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# Harnessing the Energy Potential of Associated Gases from Geothermal Water Deposits in Micro-Cogeneration Power Plants

Valorificarea potențialului energetic a gazelor asociate din zăcămintele de apă geotermală în instalații de cogenerare

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**Abstract:** *The paper presents an approach to use the associated gases from geothermal water deposits for electric and thermal energy cogeneration in centralized distribution systems.*

**Key words:** associated gases, energy sources

## 1. Introduction

In the current political and economic context, where the diversification of energy sources used to produce electricity and thermal energy is becoming an increasingly prominent advantage and renewable energy sources with as little impact on the environment as possible are becoming more and more necessary, the use of the geothermal water resource that Romania has, is becoming more and more attractive. This is encouraged by the Romanian state and the European Union by allocating substantial non-reimbursable financing in this field.

The paper does not aim to present revolutionary information in the field but to place it in a context that will be of interest for many years.

The paper deals with the basic technological scheme of an installation for separating associated gases from the geothermal exploit its energy potential in thermal power plants. If these gases have high energy potential, they should be preferred for use in high-efficiency cogeneration installations to obtain electrical and thermal energy, water extracted from the deposit to obtain electrical and thermal energy.

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Fig. 1. Distribution of geothermal water deposits in Romania

## 2. Description of the technological scheme:

The phenomenon of gas release when geothermal water is extracted from the well is scientifically modelled by Henry's law. One formulation of the law is: "*At constant temperature, the amount of gas dissolved in a liquid, at saturation, varies in direct proportion to the partial pressure of the gas in contact with the liquid.*" [1]. Thus, gases are released inside the borehole and also after extracting the water from it, because on the technological route represented in Fig. 2, the pressure is much lower than in the deposit.

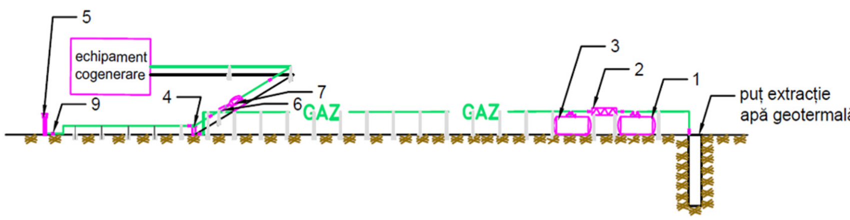


Fig. 2 The basic technological scheme for producing electricity and thermal energy in cogeneration, using aggregates fed with associated gases, with more than 50% methane, from geothermal water well, 1-biphasic separator, 2-heat recovery, 3-buffer vessel, 4-centrifugal liquid separator, 5-torch, 6-conical filter, 7-compressor.

In the technological scheme presented above (Fig. 2), two gas capture points have been provided: one is the well extraction head, and the second is the two-phase separator, where the final degassing of the geothermal water takes place. From the two-phase separator, the geothermal water follows its route to the thermal power plant and then to the reinjection well. If the associated gases extracted in this way have a minimum required methane content of over 50%, they can be exploited by burning them in high-efficiency cogeneration aggregates where electrical and thermal energy will be produced. In this situation, the associated gases follow the technological path presented in Fig. 2.

Fig. 3. Two-phase separator [4]

From the two-phase separator (Fig. 3), the gases, if necessary, pass through a heat recovery unit and then reach the buffer vessel, which will be sized so that when the aggregates are switched on, the pressure does not drop by more than 30% from the nominal value chosen for the operation of the installation [7]. In the buffer tank, it takes place the accumulation of a quantity of gas required for the operation of the installation in good conditions, without flow fluctuations. Also, the condensate collection resulting from the cooling of the gases within the heat recovery unit and the buffer tank itself occurs. The buffer tank will be purged periodically, either automatically or manually. Condensate pans with float can be used, provided they close tightly enough and quickly so that there is no escape of gases into the atmosphere. It is recommended that an automatic air freshener be included in the scheme. After the buffer tank, the gases pass through one or more centrifugal liquid separators, as noted in Fig. 2 with 4.

Fig. 4. Centrifugal liquid separator [5]

Then, the gases reach the compressor, but not before being passed through a conical filter, which protects it from possible mechanical impurities. The compressor (Fig. 5) supplies the cogeneration aggregates with gas at constant pressure and flow rate (the supplier equips the aggregates with filters, pressure regulators, and flame-back protection devices).

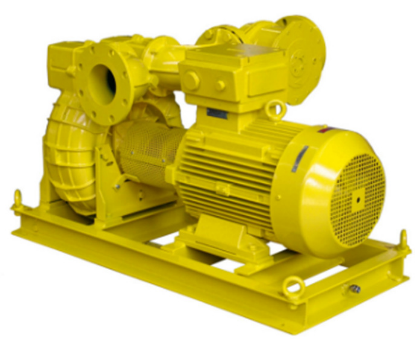

Fig. 5. Gas blower [6]

The cogeneration unit consists of the following primary equipment: a four-stroke thermal engine designed to work optimally with the gas mixture provided by the well, an electric power generator, and equipment for recovering thermal energy released by the engine and from the combustion gases. For this purpose, it is advised that the engines be manufactured following the composition analysis of the gases from the geothermal well and the project's technical requirements. The engine drives the electric power generator. Thus, the engine's power is determined according to the flow rate and the calorific value of the gases extracted together with the geothermal water.

The engine is equipped with heat recovery from the cooling circuit and from the burnt gases discharged to the chimney (Fig. 6 and Fig. 7)

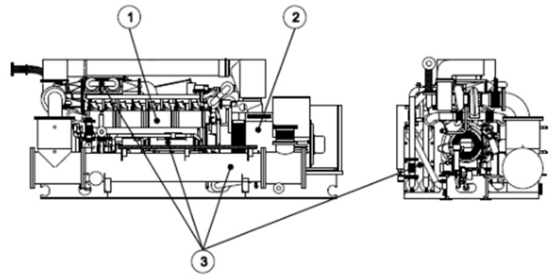


Fig. 6 Cogeneration aggregate [8]
1-Gas engine, 2-Electricity Generator, 3-Heat Exchanger

The engine drives the electric power generator, and the heat produced during the production process is recovered and sent to the thermal power plant.

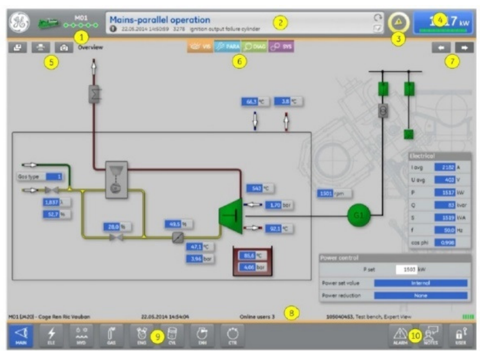


Fig. 7 Basic diagram of cogeneration aggregate [7]

The thermal power plant can be supplied with water heated up to 90°C (Fig. 7). The amount of energy varies depending on the engine load. In general, these types of engines are recommended to operate at least 50% of capacity.

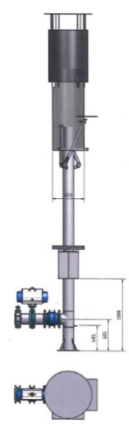

Fig. 8. Torch

Such an installation must also contain a torch (Fig. 8) that takes over the excess gases produced accidentally or when starting/stopping the installation. In general, the torch is equipped with automatic ignition and a device to prevent the flame from returning.

### 3. Case study: well no. 4628 from Timis County

According to project no. 34300/100, designed by IPROTIM Timișoara in 1990 [2], the well no. 4628 shows a geothermal water deposit with a temperature of 80°C, a flow rate of 10 l/s (36 $m^3$/h), and an associated gas content of 2.08 $m^3$ at 1 $m^3$ geothermal water.

According to the above data, there is a flow of associated gases at a temperature of 80°C, which can be considered. However, according to project 34300/100 [2], following the cooling of the gases and the condensation of the water vapor, we can take into account a 60% lower associated gas flow, as it was established.

$$\frac{G\,gaz\,15^0}{G\,gaz\,80^0} = 0{,}4047 \quad (1)$$

Thus, according to project 28226/090 designed by IPROTIM Timișoara in 1984 [3], the associated gases resulting from the exploitation of well no. 4260 contains methane with a concentration of more than 92% and a lower calorific value of 7100 – 7900 kcal/$Nm^3$, resulting in an available power which can be estimated.

$$P = \frac{D_{gaz} \times Q_i}{860} \quad (2)$$

Formulas (1) and (2) result in an available power input of 247 kW.

According to the data above, from the catalogue of one of the manufacturers of such machines [8], it can be determined the aggregate with the following characteristics:

- when operating in nominal parameters: delivered electric power 104 kW, thermal power 141/155 kW (depending on equipment), electrical efficiency 37.1%, thermal efficiency 50.4/55.4% (depending on equipment); gas consumption 30 $Nm^3$/h;
- when operating at 75% of capacity: delivered electric power 78 kW, thermal power 117 kW (depending on equipment), electrical efficiency 35%, thermal efficiency 52% (depending on equipment); gas consumption 24 $Nm^3$/h;
- when operating at 50% of capacity: delivered electric power 52 kW, thermal power 95 kW (depending on equipment), electrical efficiency 31%, thermal efficiency 56.6% (depending on equipment); gas consumption 18 $Nm^3$/h.

## 4. Conclusions

In the context of diversifying energy sources and encouraging the use of local resources as much as possible with as little environmental impact as possible,

geothermal water becomes a valuable asset for the local communities that have it. Where the quantity and quality of the associated gases allow the production of electricity and heat in cogeneration facilities, relatively simple from a constructive point of view, they considerably increase the energy efficiency of the respective installations.
Considering the relatively wide distribution of these resources on Romanian territory, an important number of local communities can be protected from price fluctuations and the uncertainty of access to classic energy sources in the very near future.

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