Laboratory work No 2

Experimental determination of the nominal power of the heater

Purpose of work: To familiarize with the methods of implementation of heat engineering experiment. To get skills of heat engineering measurements, compilation of heat balance equations based on measurement results.

Scheme of the experimental setup is in the second laboratory work. Initial circuit configuration for the experiments is for one working heater (H1).

The determination of the nominal power of the heater in steady state is based on the heat balance equation. The heat output of the heater is equated with the heat output given by the heat carrier flow:

$$Q_{ПР} = G_{ПР} C_P (t_{ВХ} - t_{ВЫХ}), \qquad (1)$$

where $Q_{пр}$ is the heat output of a heater, W;

$G_{пр}$ is the flow rate of the heat carrier, kg/s;

C_p is the heat capacity, J/(kg·°C) for water 4.1868 kJ/(kg·°C);

$t_{вх}$ is the water temperature at the heater inlet;

$t_{вых}$ is water temperature at the heater outlet.

The temperature at the entrance to the system is limited by the type of heater used. For cast iron or aluminum radiators, its value should not be above 95 °C, for convectors – 105 °C. The device under these conditions operates in the design mode and at the outlet temperature of the coolant will be equal to 70 °C. The flow rate of the heat carrier, depending on the nominal power of the heater, can be estimated from the ratio (1):

$$G_{НОМ} = \frac{Q}{C_P (t_{ВХ} - t_{ВЫХ})}.$$

Then for radiators:

$$G_{НОМ} = \frac{Q}{4{,}1868 \cdot (95 - 70)},$$

for convectors:

$$G_{НОМ} = \frac{Q}{4{,}1868 \cdot (105 - 70)}.$$

For power values from the nomenclature series of heating devices, in this case, you can specify the values of the nominal flow rates of the coolant. The actual values of the coolant flow in the experiments should be assigned in the interval (0,3 ÷ 1,2) $G_{ном}$.

Table 1. Estimated values of heat carrier flow rate

Q , Вт	2000	1500	1000	700	400	Примечание
$G_{ном}$, г/с	~19,10	14,30	9,55	6,70	3,81	Радиатор
$G_{ном}$, г/с	13,60	10,2	6,83	4,76	2,74	Конвектор

Parameter measurements are performed in a stationary mode. The stationary mode is fixed by the constancy of the values of flow and temperature. Achievement of stationary mode occurs when the power of the heat generator and heater is equal to each other. Therefore, experiments should be conducted starting with small temperatures at the entrance to the system. The temperature at the entrance to the system is formed by an automatic temperature controller in accordance with set value of $t_{зад}$ in the program.

The initial temperature of the series of experiments should be set to 20 - 25 ºC above the internal temperature in the room. Step of change is recommended to take in the experiments in the interval of 15-20 ° C.

The series of experiments ends when the temperature at the inlet to the heater is equal to the nominal value for this type of heating devices. To determine the dependence of power on heat carrier flow rate in each series you should vary the flow rate of the two or three levels. You should fill the Table 2 with measurement results.

Table 2. Results of measurements

№	$G_{ПР}$, г/с	$t_{1ВХ} - t_{1ВЫХ}$, °С	Q_1, Вт	$t_{2ВХ} - t_{2ВЫХ}$, °С	Q_2, Вт	$t_{3ВХ} - t_{3ВЫХ}$, °С	Q_3, Вт
1	0,3						
2	0,7						
3	1,0						

Analyze the results of power versus flow and temperature.

Control questions for preparing to defend:

1. What determines the heat output of the heater?
2. Is it possible to assert that an increase in the coolant flow rate always leads to an increase in the heat output of the heater?
3. What methods of power regulation do exist in heating systems?

Read Lectures in order to prepare for defense.