrysot.)	Log.Q/K (Amorph. Silica.)
86	4,189	-4,008	0,663	-0,747
60	3,509	-4,112	1,085	-0,781
40	2,189	-4,673	-0,805	-0,635
25	2,022	-4,989	-1,278	-0,514

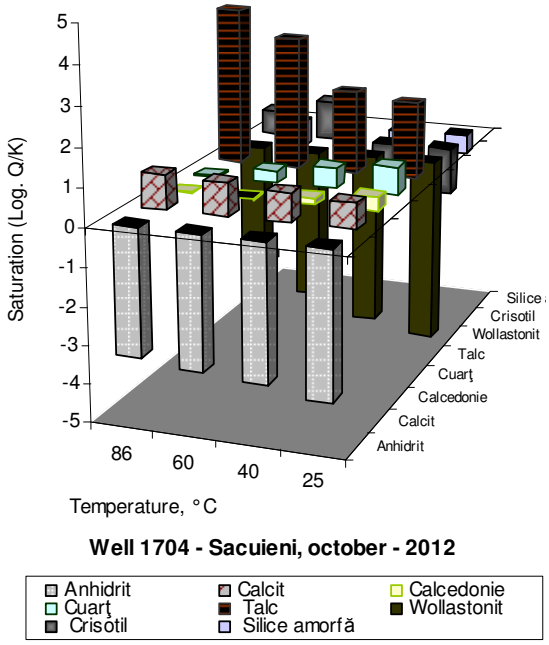

Fig. 4. Log.Q/K vs temperature for selected water from well 1704 - Sacuieni, october - 2012

In October values of calcite saturation index is positive, but < 1, which means that small deposits of calcite were quantitatively.

4. CONCLUSIONS

The problem, that can to appear at the use of geothermal waters is mineral deposits that can form inside the well and installations that leads to a decrease in production

efficiency. Without control of deposits these would lead to the necessity of closing the probe for cleaning pipes and equipment. Eliminated or reduced different constituents of deposits, would be the most effective method.

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.

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