
THE POSSIBILITIES OF EXPLOITATION OF SERBIAN THERMOMINERAL WATERS

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ABSTRACT

Global ecological problem of petrol resources deficit caused an intensive search of alternative energy sources. Deficit of conventional energofluids in Yugoslavia requires serious efforts to create a program of alternative energy sources exploitation. Geothermal energy represents an important energetic source for the countries with poor energy resources. Geothermal energy can become the basis for economic development. At present these geothermal resources are not being exploited in Yugoslavia. The possibilities of effective exploitation of thermal and thermomineral water resources in Yugoslavia are presented in this paper.

Key words: energy sources, geothermal energy, exploitation

INTRODUCTION

In Yugoslavia we have about 500 sources of thermal, mineral and thermomineral waters. Thermal water is marginally used for heating of greenhouses, hotbeds, farms, factories and some spas and health centers (Vranjska spa, Kuršumlja, Niška spa, Sijarinska spa).

Thermomineral and mineral sources in health resorts in Yugoslavia represent natural resources with large possibilities for the development of healthtourism, agriculture, aquaculture, industry, heating and other economic activities.

The domains of thermal energy use are presented in Fig. 1.

Favourable geological and geotectonic conditions produced large number of hydrothermal systems with sources of thermal and thermomineral waters. At present these geothermal resources (550×10^6 t of equivalent liquid fuel) are not being exploited.

SERBIAN THERMOMINERAL WATERS

Numerous mineral water sources make Yugoslavia the richest in thermomineral water resources on the Balkans. Most of the sources are located on the territory of Serbia proper.

With few exceptions, thermomineral water sources are developed in Paleozoic and Precambrian metamorphic rock complexes.

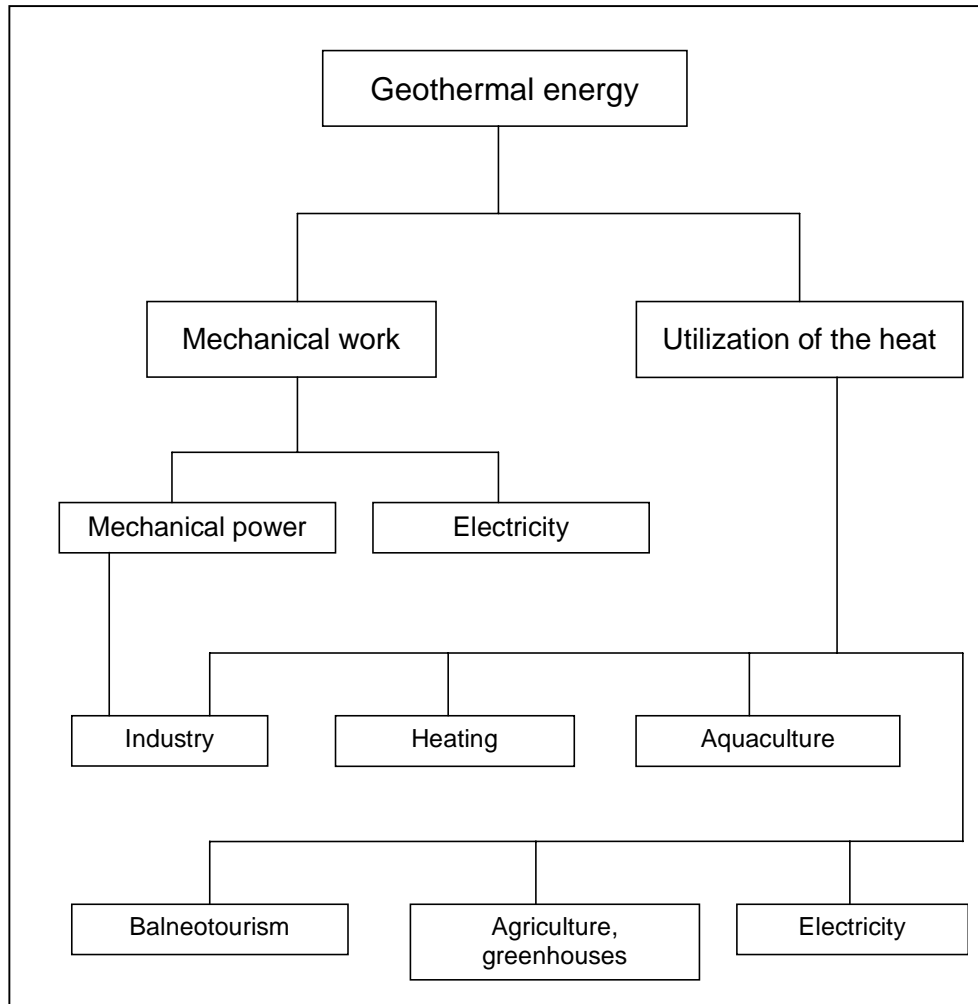


Fig. 1: Utilization of geothermal resources

Healthtourism in the Republic of Serbia lies in natural resources of thermal, mineral and radon water. Serbia is rich with thermal waters that were used already in the Roman times. Mineral waters from deposits at Serbian spas Vrnjci, Trstenik, Smederevska Palanka, Prolomska spa, Kuršumlja and some other have been analyzed by AAS, combined with ICP methods. Concentrations of B, Ba, Li, Sr, Mn, Zn, Al and P in water were identified by spectrochemical analyses. According to the results of these analyses mineral waters can be classified in the six types:

- Sulphur
- Radon

Ferrous
 Iodine
 Hydrocarbonate (alkaline type)
 Hydrocarbonate (magnesium type)

Table 1: Use of Mineral and Thermomineral Water for Hydropathy

Type of mineral water	T (°C)	Hydropathy of diseases
I. Sulphur mineral waters		
Bečejska spa	31-42	skin diseases, rheumatism, gynaecological diseases, neuralgia, neurasthenia, neurosis
Bogutovačka spa	23-25	
Brestovačka spa	36-41	
Vranjska spa	88-94	
Jošanička spa	62-78	
Koviljača spa	24-32	
Mataruška spa	48-50	
Novopazarska spa	46-50	
Obrenovačka spa	26-31	
Pećka spa	45-56	
Sijarinska spa	72	
II. Radon mineral waters		
Gornja Trepča	35	neuralgia, neurasthenia, neurosis, rheumatism, cardiovascular diseases, sciatica
Zvonačka spa	30	
Kanjiža spa	29-34	
Nička spa	39-40	
Pribojska spa	36	
III. Ferrous mineral waters		
Vranjska spa	61-79	rheumatism, arthritis, sterility, gynaecological diseases
Vrujci spa	25-27	
IV. Iodine mineral waters		
Koviljača spa	14-32	asthma, allergic diseases, managerial diseases
Novosadska spa	30	
Kanjiža spa	63-65	
Bečejska spa	63-66	
V. Hydrocarbonate mineral waters (alkaline type)		
Palanački kiseljak	12-17	digestive organ diseases, diabetes, ulcer, liver diseases, kidney diseases
Bukovička spa	16	
Bukovička spa	14-36	
Vrnjačka spa	17	
Minakva	26-32	
Prolom		
VI. Hydrocarbonate mineral waters (magnesium type)		
Mivela	17	cardio-vascular diseases, managerial diseases
Slatina	16	

The average contents of Mg, Ca, K, Na and trace elements Al, Ti, Mn, Fe, P show that these types of water can be used as preventive treatment for many diseases (table 1).

Sedimentary-petrographic relationships of rocks in the mineral water source area were studied to determine the source of mineral matter in water and to identify geochemical factors of the final mineral water formation in this source.

Several conclusions based on lithological, structural and geochemical relationships were obtained:

According to data obtained from CO₂ analyses, these types of mineral waters have been formed in metamorphic environment.

Complex physical, chemical and physico-chemical processes in the deep zone, together with the presence of ground water in sediments of the hypergenesis zone had intensive influence on composition of mineral waters.

In sanatoriums of the Republic of Serbia can develop health, recreational, manifestational and congress tourism. Good locations of spa centers give possibility for development of vacational tourism. The traffic network in the country offers possibility for development of transit tourism.

UTILIZATION OF GEOTHERMAL ENERGY FOR HEATING AND HORTICULTURE

The existence of large hydrogeothermal convective system with the reservoir of the thermal lowmineralized water (temperature between 75 and 120°C) is important for heating. Geothermal energy could be efficiently utilized for various purposes in the Republic of Serbia (table 2).

Limited use of geothermal fluid characterized by high mineral concentration and great content of eruptive gases is brought about by technical problems related to corrosion effects on plants. To overcome this problem, a technology for fluid use has been developed providing optimum conditions for heat transfer.

Horticultural hotbed gardens are usually growing nearby thermal springs. Thermal water is desirable for hotbeds heating, in particular. This kind of water is useful for irrigation after cooling if its quality is suitable.

Investigations of thermomineral water sources carried out in Yugoslavia have indicated high quality mineral waters that can be used for many purposes.

The exploitation of geothermal resources for the needs of industry, heating, medical therapy and agriculture is of great importance for the future economic development of Yugoslavia. Intensive exploitation of thermomineral and thermal waters must become one of the important goals of economic development in Yugoslavia.

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Table 2: Use of Thermomineral Waters

Location	Type of use	Capacity kg/s	T (°C)		Used energy TJ/year
			in	out	
Kanjiza 1	D/B	5.0	41	26	9.89
Kanjiza 2	D/B	14.0	65	26	72.02
Kula 1	B	9.5	50	25	46.16
Kula 2	I	8.3	53	25	30.65
Kula 4	I	8.5	51	26	28.03
B. Petrovac 1	G	16.7	46	25	46.26
B. Petrovac 2	A	7.8	45	24	21.60
Prigrevica	D/B	21.0	54	25	80.33
Srbobran	G	11.7	63	24	60.18
Kikinda 1	D	6.2	50	27	18.81
Kikinda 2	F	15.2	51	26	50.12
Mokrin	F	10.5	51	26	34.62
Vrbas	B	4.3	51	23	13.26
Temerin	B	20.0	41	25	39.57
B. P. Selo	F	10.0	43	26	34.29
Becej	D	19.4	65	24	104.91
Vranjska spa	I/F/D/B/G	77.0	96	50	467.20
Sijarinska spa	D/B	7.4	76	25	49.78
Josanicka spa	D/B	17.0	78	40	85.21
Lukovska spa	D/B	12.0	67	35	50.65
Kursumlija	D/B	20.0	68	25	113.43
Mladenovac	B	19.0	53	25	70.17
S. Palanka	B	13.0	56	25	53.16
N. Pazar	B	10.0	52	28	31.65
Mataruge	B	47.0	43	24	117.79
Ribarska spa	D/B	37.0	44	25	92.73
Pecka spa	B	4.0	36	25	5.80
Ilidza (Pec)	B	17.5	48	26	50.78
Bujanovacka spa	D/B	7.0	43	24	17.54
Gamzigrad	D/B	10.0	42	24	23.74
Ovcar spa	D/B	50.0	38	27	72.54
Vrnjacka spa	B	5.0	36	25	7.25
Niska spa	D/B	60.0	37	25	94.97
Pribojska spa	B	70.0	36	30	55.40
Klokot	B	15.0	34	25	17.80
Koviljaca	B	130.0	30	24	102.88
Brestovacka s.	B	3.0	40	30	3.96
Rajcinovica spa	B	8.0	36	28	8.44
Bukovicka spa	B	15.0	34	28	11.87
Prolom spa	B	15.0	31	24	13.84
G. Trepeca	B	20.0	30	24	15.82
Debrč I	D	15.0	53	48	9.89
TOTAL:					2335

Type of use: I – Industry, A – Drying of agricultural products, F – Agriculture, D – Heating, B – Balneology, G – Hotbeds

Source: Milivojevic & Martinovic (1996)