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DETERMINING THE COEFFICIENT OF HEAT TRAHSFER IN HEAT EXCHANGER

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Abstract: *The paper present's he performances of heat exchanger. As refrigerators agents there were used substances with properties who have a series of special thermodynamics, physical-chemical, physiological and economical requirements.*

Key words: *heat transfer, heat exchanger, microchannels.*

1. Introduction

Transformer oil has the following advantages: ensure high temperatures (over 200°C), coefficient of heat transfer satisfactory (usually over $100 W/m^2 \cdot K$) and not attack the metals and is not corrosive. As mentioned disadvantage is that it has high viscosity, low specific heat, and require special transport.

2. The Choice the Fluid will Flow through Pipes

In choosing the required fluid that flows through pipes will take in account of some physical properties and sizes of thermal agents:

1. Degree of dirt. The dirtier fluid and more difficult to clean will be inserted through the straight pipes that can be easily and effectively clean mechanically.
2. Corrosion. Corrosive fluid will usually move through the pipes, and therefore is necessary to execute these pipes of an anticorrosive material. If in the anti-corrosion protection is required the proofing, this can not be done inside the pipes and in this case the corrosive agent will circulate through mantle.
3. Pressure. Fluid with higher pressure is indicated to move the pipes, which resist having small diameter high pressure without the need thickness high wall. If the fluid with high pressure would circulate through the mantle, its thickness, so the cost would increase considerably.
4. Temperature. Similarly, the hot fluid should move through pipes to reduce thermal stresses in the material and decrease the thickness of the insulation mantle.
5. Toxicity. Toxic fluids, flammable, explosive or expensive will be place in the most sealing part of the device, usually inside the pipes.
6. Flow. Fluid with the lowest flow rate is indicate to introduce in the mantle, to obtain a smaller number of passes through pipes because the flow over the tubes is turbulent at lower Reynolds criterion ($Re_{limită} = 10^3$).
7. Viscosity. The sticky fluid is inserted into the mantle because in this area we can achieve the turbulent flow at lower Reynolds criterion.

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3. Experimental Stand

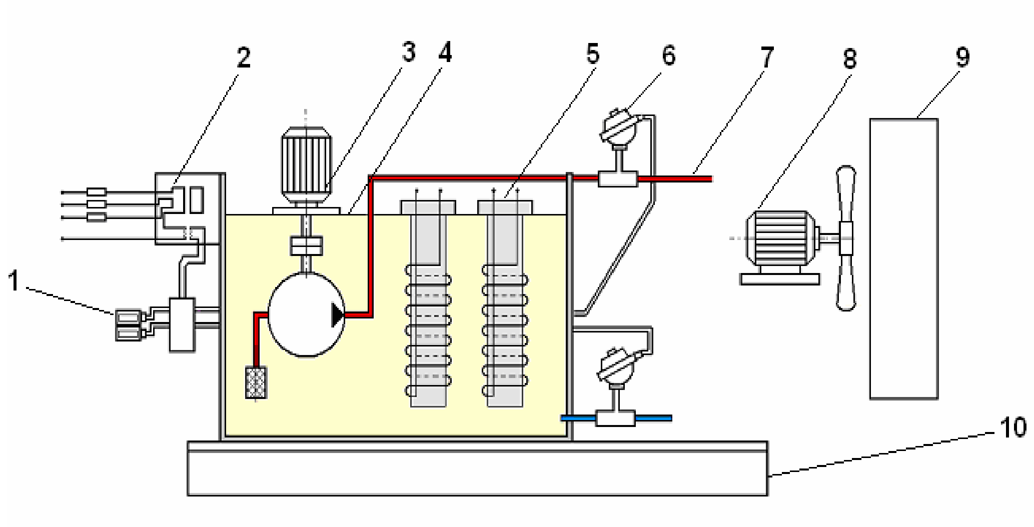

Fig. 1. *Experimental stand 1-digital thermometers, 2 - electrical panel, 3-electropompă 4-tank of liquid 5-resistance electric 6 – TTC thermocouples Iron-Constantan 7-recirculation ducts; 8-electric motor with fan; 9-exchanger Heat 10 - support*

In order to determine the operating efficiency of heat exchangers with smooth plates and ribs was realize and tried an experimental installation by a cooling fluid with transformer oil.

The installation allows the determination of functional parameters of heat exchanger plates with ribs and smooth using the second heat exchanger cross circuits: a circuit for heating the fluid (oil) formed from an oil tank, a group of electrical resistance for lifting the fluid temperature and a recirculation system consists of a motto-pump, recirculation ducts of the fluid and filter in immersion oil reservoir, for cooling a circuit consisting of a motor and fan blades with a stream which crosses perpendicular surface cooling heat exchanger.

In order to measure functional parameters, the installation was provided with a pair of probes thermocouple which was in contact with heating fluid, two digital thermometers thermocouples coupled to temperature for a determination of fluid flow in transmitted installation.

The installation is equipped with an electrical panel that controls the supply of electricity, both sources of heat (electric resistances) and the two electric motors to power the hydraulic pump and fan. To determine the temperature and flow rate of cooling fluid transmitted fan we used an electronic thermometer anemometry with the help of which we have measured in nine point temperatures determined on the surface of the heat exchanger and the rate of ventilation in these points.

In determining the temperature of cooling fluid entering the exchanger, the installation is equipped with a mercury thermometer, graduated in degrees Celsius, with the accuracy of 1^0 C. In order to determine consumption of electricity consumed during cooling with heat exchanger, the supply circuit of the electrical resistances autotransformer, installation is provided with an ammeter, mounted in series and a voltmeter mounted in parallel on electrical conductors, the obtained by reading them from being converted by known relations in consumption of electricity.

3. Stages of Making Measurements

Data registered carrying cooling process have been stored for determining the parameters functional and regimes of the system and using specialized software have made calculations to obtain the final data.

The data obtained were processed using Microsoft Excel software, achieving finally a series of graphs of variation of process parameters (figure1).

Measurements were performed for a number of ten distinct values of the temperature of heating fluid, by actually going through the entire cycle of measurement.

To achieve effective measurements we have take the following steps:

1. was measured and recorded temperature entering the heat exchanger electronic thermometer T1;
2. was measured and recorded temperature output heat exchanger in the electronic thermometer T2;
3. was measured at mercury thermometer the temperature of the air of cooling heat exchanger;
4. it was determined the flow of oil through transmitted heat exchanger.
5. were determined the flow velocities of cooling air through the heat exchanger, in nine points, with anemometer. With the recording of flow velocity and temperature was measured at every point on the surface of the heat exchanger.
6. for each of the increase of the temperature and recording data of the cooling process parameters, it was determined the period during which the temperature was increased from the previous value until the subsequent (increase of temperature was 2 to 2 ^{0}C).

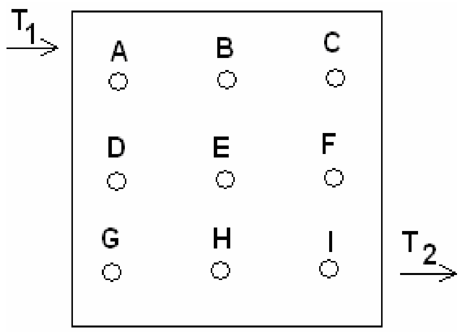

Fig. 2. *Representation of measurement points on the surface of heat exchanger*

3.1. Partial Conclusions on the Study Behavior of Thermal Regimes of Heat Exchangers with Fsins A

Conclusion regarding the thermal regimes of heat exchangers with fins.

From experimental data obtained by studying the thermal regimes of heat exchangers with fins we notice:

- As the temperature of transformer oil exchanger increases, increases the temperature of surfaces of heat exchanger measured with anemometer.
- Oil temperature increases from 36.2^0 C to 79.8^{0}C, corresponding to this increase, temperature (near the entry into the heat exchanger) increases from 27.8^0 C to 50.2^{0}C.
- For the first set of determinations we have obtained a variation of temperature on the heat exchanger with minimum values between 26.5^{0}C and 28.3^{0}C for a maximum temperature of input fluid 36.2^0 C.

Corresponding the nine points of measurement on the surfaces of the heat exchanger (A,B,..I) we notice a variation of temperatures so in the middle of the heat exchanger in point E the temperature become maximum at value of 28,3^{0}C. The temperature on the surfaces of the heat exchanger at entrance in point A has the value of 27, 8^{0}C and the temperature at the exit of the heat exchanger in point I has a value of 26,5^{0}C.

In case of the fifth determination (on the ten which have made) is observed that at the temperature at entrance of the oil of 55^{0}C, the temperature on the surfaces of the heat exchanger varies between 32,2^{0}C and 37,6^{0}C. The variation on the surfaces of the heat exchanger is divided so the temperature in point of entrance A has the value of 37,6^{0}C, the temperature in point E (in the middle of the exchanger), 37,1^{0}C, and the temperature in point I, the exit zone have a value of 32,2^{0}C.

In case of the tenth determination at a temperature of entrance of the oil of 79,8^{0}C it is noticed that the temperature on the surfaces of the heat exchanger is in a state of relative equilibrium having the minimum value of 50,2^{0}C and the maximum temperature of 51,7^{0}C. The minimum value of the temperature is in point A 50,2^{0}C and the value of the temperature is in point I, the exit zone is 51,7^{0}C.

We notice that when the temperature of the working fluids rises, as we measure the temperature in the heat exchanger, we obtained value in which the different become smaller; its happen an smoothness of the temperature on the surfaces of the exchanger, keeping the characteristics presented anterior, that in the central point the value of the temperature is smaller that in the peripheries.

Analyzing the results obtained and presented in table we can notice a partial conclusion that the temperature in the center of the heat exchangers has higher values than the peripheries but with a tendency of uniformization when the temperature of working fluid increases.

Analyzing the variation of the speed of air measured with the a anemometer in nine points we notice that:

1. The variation of temperature on the surface of the exchanger with fins, type A, for the first set of determinations.

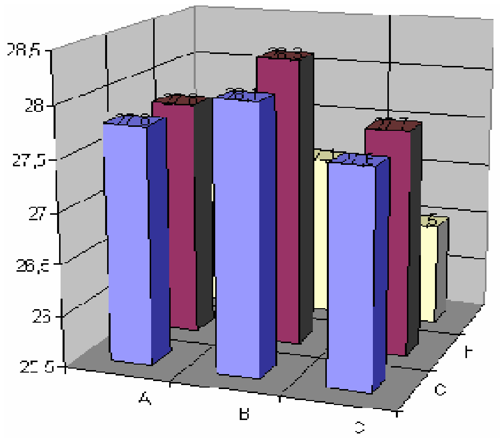

Fig.3. *The variation of temperature for the first set of determinations.*

2. The variation of temperature on the surface of the exchanger with fins, type A, for the fifth set of determinations

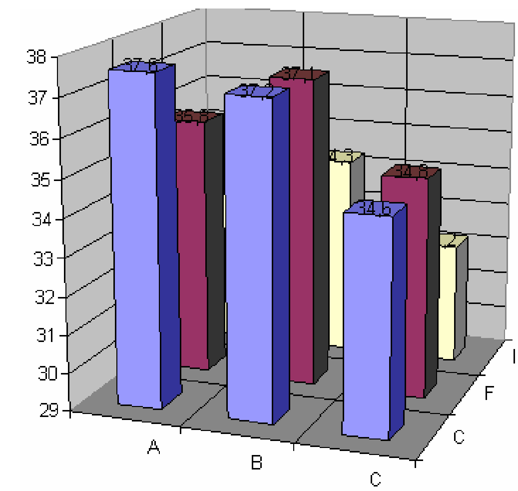

Fig. 4. *The variation of temperature for the fifth set of determinations.*

3. The variation of temperature on the surface of the exchanger with fins, type A, for the tenth set of determinations

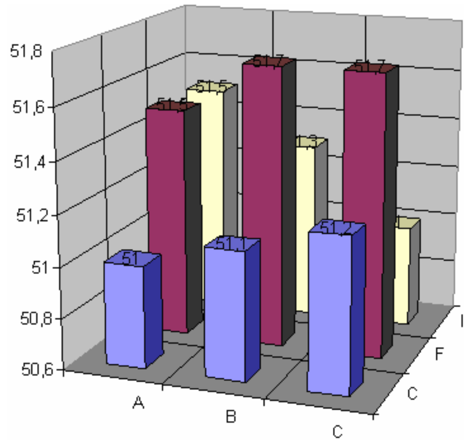

Fig.5. *The variation of temperature for the tenth set of determinations*

Studying the variation of the speed of air measured with anemometer in the nine points it is notice that:

- the speed of air blowned by the fan varies with values between 1 m/s and 3,8 m/s, so for the case of minimum value of the temperature of the fluids through the exchanger 36,2^{0}C we notice that the speed in the point A has the value of 3,1 m/s, in point E in the middle of the exchanger, the speed become minimum 1 m/s and in point I at the exit zone of the fluid the value measured is 2 m/s. We observe that the speed of air on the surfaces of the heat exchanger is bigger than central zone due to the configuration of the cooling system with the fan with three palette fix axial on the electric motor.
- in the case of the fifth determination it is noticed that for a temperature of fluid of 55^{0}C it is observe that the air of the fan varies between 1,5 m/s and 2,7 m/s. On the table is observed that the speed in the entrance zone of the fluid on the surfaces of the heat exchanger is 2,7 m/s in the central zone the speed is 1,5 m/s and in exit zone the speed of air of the fan has a value of 2,6 m/s.
- in the case of the fifth determination at a temperature of entrance of the oil is 79,8^{0}C it is noticed that the speed of air of the fan on the surfaces on the heat exchanger varies between 1,7 m/s and 3,6 m/s. So in point A in the entrance zone the speed of air has a value of 2,8 m/s, in point E in the middle of the exchanger the speed of air is 1,7 m/s and in point I ant the exit zone the speed of air is 3,1 m/s.

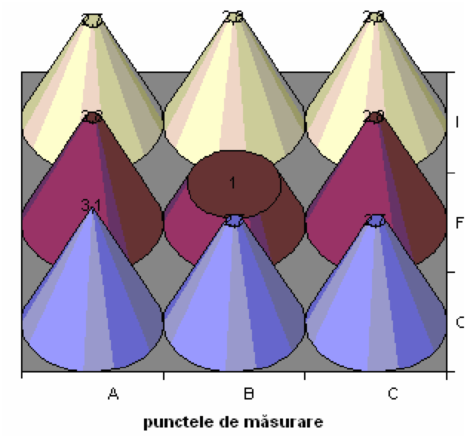

Fig. 6. *The variation of the velocity on the surface of the heat exchanger for the first set of determinations*

5. The variation of the velocity on the surface of the exchanger fins, type A, for the fifth set of determinations.

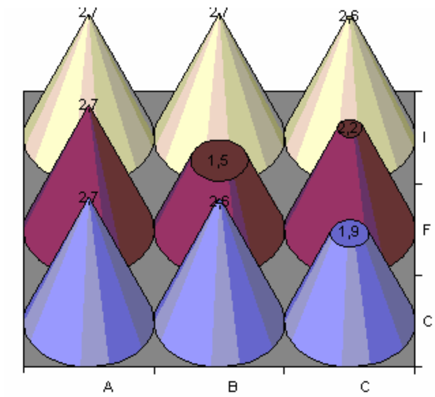

Fig.7. *The variation of the velocity on the surface of the heat exchanger for the fifth set of determinations.*

6. The variation of the velocity on the surface of the exchanger fins, type A, for the tenth set of determinations

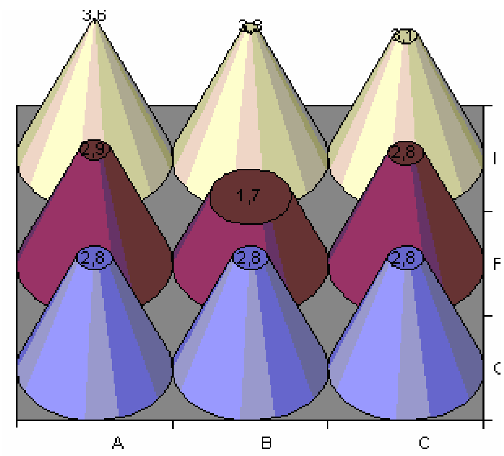

Fig.8 *The variation of the velocity on the surface for the tenth set of determinations*

4. Conclusion

Studying the two data sets, the variation in temperature on the heat exchanger and the variation on the speed fan blowing air we can be observe that where are the maximum temperature values in point E, in the middle the exchanger, the speed of air blowing fan has minimum values. As a partial conclusion we can say that because the exchanger is uninformed ventilated there are areas are on surface exchanger where the temperature becomes higher than the neighboring points (middle of the exchanger).

References

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