SYSTEM FOR HEATING VISCOUS OIL USING HEAT PUMPS

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Abstract: *In the case of viscous oil transport through pipelines, one of the methods used to decrease the oil viscosity consist in its heating.*
In the laboratories of Thermotechnics from Petroleum-Gas University of Ploieşti a new heating system was created, a system for viscous oil with a heat pump water-water that uses the surface geothermal energy as cold source. The paper describes the system used for heating the oil and also its performance compared with the classical systems.

Key words: *heat, pump, viscous, oil*

Introduction

Currently, the most prevalent method in practice for the transport of crude oil is pumping after heating it, before the main pumping station at a temperature which must not exceed 70 °C to avoid losses by evaporation.

At the present moment oil heating is done in tanks with heat exchangers of various construction types. The solution depends on both the type and volume of the tanks, and also on the size of the surface.

Generally, in order to heat a petroleum product, the heat produced by burning fossil fuels is used, either directly by the combustion gases or indirectly by hot water or water vapors.

Emissions of pollutants and greenhouse gases and the growth of prices of fossil fuels needed to produce heat have led to alternative solutions for heating using renewable energy.

For experimental testing of crude oil transportation in the sticky neizoterm heated with a heat pump type of ground-water, a mini-system transport was performed in a laboratory from the Petroleum – Gas University of Ploiesti.

Description of the proposed heating system

A heat pump from the equipment of laboratory of Renewable Energy Sources was used for heating the oil (Figure 1).

Fig. 1

The heat pump is coupled to 4 systems of heat extraction from the soil: a 15-meter groundwater well with the hydrostatic level at 4m, a spiral loupe of polyethylene with a length of 180m buried at a depth of 2m, a 40 meters shaft with a loop of polyethylene inserted and a simple loop of polyethylene buried at 1m, with the total length of 60m.

Operating parameters of the heat pump are monitored constantly through a performant data acquisition system. The monitoring pump situation is presented in Figure 2.

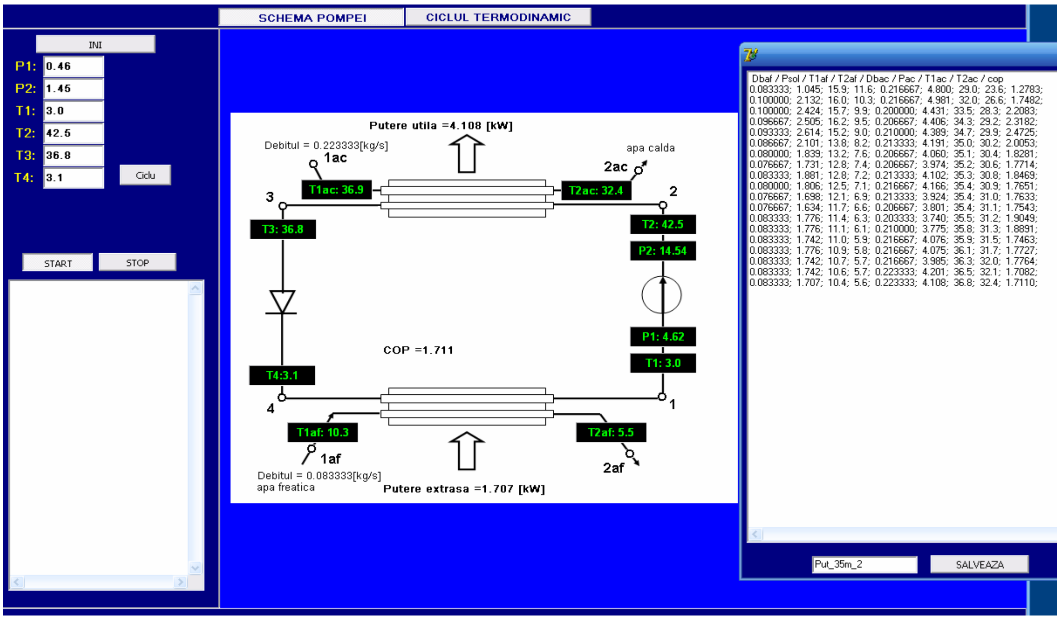

Fig. 2

The oil tank is fitted with two copper coils that circulate hot water from the heat pump.

Temperature transducers were mounted in order to control the heating process in the tank (Figure 3).

Fig. 3

Experimental results

The 800 liters of crude oil stored in the tank were heated with hot water from the heat pump. The water has approximately 60°C at the pump discharge.

Three versions were chosen for presentation from these experiments.

In the first experiment the crude oil was heated from 8°C to 28°C without a mechanical agitation for a period of 150 minutes (Figure 4).

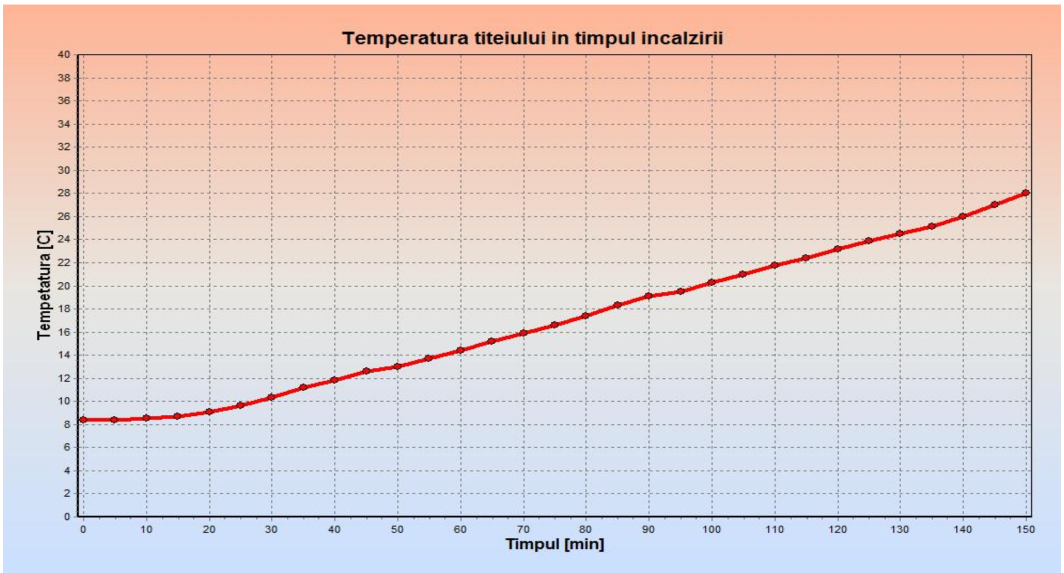

Fig. 4

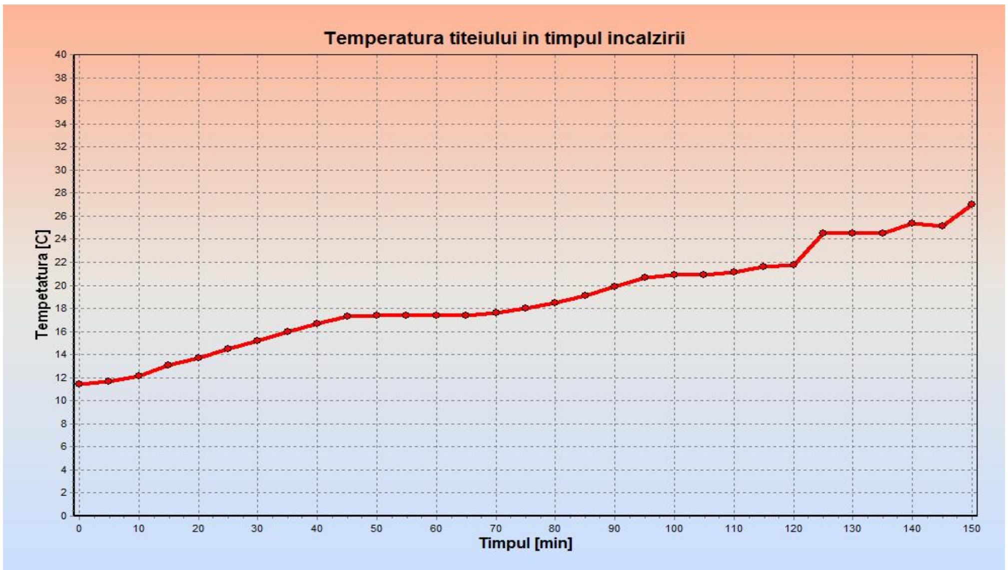

Fig. 5

The rate of temperature variation is relatively uniform 0.15 °C/min.

One could observe during the experiment that the oil temperature is stratified, lower at the bottom of the tank and higher at the top; there is a difference of almost 3°C.

In the following experiments, during the heating process, a stirring of the oil from tank was performed, bubbling with compressed air, for the uniformization of temperature.

The heating bubbling process is shown in figures 5 and 6. It changes the appearance of the heating curve during the bubbling and shortly after. The temperature increases faster than the rest.

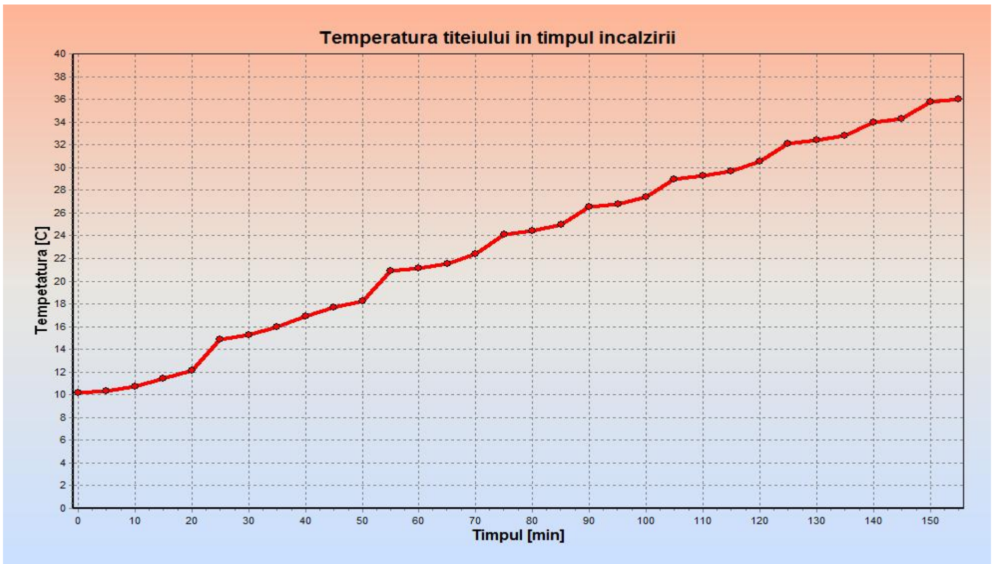

Fig. 6

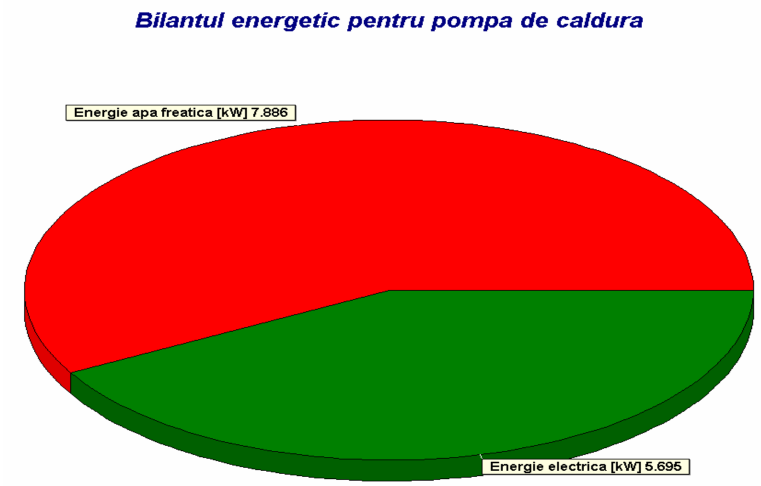

Fig. 7

From one experiment to another the increase of heating efficiency was pursued, so in Figure 6 the best obtained version is presented. A rate of temperature increase of 0,173^{o}C/min was achieved.

Energy balance of heat pump for the duration of the heating process is shown in Figure 7.

From this diagram follows the reasoning of using heat pumps for heating viscous oil. Even if we didn't use a heat pump with high performance, it can be easily seen the energy saving achieved for the process of oil heating.

Conclusions

The essential novelty consists in the replacement of classical heating oil system with a heat pump of ground-water type. This takes the heat from the soil using heat exchangers made of polyethylene pipes in various geometry or from groundwater. The pump provides this energy as hot water at a temperature of 55-60^{o}C with a COP of 3-3,5.

The oil heating is made before pumping into a tank through two coil pipes. Experimentally, heating the oil from 4-5^{o}C up to 36^{o}C was a successful undertake, a temperature that is sufficient to non-isothermal transport process because it does not affect the evaporation of volatile fractions.

Using this new technology of heating oil with heat pumps makes a 60-70% reduction in the amount of energy needed for the heating process, and in the same proportion it reduces pollutants and greenhouse gases.

This paper shows that for viscous oil heating the technology proposed for heating the oil with ground-water heat pumps can be used successfully. This allows achieving the necessary temperatures for pumping, using a renewable and non-polluting energy resource.

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