SOFTENERS GEOTHERMAL WORN-OUT THERMIC WATER USING CATIONIC RESINS AMBERLITE IR 120Na, WITH THE OBJECTIVE PROTECTION AND IMPROVEMENT OF THE ENVIRONMENT

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Abstract
In this paper there has been used, for the first time, the method of ion exchange for the treatment of geothermal worn-out thermic waters in order to diminish the risks for the environment and the possibility to use it for domestic purposes or for irrigations, etc. In order to accomplish this aim, a ion exchange equipment has been used, W9, the cation resin Amberlite IRA 120 Na, manufactured by the company ROHM&HAAS. The geothermal worn-out thermic water comes from the Derrick 4795 Calea Aradului (Nursery).
The results obtained demonstrated that the process of water softening decreased from the value of 36 to 10 German degrees

Key.words*:* water geothermal, Amberlite IR 120Na, ion exchange resin, softener.

INTRODUCTION

The adoption of some treatment technologies for the geothermal water having as a main purpose the environment protection, is a method of diminishing the emissaries impurity as a result of worn-out water evacuation (Roman, M., Mirel, I, 2009).

This paper has as its main purpose the monitoring of the softening of the geothermal water with the help of ion exchange resins. The research has been done on the geothermal water which resulted from its use to get thermic energy.

The modern technologies of water treatment by using ion exchange resins in the processes of water softening and their usefulness has determined the choice of this method for geothermal water treatment. The elaboration of some water softening methods for thermal waters which are thermic worn-out and of water demineralization involves a very good knowledge of the types of ion exchange resins and of their properties. The choice of a resin in a practical application has to take into consideration the speed and the mechanism of the ion exchange process. For the geothermal waters it is necessary to consider the maximum operational temperature for these ion exchange resins (Wachinski, A.M., Etzel, J.E., 1997).

MATERIALS AND METHODS

The used resin was Amberlite IR 120Na (cation resin strongly acid) manufactured by the ROHM&HAAS company (Rohm and Haas, 1994).

There has been used an apparatus manufactured by the company ARMFIELD from Great Britain, W 9 (Fig. 1).

Fig.1 W9

The working diagram for this procedure of monitoring the geothermal water through the cation resin is presented in Fig. 2. The process of geothermal water softening by downwards passing on the column which contains cationic resin Amberlite IR 120Na.

Tank C is selected, valves 2 and 10 are opened. The flowmeter is set at a flow between 50 and 70 ml/min. Samples are collected from 5 to 5 minutes. The hardness of each sample is determined. The water softening is continued until the hardness of the effluent increases more than 100 mg/l $CaCO_3$.

In order to maintain the temperature of geothermal water around 32 – 35 ^{0}C I gradually added geothermal water in tank C.

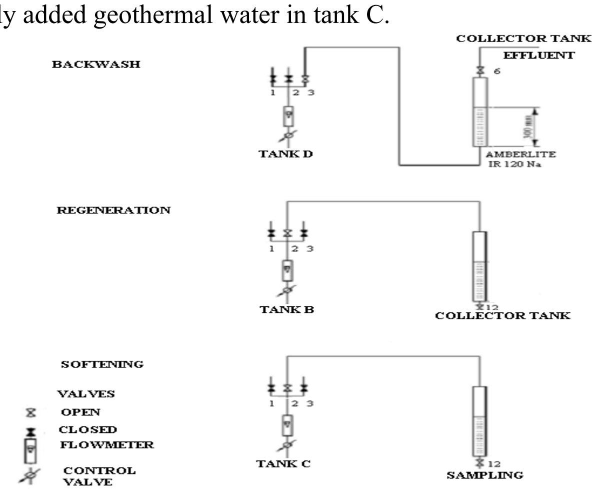

Figure 2 . The process of geothermal water softening by downwards passing only through the cation exchanger Amberlite IR 120Na.

Determination of water hardness

I measured the volumetric quantity of Ca^{2+} and Mg^{2+} for all the samples, which are necessary to measure the exchange ability of the cation resin (Liteanu, C, 1985).

At the begining of the research, we determined the concentration of the Ca and Mg ions , at 30 and 60 minutes, with the help of the apparatus SPECTROQUANT Nova 60A.

The total hardness was determined with the tester Duroval which is manufactured by the company Schliessmann Schwäbisch Hall from 5 to 5 minutes .

RESULTS AND DISCUSSIONS

The physical-chemical characteristics of the resin and the working diagram used in this research are presented in Table 1 and 2.

Table 1.

The physical-chemical characteristics

PROPERTIES	**AMBERLITE IR 120Na**
Matrix	Styrene divinylbenzene copolymer
Functional Groups	Sulfonic Acid
Physical Form	Amber beads
Ionic Form, as shipped	Sodium
Total Exchange Capacity	≥2 echivalenți/l (forma Na^+)
Moisture Holding Capacity	45-50%
Shipping Weight	840 g/l

Tabel 2.

Suggested operating conditions

	AMBERLITE IR 120Na
pH range	0÷14
Maximum Operating Temperature	121 ^{0}C
Grosimea stratului, min	600mm
Regenerants	NaCl
Level - Concentration - Flow Rate - Minimum Contact Time	50 – 240 g/l 10% 0,5÷1 30 minute
Slow rinse	2 BV at regeneration flow rate

*1 BV(Bed Volume) = 1m^3 solution per m^3 resin

The processes which take place at the crossing of geothermal worn-out thermic water through the ion exchange column which contains mixt resin are presented in Fig. 3 (Helfferich, F.G, 1995).

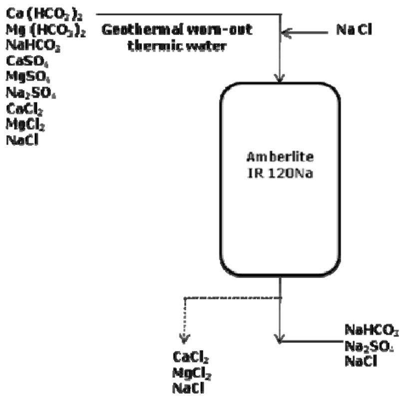

Fig. 3. The diagram of the water softening with Amberlite IR 120Na resin

The equation 1.1 has been used in order to determine the exchange ability of Amberlite IR 120Na resin.

$$\text{Exchange capacity} = \frac{\text{mass } CaCO_3}{\text{The volume of the resin bed}} \qquad (1.1)$$

$$\text{The volume of the wet resin bed} = \frac{\pi \times (16 \times 10^{-3})^2}{4} \times h_{column}$$
$$= 200{,}96 \times 10^{-6} \times 0{,}20\ m^3 = 56\ ml \qquad (1.2)$$

The results obtained at this procedure of water treatment are presented in Table 3.

Table 3

Cationic resin Amberlite IR 120Na

Timing (minutes)	Conductivity (mS/cm)	Softeners (^{0}German)	Mass of $CaCO_3$ (mg)	Exchange capacity (meq)	Volume of treated water (ml)	Ca^{2+} (mg)	Mg^{2+} (mg)
0	1160.0	36	648	11.57	0	196	31.4
5	714.0	32	576	10.28	300	178.5	28.3
10	528	28	504	9.00	600	150.2	24.6
15	246	25	450	8.04	900	141.2	20.9
20	87.3	21	378	6.75	1200	116.5	19.6
25	64.5	18	324	5.78	1500	103.4	17.1
30	31.2	15	270	4.82	1800	83.2	14.5
35	23.6	13	234	4.18	2100	71.3	10.9
40	15.0	12	216	3.86	2400	69.0	10.5
45	1.926	11	198	3.53	2700	60.9	8.9
50	1.831	10	180	3.21	3000	58.1	8.3
55	156.0	13	234	4.18	3300	73.5	10.6
60	325.0	14	252	4.50	3600	80.1	12.3

Fig. 4 represents the variation in time of the hardness of the geothermal worn-out thermic water treated with mixt Amberlite IR 120Na resin. There has been noticed that the resin is exhausted after 50 minutes.

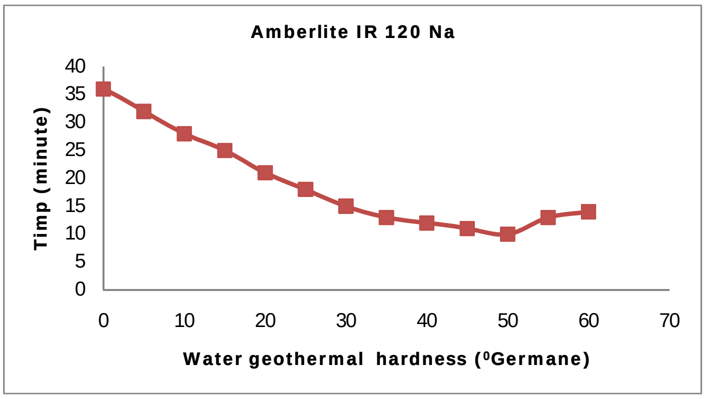

Fig. 4. The variation in time of the hardness of the geothermal water treated with mixt Amberlite IR 120Na resin

Fig. 5 and 6 presents the dependence of the concentration Ca and Mg ions for the geothermal worn-out thermic water which can be treated with mixt resin .

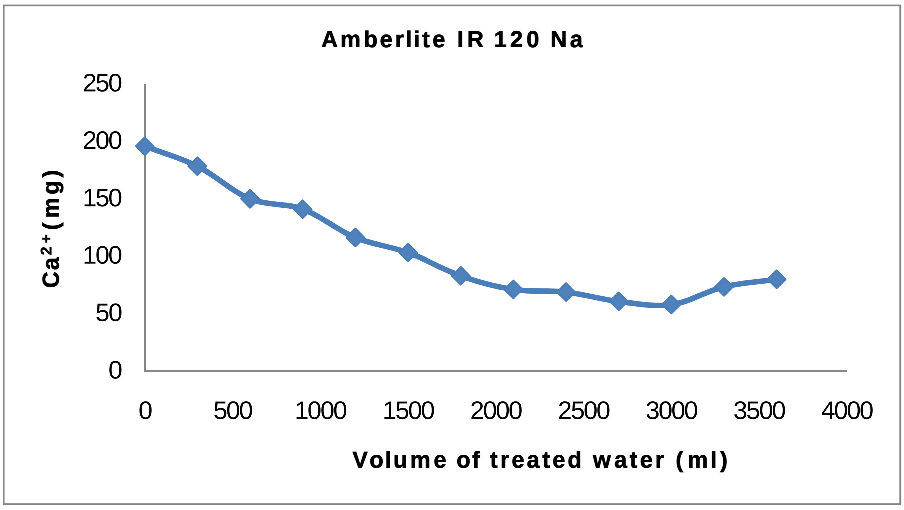

Fig. 5. The dependence of the concentration Ca^{2+} for the quantity geothermal worn-out water which can be treated with cationic resin Amberlite IR 120Na

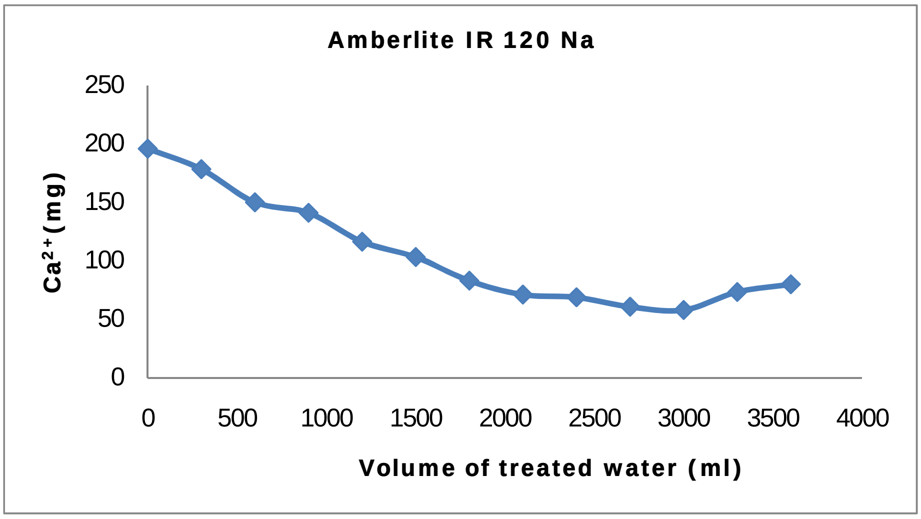

Fig. 6. The dependence of the concentration Mg^{2+} for the quantity geothermal worn-out water which can be treated with cationic resin Amberlite IR 120Na

Similar studies have been used with the help of a cation resin Amberlite IR 120Na. Compared to the treatment of water using the cation resin Amberlite IR 120Na, the mixt resin is exhausted more difficult and, in this way, it can treat a bigger quantity of geothermal worn-out thermic water.

The experimental researches proved that the hardness of the geothermal worn-out thermic water decreases from the initial value of 36 German degrees to 10 German degrees , using the plant W9 with ion exchangers and the mixt resin cationic Amberlite IR 120Na.

The total exchange capacity determined from the experimental results obtained at the treatment of the geothermal worn-out thermic water doesn't correspond with the technical paper of the resins. So that the Amberlite IR 120Na resin has the total exchange ability of 3,21 compared to 2 gram/l equivalents for the geothermal worn-out thermic water .

CONCLUSIONS

The analyse of the experimental results obtained at the treatment of the geothermal worn-out thermic water through the method of ion exchangers emphasises the fact that the hardness of the geothermal water decreased, its value being lower than that admitted for the domestic hot waters .

The theme of this paper is one of large practical and present interest, dealing with a very important issue, i.e. the softening of geothermal worn-out thermic waters with the help of ion exchange resins.

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