It is demonstrated that modernization not only of basic production equipment, but also auxiliary distillation columns in which alcohol-containing wastes are processed, is important for increased output of alcohol production. It is established that use of special technical solutions may support an increase in the number of theoretical plates without increasing the height of the column, and without appreciable capital expenditures. A practical example of the modernization of a distillation column, as a result of which not only the amount of the concentrate overhead of the head fraction, but also the content of ethyl alcohol in the concentrate has been reduced with minimal capital expenditures, is presented.

As a rule, distillation plants for the production of ethyl alcohol are multiple-column, and represent a complex equipment layout: basic – for production of the target product; and, auxiliary – for processing of alcohol-containing wastes [1–3]. In connection with growth of the ethyl alcohol market, the task of modernizing basic production equipment to improve its yield is extremely urgent for the majority of alcohol plants. Moreover, the fact that the capacity of the basic and auxiliary equipment should be carefully balanced is frequently disregarded.

Since additional capital expenditures are required for modernization of auxiliary equipment, modernization is not often regarded as mandatory. After the output of the basic equipment is improved, however, the amount of alcohol-containing waste will increase, as a result of which the load on the auxiliary distillation columns will also be elevated (consumptions of the liquid and vapor phases will be increased as compared with the design values). In columns with plate overflow contact devices (such columns are used in the majority of alcohol plants), this will lead to a reduction in the contact time of the phases, and an increase in spray-induced carry-off due to which return dispersion will increase with respect to the liquid phase, and all this will dictate a reduction in the mass-exchange efficiency of the plates. Consequently, the separating capacity of the auxiliary distillation columns decreases with increasing output; this will effect an increase in impurity concentrations (frequently to
Moreover, the concentration of impurities in the head fraction is lower than 10 vol.% on the one hand, and it is possible to increase the efficiency of the distillation column on the other. According to the classical approach, it would be correct to replace the auxiliary columns with new large-diameter columns with the same (or greater) number of mass-exchange plates. Here, significant capital expenditures would be required. As an alternative, it is possible to extend the inter-plate distance, and increase the number of plates in the columns; this is also associated with the need for complete replacement of the columns, and the same expenditures.

An alternate scheme calling for a reduction in mass-exchange efficiency of the plates with increasing output and retention of existing columns is most preferable from the standpoint of cost minimization. The reduction in mass-exchange efficiency can be offset by increasing the number of plates (building-up the columns). This approach can be employed when the output is increased by tens of percents, but not by several times. For the case in question, however, there is also a considerable constraint, which is associated with the increase in the height of the new column (it cannot be installed within the existing buildings or structures).

Use of special technical solutions, however, can support an increase in the number of theoretical plates without raising the height of the column, and will make it possible to avoid substantial capital expenditures. The gist of the approach consists in the building of a combined distillation column: the topping-off section remains from the previous plate tower, and the concentration section is packed [4, 5]. Structured modular wire-mesh packings, which have a very high specific surface and mass-exchange efficiency with low hydraulic resistance, are currently under development [5, 6]. Considering that the velocity of the vapor flow within the packed section of the column is higher than that in the plate section, the modernized portion of the column has a smaller diameter, and, of course, also a lower metal consumption. Owing to the high mass-exchange capacity of the packing, it is possible to ensure a mass-exchange capacity corresponding to a larger number of theoretical plates than existed previously over the height of the dismantled section.

Let us examine the feasibility of using the proposed approach in a practical example.

During the distillation treatment of undistilled alcohol (untreated alcohol containing virtually all the impurities that have formed during fermentative fermentation) into distilled alcohol, the head fraction of the ethyl alcohol is extracted as waste. This fraction is an alcohol solution of impurities (some esters, aldehydes, and methyl alcohol), the volatility of which is higher than the concentrated aqueous solution of ethyl alcohol. The ethyl content (target product) in the head fraction usually exceeds 95 vol.%. To reduce the loss of alcohol with the waste, secondary processing of the head fraction of the ethyl alcohol in an additional fractionating column, which has been aptly called a distillation column, is specified in modern alcohol-production schemes.