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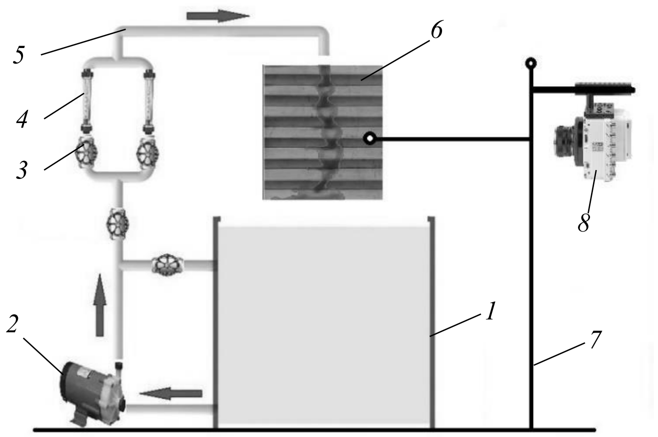
INVESTIGATION OF THE WETTING OF THE SURFACE OF A REGULAR STRUCTURED ELEMENT OF A PACKING

Structured packings are widely used in absorption, distillation, and rectification processes due to their high throughput capacity, efficient mass transfer, and resistance to flooding [1, 2].

Previous experiments on the hydrodynamics and mass transfer of corrugated sheet packings revealed the influence of geometry and operational modes on their performance. Perforation is one optimization method that enhances liquid distribution and surface wetting [3, 4].

We prepared aluminum corrugated sheet samples with corrugation edge lengths of 5, 8, and 11 mm, a corrugation angle of 90°, and dimensions of 100×100 mm. For comparison, three additional sheets with perforation (3 mm diameter holes) were fabricated. The perforations were applied to every second corrugation step, excluding the first, which served as the liquid-distributing surface.

Figure 1 shows the schematic of the experimental setup for studying film flow on the surface of a corrugated sheet.



1 – reservoir; 2 – centrifugal pump; 3 – valve; 4 – rotameter;
5 – pipeline system; 6 – corrugated sheet; 7 – stand; 8 – camera

Figure 1 – Schematic of the experimental setup

The experimental setup operates as follows: Water from reservoir 1 is pumped by centrifugal pump 2 through the piping system 5 via valve 3, which allows for flow regulation. The water passes through flow meter 4 and is then directed through a nozzle onto the surface of the corrugated sheet 6. When the film flow regime of the liquid is established, camera 8, mounted on stand 7, is activated.

The experimental investigation of film flow was conducted for a liquid flow rate range Q of 0.01 to 0.054 m³/h. During the experiments, photographs of the established film flow were obtained. Based on the received photographs, the boundaries of film flow were determined. For the wetted surface, the specific value was calculated as a percentage.

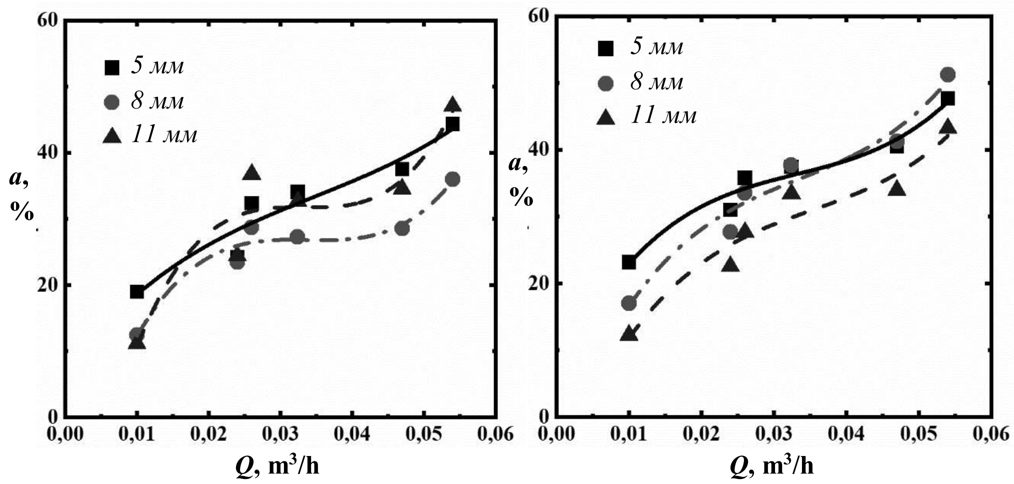
The specific value of the wetted surface of the corrugated sheet was determined using formula:

$$a = \frac{S_{wet}}{S_{dry}} \cdot 100\%$$

where S_{dry}, S_{wet} – are the areas of the dry and wetted surfaces on one side of the corrugated sheet, in m^2 [5].

Based on formula, calculations were performed, and graphical dependencies of the change in the specific value of the wetted surface of the corrugated sheet were constructed as a function of the liquid flow rate.

Figure 2 shows the graphical dependency of the change in the specific value of the wetted surface on the water flow rate for all samples.



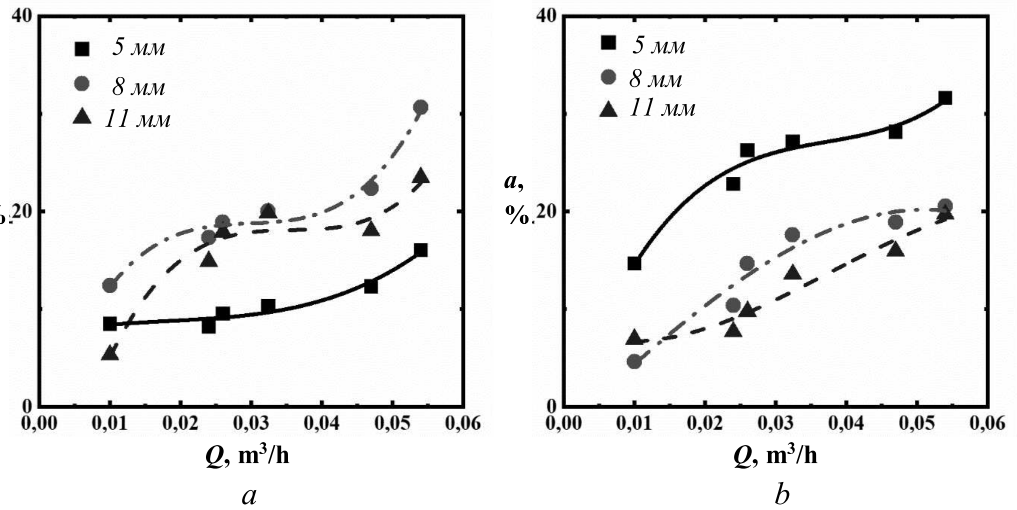
a *b*

a – without perforation; *b* – with perforation

Figure 2 – Change in the specific value of the wetted surface *a* with respect to the liquid flow rate *Q*, m³/h for corrugated sheets

Figure 2*a* shows that wetting of surfaces with different generatrix lengths differs. For sides of 8 and 11 mm, the dependence change is similar, but differs in magnitude. For a generatrix of 5 mm in length, a linear dependence is observed, which is due to a large number of steps forming a corrugation that evenly distribute the water flow. The study of perforated sheets (Figure 2*b*) showed that the corrugated sheet with a generatrix length of 5 mm has the highest value. The dependences for 5 mm and 8 mm generatrices converge after a flow rate of 0.03 m^3/h and then have identical indicators over the remaining range of flow rate changes. Compared with the dependences for corrugated sheets without perforation, which are shown in Figure 2*a*, it is clear that perforation allows increasing the specific wetting value mainly for the channel generatrix size of 8 mm. For the other two samples, the dependences do not differ significantly.

Figure 3 shows the graphical dependence of the change in the specific value of the wetted surface on the water consumption on the front and back sides for corrugated sheets with perforation.



a – front side; *b* – back side

Figure 3 – Change in the specific value of the wetted surface *a* from the liquid flow rate *Q*, m^3/h for the front and back sides of corrugated sheets with perforation

In Figure 3*a* it is evident that for the corrugation generatrix size of 5 mm, the wetting of the front side, as noted above in the photographs, is worse, which is associated with a large number of perforated holes and water flowing to the back side. For the other two samples with a generatrix length of 8 and 11 mm, the dependencies are similar. However, for the size of 8 mm, the specific value of the wetted surface is higher over the entire interval. In Figure 3*b* it is evident that the best wetting on the back side of the corrugated sheets is achieved for the corrugation generatrix size of 5 mm. For the other two samples, the dependencies intersect and do not move significantly away from each other.

Based on the obtained graphical dependencies and the analysis performed, we can summarize that the most preferable for us is the sample with perforation of the corrugated sheet and a generatrix length of 8 mm for further design of the nozzle. Here it became clear that an increase in the holes worsens the wetting of the front surface.

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ЭКСПЕРИМЕНТАЛЬНЫЕ ИССЛЕДОВАНИЯ СВОБОДНО-КОНВЕКТИВНОГО ТЕПЛООБМЕНА ДВУХРЯДНОГО ПУЧКА ИЗ РЕБРИСТЫХ ТРУБ С РАЗЛИЧНЫМИ ПОПЕРЕЧНЫМИ ШАГАМИ ИХ УСТАНОВКИ В ПУЧКЕ

Использование теплообменников воздушного охлаждения в режиме свободной конвекции является способом уменьшения или исключением теплообменных процессов с вынужденной конвекцией. Однако существенным недостатком такого режима являются небольшой коэффициент теплопередачи для повышения которого используется оребрение. При этом с целью повышения эффективности процессов теплоотдачи целесообразно проводить оптимизацию геометрических параметров и компоновки пучка, числа рядов.

Целью работы является экспериментальное определение оптимального межтрубного шага горизонтального двухрядного шахматного пучка равносторонней компоновки из труб со спиральными ребрами (коэффициент оребрения $\varphi = 21$) в режиме свободной конвекции воздуха. Данная работа является продолжением экспериментальных исследований теплоотдачи горизонтальных шахматных пучков равносторонней компоновки в режиме свободной конвекции [1, 2], где пуч-