Proceedings World Geothermal Congress 2023
Beijing, China, April 17 – 21, 2023

Geothermal energy in Uniejów - over 20 years of contribution to the development of the city and 10 years of the first thermal spa in Poland

Aneta Sapińska-Śliwa, Tomasz Sliwa

AGH University of Science and Technology, Faculty of Drilling, Oil and Gas, Laboratory of Geoenergetics AGH UST, Krakow, Poland, ans@agh.edu.pl, sliwa@agh.edu.pl,

Keywords: geothermal heating plant, geothermal plant, geothermal water, geothermal heat, thermal health resort

ABSTRACT

In 1978, the Uniejów IGH-1 borehole was drilled in the Uniejów commune. In 1984, the documentation for this well was approved by the Polish Geological Institute. In the years 1988-1990, design works were carried out on geological, hydrogeological, drilling and heating issues, carried out by the Geothermal Department of the Institute of Energy Raw Materials at the AGH University of Science and Technology in Krakow. As part of these works, a geological survey project was carried out, which involved the drilling of three boreholes (Uniejów AGH-1, Uniejów AGH-2, Uniejów AGH-3) to identify geothermal resources and at the same time constituting the basis for the construction of a geothermal installation in Uniejów based on two geothermal doublets. In the years 1990-1991, the Uniejów PIG / AGH-1 and Uniejów PIG / AGH-2 wells were drilled.

The PIG / AGH-1 and PIG / AGH-2 boreholes were characterized by significant flow rates, of the order of 90 m3 / h in the conditions of self-production at a pressure of approx. 3 bar and a temperature of approx. 70 ° C. In addition, these waters, according to the opinion of specialists, have healing properties.

In 1997, the Uniejów City Council made a decision about the possibility of making the city warm with the use of geothermal waters. In 1998, the "Study of the profitability of using geothermal waters in Uniejów for heating, balneological and recreational purposes" was prepared by the Department of Energy Raw Materials - Faculty of Geology, Geophysics and Environmental Protection at the AGH University of Science and Technology in Krakow.

In March 1999, Aneta Sapińska has developed a "Preliminary concept for the use of thermal waters in Uniejów". A study commissioned by the Provincial Fund for Environmental Protection and Water Management in Łódź resulted in the establishment of the limited liability company "Geotermia Uniejów" on July 12, 1999.

From the very beginning, the entity undertook intensive activities aimed at making the city warm. It deals with the production and distribution of thermal energy (central heating and domestic hot water) obtained from geothermal water, as well as the production of water for recreation and promotion of the city.

Since the establishment of the company can be dated the successful development of Uniejów after the difficult period of the 1990s. For over 20 years, new tourist and recreational facilities and a health resort have been built in Uniejów. Geothermal cosmetics are produced, people have jobs that were hard to come by before. The works of the 21st century luxury are created with such amenities as thermal water in the third tap in new apartments, for private baths. It is planned to generate electricity from thermal waters and further development of the health resort. The paper presents the history, current state and plans resulting from the symbiosis of the city and local geothermal water resources.

1. INTRODUCTION

The development of Uniejów before 1999 was very limited. One of the reasons was the location of the city, always close to the borders of the changing administrative divisions of Poland.

Fig. 1. Archival photo from Uniejów

Fig. 2. Archival photo from Uniejów

Fig. 3. Archival photo from Uniejów

The first well in the Uniejów commune, Uniejów IGH-1, was drilled in the village of Ostrowsko in 1978. In 1984, the documentation of this well, prepared by the Polish Geological Institute in Warsaw, was approved by the Commission of Hydrogeological Documentation in the Ministry of the Environment. In the years 1988-1990, design work on geological, hydrogeological, drilling and heating issues was carried out by the Geothermal Department of the Institute of Energy Resources of the AGH University of Science and Technology in Krakow. As part of these works, a geological research project was developed, which assumed the drilling of three boreholes (Uniejów AGH-1, Uniejów AGH-2, Uniejów AGH-3) in order to explore geothermal resources and at the same time constituting the basis for the construction of a geothermal installation in Uniejów based on two doublets geothermal. In 1990-1991, two wells were drilled: Uniejów PIG/AGH-1 and Uniejów PIG/AGH-2. The Uniejów AGH-3 well has not yet been drilled.

According to the measurements carried out at that time, the Uniejów PIG/AGH-1 and Uniejów PIG/AGH-2 boreholes were characterized by a significant productivity of approx. 90 m^3/h under self-outflow conditions at a pressure of approx. 3 bar and a temperature of approx. 70°C. These waters were classified as chloride-sodium-bromide. These waters, according to experts, had healing properties. In 1992, the Undersecretary of State, Chief National Geologist in the Ministry of Environmental Protection, Natural Resources and Forestry, in a letter of February 24, 1992, transferred the hydrogeological wells Uniejów IGH-1, Uniejów

PIG/AGH-1 and Uniejów PIG/AGH-2 to the property of the Commune Board and the City of Uniejów. The wells were moved by the protocol of April 1, 1992.

In 1997, the Uniejów City Council decided to investigate the possibility of using geothermal waters to heat the city. In 1998, the Institute of Energy Resources, Faculty of Geology, Geophysics and Environmental Protection of the AGH University of Science and Technology in Krakow, developed a "Study on the profitability of using geothermal waters in Uniejów for heating, balneological and recreational purposes" under the leadership of prof. dr hab. eng. Wojciech Górecki. In March 1999, MSc. eng. Aneta Sapińska developed a "Preliminary concept of using geothermal waters in Uniejów" (Sapińska 2000).

As a result of administrative changes in the country, after 1998 Uniejów was incorporated into the Łódź Voivodeship. This resulted in the establishment on July 12, 1999 of the limited liability company "Geotermia Uniejów" - an entity dealing with the production and distribution of thermal energy (central heating and hot water) obtained from geothermal waters. The company's shareholders were: the Uniejów Commune and the Regional Fund for Environmental Protection and Water Management in Łódź. In January 2000, the tender for the task "Heating system of the city of Uniejów based on thermal waters" was resolved, and in May "Geotermia Uniejów" signed a contract for the implementation of the task. The funds were obtained from a loan granted by the Voivodship Fund for Environmental Protection and Water Management in Łódź.

In the period from October 2000 to June 2001, The Geological Company "Polgeol" SA updated the hydrogeological conditions for the exploitation of the PIG/AGH-1 and PIG/AGH-2 wells. At the request of "Geotermia Uniejów" an annex to the existing hydrogeological documentation was prepared. As part of the work, the production well PIG/AGH-2 and the absorption well PIG/AGH-1 were rebuilt, and a pipeline connecting the two wells was laid.

In the second half of 2001, the construction of a heating system in Uniejów was completed and commissioned. The heating plant was equipped with heat exchangers and an oil-storage boiler house, a pump unit for pumping water into the aquifer, and approxymetely 10 km of a heating network was laid in Uniejów.

On October 1, 2001, the company "Geotermia Uniejów" started the process of supplying public and residential buildings with heat energy generated from geothermal waters. Due to the healing properties of the Uniejów geothermal waters, in July 2002, part of the office building was adapted into a balneological treatment room in order to conduct research confirming the effectiveness of the Uniejów geothermal water for therapeutic purposes. In two tubs with hydromassage, the then students of the Medical Academy in Łódź carried out baths for the inhabitants of the Uniejów Commune and described the improvement of their health after repeated treatments.

The deterioration of the injection capacity of the Uniejów PIG/AGH-1 injection well made it necessary to start the reconstruction of the oldest Uniejów IGH-1 well and to perform works to improve the injection capacity in the Uniejów PIG/AGH-1 well. From August 2004 to September 2005, geological works were carried out to improve the absorbability of the Lower Cretaceous aquifers in the IGH-1 well, together with additional works in the Uniejów PIG/AGH-1 and PIG/AGH-2 wells, and with the implementation of preparatory works - preparation of hydrogeological documentation. The company obtained funds for this task in the form of a grant from the National Fund for Environmental Protection and Water Management in Warsaw.

In 2004, the concept of building a biomass boiler house was created, which was created in 2006 thanks to the financial support of EKOFund in Warsaw. In 2006-2008, the heating network on the right bank of the city and the geothermal network on the left side of the Warta were expanded. In 2007, a sports field with turf heated with geothermal water was put into use.

In July 2008, the Uniejów commune commissioned a thermal and swimming pool complex powered by geothermal water, Kasztel Uniejów Hotel&Spa, where geothermal water was used for bathing in wooden tubs (currently stainless steel tubs), as well as a Thermal Restaurant using geothermal heat and a fountain with geothermal water on the market square in Uniejów. In 2008, a small graduation tower with geothermal water was built (Fig. 4), and fountains of geothermal water in the shape of 17th-century cannons were placed over the Warta river, next to the footbridge from the city side (Fig. 5). In 2012, the Uniejów commune expanded the thermal and swimming pool complex. Due to the increased demand for heat, it became necessary to build a heating network leading geothermal waters to the left-bank part of the city in order to supply heat to newly built tourist facilities. In addition to the thermal and swimming pool complex, in 2012 the Uniejów Commune built a House of Creative Work, a Mill Farm and a complex of football fields.

Fig. 4. Hot water fountains operate all year round (uniejow.net.pl, mapio.net/pic)

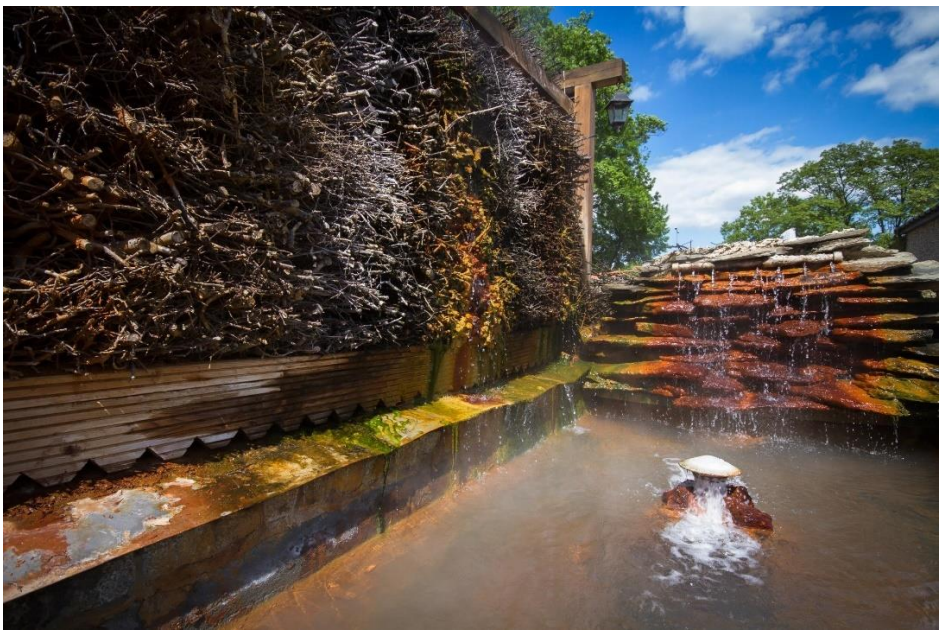

Fig. 5. Graduation tower with geothermal water in Uniejów (ekouniejow.pl/uzdrowisko-termalne/niezwykla-woda)

Also in 2012, an external investor built the Hotel Medical Spa "Lawendowe Termy", which uses heat for heating purposes and geothermal water for swimming and balneological purposes. In the same year, an external investor built the “Uniejów Park” spa building, which uses heat and geothermal water for therapeutic purposes (Latour and Smętkiewicz 2012).

In 2017, "Geotermia Uniejów" Sp. z o. o. (Fig. 6, 7) extended the district heating and geothermal network to two newly built blocks of flats at ul. Adam Asnyk. The network was built with the company's own resources. Two years later, the company built a heating and geothermal network at ul. Reymonta, Targowa and Długa, as an additional power supply to the existing heating network in the 700-lecia housing estate and as a final connection for the residential blocks under construction at ul. Długa. The network was also built with the company's own funds.

In addition, the company conducts environmental education of students and all interested parties on an ongoing basis, and makes efforts to use Uniejów geothermal waters in the food, cosmetic and medical industries. Many conferences and trainings are held in Uniejów. In 2022, the 2nd Seminar "Geoenergy and geothermal heat pumps" was held in Uniejów, organized by the Faculty of Drilling, Oil and Gas of the AGH University of Science and Technology in Kraków. The same faculty of AGH University of Science and Technology in Uniejów also conducted classes for students of the Postgraduate Studies "Geotermics".

Fig. 6. The seat of Geotermia Uniejów

Fig. 7. The area of Geotermia Uniejów

2. GEOTHERMAL BOREHOLES

The Uniejów IGH-1 geothermal borehole was drilled in 1978 to a depth of 2,254 m. In 2004 and 2005, works were carried out in the borehole to be used as an absorptive well in the geothermal water circulation system. Geothermal water is injected into the aquifer located at a depth of 1915-2084 m. The maximum absorption capacity is about 55.8 m^3h^{-1} (Sapińska-Śliwa 2010).

The Uniejów IGH-1 well together with the Uniejów PIG/AGH-1 and Uniejów PIG/AGH-2 wells are part of the Geothermal Plant in Uniejów. The openings are arranged almost in a straight line to each other. The distance between the extreme wells, i.e. Uniejów PIG/AGH-2 and Uniejów IGH-1, is 1950 m (Sapińska-Śliwa 2010).

The Uniejów IGH-1 well was piped as follows (Fig. 8) (Sapińska-Śliwa 2010):

- from 0 to 11 m – rury 20" casing pipe cemented to the top,
- from 0 to 100 m – rury 13 $^3/_8$" casing pipe cemented to the top,
- from 0 to 848 m – rury 9 $^5/_8$" casing pipes cemented to the top,
- from 678 to 1882 m – rury 6 $^5/_8$" pipes cemented in the interval from 678 m to 1882 m,
- from 1842,40 to 1927,46 m – pipes 4 $^5/_8$",
- from 1927,46 to 2078,60 m – active part of the filter 4 $^5/_8$",
- from 2078,60 to 2100,00 m – pipes 4 $^1/_2$".

The section of the hole in the interval from 2100 to 2254 m was closed with a cement plug after performing geophysical tests. The depression calculated from the fixed water table in the heated borehole is 22.5 m with the radius of the depression cone being 161.3 m (Sapińska-Śliwa 2010).

The Uniejów PIG/AGH-1 geothermal well was drilled in 1991 to a depth of 2065 m. Geothermal water is injected into the aquifer at a depth of 1918–2045 m. (Kępińska et al. 2011) to 90.14 m^3h^{-1} (Sapińska-Śliwa 2010).

The distance between the Uniejów PIG/AGH-2 and Uniejów PIG/AGH-1 wells is 1,120 m. At the end of 2000, reconstruction works were carried out in the Uniejów PIG/AGH-1 well (Sapińska-Śliwa 2010).

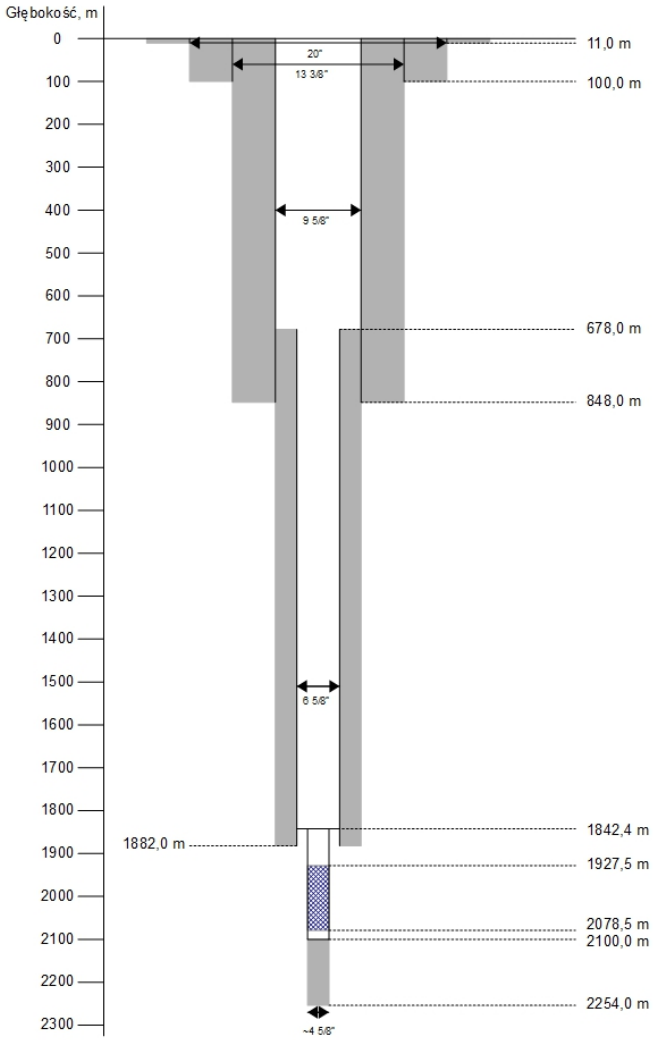

Fig. 8. Scheme of casing pipes in the well Uniejów IGH-1

The Uniejów PIG/AGH-1 well was piped as follows (Fig. 9, 10) (Sapińska-Śliwa 2010):

- from 0 d to o 65 m – pipes $13^{3}/_{8}$" casing pipe cemented to the top,
- from 0 to 541 m – pipes $9^{5}/_{8}$" pipes cemented in the interval from 125 m to 541 m,
- from 0 to 2065 m – pipes $6^{5}/_{8}$",
- from 1918 to 2045 m – filter in the form of a perforated pipe, slots with dimensions 150×8 mm,
- from 2045 to 2065 m – sub-filter pipe.

The column of $6^{5}/_{8}$" pipes was cemented in two stages at intervals from 1680 m to 1877 m and from 308 m to 1680 m. The depression calculated from the fixed water table in the heated well is 26 m with the radius of the depression cone being 236.57 m (Sapińska-Śliwa 2010).

The Uniejów PIG/AGH-2 geothermal well was drilled at the turn of 1990/91 to a depth of 2031 m (Sapińska-Śliwa 2010). Geothermal water is exploited from the aquifer located in the interval 1982-2025 m. The maximum capacity is 120 m^3h^{-1}. The maximum water temperature at the head is 69.2°C. The technical column and the pump chamber are made of steel (Kępińska et al. 2011, Sapińska-Śliwa 2010).

The Uniejów PIG/AGH-2 well was piped as follows (Fig. 11,12) (Sapińska-Śliwa 2010):

- from 0 to 30 m – pipes 13 $^{3}/_{8}$" cementowane do wierzchu,
- from 0 to 457 m – pipes 9 $^{5}/_{8}$" cementowane do wierzchu,
- from 200 to 2031 m – pipes 6 $^{5}/_{8}$", na co skałada się:
- from 200 to 1892 m – over-filter pipes (pełne),
- from 1892 to 2025 m – perforated pipes,
- from 2025 to 2031 m – sub-filter pipes (full),
- from 0 to 87 m – extraction pipe 5".

In 2005, reconstruction works were carried out consisting in cutting out casing pipes in order to run a Centrilift type submersible pump. The column of 6 $^{5}/_{8}$" pipes was cemented in two stages in the intervals from 1654 m to 1838 m and from 630 m to 1654 m. The depression calculated from the fixed water table in the heated well is 74.7 m (Sapińska-Śliwa 2010).

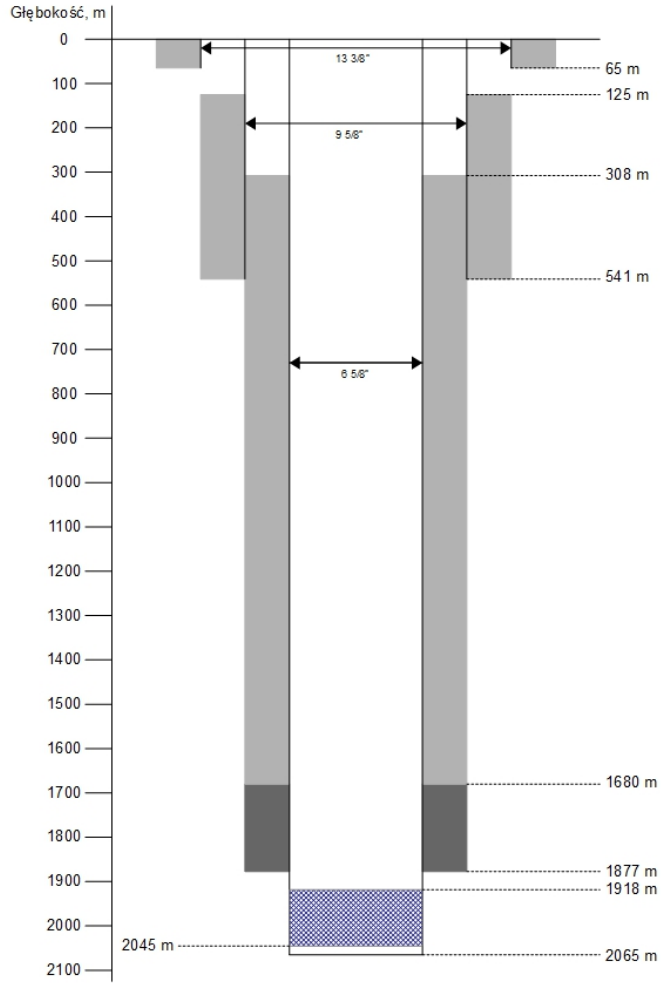

Fig. 9. Scheme of casing pipes in the well Uniejów PIG/AGH-1

Fig. 10. Geological works on the Uniejów PIG/AGH-1 well on the outskirts of Uniejów

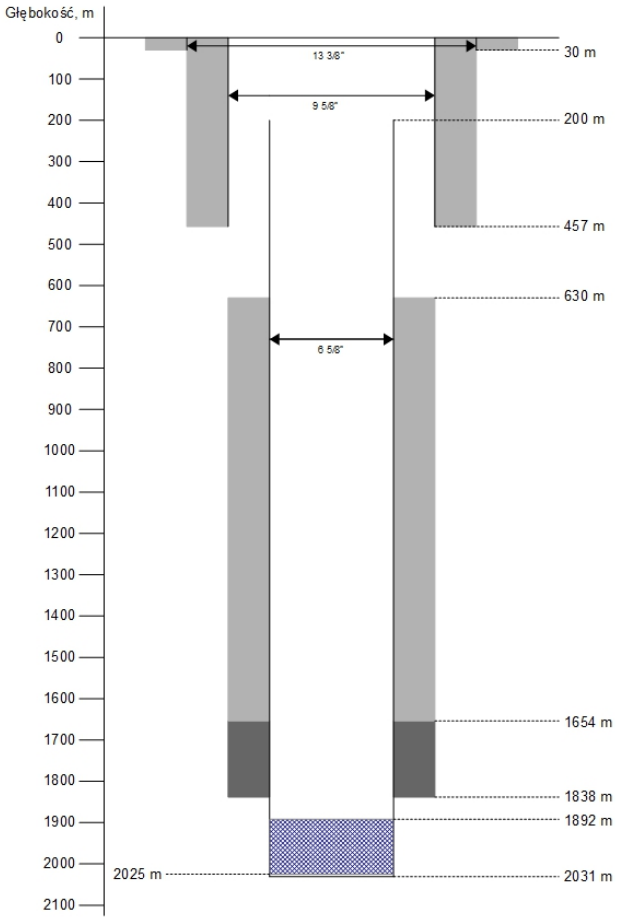

Fig. 11. Scheme of casing pipes in the well Uniejów PIG/AGH-2

Fig. 12. The head of the Uniejów PIG/AGH-2 well in the center of Uniejów

4. HEATING SYSTEM

In 1997, the City Council of Uniejów made a decision on the possibility of heating the city based on geothermal waters. In 1998, the Department of Energy Resources - Faculty of Geology, Geophysics and Environmental Protection at the AGH University of Science and Technology in Krakow, "Study on the profitability of using geothermal waters located in Uniejów for heating, balneological and recreational purposes".

In March 1999, MSc. Eng. Aneta Sapińska developed the "Preliminary concept of using thermal waters in Uniejów". The study commissioned by the Provincial Fund for Environmental Protection and Water Management in Łódź resulted in the establishment of the limited liability company "Geotermia Uniejów" on July 12, 1999. From the very beginning, the entity undertook intensive activities aimed at heating the city. It deals with the production and distribution of thermal energy (central heating and domestic hot water) obtained from geothermal water, as well as the production of water for recreation and promotion of the city.

Since the establishment of the company, the successful development of Uniejów can be dated after the difficult period of the 1990s. For over 20 years, new tourist and recreational facilities and a health resort have been built in Uniejów. Geothermal cosmetics are produced, people have jobs that were previously hard to find. Works of 21st century luxury are being created with amenities such as geothermal water in the third tap in new apartments (Fig. 13), for private baths. Generation of electricity from thermal waters and further development of the health resort are planned. Presented below are the current state and plans resulting from the symbiosis of the city and geothermal water resources.

Fig. 13. Third tap (with geothermal water) for balneological treatments in new private apartments (geotermia-uniejow.pl)

Table 1 presents the current (as of 2021) contracts for the supply of heat by individual facilities. Table 2 presents data on heat and water supplied by "Geotermia Uniejów".

Table 1. *Summary of the number of contracts for the supply of heat by individual facilities in Uniejów (data provided by Geotermia Uniejów sp. z o.o.)*

		From the date of							
L.p.	**Obiekt**	**1 Jan 2015**	**12 Dec 2015**	**31 Dec 2016**	**31 Dec 2017**	**31 Dec 2018**	**31 Dec 2019**	**31 Dec 2020**	**31 Dec 2021**
1	Blocks of flats	13	15	15	17	17	17	17	17
2	Public institutions*	9	9	9	9	9	9	10	10
3	Hotels	15	9	12	12	12	13	13	13
4	Restaurants	6	6	6	5	3	5	5	5
5	Recreational facilities	2	1	1	1	2	3	3	3
6	Individual recipients	95	97	92	82	94	95	93	92
7	Services **	17	18	18	29	21	26	26	26
Total		**157**	**155**	**153**	**155**	**158**	**168**	**167**	**166**

* offices, school, sports hall, kindergarten, banks, Volunteer Fire Department, Municipal and Communal Cultural Center, public library,

** shops, clinics, accounting offices, hairdressing and beauty salons.

Tabela 2*. Data on heat and water provided by "Geotermie Uniejów" (data provided by Geotermia Uniejów sp. z o.o.)*

Lp.	**Consumption of heat and hot water during the year**	**2019**	**2020**	**2021 (Jan-May)**
1	Ordered heat power of recipients, MW_t	5,89	5,7	5,62
2	Total annual heat sales, GJ	23 429,2181	24 060,0547	13 399,0539
3	Annual sales of geothermal heat, GJ	2 338,5611	3 742,6847	4 725,0539
4	Annual direct sales of geothermal water, m^3	64 8652	765 273	296 407
5	Total annual heat sales from the heating plant, GJ including:	2 710,1462	8 804,1889	6 747,3066
5.1	household sector and municipal, GJ	1 490,5805	4 137,9688	3 103,761
	- for heating purposes, GJ	1 490,5805	4 137,9688	3 103,761
	- sale of geothermal water, m^3	0	120	164
5.2	recreation and balneology, GJ	677,5365	3 433,6337	1 551,8806
	- for heating purposes, GJ	677,5365	3 433,6337	1 551,8806
	- sale of geothermal water, m^3	648 652	765 153	296 243
5.3	others, GJ	542,0292	1 232,5864	2 091,665
	- for heating purposes, GJ	542,0292	1 232,5864	2 091,665
	- sale of geothermal water, m^3	0	0	0
6	Coverage of heating needs, %	77	77	77

Moreover, in Uniejów there is a gas power plant operating in a cogeneration system, i.e. producing electricity and heat. Combustion engines powered by natural gas drive generators that generate electricity, and the engines themselves give off heat in the combustion process, which is also used to heat buildings (Sapińska-

Śliwa et al. 2013). There are 4 engines with installed generators, each with an electric power of 0.6 MW and a thermal power of 0.8 MW. As a result, the total electric power of the power plant is 2.4 MW, and the thermal power is 3.2 MW. The heat is used to supplement the missing amount of heat energy obtained from the geothermal heating plant, which minimized the use of the peak load boiler room, generating the missing amount of heat in periods of the lowest external temperatures. Electricity produced in the power plant is supplied to municipal facilities such as: water pumping station, sewage pumping station, school, collective municipal residential buildings, recreational facilities (thermal complex), hotel and restaurant facilities owned by the Uniejów Commune. This allows complete independence from the prices of external electricity suppliers, as the electricity is transmitted through its own transmission networks.

The ordered thermal power from the geothermal heating plant is shown in Fig. 14. Fig. 15 shows the monthly amounts of geothermal heat sold. The quantities of hot utility water sold are shown in Fig. 16. The figures show the values from the last years of operation of the geothermal heating plant in Uniejów.

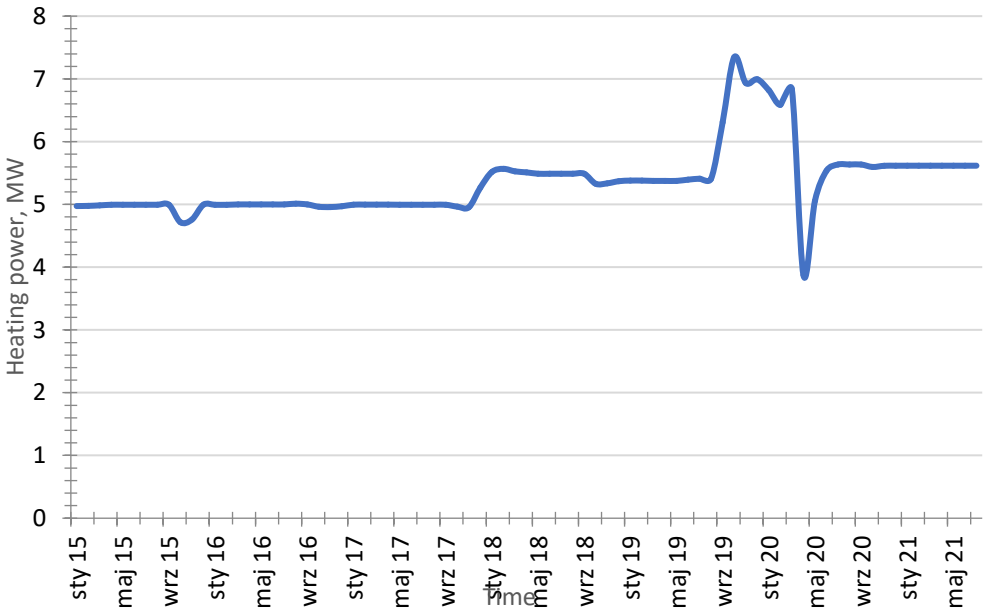

Fig. 14. Monthly ordered power (data provided by Geotermia Uniejów sp. z o.o.)

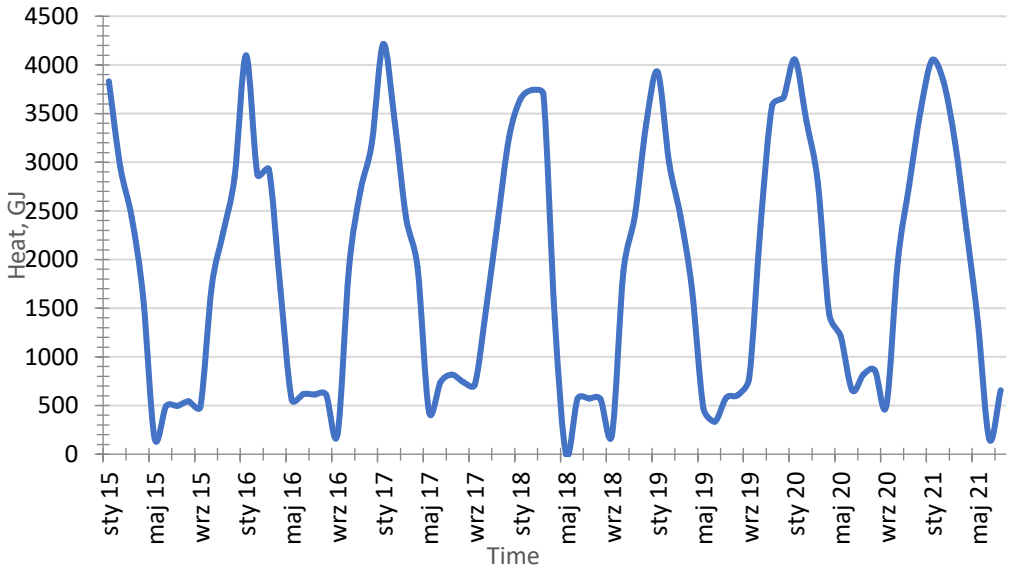

Fig. 15. Monthly amounts of geothermal heat sold (data provided by Geotermia Uniejów sp. z o.o.)

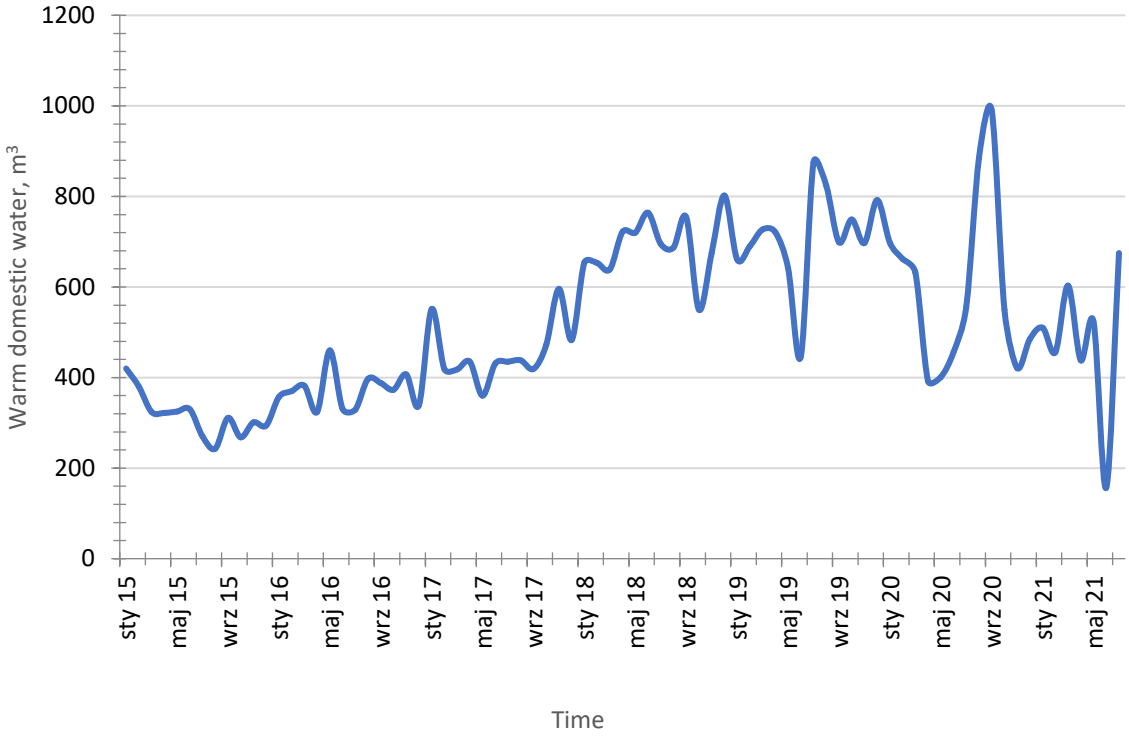

Fig. 16. Quantity of domestic hot water sold monthly (data provided by Geotermia Uniejów sp. z o.o.)

As in the case of many geothermal installations in Poland, recreational services are also offered in the large aquapark "Termy Uniejów" (Fig. 17). The waste heat is also used to heat the surface of the football field (Fig. 18). The hotel base is developing intensively in Uniejów (Fig. 17, 18, 19).

Fig. 17. Geothermal aquapark in Uniejów "Termy Uniejów" (geotermia-uniejow.pl, www.lm.pl/aktualnosci/gorace-kapiele-w-uniejowie, www.termyuniejow.pl)

Fig. 18. A football field with a surface heated by waste geothermal water (geotermia-uniejow.pl)

5. SPA

Since the heating season of 2000/01, the inhabitants of Uniejów have been heating public utility buildings and most multi-family and single-family buildings with heat from geothermal waters. The popularization and use of geothermal energy is gaining momentum every year. In Uniejów, an urban product has been built around geothermal energy for residents and tourists, as well as for patients.

There are balneological facilities and thermal pools in the city, there are three taps in the new apartments - the third one with geothermal water straight from the Lower Cretaceous, from aquifer sandstone. Food products such as pickled cucumbers are also produced on the basis of thermal water (Fig. 19). The minerals contained in the water are also used in the production of cosmetics for humans and animals. Construction is developing, mainly focused on rental (Figs. 20-22). Tourists come not only from the west, from Wielkopolska, from the east, from Łódź, but also from all over Poland. Football clubs during training camps can train in winter on fields heated with thermal water, also abroad (Fig. 18). There is warm water in the city fountains, thanks to which the fountains also work in winter and you can keep warm (Fig. 4) . In a city with a population of 3,000 people, there are over 30 catering outlets (Fig. 23). For 10 years, balneotherapy has been developing intensively (Fig. 24), when the city was granted the status of a thermal spa (the first and only thermal spa in Poland).

Fig. 19. Soups and pickled cucumbers on geothermal water (geotermia-uniejow.pl)

Fig. 20. Aparthotel Termy Uniejów

Fig. 21. Hotel Uniejów

Fig. 22. Uniejów Palast

Fig. 23. Over 30 food outlets in a city inhabited by 3,000 people

In such a health resort, mineral waters are not the basis of healing activity, but thermal waters. In Uniejów, water at a temperature of almost 70°C is obtained from the Uniejów PIG/AGH-2 well. Table 3 presents the detailed chemical composition of geothermal waters from the Uniejów PIG/AGH-2 well. The exploitation data of geothermal waters are:

- self-flow capacity 68 m^3/h, head pressure at self-flow and heated well 2.6 bar and temperature 69°C, capacity with a submersible pump 120 m^3/h;

- capacity 120 m^3/h, head pressure 7.5 bar and temperature 69.6°C when operating a submersible pump (according to the license);

- the parameters of the borehole operation (efficiency) do not change over time (Sapińska-Śliwa 2010),

- the potential heating power of the pumped water, when cooled to 5°C (planned use of heat pumps), is almost 9 megawatts.

Table 3. *Chemical composition of geothermal waters from the Uniejów PIG/AGH-2 borehole (Latour i Smętkiewicz 2012)*

cations	Sodium Na+ Calcium Ca^{2+} Magnesium Mg+ Potassium K+	2300 mg/dm³ 70 mg/dm³ 25 mg/dm³ 21 mg/dm³
anions	Chlorine Cl- Bicarbonate HCO^{-}_{3} Sulfur SO_4^{2-} Bromine Br-	3687 mg/dm³ 140,5 mg/dm³ 5,2 mg/dm³ 1,8 mg/dm³
another	Metasilicic acid H_2SiO_3	6,1 mg/dm³

Additional attractions, apart from balneological treatments (Fig. 24), are the possibility of purchasing e.g. pickled cucumbers and ready-made soups on geothermal water, so naturally salted (Fig. 19), juices based on water extracted from a depth of 2000 m (Fig. 25), cosmetics (Fig. 26). An interesting offer is cosmetic preparations for pets (Fig. 27).

Fig. 24. More and more facilities offer balneological treatments based on geothermal waters (lawendowetermy.pl, kaszteluniejow.pl/strefa-spa, www.lm.pl/aktualnosci/gorace-kapiele-w-uniejowie)

Fig. 25. Juices with geothermal water (geotermia-uniejow.pl)

In 2011, the Uniejów Commune was granted the status of the 45th spa in Poland and the 1st thermal spa in Poland pursuant to Art. 45 points 1 of the Act on spa treatment, spas, spa protection areas and spa communes (2005).

The city became a thermal spa on the basis of the Act of 28 July 2005 on spa treatment, spas and spa protection areas, and on spa communes. In Article 34, we read in point 1 about the conditions for granting the status of a health resort or a health resort protection area:

The status of a health resort can be granted to an area that meets all of the following conditions:

1) has deposits of natural medicinal raw materials with confirmed medicinal properties on the terms set out in the Act;

2) has a climate with medicinal properties confirmed in accordance with the rules set out in the Act;

3) on its territory there are spa treatment facilities and spa treatment facilities, prepared to conduct spa treatment;

4) meets the environmental requirements specified in the environmental protection regulations;

5) has technical infrastructure in the field of water and sewage management, energy, collective transport, and also conducts waste management.

In Article 45 point 1, in chapter 6 on spa communes and communes with the status of spa protection area, we read: the name of the locality within whose administrative borders the spa area is located may be supplemented with the word "spa", if the basis of spa treatment is curative waters, or the word "hot springs" or "thermal spa" if thermal waters are the basis of spa treatment. Uniejów chose the name "Uniejów thermal spa".

Fig. 26. Geothermal Cosmetic Lines (geotermia-uniejow.pl)

Fig. 27. Cosmetic preparations for pets (geotermia-uniejow.pl)

CONCLUSIONS

It can be said with full responsibility that heat and geothermal waters are becoming a factor that increases the income of both the city and its inhabitants. And geothermal waters are used in Uniejów in many ways.

The EARTH FESTIVAL has been held in Uniejów for several years. The city is then visited by thousands of guests, who can enjoy many attractions in specially prepared zones: an electric scooter ride, a meeting with a real Martian rover, a screening at the Outdoor Cinema or learning Dance for the Earth. The climax is usually the great TV Concert "Stars for the Earth" broadcast "live" by TV. The concert was watched by over a million viewers in front of TV sets. The reception of the Festival is very positive, both for the inhabitants of Uniejów and visitors. This is another example of the activation of the local community based on geothermal waters, thanks to which the first and so far only thermal spa in Poland was created.

REFERENCES

Aneta Sapińska-Śliwa, Aleksandra Lewkiewicz-Małysa, Bogumiła Winid, Wody termalne Uniejowa w świetle interpretacji wskaźników hydrochemicznych, DOG AGH, Krakow, 2011

Latour T., Smętkiewicz K., Właściwości fizykochemiczne i chemiczne wód geotermalnych i ich zastosowanie lecznicze ze szczególnym uwzględnieniem wody z odwiertu PIG/AGH-2 w Uniejowie, Biuletyn Uniejowski, nr 1, 2012

Sapińska A., Stan prac przy budowie zakładu geotermlanego w Uniejowie, Międzynarodowe Seminarium na temat „Rola energii geotermlanej w zrównoważonym rozwoju regionów mazowieckiego i łódzkiego", Osuchów 2000; Sympozja i Konferencje, nr 45, Wydawnictwo Instytutu Gospodarki Surowcami Mineralnymi i Energią PAN, Kraków 2000

Sapińska-Śliwa A., Kurpik J., Gonet A., Wykorzystanie wody i energii geotermalnej w Uniejowie - stan aktualny i perspektywy dalszego rozwoju, IV Ogólnopolski Kongres Geotermalny, Zakopane, 30.09–2.10.2013

Sapińska-Śliwa A., Technologiczne i ekonomiczne zagadnienia zagospodarowania wody termalnej na przykładzie Uniejowa (Technological and economic issues relating to thermal water utilisation with the use of an example of Uniejów), Wydawnictwa AGH, Kraków 2010

Szromek A.R., Perspektywy powstania uzdrowisk termalnych w Polsce, Turystyka i Rekreacja, nr 3, 2007

Strony internetowe i inne – grudzień, 2021

Geotermia Uniejów, 2021, Dane Spółki z o.o. "Geotermia Uniejów", (www.geotermia-uniejow.pl)

Strona przedsięwzięcia „For Earth for Us), www.forearthforus.com

Rozporządzenie Rady Ministrów z dnia 27 czerwca 2012 r. w sprawie nadania statusu uzdrowiska miastu Uniejów wraz z sołectwami: Spycimierz, Spycimierz-Kolonia, Zieleń i Człopy położonym na obszarze gminy Uniejów, a podstawie art. 42 ust. 2 ustawy z dnia 28 lipca 2005 r. o lecznictwie uzdrowiskowym, uzdrowiskach i obszarach ochrony uzdrowiskowej oraz o gminach uzdrowiskowych (Dz. U. z 2012 r. poz. 651 i 742)

Świadectwo potwierdzające właściwości lecznicze wody z odwiertu PIG/AGH-2 w miejscowości Uniejów, wydane 29.09.2008, Nr HU-96/WL/2008, Narodowy Instytut Zdrowia Publicznego. Zakład Higieny w Warszawie, Zakład Tworzyw Uzdrowiskowych w Poznaniu, Ustawa z dnia 28 lipca 2005 r. o lecznictwie uzdrowiskowym, uzdrowiskach i obszarach ochrony uzdrowiskowej oraz o gminach uzdrowiskowych (Dz. U. 2005 Nr 167 poz. 1399)

Śliwa T. (red), otwory wiertnicze - istotny element przekształceń energetycznych, Materiały Poseminaryjne, I Seminarium „Geoenergetyka i Geotermalne Pompy Ciepła" na temat: Górnictwo otworowe w rewolucji energetycznej Wydział Wiertnictwa, Nafty i Gazu Akademia Górniczo-Hutnicza w Krakowie, Laboratorium Geoenergetyki AGH, Wydawnictwo Laboratorium Geoenergetyki AGH Kraków, 2022 r.

Aneta Sapińska-Śliwa, Józef Kaczmarek, Uniejów I Geotermia – Studium Przypadku, II Seminarium Geoenergetyka i Geotermalne Pompy Ciepła, Uniejów 24 – 26 Maja 2022 „Inżynieria otworowa dla przekształceń energetycznych w Polsce"

Bentkowski A., Biernat H., Bujakowska K., Kapuściński J.: Aneks do „Dokumentacji zasobów wód termalnych w kategorii B i C z utworów kredy dolnej regionu Uniejowa. Przedsiębiorstwo Geologiczne POLGEOL S.A., Warszawa 2001

Bentkowski A., Biernat H., Kapuściński J, Posyniak A.: Dodatek do dokumentacji ustalającej zasoby eksploatacyjne wód termalnych z utworów kredy dolnej regionu Uniejowa wraz z określeniem warunków hydrogeologicznych w związków z wtłaczaniem wód do dolnokredowego poziomu wodonośnego. Przedsiębiorstwo Geologiczne POLGEOL S.A., Warszawa 2005

Biernat H. Firląg A.: Projekt zagospodarowania złoża wód termalnych z utworów kredy dolnej regionu Uniejowa. Przedsiębiorstwo Geologiczne POLGEOL S.A., Warszawa 2006

Bojarski L., Sokołowski A.: Dokumentacja zasobów wód termalnych w kategorii C i B z utworów kredy dolnej regionu Uniejowa. Państwowy Instytut Geologiczny, Warszawa 1991

Collins A.G.: Geochemistry of Oil-Field Waters. Devel. in Petroleum Sc No 1, Elsevier Sc.Publ.Comp. 1975

Dembowska J., Marek S.: Koło IG-3, Koło IG-4, Poddębice IG-1 w : Profile głębokich otworów wiertniczych Państwowego Instytutu Geologicznego, z. 69, PIG, Warszawa 1990

Górecki W. (red.).: Atlas zasobów energii geotermalnej na Niżu Polskim. Towarzystwo Geosynoptyków GEOS, Kraków 1995

Haładus A., Reicher B.: Warunki hydrogeologiczne dolnokredowego zbiornika wód geotermalnych, w: Mat. Konf. „Możliwości wykorzystania wód geotermalnych w Polsce ze szczególnym uwzględnieniem synklinorium mogileńsko-łódzkiego”, Ślesin k.Konina 26-27 października 1990

Materiały archiwalne Sp. z o.o. „Geotermii Uniejów”. Analiza fizykochemiczna wody podziemnej z otworu Uniejów PIG/AGH-2 wykonana przez Zakład Hydrogeologii i Ochrony Wód. AGH. Uniejów 2006

Materiały archiwalne Sp. z o.o. „Geotermii Uniejów”. Książka odwiertu Uniejów PIG/AGH-2 i Uniejów PIG/AGH-1. Uniejów 2007.

Pazdro Z, Kozerski B.: Hydrogeologia ogólna. Wydawnictwa Geologiczne, Warszawa 1990

Razowska L.: Wskaźniki hydrochemiczne – mało przydatne czy niedoceniane. Współczesne problemy hydrogeologii t.IX Warszawa - Kielce 15-17 września 1999, str. 307-313, PIG Warszawa 1999

Rosenthal E.: Hydrochemistry of Groundwater at Unique Outlets of the Bet Shean-Harod Multiple-Aquifer System. Israel Journal of Hydrology 97, s. 75—87., 1988

Sapińska-Śliwa A.: Technologiczne i ekonomiczne zagadnienia zagospodarowania wody termalnej na przykładzie Uniejowa. Wydawnictwa AGH, Kraków 2010

Macioszczyk A. Hydrogeochemia. Wydawnictwa Geologiczne, Warszawa 1987

Matray J-M, Fontes J-C.: Origin of the oil-field brines in the Paris basin. Geology v18 p 501-504, 1990

White D.E., Hem J.D., Warning G.A.: Tabulation and discussion of chemical analyses many previously unpublished, representing subsurface waters from many geologic environments with descriptions of the sources of the water. Geological Survey Professional Paper 440- F, 1963.

Witczak S., Pietras J.S.: Prognozowanie ruchu zanieczyszczeń w zmiennym polu hydrodynamicznym na przykładzie dużego zbiornika odpadów poflotacyjnych. XXXVIII Sesja Naukowa AGH Zjazd Naukowy, Kraków, Wydawnictwa Geologiczne 1978.

The research leading to these results has received funding from the Norway Grants 2014–2021 via the National Centre for Research and Development in Warsaw.