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Control system of methane chlorination

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Chlorination is the most important stage in the production of methylene chloride, which requires clear temperature control because when the reaction gases overheat to a temperature above 550 °C, an explosion can occur.

Methyl chloride is used as a solvent in the production of butyl rubber, insecticides, as well as for the separation of oils, fats, gums in petroleum products and the production of plastics and fumigants. Methyl chloride is used as a methylating agent in organic synthesis to obtain tetramethyl lead, methylcellulose, organosilicon compounds (silanes), used in the paint industry.

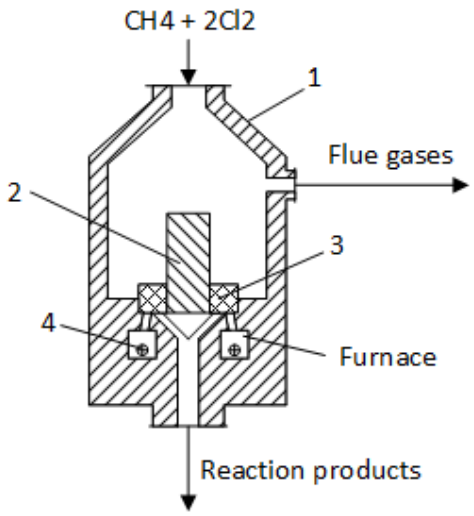

Fig 1. Scheme of the chlorinator

1 - steel case with insulation; 2 - inner nozzle (fireclay brick); 3 - ceramic rings; 4 - burners;

The reactor is a vertical cylindrical apparatus, the steel body of which is lined from the inside with two layers of diabase tiles and a layer of fireclay bricks. The device is insulated from the outside with a layer of asbestos. In the lower part of the reactor there is an annular furnace, into which burners for burning combustible gas are inserted. In the center of the chlorinator is a nozzle made of acid-resistant fireclay bricks.

Combustible gas is burned in the furnace before introduction of reaction gases into the chlorinator; the combustion products heat the reactor, which accumulates heat. After reaching the desired temperature, a mixture of hydrocarbons and chlorine is introduced into the apparatus. After heating, the exothermic chlorination reaction occurs autothermally. The reaction products are removed from the bottom of the apparatus. In the process of chlorination, a small part of methane undergoes deep transformations, with the formation of resinous products and soot. To prevent these substances from entering the exhaust pipe, a layer of ceramic rings about 200 mm high is placed in the annular space of the chlorinator.

Periodically, as they accumulate in the chlorinator soot and resinous substances, they are burned. To do this, stop the supply of reaction gases to the chlorinator, ignite the combustible gas in the furnace and feed the products of its combustion together with excess air in the chlorination chamber. After removal of the carbon-containing substances, the fire in the furnace is extinguished and the reaction gases are fed back into the chlorinator.

The chlorination products are removed from the lower part of the reactor, passed through a carbon black trap and cooled in an air refrigerator 6 to 100 °C.

Gaseous chlorination products contain approximately 55-57% by volume. unreacted methane, 17-18% hydrogen chloride, 9-10% methyl chloride, 5-6% methylene chloride and about 1.5% higher chlorides, the rest - nitrogen, carbon monoxide and dioxide, etc. [1]

To improve the quality of control, an automation scheme is developed, which is shown in Figure 2. The scheme consists of the following circuits:

- circuit 1, 2 maintaining a given cost ratio.
- circuit 3 temperature control in the chlorinator with concentration correction
- circuit 4 level control in the chlorinator
- circuit 5 control and regulation of concentration

Temperature control will be carried out as follows: using a thermocouple (3-1) we obtain the temperature in the middle of the chlorinator, which enters the temperature control device (3-2), equipped with a built-in regulator that transmits the signal to the electropneumatic transducer (3-3), which converts the signal and feeds it into the pneumatic actuator (3-4) of the regulator, changing the air supply, which affects the reactor temperature, as well as the bulbs on the control panel (HL1, HL2, HL3).

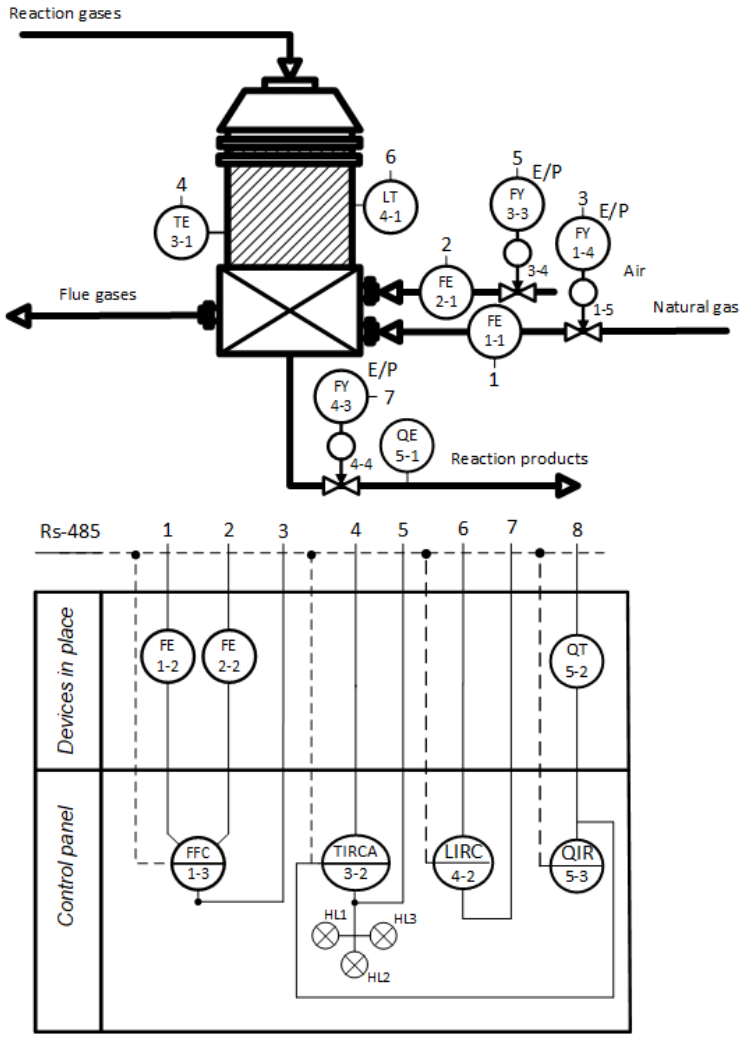

Fig 2. Scheme of chlorinator automation

This scheme provides effective control of the main indirect mode parameter - temperature. Further research will be to determine the dynamic characteristics of the control channels and perturbations, to create a mathematical model of the device in order to adjust the regulators.

Literature

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