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MODELING OF THE BOILER'S STATIC MODE OF THE CUBE RESIDUE

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Oil refineries are a combination of a distillation column and a heat exchanger. In our case, the boiler acts as a heat exchanger. We have investigated this phenomenon and made a mathematical model for it [1].

The heat is supplied to the rectification columns from bottom to create an upward vapour flow (feedsteam).The part of the cube liquid is sent to the heat exchanger to create that flow andthe resulting vapor is returned under the column's lower plate .

Thus, there are two flows created in the column cube: the first one is a liquid flowing down from the top, and the second one is vapors rising from the bottom of the column [2].

Fig. 1 shows us the structural and parametric diagram of the cube residue boiler as well as its input and output flows.

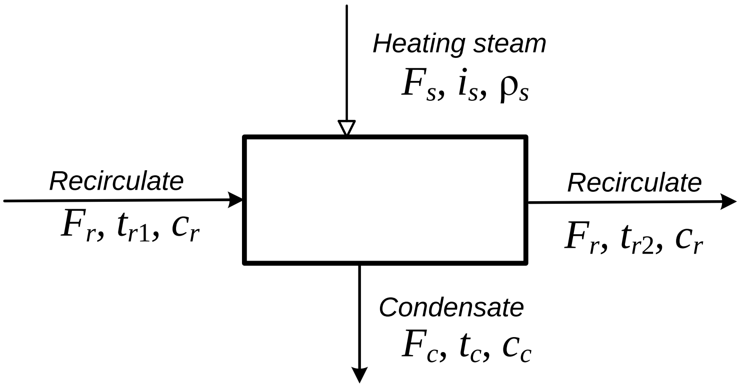

Fig. 1. Structural and parametric diagram of the cube residue boiler
Where F_s – the consumption of heating steam; F_r – recirculate flow rate; F_c – the condensate flow; F_r – recirculate flow rate; t_{r2} – recirculate temperature; t_c – the condensate temperature; T_{r1} – temperature of the cube balance; c_r – heat capacity of the recirculator; c_c – heat capacity of condensate; c_r – heat capacity of the recirculator; ρ_s – the density of the heating steam; i_s – enthalpy of the heating pair

Since the temperature is the main parameter of the process quality , we consider the heat balance as the basis for describing the process [3].

The heat balance of the both intertubular (1) and pipe (2) space is shown below:

$$F_s i_s \rho_s - F_s \rho_s c_c t_c - F_2 s_2 (t_{r2} - t_c) - 0{,}2\, F_s i_s \rho_s = 0. \quad (1)$$

$$F_r c_r t_{r1} - F_r c_r t_{r2} + F_2 s_2 (t_{r2} - t_c) - F_r q_2 = 0. \quad (2)$$

We select the temperature of the recirculator output of the cubic residue boiler as the controlled valueand build its static characteristic.

We form the functions of the dependence of the temperature of the initial mixture t_{r2} on the flow rate of the heating pair (1) and (2). Expressed from (1) t_c:

$$t_c = \frac{-0{,}8 F_s \rho_s i_s + F_2 s_2 t_{r2}}{F_2 s_2 - F_s \rho_s c_c}.$$

Substitute the temperature t_c in (2) and express the controlled value of the initial mixture t_{r2}:

$$F_r c_r t_{r1} - F_r c_r t_{r2} + F_2 s_2 \left(t_{r2} - \frac{-0{,}8 F_s \rho_s i_s + F_2 s_2 t_{r2}}{F_2 s_2 - F_s \rho_s c_c} \right) - F_r q_2 = 0.$$

$$t_{r2} = \frac{F_r c_r t_{r1} - F_r q_2 - F_2 s_2 \dfrac{-0{,}8 F_s \rho_s i_s + F_2 s_2 t_{r2}}{F_2 s_2 - F_s \rho_s c_c}}{-F_r c_r + F_2 s_2 - F_2 s_2 \dfrac{F_2 s_2}{F_2 s_2 - F_s \rho_s c_c}}. \quad (3)$$

Following expression (4) shows dependence on the heating steam consumption which is also shown on fig. 2:

$$t_{r2} = f_1(F_s). \quad (4)$$

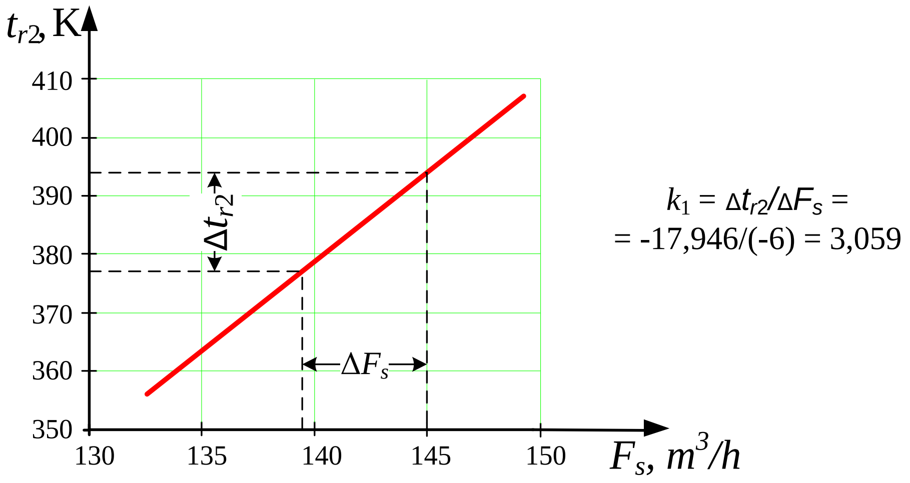

Fig.2. Static characteristic according to t_{r2} of F_s

The resulting static characteristic represents the influence of the control value on the controlled parameter. The graph shows that as higher the steam consumption, as higher temperature of the output mixture.

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