THE MIXTURES SEPARATION IN THE COMPLEX COLUMNS WITH THE CONNECTED SECTIONS

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The Abstract: The mixtures separation circuits in the complex columns with the connected sections, having permitted to be improved the obtained final products quality, at lower energy consumption have already been proposed. The multi-flow output and input organization of the lateral pursuits in the columns is being approached them to the thermodynamically more perfect ones, due to the use possibility provision of the distributed along the height of the column supply and heat removal with the lateral pursuits and, respectively, the heat recovery improvement of the separation final products and the refrigerants and heat-transfer agents use. Such circuits' high efficiency at the mixture separation of three or four fractions has been shown by the calculated researches, and also it has been shown in the concrete examples of the industrial installations, that in the wide fractional composition mixtures it is quite possible to be obtained higher savings from the lateral pursuits withdrawal use, than on the narrow fractional composition mixtures.

Keywords: rectifying column, distillate, steaming off section, fractional composition, lateral pursuit.

The certain components accumulation is taken its place at the multi-component mixtures separation in the certain areas of the rectifying column, as in the reinforcing ones, well as in the stripping sections [4]. Having taken into consideration this specific feature and its peculiarity, it is desirable to have such separation circuit, in which the outputs by the lateral pursuits of these components are provided from the areas of their maximum concentration. Such possibility is not practically used in the simple columns system, as well as in the columns of the mixture fuzzy pre-separation in the complex columns with the fully-connected flows. For all this, the fluid, having flowed out from the column rectifying section, or the steam, having risen from the stripping section, which are enriched by the desired and target products, again are mixed, respectively, with the liquid and the vapor raw material phase.

If the components are polluted, simultaneously, for the distillate and the residue, than, in this case, it is necessary to have a large number of the trays to be obtained the desired quality of the target products in the rectifying column and also the high energy consumptions to be created the vapor and the fluid irrigation. The output by the lateral pursuit of the intermediate fractions small amount from the areas of their maximum concentration is practically allowed significantly to be improved the obtained target products quality, at lower power consumption. The lateral pursuit can be supplied into the subsequent separation columns or to be used, as the raw material for the secondary processes, but in some cases, to be used, as the component for the commercial products preparation, for example, such as the motor fuels [5].

So, it is quite also possible the multi-flow output of the lateral pursuits and the input into the subsequent columns, in the presence of the sufficient number of the trays in the column. The multi-flow output and input implementation of the lateral pursuits in the columns is being approached them to the thermodynamically more perfect ones, due to the use possibility provision of the distributed along the height of the column supply and heat removal with the lateral pursuits and, respectively, the heat recovery improvement of the separation final products and the refrigerants and heat-transfer agents use.

The mixture separation circuits have already been developed into three products, on this basis (see, Fig.1). The separation intermediate products, depending on the necessity, may be heated up or be cooled down, due to the unused thermal flows regeneration.

Likewise, it is quite possible to be provided the circuits, corresponding to the indicated principle, at the mixture separation of 4 and more products, only they will be substantially greater, since the possible circuits number is progressively being increased, with the separation products quantity increase.

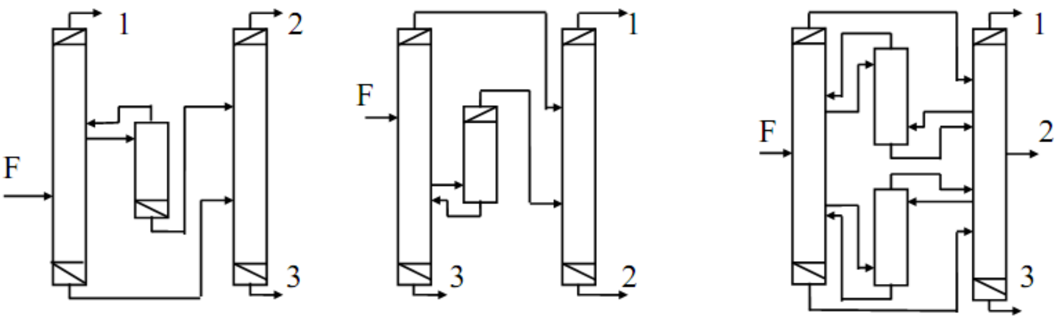


Схема 1 Схема 2 Схема 3

Circuit 1 Circuit 2 Circuit 3

Fig. 1. The Complex Columns for Mixture Separation into Three Products

F – raw material; 1 - 3 – separation products number.

So, it has been done the circuit 1 calculated comparison, having given in Fig. 1, with the conventional circuit, having the distillates' sequential selection, which is differed from the Circuit 1 by the side steaming off section exception, the lateral pursuit selection in the first column, and its further entering into the second one. Thus, the calculated analysis has already made, on the two industrial columns of the gas-fractionation plant operation. So, in these calculations, in the first column, from the top of which the propane is being derived, the 30 theoretical trays have been taken, and, in the second column, having served for the isobutene and the butane mixture separation, the 60 theoretical trays have been accepted, and they have been passed. The lateral pursuit is displayed and output into the steaming off section from the 12 (e.g. the count is made from the top) of the first column theoretical tray. The 18 theoretical trays have already been taken and accepted in the steaming off section. In the circuit 1 the total heat input in the bottom of the first column and the steaming off section is equal to the heat input supply of the first column bottoms in the conventional circuit with the distillates' successive selection. So, the separation products release clarity in the both circuits has already been adopted the same: the propane content is 99,95%, the isobutane – 99,47%, and the butane – 99,67% of the mass.

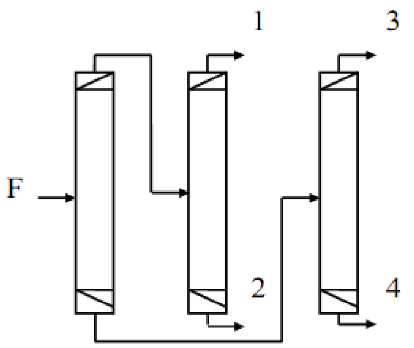
Constructively, the steaming off section can be made within the first column, below the area of the lateral pursuit output. For all this, its diameter is not practically changed, and the capital costs will not be increased substantially.

All these calculations have been indicated, that the circuit 1, in comparison with the conventional one, is practically allowed to be reduced the total heat supply input and the heat input, nearly 5%, respectively, to be reduced the fluid loads of the second column. In is turn, this is approved and demonstrated higher economical efficiency of the circuit 1, as compared with the industrial one. So, in the first column, without any power consumptions further increase, it can be received the two products, the column residue and the lateral pursuit, the isobutane content of which is differed substantially (e.g. more, than 28%). And this is allowed to be reduced the power consumptions for the subsequent separation in the second column.

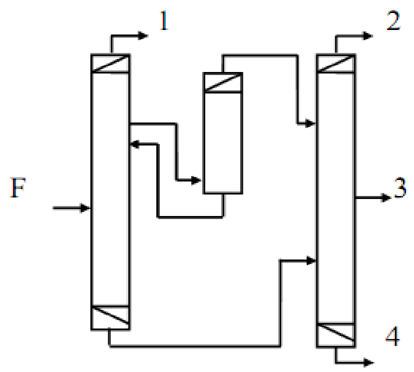
The output cost efficiency of the intermediate product by the lateral pursuit through the reinforcing section, in comparison with conventional circuit, has also been shown on the example of the gasoline separation by the four narrow fractions: n.k. - 65 ^{0}C; 65 - 120 ^{0}C; 120 - 180 ^{0}C and 180 ^{0}C - k.k.

So, the system performance indicators of the gasoline separation into the narrow fractions by the both circuits have already been compared by us: the existing three – columned one with the parallel – serially connection of the simple columns and the new two – columned circuit with the reinforcing section (see, Fig. 2). In the new circuit, the gasoline light fraction, having output from the upper reinforcing section of the first column, and the residue are sent into the second four – sectioned column between the distillate outputs from the column's top, the lateral pursuit, and its residue, respectively.

So, it has already been accepted and taken by the 90 theoretical trays in the calculation circuits. Then, the separation products selections have already been adopted to be equal to the potential content of these indicated fractions in the raw material (e.g. 3,2:38,9:44,5:13,4).



The Conventional Circuit



The New Circuit

Fig. 2. The Gasoline Separation Circuits into Four Fractions

F- gasoline; 1 - н.к.- 65 ^{0}C; 2 - 65 - 120 ^{0}C; 3 - 120 -180 ^{0}C; 4- 180 ^{0}C - к.к.

So, the carried out calculations have been shown, that the new circuit, in comparison with the industrial one, is practically allowed significantly to be increased the separation sharpness. For the compared circuits, the 65 - 120 ^{0}C and 120 -180 ^{0}C are the target fractions. Approximately, at the same pollutions, the n.k. fractions - 65^0 C by the 65 - 120^{0}C fraction (17%) and vice versa (1,5%), the heavy impurities content in the 65-120 ^{0}C fraction and the light impurities in the 120-80^{0}C fracture are being decreased, almost in three times (e.g. from 20,4 down to 7,4% and from 17,8 down to 6,5% mass., respectively). In addition, the new circuit is practically allowed significantly to be reduced the energy consumptions for the separation. The total heat input supply is being reduced for 18,3%, and the heat removal in the capacitors – the refrigerators is being decreased for 21,4%.

So, the new circuit is practically allowed to be maintained lower pressure in the second column, that is improved the separation sharpness, due to the relative volatility increase of the components.

The circuit with its output from the column by the intermediate fracture lateral pursuit and also its supply into the next column has already been designed, with regard to the oil separation process. The columns' diagram connection circuit, by the new technology, has been shown in the Fig 3 [3]. In this circuit, the light intermediate fraction, having withdrawn in the liquid form by the lateral pursuit from the rectifying column section, for the partial oil topping, it is being supplied in the atmospheric column into the cross section between the heavy diesel fraction extraction and the first column residue input. Moreover, the column residue for the partial topping is sent to the atmospheric column's power by the both flows. The first flow is being heated up and it is injected into the power area, and the second flow, without any heating up, in the surface is being entered into the power area of the first column lateral pursuit and the two flows are being mixed directly in the column.

So, it has been made the calculated comparison of the column operation performance of the partial oil topping and the complex atmospheric column by, as the new one, well as the industrial circuits. As the example, the columns and the main modal operation's performance characteristics have already been taken, with regard to the ЛК – 6У installation.

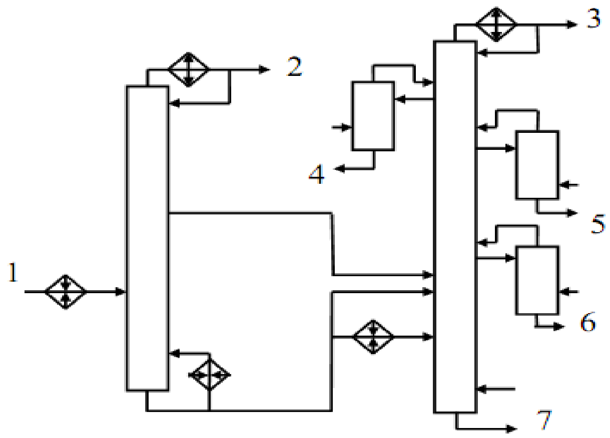


Fig.3. The Crude Oil Fractionating in the Columns with the Partially Connected Flows:
1-oil; 2-light gasoline; 3-heavy gasoline; 4-kerosene; 5-light diesel fuel;
6-heavy diesel fuel; 7-mazut.

So, the calculated researches and studies have already been shown, that the new circuit is more economical, in comparison with the industrial one. It is allowed to be increased the distillate fractions selection, the specific capacity of the complex atmospheric column, and also to be decreased the power consumptions. The light diesel fraction composition is being increased for 1,0%, and the heavy diesel fraction – for 4,3% mass. for the received raw material composition, and the selection conditions. The vapors' linear velocity in the rectifying column of the atmospheric column is being reduced for 9-11%, which is practically allowed, in its turn, to be increased the column's specific productivity. Due to the fact that the column's residue part of the oil partial topping is being supplied to the atmospheric column, without any heating up, into the furnace (e.g. in the calculations, it is practically made 4,4% for the oil), the furnace thermal load for the heating up of the main flow of the complex atmospheric column raw material is being reduced for 2,1%, respectively, the heat amount, having removed in the capacitors-refrigerators, is being reduced for 7,2%. For all this, the fracture content 360 ^{0}C- к.к. in the diesel fractures mixture is practically reduced from 7,2% down to 6,4% mass, at the constant quality and the separation other products selection.

So, it should be noted, that, in the usual circuit, the loads by the liquid are practically very low, and in the pairs they are high on the trays of the complex atmospheric column, having disposed between the raw material input and the heavy diesel fraction distraction. The steam flow ratio to the fluid flow is made up 5-15 on these trays, while it is not exceeded 1-3 on the remaining trays, as the rectifying section. The efficiency of their operation is quite very low, because of such a small ratio of the vapor and the fluid on the trays. The intermediate fraction supply, having obtained by the lateral pursuit from the column rectifying section of the partial oil topping, and the residue part of this column without any heating up in the furnace on these trays, is practically allowed to be increased the load on the fluid on these trays, to be improved the ratio of the vapor and the fluid, and also to be increased the trays' operation efficiency. Then, the ratio of the steam flow consumption to the liquid flow has been become equal to 4-5 on these trays.

The carried out calculated studies on the specific examples of the industrial installations and the results of the practical implementation of the obtaining circuit by the lateral pursuit of the intermediate fraction from the column of the rectifying section of the partial oil topping [1, 2] have been shown, that it is quite possible to be received the higher economy on the wide fractional composition mixtures from the lateral pursuits' output application, than on the narrow fractional composition mixtures. At the same time, the columns with the lateral selections are quite the most simple from the complex columns, they are not required the large capital investments in the existing industrial installations' and their facilities' reconstruction. Therefore, the current development, the up-to-date design, and the complex columns application with the lateral selections are quite the most actual ones, especially for those fractionation processes of the multi-component mixtures, in which they are not have not been used yet.

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