THE DETERMINATION OF SOME PHYSICAL-CHEMICAL PARAMETERS TO PLANT WATER EVACUATED BY ENERGY CONVERTERS IN THE JIU RIVER

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Abstract. The present study consisted in monitoring the Turceni and Rovinari Energy Complexes, consisting of thermal energy blocks with very high installed capacity - 330 MW, which operate on lignite fuel. These blocks are located on the bank of the Jiu River, near the coal mines. Due to this technological process that pollutes the water, we monitored some of the physico-chemical parameters of the captured and discharged water, establishing that temperature is the most affected factor with implications on the ecosystems of the Jiu River. The evolution of the temperature in the operating system - open circuit - affects the Jiu waters at the maximum allowable limit. The monitoring of the physico-chemical parameters, especially of the temperature, determines the diminution of the thermal effects on the waters of the Jiu river, respectively the maintenance of an unpolluted fauna and flora. The electric energy produced by the thermoenergetical blocks is 65%. A feature of these energy complexes is the use of the Jiu River for both water capture and discharge. If the energy groups worked at full capacity, the technological waters discharged into the Jiu River would be heavily polluted, affecting flora and fauna.

Keywords: Turceni and Rovinari Energy Complexes, environmental protection, energy blocks, water quality.

Rezumat. Determinarea unor parametrii fizico-chimici la apa uzinală evacuată de convertorii energetici în râul Jiu. Studiul de faţă a constat în monitorizarea Complexelor Energetice Turceni şi Rovinari, formate din blocuri termoenergetice cu putere instalată foarte mare - 330 MW, care funcţionează pe bază de combustibil tip lignit. Aceste blocuri sunt amplasate pe malul râului Jiu, în apropierea exploatărilor carbonifere. Datorită acestui proces tehnologic care poluează apa, am monitorizat o parte din parametrii fizico-chimici ai apei captate şi evacuate, stabilind că temperatura este cel mai afectat factor cu implicaţii asupra ecosistemelor râului Jiu. Evoluţia temperaturii în sistem de funcţionare – circuit deschis – afectează apele Jiului la limita maximă admisibilă. Monitorizarea parametrilor fizico-chimici, cu precădere a temperaturii, determină diminuarea efectelor termice asupra apelor râului Jiu, respectiv menţinerea unei faune şi flore nepoluate. Energia electrică realizată de blocurile termoenergetice este de 65%. O caracteristică a acestor complexe energetice este folosirea râului Jiu atât pentru captarea cât şi pentru deversarea apei. În cazul în care grupurile energetice ar lucra la întreaga capacitate, apele tehnologice deversate în râul Jiu ar fi puternic impurificate, afectând flora şi fauna.

Cuvinte cheie: Complexe Energetice Turceni şi Rovinari, protecţia mediului, blocuri energetice, calitatea apei.

INTRODUCTION

Industrial development and the phenomenon of globalization are forcing the European Union to immediately reconsider its energy, production and transport necessities. The production of energy in its two main forms, electric and thermal, takes place in the thermoelectric blocks on coal. Currently, the production of electricity is 65% in thermoelectric blocks.

The study, conducted during 2020, consisted of monitoring the Turceni and Rovinari Energy Complexes, which operate on coal-lignite fuels. The monitored physico-chemical parameters largely define the quality of industrial water and therefore it is necessary to continuously monitor them, both in the supply channels and in the discharge channels. The undesirable effect of the operation of thermoelectric blocks on coal is the appearance of medium pollution vectors, namely: water discharged by thermoelectric blocks on coal; flue gases in coal-fired thermoelectric blocks; water transport; ash from thermoelectric blocks. The focus in this paper will be on the study of the water vector. These blocks have some common characteristics: they are located near coal mines, on the middle course of the Jiu River and pollute a common region, defined both by geographical elements and by specific elements of activity (BRÎNDUȘA & KOVACS, 2007; GAVRILESCU & GAVRILESCU, 2009; MARINESCU & MITITELU-IONUȘ, 2019; MITITELU-IONUȘ et al., 2021).

MATERIAL AND METHOD

The Turceni and Rovinari Energy Complexes have four major common characteristics: high installed power of the order of 1000 MW; they are located in the river basin of the Jiu River; they have as raw material a lower coal for lignite extracted from the mining basin of the Oltenia National Lignite Society; they pollute the Oltenia region, being defined both by common geographical elements and by very close specific elements of activity (technological production processes and socio-economic services) (Fig. 1).

The industrial waters that supply the thermoenergetical blocks usually are surface waters whose temperature varies depending on the season and the geographical area in the range $0\text{-}30^0$C. In the case of thermoenergetical blocks in the Turceni and Rovinari Energy Complexes we have a common characteristic, i.e. they use the same source of industrial water, namely the Jiu River (GAVRILESCU et al., 2018).

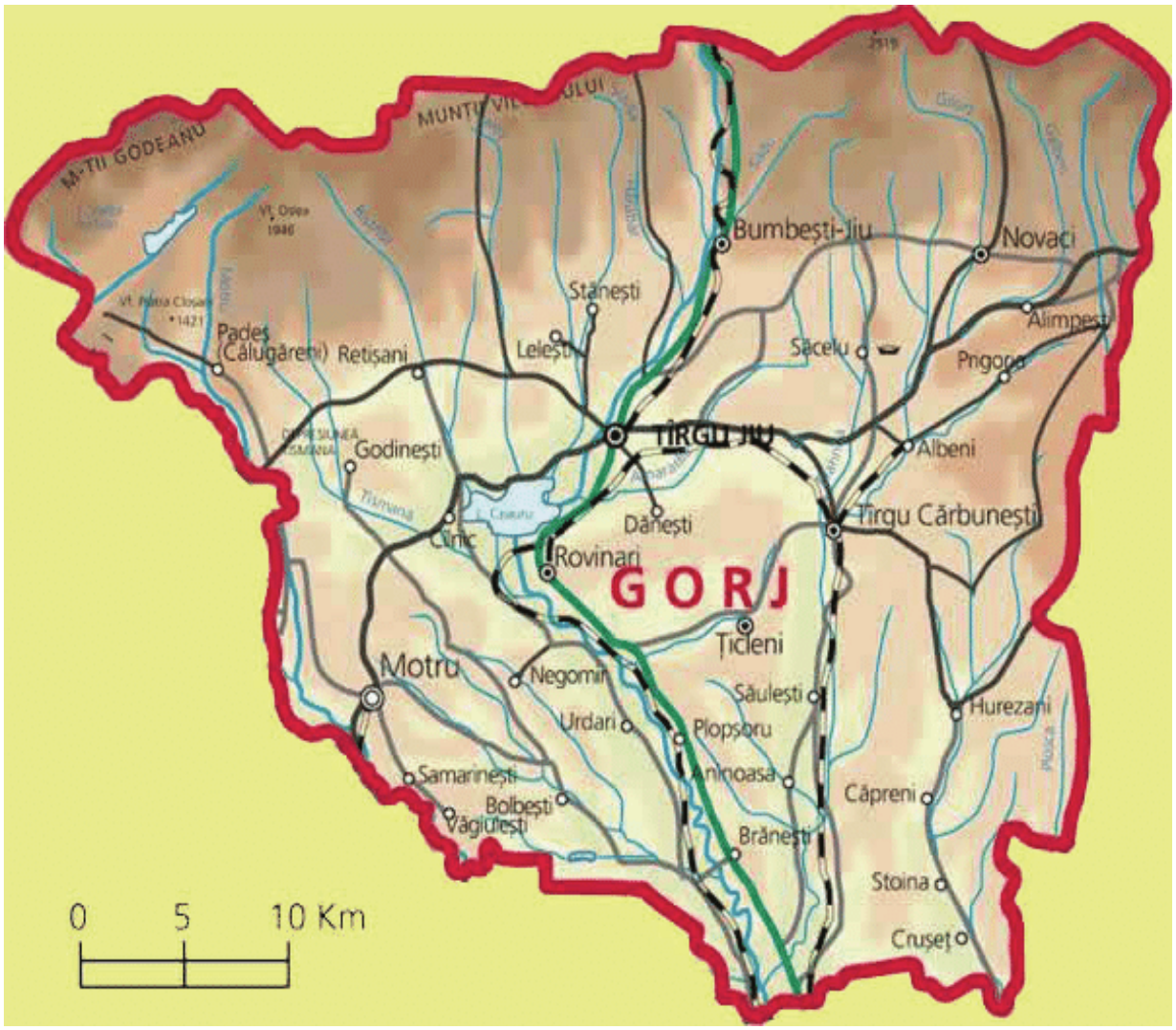


Figure 1. Location of the Turceni and Rovinari Energy Complexes in the Jiu river basin (CISMAȘIU et al., 2017).

The energy complex also includes the part for the production of lignite, extracted from the carbonifer basin of Oltenia, used as fuel, so it is possible to confuse the CET logo and the CET type of thermal power plants (heating plant, whose main product is heat).

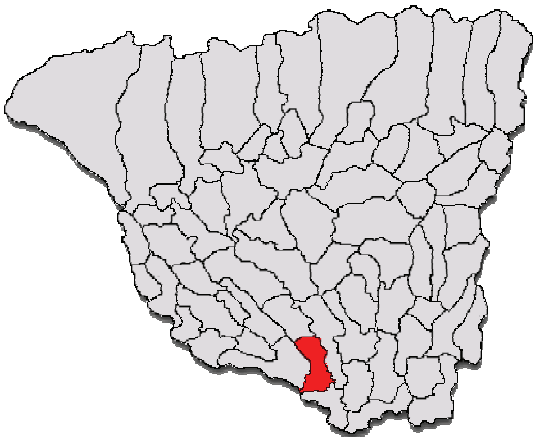
CET Turceni is one of the largest power stationpower stations in Europe, in terms of installed power (there is a similar one in China). The plant has 7 groups of 330 MW of installed capacity. CET Rovinari has an installed capacity of 1,320 MW, consisting of energy blocks no. 3, 4, 5 and 6.

After 1990, the Turceni and Rovinari power plants were refurbished, with a special importance being given to environmental protection. Until 2013, the Turceni complex made investments of almost 800 million euros, most of the money being destined for mandatory environmental investments, according to the emission reduction requirements, so established with the European Union (GAVRILESCU et al., 2018).

The following physico-chemical parameters were determined: *water temperature*, *water conductivity*, *total suspended matter*, *fixed residue*, *pH-ul*, both in the supply water and in the outlet water in the emissary (ROJANSKI et al., 1997; CIOBOIU, 2003; CÎRȚÎNĂ, 2005; GAVRILESCU, 2007).

RESULTS AND DISCUSSIONS

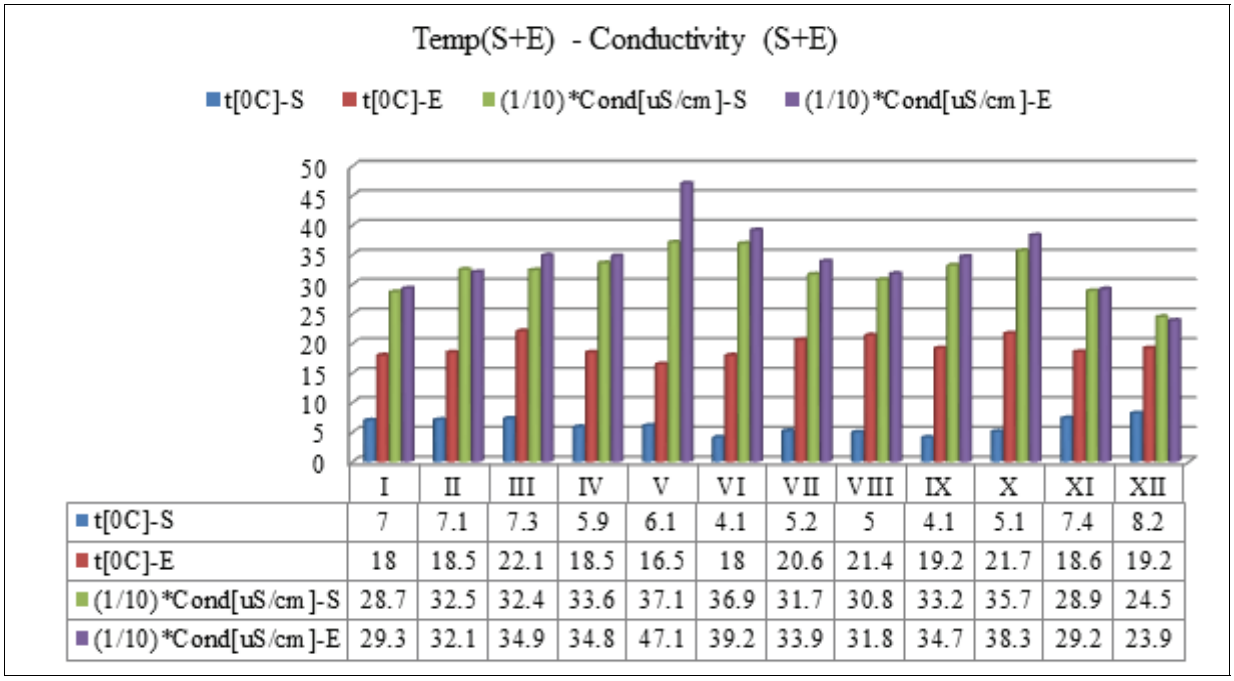
The Turceni Energy Complex located on the terrace to the right of the Jiu at its confluence with the Jilț on the territory of Gorj County, produces electric energy based on lignite brought from the Pește ana and Jilț Nord quarries (Figs. 2, 3).



Figures 2, 3. Location of the Turceni power stationpower station on the territory of Gorj county (Google Earth, accessed: March 21, 2020).

It is composed of a thermal power plant powered by lignite surface coal mining, as well as groups in block design - BENSON 1035 t / h boiler, 330 MW condensing turbine - Rateau Schneider license and ALSTHOM generator. The industrial water captured and discharged in and towards the Jiu River is made through the capture and discharge outlets and the supply and discharge channels (CIOBOIU, 2005; GAVRILESCU & OLTEANU, 2004; CISMAȘIU et al., 2017).

The values of the water temperature in the supply channel vary between 4.1 - 8.2^{0}C, and in the discharge one between 16.5 - 22.1^{0}C, and those of the water conductivity between 24.5 - 36.9 mS / cm in the supply channel respectively 23.9 - 47.1 mS / cm in the channel evacuation. There is an inverse proportional correlation between water temperature and water conductivity in both channels in the sense that low values of water temperature in the supply channel correspond to high values of water conductivity, and in the discharge channel high temperature values correspond to low values of conductivity (Fig. 4).

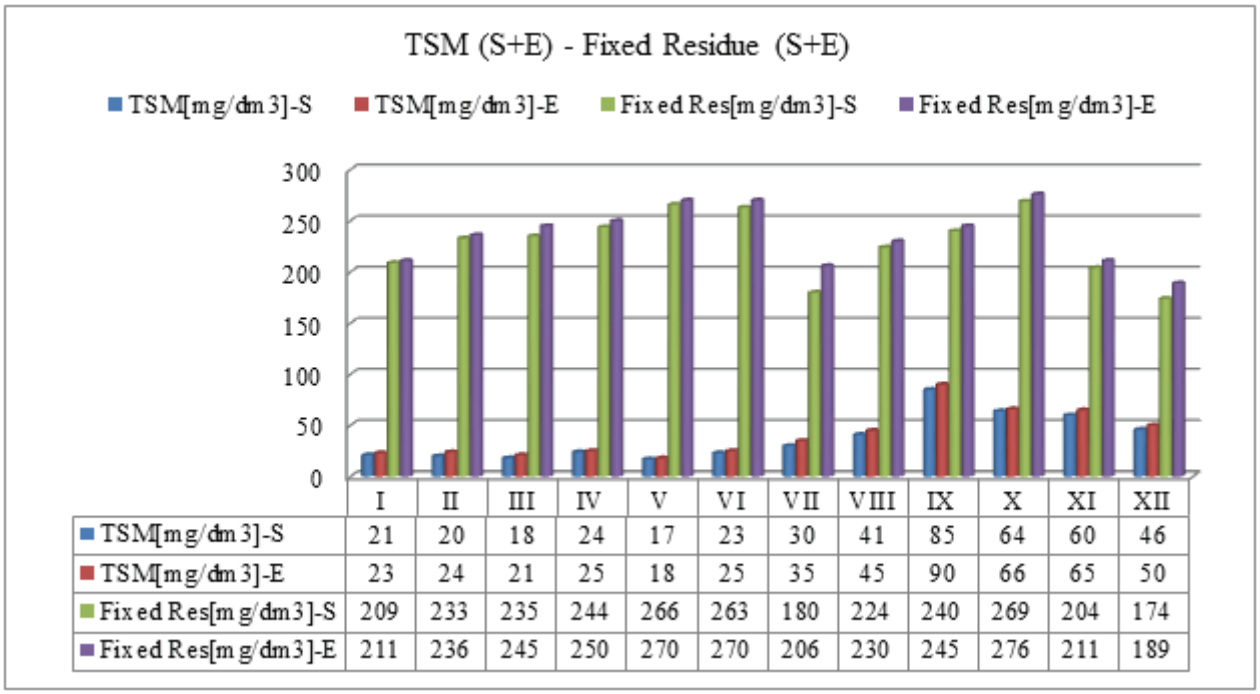


	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
t[0C]-S	7	7.1	7.3	5.9	6.1	4.1	5.2	5	4.1	5.1	7.4	8.2
t[0C]-E	18	18.5	22.1	18.5	16.5	18	20.6	21.4	19.2	21.7	18.6	19.2
(1/10)*Cond[uS/cm]-S	28.7	32.5	32.4	33.6	37.1	36.9	31.7	30.8	33.2	35.7	28.9	24.5
(1/10)*Cond[uS/cm]-E	29.3	32.1	34.9	34.8	47.1	39.2	33.9	31.8	34.7	38.3	29.2	23.9

Figure 4. The values of water temperature and water conductivity in the supply and evacuate channels.

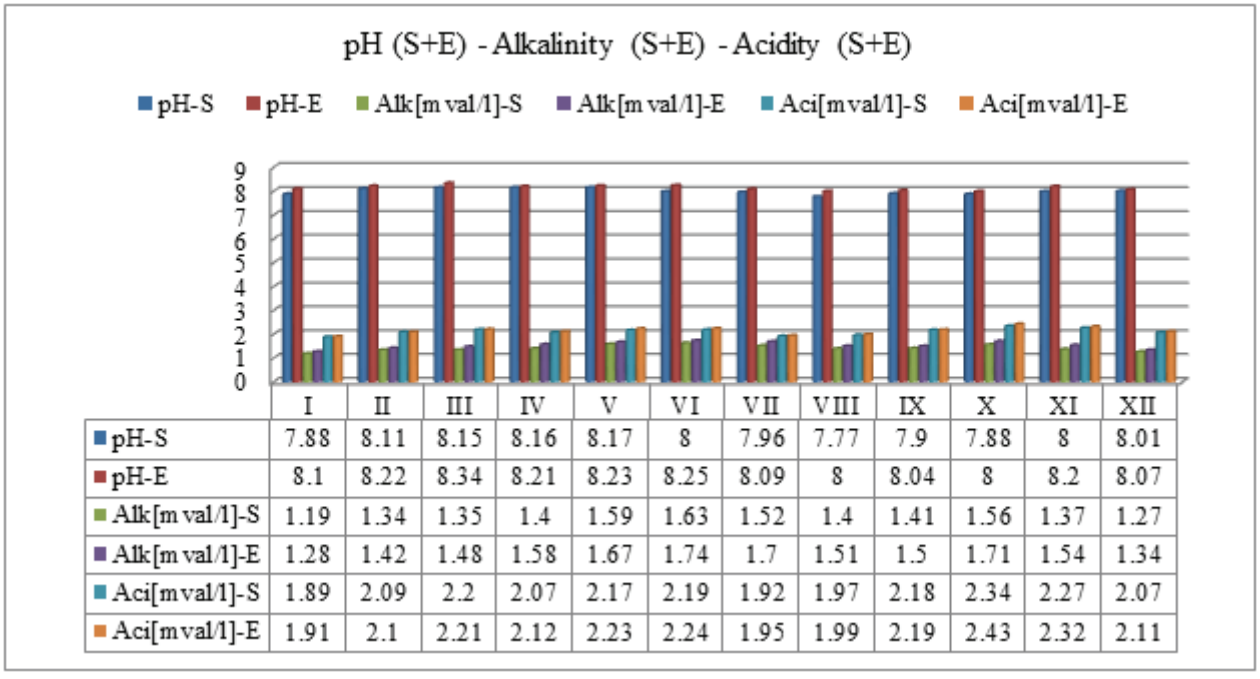
The values of the total substances in the suspensions are close between the inlet and outlet channel varying between 17 - 85 mg / dm^3, respectively 18 - 90 mg / dm^3, the highest values being recorded in September, and in terms of fixed residue, it varies between 174 - 269 mg / dm^3, respectively 189 - 276 mg / dm^3, the highest values being registered in October (Fig. 5). In the supply channel, the pH of the water is slightly alkaline with values between 7.77 - 8.11 compared to the supply channel with a moderate alkaline pH (8 - 8.34). The alkalinity of the supply water has higher values than in the discharge water, as it happens in the case of acidity, and the alkalinity values are lower than the acidity in both the supply water and the discharge water (Fig. 6). Among the analysed indicators, it was found that temperature is the most affected parameter. The temperature of the discharged water exceeds by 11.5% the temperature of the captured water.

The evolution of the temperature in the operating system - open circuit - affects the Jiu waters at the maximum allowable limit, and the monitoring of physical and chemical parameters, especially the temperature, determines the decrease of thermal effects on the Jiu river waters (RUSU & ROJANSCHI, 1980; CIOBOIU & BREZEANU, 2002; PETRIŞOR & MATEESCU, 2006; ***. Ord. 161/2006; BREZEANU et al. 2011; ZANFIR et al., 2019).



	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
TSM[mg/dm3]-S	21	20	18	24	17	23	30	41	85	64	60	46
TSM[mg/dm3]-E	23	24	21	25	18	25	35	45	90	66	65	50
Fixed Res[mg/dm3]-S	209	233	235	244	266	263	180	224	240	269	204	174
Fixed Res[mg/dm3]-E	211	236	245	250	270	270	206	230	245	276	211	189

Figure 5. Values of total matter in suspensions and fixed residue in inlet and outlet water.

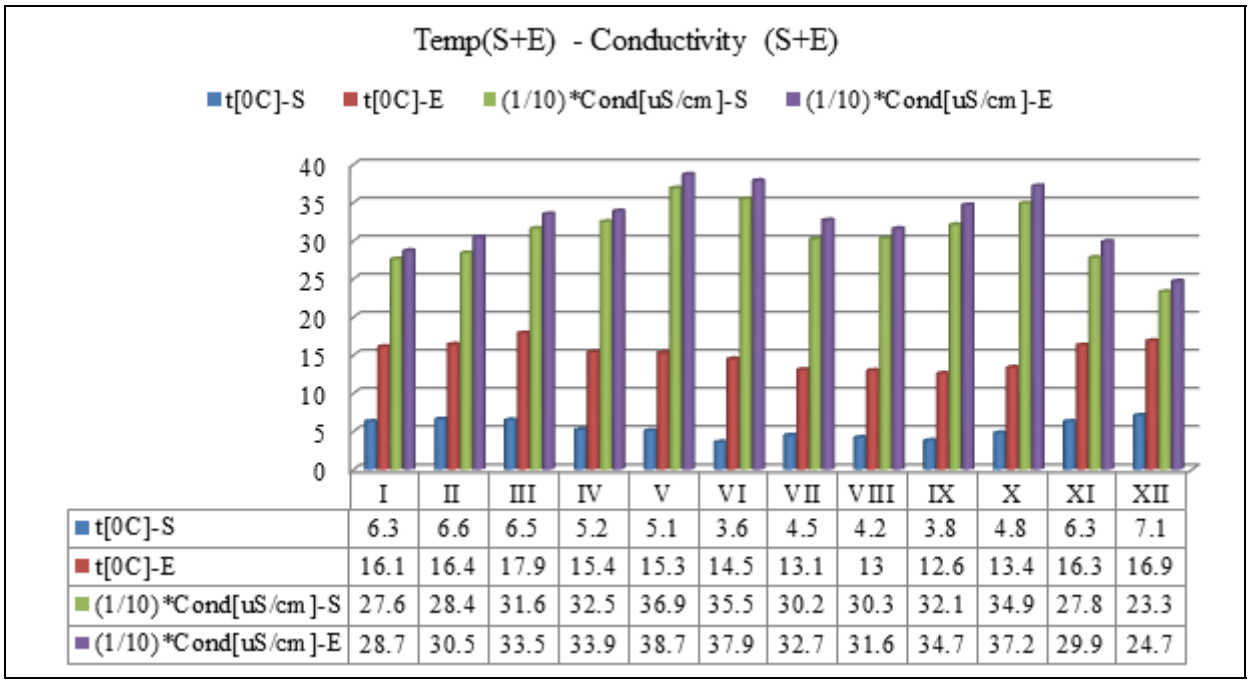


	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
pH-S	7.88	8.11	8.15	8.16	8.17	8	7.96	7.77	7.9	7.88	8	8.01
pH-E	8.1	8.22	8.34	8.21	8.23	8.25	8.09	8	8.04	8	8.2	8.07
Alk[mval/l]-S	1.19	1.34	1.35	1.4	1.59	1.63	1.52	1.4	1.41	1.56	1.37	1.27
Alk[mval/l]-E	1.28	1.42	1.48	1.58	1.67	1.74	1.7	1.51	1.5	1.71	1.54	1.34
Aci[mval/l]-S	1.89	2.09	2.2	2.07	2.17	2.19	1.92	1.97	2.18	2.34	2.27	2.07
Aci[mval/l]-E	1.91	2.1	2.21	2.12	2.23	2.24	1.95	1.99	2.19	2.43	2.32	2.11

Figure 6. Ph-ul, alkalinity and acidity of water captured and evacuated.

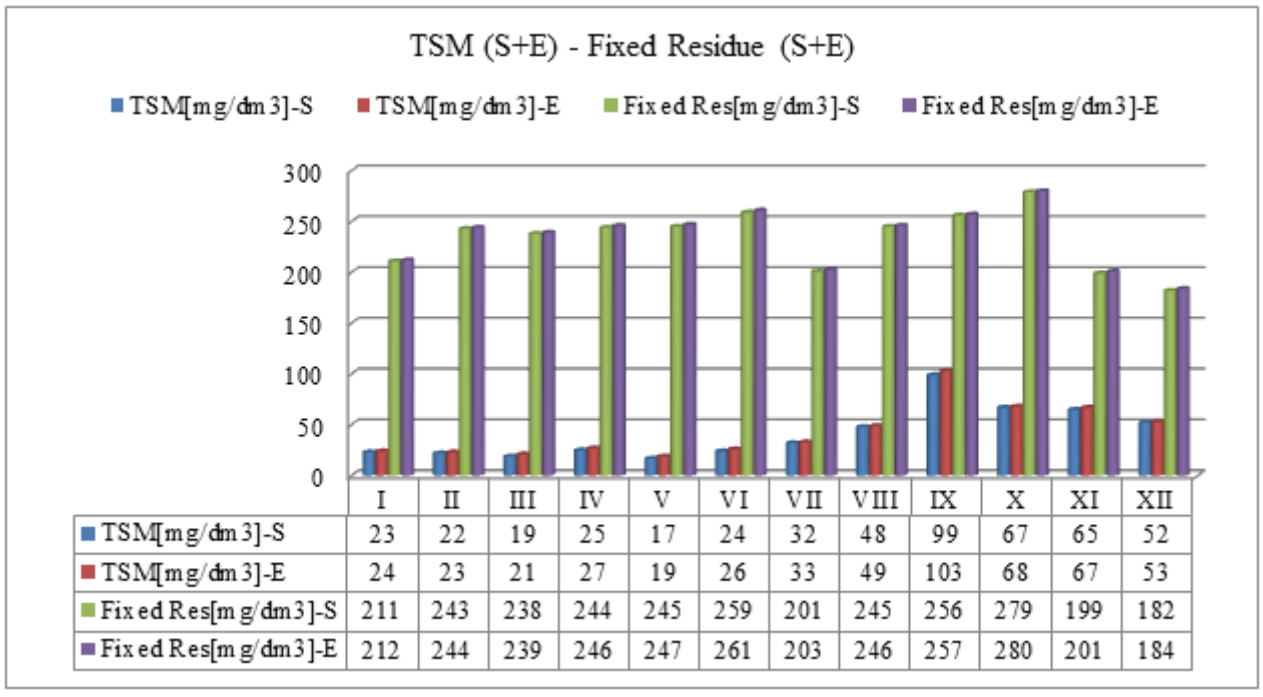
In the case of the Rovinari Energy Complex, physical and chemical analyses were performed on the industrial water captured and discharged from the 330 MW thermoenergetical blocks, and values close to those recorded at the Turceni Energy Complex were found regarding the studied parameters: water temperature in the supply channel varies between 4.2 - 7.1°C and in the exhaust channel between 12.6 - 17.9°C; conductivity 23.3 - 36.9 mS / cm respectively 24.7 - 38.7 mS / cm, with the same inversely proportional correlation between temperature and water conductivity (Fig.

7); the suspensions and fixed residue are kept within the admissible limits (Fig. 8), and the pH is alkaline, the alkalinity values being lower than the acidity in both the supply water and the discharge water (Fig. 9).



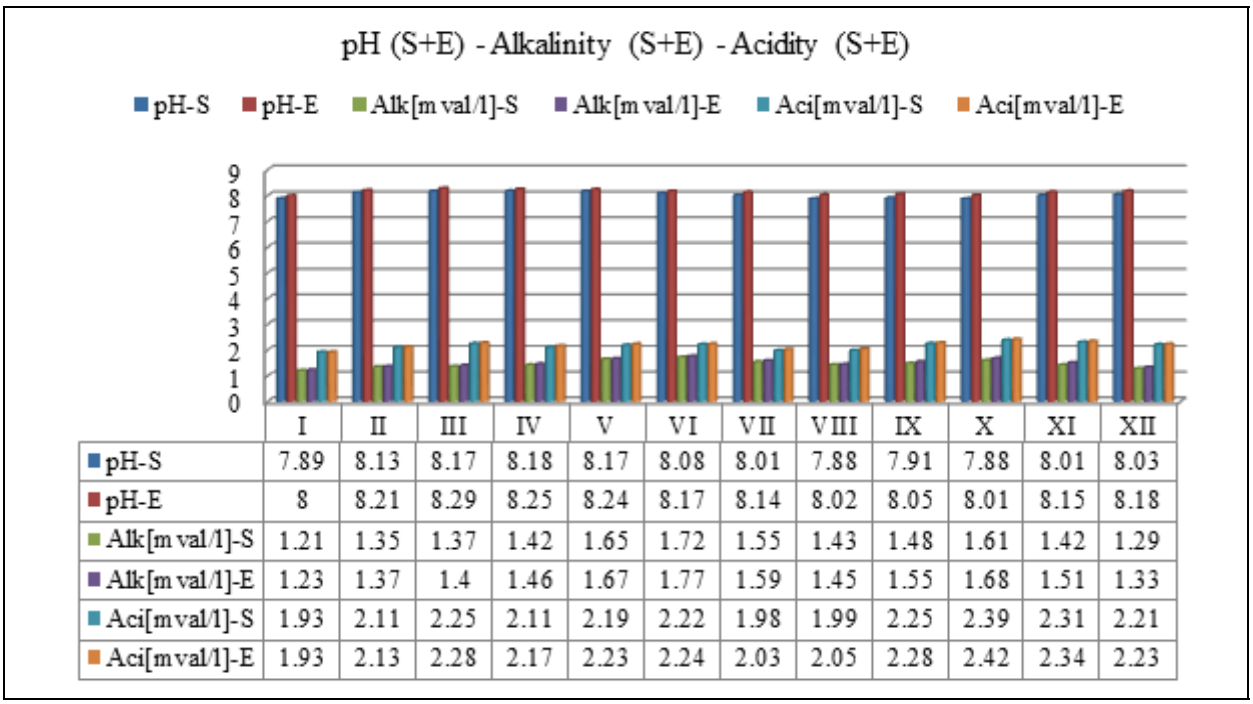
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
t[0C]-S	6.3	6.6	6.5	5.2	5.1	3.6	4.5	4.2	3.8	4.8	6.3	7.1
t[0C]-E	16.1	16.4	17.9	15.4	15.3	14.5	13.1	13	12.6	13.4	16.3	16.9
(1/10)*Cond[uS/cm]-S	27.6	28.4	31.6	32.5	36.9	35.5	30.2	30.3	32.1	34.9	27.8	23.3
(1/10)*Cond[uS/cm]-E	28.7	30.5	33.5	33.9	38.7	37.9	32.7	31.6	34.7	37.2	29.9	24.7

Figure 7. Values of water temperature and conductivity in the supply and evacuation channels.



	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
TSM[mg/dm3]-S	23	22	19	25	17	24	32	48	99	67	65	52
TSM[mg/dm3]-E	24	23	21	27	19	26	33	49	103	68	67	53
Fixed Res[mg/dm3]-S	211	243	238	244	245	259	201	245	256	279	199	182
Fixed Res[mg/dm3]-E	212	244	239	246	247	261	203	246	257	280	201	184

Figure 8. Values of total matters from suspensions and fixed residue from supply and evacuation waters.



	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
pH-S	7.89	8.13	8.17	8.18	8.17	8.08	8.01	7.88	7.91	7.88	8.01	8.03
pH-E	8	8.21	8.29	8.25	8.24	8.17	8.14	8.02	8.05	8.01	8.15	8.18
Alk[mval/l]-S	1.21	1.35	1.37	1.42	1.65	1.72	1.55	1.43	1.48	1.61	1.42	1.29
Alk[mval/l]-E	1.23	1.37	1.4	1.46	1.67	1.77	1.59	1.45	1.55	1.68	1.51	1.33
Aci[mval/l]-S	1.93	2.11	2.25	2.11	2.19	2.22	1.98	1.99	2.25	2.39	2.31	2.21
Aci[mval/l]-E	1.93	2.13	2.28	2.17	2.23	2.24	2.03	2.05	2.28	2.42	2.34	2.23

Figure 9. Ph-ul, alkalinity and acidity of water captured and discharged.

As in the case of the Turceni Energy Complex, it was found that the temperature of the discharged water exceeds by 12% the temperature of the captured water, the difference between the discharged water and the captured water being at least 10^0C, for both energy complexes in Oltenia. In order to maintain the temperature of the industrial water discharged from the thermoenergetical blocks, both energy complexes should use industrial water cooling towers so that the thermal effects on the waters of the Jiu River are as small as possible, as well as the achievement of the closed circuit industrial waters thermal energy blocks, circuits with volumetric flow losses as small as possible (CIOBOIU et al., 2019; GAVRILESCU et al., 2020; RĂDUCA et al., 2021).

CONCLUSIONS

The increase of the economic efficiency of the Turceni and Rovinari Energy Complexes requires the cooling of the thermal energy blocks, which are achieved with relatively high energy consumptions, of 330 MW for each block. The monitoring of the physical and chemical parameters shows that the physical parameters of industrial water are the most affected by the operation of the thermal energy blocks compared to the chemical parameters of industrial water which are less affected by the operation of these blocks.

The influence on the Jiu waters is different, depending on the total installed power of the thermal energy blocks, the most significant increases being the temperature of the discharged industrial water. Ecological impact studies should be carried out on the flora and fauna of the Jiu River in the sector downstream of Rovinari and upstream of Turceni for biodiversity conservation.

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