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INVESTIGATION OF GAS DISTRIBUTOR FOR PACKED COLUMNS

The article deals with the construction of gas distributor for the mass-transfer columns, particularly for packed columns. Review and analysis of existing inlets of gas (steam) flow into the column were performed and methods of its even distribution on the cross section. The article presents the results of the uniform distribution of the gas flow along the cross section of the column and the hydraulic resistance for different gas distributors. It was established that the new design of the gas flow distributor has a low hydraulic resistance and distributes the gas flow along the cross section of the column.

Introduction. Insertion of gas in the counter flow mass-transfer apparatus is carried out in the bottom of the fitting through the side fuel-supply connection or through the pipe located along the machine axis. While lateral insertion the gas flow from the fuel-supply connection moves to the opposite wall. When hit the wall, it turns up and moves along it as a flow, forming a reverse flow in the field above the connection. Gas entering along the machine axis creates a fluid jet, which expands and gradually fills the entire apparatus section. The presence of a support-distribution grid in packed columns slightly increases the uniformity of gas distribution in the cross section, if the coefficient of resistance of the grid has a sufficient value. To create a more uniform gas flow on the cross section of the column various straightening devices are used above or below the bars, but they do not always lead to the desirable result. The uniform distribution of the gas in the cross section of a packed column before a support grid is especially important because it allows to avoid bypassing gas in a nozzle on height setting [1]. According to the experimental data of many researchers the height of the nozzle equivalent to a theoretical plate (HETP), 30% is less while the uniform distribution of the gas in the cross section of the column packed.

Main part. At the department of machines and apparatus for chemical and silicate production laboratory studies deal with regular (preformed) packing columns representing packets gathered from flat or corrugated vertical plates located in parallel with the same gap.

In comparison with traditional irregular packing regular packing has a relatively low resistance and high efficiency. The main imperfection of regular packing is high sensitivity to the uniform distribution of gas and liquid at the inlet to the packing, as flows don't usually redistribute along the height of the packing.

The design of gas distribution for packed columns was developed at the department ; the studies were carried on the installation shown in Fig.1.

Air from the blower *5* fed to the bottom of column *1*, which supplies the distributor *3*, evenly distributed over the cross section of the column and climb up through the nozzle *2*. Passing liquid distributor *4*, air enters the atmosphere. Water from the container *9* was supplied to the liquid distributor by the pump *10*, where it is evenly distributed over the cross section of the column, sprinkling the nozzle. After contact with the air in the nozzle, the water returns back to the tank. Air consumption was measured by using the diaphragm *6* and the differential manometer *7*. Water discharge was defined with rotameter *11*.

Hydraulic resistance of the nozzle and air dispensers were determined by the static pressure difference before and after the nozzle distributor which was fixed by the differential manometer *8*.

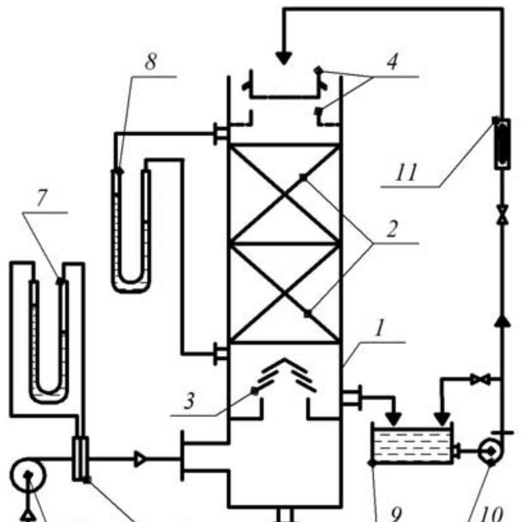

Fig. 1. Installation diagram:
1 – the case of the column; *2* – nozzle(filling); *3* – gas distributor; *4* – liquid distributor; *5* – air blower; *6* – diaphragm; *7* – differential manometer of diaphragm; *8* – differential manometer to determine hydraulic resistance; *9* – container; *10* – pump; *11* – rotameter

In the first phase of studies there was the problem of even gas distribution on the cross section of the column.

The complete information concerning gas flow distribution over the cross section can be found out if instantaneous flow rate (velocity) is known in any point of the cross section that is the flow velocity profile.

Velocity profile was received by means of Pito – Prandtl tube established in section at distance of 0.15 m from the gas distributor. Then the received velocity profile was integrated and found out a consumption of air in this section. The calculated consumption of air verified with a working expense determined by a diaphragm. If the error made more than 5%, studies (researches)of the profile were repeated.

To compare the existing gas distributors the straight pipe was chosen, installed along the column axis, the standard gas distributor (the straight pipe installed on the axis of the column, with pneumatic cone(fender – отбойное приспособление) on the top) and the new distributor which includes the straight pipe, two truncated cones and pneumatic cone on the top (Fig. 2).

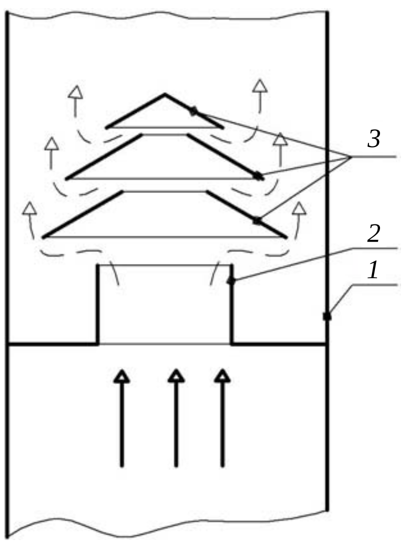

Fig. 2. Gas distributors:
1 – column casing; *2* – straight pipe;
3 – fenders

Research results. Fig. 3 shows the velocity profile for the distributor of the “straight pipe”, installed on the axis of the column. It can be seen that the velocity profile has a maximum along the tube axis, average-maximum metering characteristic of speed ratio is 0.75, which corresponds to the velocity profile for turbulent flow in straight tubes.

Fig. 4 shows the velocity profile for the distributor with one fender, when the straight tube has a pneumatic cone on the top. The velocity profile contains three maxima, namely two small at the wall and one on the axis.

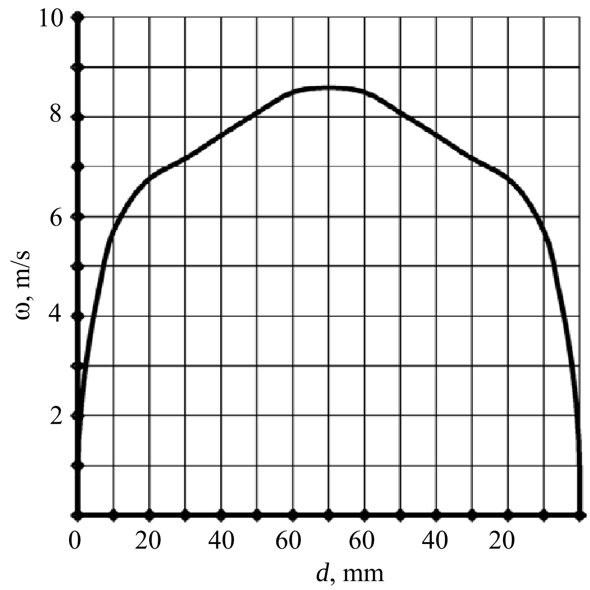

Fig. 3. The velocity profile
for the distributor “straight pipe”

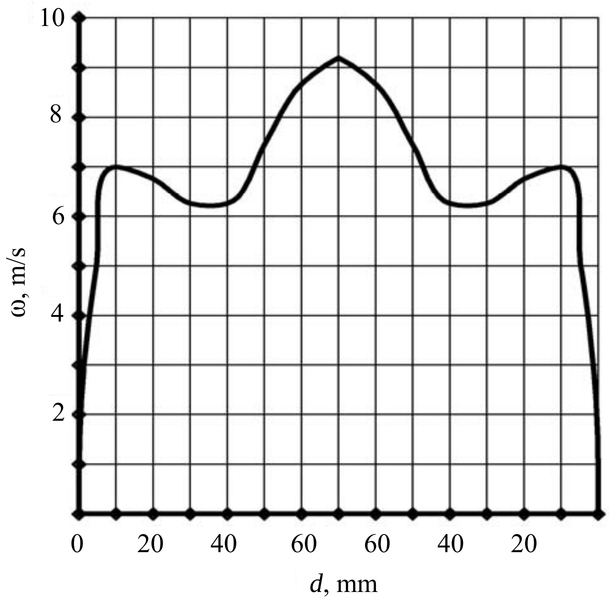

Fig. 4. The velocity profile
for the distributor with one fender

The average-maximum metering characteristic of speed ratio is 0.82. The velocity profile of the distributor with three fenders (Fig. 5) has two maxima at the wall of the column. The average-maximum velocity ratio is 0.84.

Fig. 5 shows that the distributor with three fenders results in the most uniform distribution of the gas flow on the cross section of the column.

Fig. 6 shows the velocity profile obtained by experiment in the cross-section of the column above the nozzle, when installed the distributor with three fenders. One may notice that the velocity profile of gas flow through the nozzle changes, gradually acquiring the straight pipe profile.

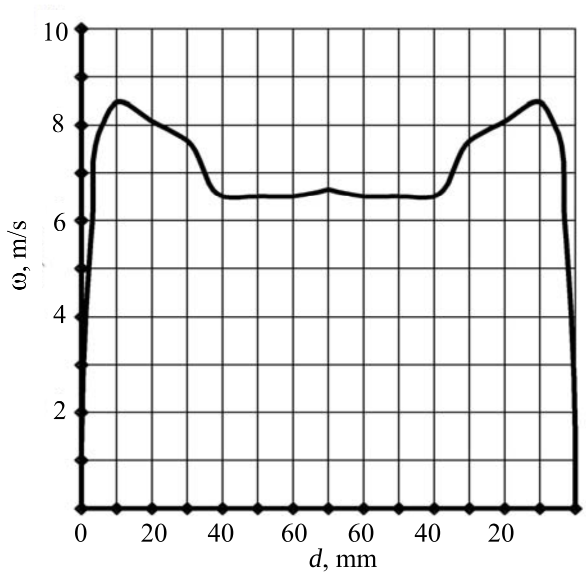

Fig. 5. The velocity profile
for the distributor with three fenders

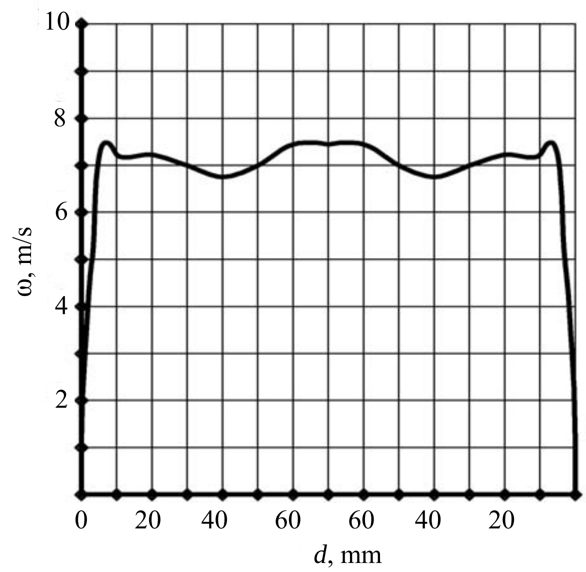

Fig. 6. The velocity profile
for the distributor with three fenders received
in the section above the nozzle

Fig. 7 shows the hydraulic resistance dependence of each of the gas flow three fenders, depending on the gas velocity average rate. The diagram shows that the hydraulic resistance of the straight pipe is the lowest, as expected. The resistance of the distributor with three strikers is 15% lower than that of the distributor with one fender.

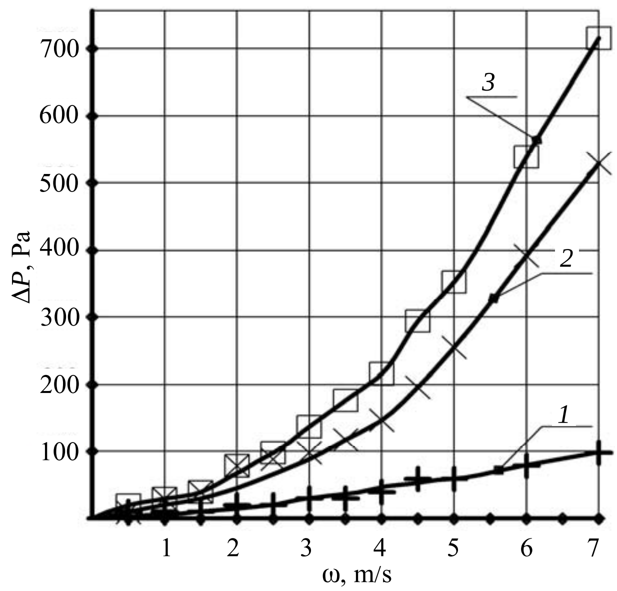

Fig. 7. The hydraulic resistance
distributors dependence on the velocity average rate:
1 – straight pipe; *2* – the distributor with three fenders;
3 – straight pipe with conical fender

Conclusion. The gas distributor design of flow mass-transfer columns with three fenders provides an even (uniform) flow distribution across the cross section of the column. Hydraulic resistance of the distributor is 15% lower than the resistance of the distributor with one fender.

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