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GEOTHERMAL ENERGY APPLICATION FOR HEATING SYSTEMS IN SELECTED TOWNS IN POLAND – AN INSIGHT AND RECOMMENDATION FROM THE ICELANDIC POINT OF VIEW

ABSTRACT

The paper presents some selected aspects related to optimal geothermal energy application for space heating systems in four Polish towns being in focus on the EEA Project "Geothermal energy – a basis for low-emission heating, improving living conditions and sustainable development – pre-feasibility studies for selected areas in Poland" (www.eeagrants.agh.edu.pl). A brief description of the current situation in each of the 4 towns considered for the Project (Konstantynów Łódzki, Poddębice, Sochaczew, Lądek-Zdrój) and a summary of the general recommendations for the implementation of district heating systems are given. These take into account significant experience and proven solutions applied in Iceland – a leading country in the world and Europe in terms of geothermal space heating systems. The papers also considers Norwegian experiences in using heat pumps in heating systems because in Polish conditions they are also of purpose.

KEYWORDS

Geothermal energy, space heating, optimisation, Poland, EEA grants

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INTRODUCTION

The paper presents some selected aspects related to optimal geothermal energy application for space heating systems in four Polish towns being in focus on the EEA Project "Geothermal energy – a basis for low-emission heating, improving living conditions and sustainable development – pre-feasibility studies for selected areas in Poland" (www.eeagrants.agh.edu.pl). A brief description of the current situation in each of the 4 towns considered for the Project (Konstantynów Łódzki, Poddębice, Sochaczew, Lądek-Zdrój) and a summary of general recommendations for the implementation of district heating systems are given. These take into account significant experience and proven solutions applied in Iceland – a leading country in the world and Europe in terms of geothermal space heating systems. Moreover, the author considers Norwegian experiences in using heat pumps in heating systems because in Polish conditions they are also of purpose.

The information and outcomes given in this paper are based on Study Visit to Poland, information shared by towns and companies involved in the Project and further analyses made by author and discussed with other Project partners and performers from Poland and Norway.

1. KONSTANTYNÓW ŁÓDZKI

The town population is close to 18.000 inhabitants. The peak load demand (ordered capacity) in Konstantinów Lódzki is around 7.8 MWth. The current heating installation in Konstantynów Łódzki has been modified recently, so that now it receives hot water from the heating installation in Łódź, from a distance of around 8 km to the east. There are oil and gas boilers in the current heat central, acting as reserve.

The total capacity of the heating network in Łódź, operated by Veolia Energia, is several orders of magnitude higher than in Konstantynów, or around 1750 MWth.

Heating in this area is required approximately 220 days per year and peak load is needed some 10–15 days per year. The peak load period starts at around 75% of maximum peak load. The supply temperature is highest during maximum peak load, around 110°C. It is regulated at 65–90°C during the rest of the year, which is most of the time. The radiator design temperature, from information gathered during the site visit is 80/60°C supply/return temperature, referring to 20°C indoor temperature and –20°C outdoor temperature. Tap water heating load is approximately 10% of peak load.

The control for district heating is centralized for all of Veolia Energia heating installation. Heat is produced through co-generation from electricity production (approximately 400 MWel), mostly from coal. All supply temperature variation in the system is automatically regulated, through careful programming of the control system and predictions of the heat load in the next 12–24 hour period, based among other things on weather forecast and known demand patterns during a typical workday or weekend. The volume of the district heating system in Łódź is thousands of cubic meters and variation of temperatures can take several hours to be transported through the very long distribution system in the city. Also, there is significant leakage from a distribution system of this size, can be as much as 20 m^3/hour.

Heating is controlled locally near users, through substations, where secondary heat exchangers are used and flow/temperature/pressure can be controlled in a more localized manner.

A very simple schematic diagram, showing how heat is generated in Łódź and Konstantynów through the cold end of electricity production is shown below, in Figure 1.

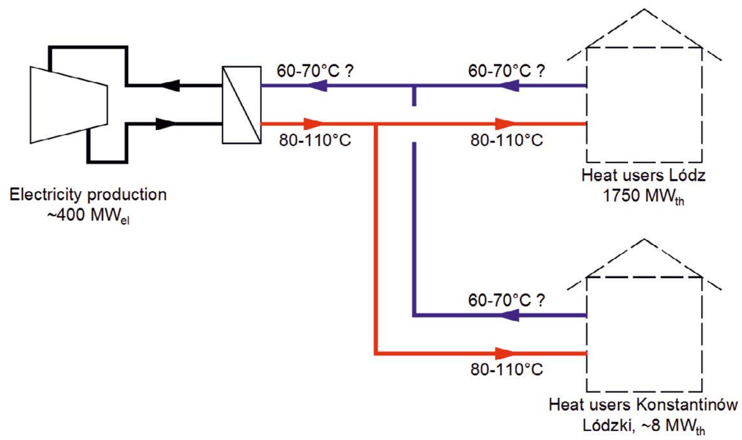

Fig. 1. Heating system in Łódź and Konstantynów Łódzki, simple diagram

Rys. 1. Uproszczony schemat systemu ciepłowniczego Łodzi i Konstantynowa Łódzkiego

The heat input from the proposed geothermal well in Konstantynów Łódzki is only a drop in the ocean, compared to heat demand in Łódź. Estimated flow rate from the well is 100 m^3/hour (27 kg/s) of 70°C hot water. If it is to be utilized down to 15°C, the energy that can be extracted from the well is 6.0 MWth, at most, only 0.2–0.3% of the total peak heat demand in Łódź. It is, however, a significant portion of the local demand in Konstantynów Łódzki.

Therefore, it is proposed that any district heating from the geothermal resource, which is around 6 MWth, be done in Konstantynów only. Since the distribution system is a high temperature one, the proposed system is assumed to operate fully on a heat pump. The simplified schematic diagram for the proposed heating system in Konstantynów Łódzki is shown in Figure 2.

A proposed pilot project for Konstantynów Łódzki is to use geothermal fluid to de-aerate cold water used for make-up water in the distribution system of both Łódz and Konstantynów Łódzki. Estimated water leakage is around 20 m^3/hr, so the capacity of the geothermal well would be more then adequate.

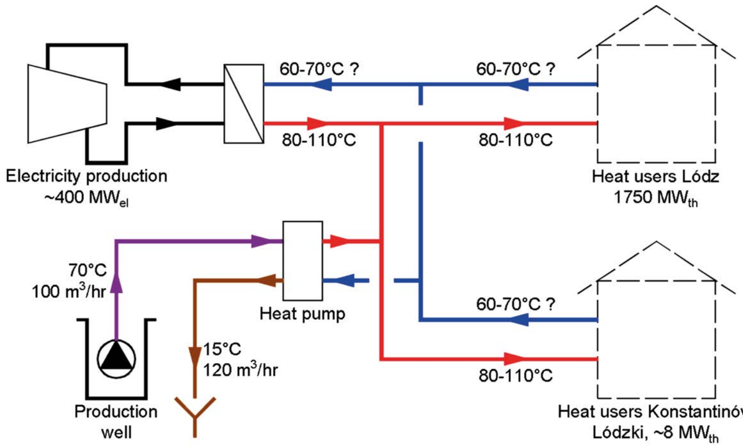

Fig. 2. Konstantynów Łódzki planned geothermal well and heat pump, schematic diagram

Rys. 2. Schemat włączenia otworu geotermalnego i pompy ciepła w Konstantynowie w system ciepłowniczy

Geothermal fluid at 70°C would be used to heat cold water at around 10°C through a heat exchanger, to 65°C. The return geothermal fluid would be around 15°C. The heated cold water would require de-aeration at 65°C, in a vacuum tank at 0.25 barabs (–0.75 barg) vacuum pressure.

A schematic diagram of the process is shown in Figure 3.

The system of geothermal heating is shown within a dotted line in the lower half of the diagram. A heat exchanger with the geothermal fluid is used to heat cold water from the water reservoir to a temperature of 65°C. It is passed to a vertical vacuum tank, where vacuum pressure is maintained with a liquid ring vacuum pump (LRVP). Such a pump maintains vapour pressure of water at 65°C, around 0.25 barabs. The LRVP uses a small amount of water from the reservoir for maintaining the liquid ring and cooling the pump. The 65°C water boils at this pressure and oxygen is boiled from the water, before the water is pumped to the return water pipeline to Łódź.

There is already a make-up water plant in Łódź, at one of the Veolia heat centrals. The high temperature in the installation allows for de-aeration at atmospheric pressure. This existing plant will remain operational (stand-by) and needs to communicate with the geothermal de-aeration plant in Konstantynów Łódzki, demanding addition of make-up water into the system through the return water pipeline from Konstantynów to Łódź.

The heating power required to heat 20 m^3/hr of water from 10°C to 65°C is close to 1.3 MWth. It can be assumed that water leakage is more or less constant throughout the year, as leakage rate only depends on the condition of the distribution system and water pressure, which is more or less constant. The energy required for heating the water is around 11 200 MWh,th/year. If gas is used for heating the make-up water (at around 110 PLN/MWh), this amounts to around 1.2 million PLN/year.

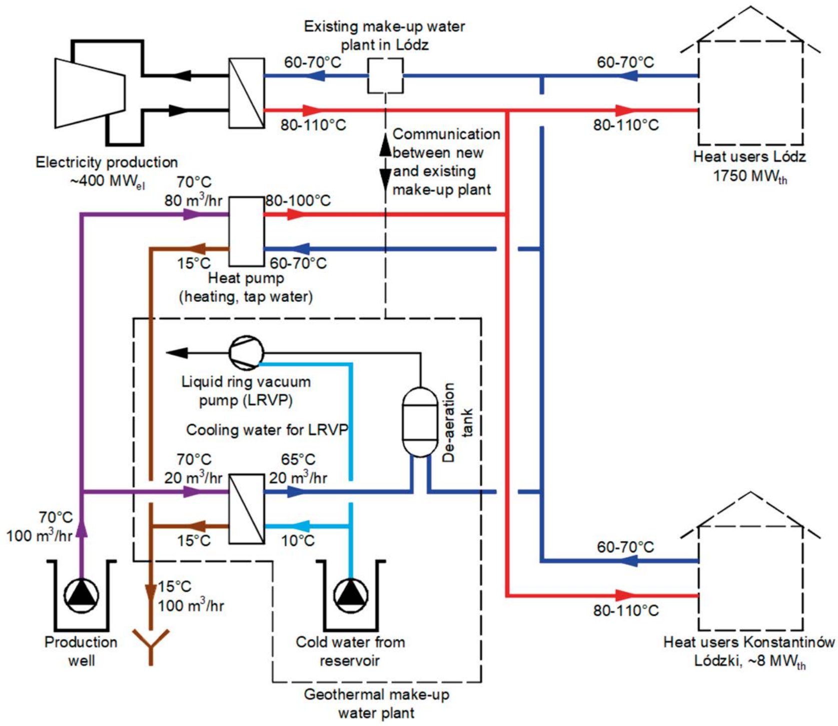

Fig. 3. Make-up water heating and de-aeration in Konstantynów Łódzki

Rys. 3. Układ podgrzania i odgazowania wody uzupełniającej w systemie ciepłowniczym Konstantynowa Łódzkiego

It is therefore economically justified to install a de-aeration installation, using geothermal energy. The main pipeline for the system is only 65–80 mm. What is needed is the following components:

— A liquid ring vacuum pump, size approx. 1 kW.

— Heat exchanger between geothermal fluid, area 60–80 m^2.

— Vacuum tank, control valves, etc., needed for flow control in the de-aeration installation.

— Communication line between existing make-up water plant in Łódź and proposed system in Konstantynów Łódzki (where the proposed geothermal well is to be built).

— Connection to cold water supply, 20 m^3/hr capacity.

— Other local electronic controls, using signal from Łódź that demands more make-up water

The cost of such an installation would probably be several hundred thousand PLN but will probably not exceed 1,0 milion PLN. The economic savings alone from not using 11,2 GWh from gas would therefore be quite significant. The heated make-up water would be sent through the return water pipeline, from Konstantynów Łódzki to the pump substation in Western Łódź. No additional transmission pipelines would be needed for this installation.

This make-up water installation is considered to be an addition to the geothermal heating system in Konstantynów Łódzki, which would still use around 80% of the energy from geothermal fluid for district heating.

Emissions from gas heating are close to 180 tons CO_2/GWh, so the amount of CO_2 release avoided would be around 2000 tons CO_2/year.

The key justificiations for implementing this pilot project are direct economical savings from not using gas for heating (which would repay the investment in the geothermal de-aeration in a short time) and reduction of greenhouse gas emission. In case of outage of this proposed system, there would always be access to make-up water production in the existing installation in Łódź, which would be operated as a stand-by system.

2. PODDĘBICE

The situation in Poddębice – a town with close to 8,000 inhabitants – is more or less unchanged since some time. The only major change is the extension of the current cooling pond, by a volume of approximately 1500 m^3 of water. This extension is built to accommodate increased flow from the geothermal well Poddębice GT-2. The current geothermal well, heat central and distribution network still has installed capacity of around 5.5 MWth, where approximately 1 MWth comes from peak load boilers.

A simple schematic diagram of the current system is shown in Figure 4. Part of the return geothermal fluid is sent to the local swimming pool which is still only open during summertime.

The next immediate change to the heating system is to increase the flow rate of the downhole pump in production well Poddębice GT-2, from 190 to 252 m^3/hr. This may slightly increase the heating capacity from geothermal fluid but the problem remains, that not nearly enough energy is being extracted from the geothermal fluid. Ideally, the return temperature of geothermal fluid should be 30°C, not 50–55°C.

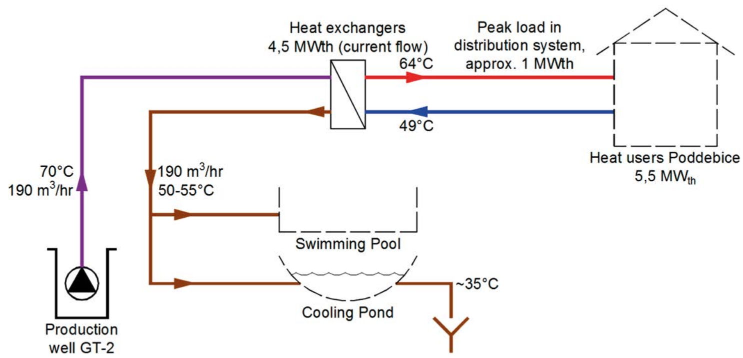

Fig. 4. Current geothermal heating system in Poddębice, simple diagram

Rys. 4. Uproszczony schemat geotermalnego system ciepłowniczego w Poddębicach – stan obecny

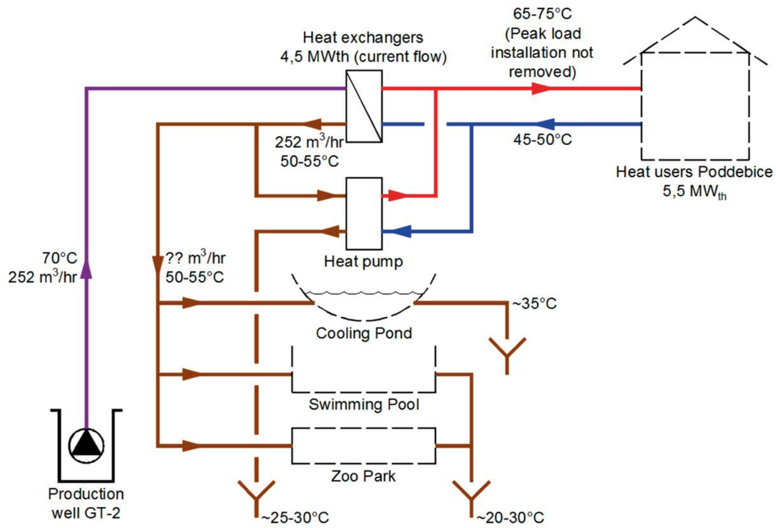

Fig. 5. Heating system in Poddębice in the next years after 2018

Rys. 5. System ciepłowniczy w Poddębicach po 2018 roku

The proposed general setup for the heating system in the near future is shown in Figure 5.

After the flow from Poddębice GT-2 production well has been increased, there will be more heating energy for the town and more water can be discharged to the cooling pond. It is recommended that:

— The cooling pond will remain at the installation in case of emergency discharge
— Peak load boiler installations in the distribution remain in the system, at least in the first years

The installation of a heat pump will be the most efficient way to extract as much energy from the geothermal fluid as possible. If a separate transmission pipeline will be built towards the nearby Zoo Park (around 500 meters away) and used there for heating/pool warming purposes, there will be less water left to be discharged.

If the swimming pool is to be expanded and used all year, there will be increased use for the hot return water from the primary heat exchangers in the heat central. Also, if the Zoo Park will also be using excess geothermal return fluid for winter heating, there may be considerably less than 252 m^3/hr flow of 50–55°C fluid left to power the heat pump. At this stage of the project, a local company in Poland is estimating the heat load at the Zoo Park. The swimming pool heat load will also have to be increased from what it is today and if it is to become an all-year pool, there may be significantly less water left.

If, say, half the water is used (125 m^3/hr), and cooled from 50 down to 30°C, the energy from the geothermal fluid to a heat pump would be 2.9 MWth. Assuming a compressor heat pump with COP between 3–4, the output to the district heating system, at a temperature of up to 75°C, might be around 4.0 MWth, so electrical capacity would be around 1.0 MWel.

Using an absorption heat pump, with COP of – say – 1.4, it would use around 7 MWth of energy from gas and deliver around 10 MWth to the district heating network, also consuming 2.9 MWth from the geothermal fluid by cooling it down from 50 down to 30°C.

If all the return water is used for heating, the capacities would, of course, be twice as high from either compressor or absorption heat pumps.

It is therefore recommended that, in the beginning, a suitably large heat pump (that will heat the supply temperature up to around 70°C) be installed and a fuel boiler peak load (existing in the network) be used as secondary peak load in the network.

Another proposed operation in the district heating system is to increase the heating surface of radiators in selected buildings to reduce return temperature and water flow through the radiators in the building. It is therefore suggested as a pilot project that one or more apartments be fitted with a larger radiator area, to demonstrate how that change will reduce the return water temperature in buildings. Temperature drop may, in this way, be increased to over 30°C, therefore requiring 50% less water flow through each building. Supply temperature is still adequately high in the system for normal radiators, so floor heating is not needed.

A schematic diagram of the process is shown in Figure 6. The indicated supply temperature is shown as 64°C, which is the temperature in the heating network without added peak load. During the coldest days, the supply temperature is increased to 75°C.

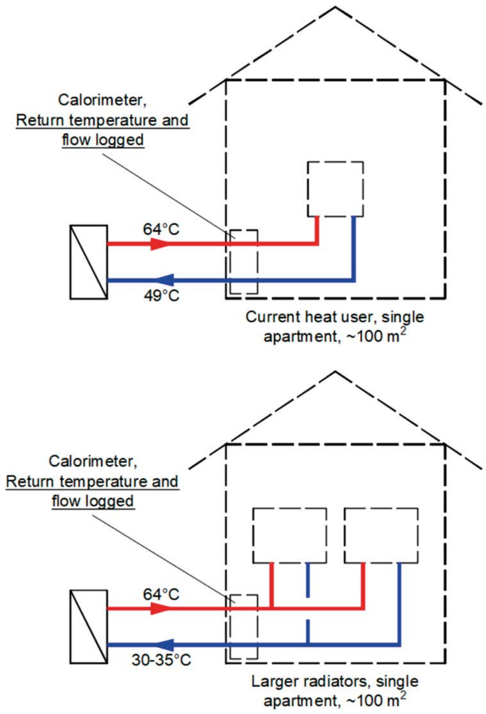

Fig. 6. Current radiator system and large radiator system in Poddębice, supply temperature without peak load

Rys. 6. Obecny system grzejników oraz ich zwiększonej powierzchni grzewczej w Poddębicach; temperatura zasilania nie uwzględnia podgrzewania szczytowego

The proposed action is to install large radiators in an apartment of approximately 100 m^2, which corresponds to roughly 5,0 kWth heating peak load. Radiators should be selected for 75/30°C supply/return temperature during peak load and the number/size of radiators should then correspond to the estimated heat demand of the apartment.

These larger radiators are estimated to be around 60% larger than the more common 80/60°C to 90/70°C radiators that are more commonly used in Poland. This means that they will take up more wall space than usual and will require probably more connection piping.

A calorimeter would be installed on the supply/return pipe in the house connection, measuring supply/return temperature and flow rate. This should be a logged calorimeter, which gathers average flow/temperature data at every hour. The behavior of the heating could thus be monitored over a whole year.

A similar calorimeter with data logging should be installed in a nearby apartment of the same size but using conventional high-temperature radiators, where data would also be collected over 1 whole year. The flow and supply/return temperature curve of an apartment with conventional heating could thus be compared to the same operational data from a house with larger low-temperature radiators during the same period. The end result will be lower flow rate and lower return temperature profile in the larger radiator building, demonstrating how more energy can be extracted from distribution system and thus, the geothermal fluid.

These 3 components would be required:

— A set of large, low-temperature radiators for 1 apartment, perhaps an extension to existing radiators would be sufficient.
— A calorimeter with data logging of flow and temperatures, collected over a 1 year period with at least 1 hour frequency
— Same calorimeter as above, but installed in a house with conventional heating.

The cost of installing these components will be on the order of 10,000–12,000 PLN for the large radiator + calorimeter/logging in 1 apartment + around 5,000 PLN for the calorimeter/logger in another apartment with conventional heating.

Using larger radiators is therefore a simple suggestion for a pilot project in Poddębice, to demonstrate that return temperature in the district heating system can be lowered. Cost of such an installation would be minimal.

3. SOCHACZEW

The population of Sochaczew is around 37.000 inhabitants. There are 5 heat centrals in the town, located around the town centre. Approximately 1/4 of the town has a heating distribution system installed. The total capacity of the five heat centrals is approximately 15 MWth.

The fuels used for heating are gas (55%), oil (16%), coal (27%) and biomass (2%). The design temperature of the distribution system is 90/70°C supply/return temperature and radiator systems in houses and other heated spaces are installed accordingly. The supply temperature is raised to approximately 110°C during peak load, just like in Łódź and Konstantynów Łódzki.

The control room for all 5 heat centrals is in the main heat central at Żeromskiego 23 Street. All controls in the system are operated from this station. No automatic load prediction is in place for this installation, all supply temperature changes (and other operation parameters) are controlled manually.

In the early 2000's, the distribution heating pipelines were upgraded to pre-insulated piping. Each of the 5 heat centrals has its own distribution system, so these systems are not interconnected. The plan is to interconnect the distribution systems in the future, for added operational safety.

A simple schematic diagram of the current system is shown in Figure 7. The only source of heat is fuel boilers. No heat is produced through electricity co-generation in Sochaczew.

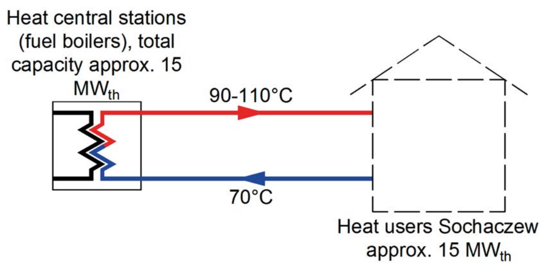

Fig. 7. Current heating system in Sochaczew, simple diagram

Rys. 7. Uproszczony schemat system ciepłowniczego w Sochaczewie – stan obecny

Heating season in Sochaczew is estimated to be around 220 days per year, with peak load reaching around 15 MWth and tap water heat demand around 1.2 MWth.

The proposed geothermal well in the town of Sochaczew will have a temperature of 40°C and flow rate of 120 m^3/hour. By cooling the geothermal fluid down to 15°C, up to 3.6 MWth may be extracted from the geothermal resource. That return geothermal fluid is from upper cretaceous reservoir (1.5 km depth) and is assumed to have low mineralization. It may therefore be injected into water reservoirs as potable water.

The maximum heat demand in Sochaczew – around 15 MWth – is far higher than the capacity of the geothermal well and heat pump, that would typically have capacity of only 3.6 MWth from the resource or 4–5 MWth from a heat pump.

Since the reservoir temperature is at the lowest practical value for geothermal heating, 40°C, it would be wise to concentrate on heating the return water from the distribution system, which is normally around 70°C. Since there is no electricity generation in the system, there is no cold end temperature to worry about (like in Lódz), so heating of the return water from 70°C to perhaps 75–80°C would only lower the heat load of the fuel boilers.

The simple representation of such a system is shown in Figure 8, where all the geothermal water goes through a heat pump, which heats the return water in the distribution system and lowers the heat load on the boilers.

The planned interconnection of the 5 distribution systems means that the return water to 2 or more heat centrals can be combined into one common header. Heating that water

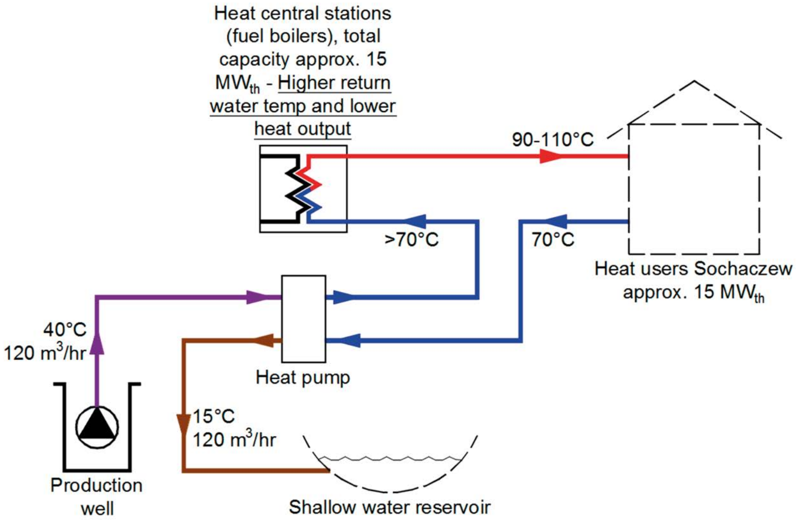

Fig. 8. Sochaczew low-temperature geothermal well and heat pump, schematic diagram

Rys. 8. Schemat współpracy niskotemperaturowego otworu geotermalnego z pompą ciepła w Sochaczewie

(which would have a higher flow rate than from the geothermal well) would therefore raise the temperature less if the flow rate is high.

Overall, the reduction of heating capacity from fuels would be somewhere on the order of 3 MWth, where the energy from the geothermal resource (total heat extracted minus the energy for heat pump) would lower the required capacity of the fuel boilers, from 15 down to 12 MWth.

Since the geothermal water is expected to be relatively free of minerals and suitable for drinking water the following pilot project is proposed: There are quite a few radiator manufacturers that supply so-called "forced convection radiators". These units are equipped with finned coils and a fan, that increases air flow and therefore convection in these units. These manufacturers are, for example, Licon (www.liconheat.com), Veneto (www.kinnan.se) and various others.

These forced convection units are somewhat thicker than normal wall-mounted radiators but the overall size. Noise levels from these units are very low (20–30 dBA) and they are able to heat houses from water as cold as 35–40°C.

Since the proposed geothermal heating system in Sochaczew is to use low mineralization geothermal fluid from upper cretaceous layers at 40°C (suitable as drinking water similarly to the neighboring plant in Mszczonów), it would be ideal to install this type of forced convection radiators in a couple of buildings near the proposed geothermal well. The cleanliness of the water would mean that no injection well would be needed. Cooling of the geothermal water would also be within 10°C, so there would be negligible risk from scaling due to temperature change. Installing a filter on the low-temperature radiator inlet would be sufficient.

Typical peak heat load in a single 100 m^2 apartment is around 5 kW, so water flow to this type of radiator would be around 0.36 m^3/hour for a single apartment, if the geothermal fluid cools from 40 down to 30°C. This would therefore require a standard 2x DN 20 mm (3/4") house connection pipe to/from the house.

A schematic diagram of the process is shown in Figure 9, where the connection to the low-temperature coil radiator is shown at the top of the picture. Using a small amount of the 40°C water from the geothermal well and re-injection 30°C return water will not affect the water temperature in the shallow water reservoir, as it is only a small fraction of the total flow.

The rest of the heating system from geothermal fluid would still be through a heat pump, where return fluid from the 90/70°C distribution system is heated through a heat pump, from the 40°C geothermal resource.

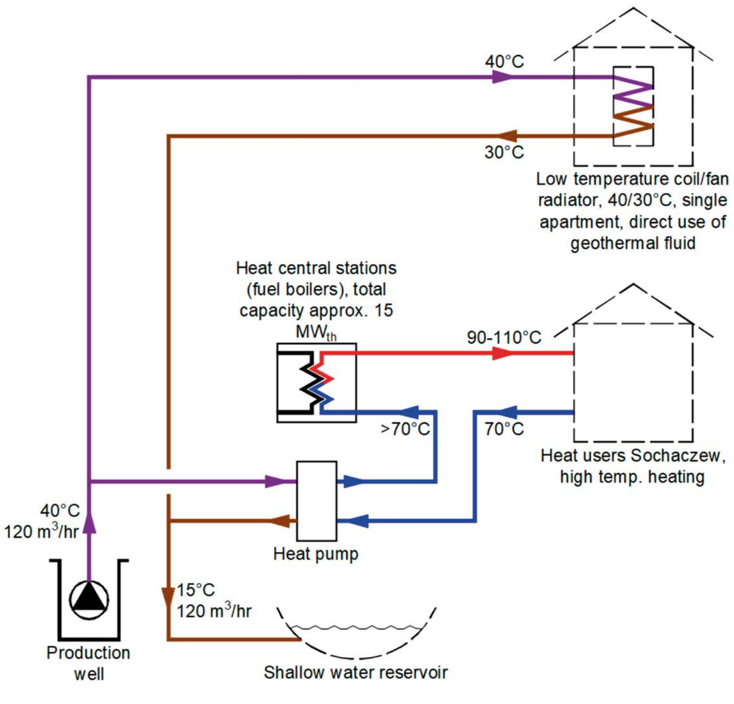

Fig. 9. Low-temperature coil radiator pilot project in Sochaczewco

Rys. 9. Niskotemperaturowy grzejnik spiralny w projekcie pilotowym w Sochaczewie

The proposed pilot project is to install one of these radiators in an apartment near the proposed geothermal well. The 30°C return geothermal fluid would be collected and combined with the 40°C fluid from the production well, with negligible cooling of the geothermal fluid to the compresion heat pump.

The following needs to be installed for this pilot project:

- Supply/return pipeline to/from a single apartment near the proposed geothermal well, a few dozen meters,
- Fan/coil radiator(s), connected though 2xDN20 house connection,
- Electric supply for the radiator fan, 24 or 240 V, power consumption typically several dozen watts.

Typically, only one unit may need to be installed but it depends on the size of the proposed apartment, as well as the quality of insulation in the area. Cost of this radiator installation would be minimal, at several thousand PLN for the radiator and connection. What this pilot project would demonstrate is that low-temperature fluid can be used in radiators, as has been done successfully in Norway. The radiator unit should be selected based on manufacturer's recommendations, where indoor temperature and heat load are first established and a suitably sized radiator then selected.

4. LĄDEK-ZDRÓJ

The population of Lądek-Zdrój is over 6,000 inhabitants. The existing low temperature geothermal reservoir is currently used at the Zakład Przyrodoleczniczy "Wojciech" spa and medicinal spa health centres. Water for these installations comes mostly from the artesian well L-2, at a temperature of around 40–45°C. This water is used for balneological purposes only, not for heating.

The elevation of Lądek-Zdrój is much higher than in the other towns in this study, or between 450–500 meters above sea level. The average annual temperature is around 2°C lower than in the other towns. Average maximum summer temperatures are only around 21°C. On the other hand, average lowest temperatures are only –6°C, so it is not expected that the coldest days will be much less than –10°C.

Therefore, the heating period can be expected to last considerably longer in Lądek-Zdrój than in the other towns, or close to 300–350 days per year, with a heating design temperature of –10°C. This means that there is a long heating season with a rather low peak load.

Heating installations in the town are partly boiler systems with water distribution system inside larger buildings. Mostly, though, heating is through coal, oil or wood furnaces in individual houses and households. There is no municipal distribution system in the town, only within buildings themselves, connected to fuel boilers up to 1.0 MWth in size. Supply/return temperatures in these installations are typically 90/70°C. The radiators in buildings, which appear to be quite common, are designed for these temperatures, just as in the rest of the country where boiler heating is used.

According to information from Lądek-Zdrój the proposed geothermal well for the town is estimated to have 70°C water and flow rate of 50 m^3/hr. By cooling down the geothermal fluid down to 15–20°C, up to 3,0 MWth of heat power may be extracted from the resource.

Using a heat pump (compressor or absorption) to extract heat from the resource and cool down the geothermal fluid will give a total heating capacity of between 5–7 MWth.

The total peak load of the entire town, if compared to Poddębice (18 MWth, with 8000 inhabitants), is probably around 12–15 MWth. In Poddębice, the coldest days are colder, so the peak load is relatively higher. It is clear, in any case, that the single geothermal well will not suffice to heat all of Lądek-Zdrój, perhaps only around half the town.

There are three possibilities to consider for geothermal heating in the town of Lądek--Zdrój:

— High temperature heating, supply temperature 90°C (current radiator setup in many buildings),
— Lower temperature heating, 65–70°C supply temperature (new radiators in houses that currently do not have radiators installed),
— Snow melting.

High temperature heating will require a system with heat pump (compressor or absorption) and perhaps a small peak load boiler. The supply temperature would be modulated between 70–90°C, depending on the head load. The total capacity of the district heating system would be around 5–7 MWth.

Low temperature heating will require a smaller peak load boiler, as a larger portion of energy would come from geothermal heating. This would of course mean that a large number of houses would need to be fitted with radiators.

Snow melting in Iceland has the following operational characteristics:

— It is normally operated between –5°C and 0°C. Snowfall is rare at colder temperatures,
— Design unit load on a snow melting system is typically 230 W/m^2,
— Supply temperature to snow melting systems is typically around 35°C,
— Return temperature of fluid from snow melting systems is typically 10–15°C.

Snow melting installations are typically operated via “snow stats”, an on/off sensor that indicates whether there is snow on the ground. If it is dry and below freezing, there is no need for snow melting and therefore, the snow melting system will not be demanding warm (≈35°C) water when it is not needed. That way, the overall energy demand for snow melting will be relatively low in the overall annual heating energy demand.

If water to snow melting cools down from 35 down to 10–15°C, each m^3/hour of geothermal fluid used directly would therefore be sufficient for melting approx. 100–125 m^2 of street area. Using all the return geothermal fluid for snow melting (50 m^3/hr) at a temperature of 35°C would therefore suffice to melt an area of 5000–6000 m^2, which is sufficient for several hundred meters of a 5–10 m wide street. That will most probably be sufficient for snow melting in the steepest parts of streets in Lądek-Zdrój, even in more than one location.

Large parts of the streets in Lądek-Zdrój are laid in cobblestone. The best road material for snow melting is concrete, under which snow melting plastic pipes are laid, with an insulating sand foundation underneath. This ensures the best heat transfer upwards to the area where snow is to be melted. Another common road material is asphalt. This is actually worse than cobblestone, since it transfers heat worse than rocky material. Cobblestone has been used successfully in snow melted zones in Iceland, in a parking lot in the Reykjavik Area.

Of course, installing snow melting will require large parts of the street to be dismantled, sanded, installing the snow melting pipes and covering everything with cobblestone. Installing a concrete surface in the melted area may therefore be just as economical as re-installing cobblestone.

An overall schematic drawing of the possible future system in Lądek-Zdrój is shown in Figure 10.

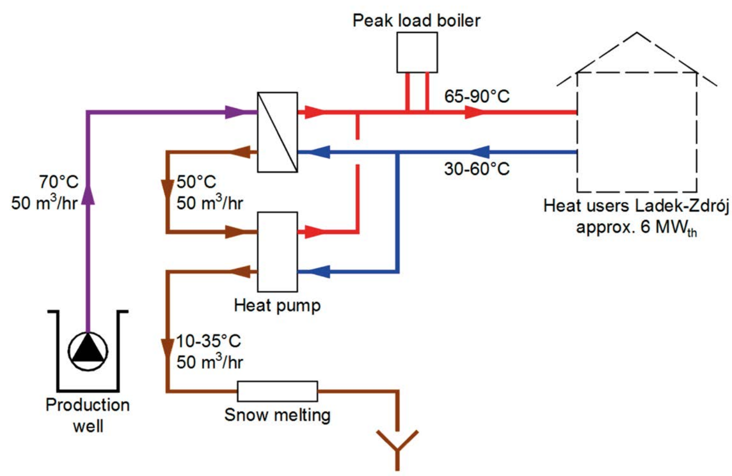

Fig. 10. Proposed heating and snow melting in Lądek-Zdrój, schematic diagram

Rys. 10. Schemat proponowanego systemu grzewczego oraz topienia śniegu w Lądku-Zdroju

This system could apply to both low and high temperature heating, whether radiators are retrofitted or not. The function of the snow melting system would be connected to the operation of the heat pump: If there is snow on the ground according to the snow sensor, the heat pump would cool the geothermal fluid down to no more than 35°C and thus, snow melting would be functional.

Otherwise, the heat pump would cool the geothermal fluid down to 10–20°C during high heat demand. That way, the water flowing through the snow melting system – whether it is needed or not – would be cooled down to as low as 5°C, if there is low outdoors temperature and no snow. In any case, the return geothermal fluid would always be flowing through the snow melting system and from there, to the river in Lądek-Zdrój, at a low temperature.

The combined capacity of the heat pump/peak load boiler would be around 50% or higher of the total heat capacity of the district heating system.

The proposed pilot project for geothermal utilization in Lądek-Zdrój is the installation of a snow melting system, using direct geothermal fluid. The system has low temperature geothermal fluid in the range 10–40°C, so plastic piping can be used almost exclusively. Injection of hot geothermal water, to increase the supply temperature if needed, would be included. the proposal is to use up to all of the return geothermal fluid, which would result in a rather costly installation, ranging between 4–5 million PLN. This would, in turn, also ensure that the return geothermal fluid would always be cooled down to less than 30°C, whether snow melting would be needed or not. Using part of the return geothermal fluid for snow melting – not all of it – would result in a lower cost pilot project but then, the safe discharge of geothermal fluid at less than 30°C to the town river, would have to be ensured, e.g. through the use of a cooling pond as in Poddębice.

SUMMARY – PROPOSALS FOR UTILIZATION OF GEOTHERMAL ENERGY IN POLAND

From the visit to the four towns in Poland, regarding experience from Iceland and Norway and based on the proposed future system and pilot project proposals, the following overall recommendations for geothermal heating in Poland can be summarized:

— Utilization of heat from geothermal fluid needs to be maximized, as flow rate is limited in all the towns,
— This can be achieved through use of heat pumps (lower temperature geothermal fluid) and/or larger radiators in buildings, that can operate on lower supply temperature than 80–90°C,
— Cascaded use of low-temperature geothermal fluid is possible, e.g. through swimming pools, zoo park heating and snow melting. Direct use is encouraged whenever possible, in these cases,
— Based on Norwegian experience, the use of ultra-low temperature radiators, using water as low as 40°C is quite possible and should be considered where geothermal fluid is clean enough for direct use.

Iceland
Liechtenstein
Norway grants

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ZASTOSOWANIA ENERGII GEOTERMALNEJ W SYSTEMACH CIEPŁOWNICZYCH W WYBRANYCH MIASTACH POLSKI – SPOSTRZEŻENIA I REKOMENDACJE Z PUNKTU WIDZENIA DOŚWIADCZEŃ ISLANDZKICH

STRESZCZENIE

W artykule przedstawiono niektóre wybrane aspekty związane z optymalnym zastosowaniem energii geotermalnej w systemach ciepłowniczych w czterech wybranych miastach w Polsce w ramach projektu EOG „Energia geotermalna – podstawa niskoemisyjnego ciepłownictwa, poprawy warunków życia i zrównoważonego rozwoju – wstępne studia możliwości dla wybranych obszarów w Polsce" (www.eeagrants.agh.edu.pl). Przedstawiono krótki opis aktualnej sytuacji w każdym z czterech miast rozważanych w Projekcie (Konstantynowie Łódzkim, Poddębicach, Sochaczewie, Lądku-Zdroju) oraz podsumowanie ogólnych zaleceń dotyczących wdrażania systemów ciepłowniczych. Uwzględniają one znaczące doświadczenie i sprawdzone rozwiązania stosowane w Islandii – wiodącym w Europie i na świecie pod względem stosowanie energii geotermalnej w ciepłownictwie. W artykule uwzględniono również norweskie doświadczenia w stosowaniu pomp ciepła w systemach grzewczych, ponieważ w polskich warunkach są one również niezwykle istotne.

SŁOWA KLUCZOWE

Energia geotermalna, ciepłownictwo, optymalizacja, Polska, granty EOG

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Norway grants

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