Mass transfer contact devices

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Abstract. Mass transfer processes play a significant role in petrochemical production. In this regard, the issue of increasing the efficiency of mass transfer processes becomes urgent due to the use of highly efficient contact devices with low hydraulic resistance. This article discusses poppet contact devices that are highly efficient, have relatively low metal consumption and cost.

Keywords: mass transfer processes, efficiency, mass transfer devices

It is now known a large variety of mass transfer devices, and the continuing development of new progressive. This is due to the fact that a mass transfer devices presented a large number of requirements, many of which contradict each other. Therefore, it is impossible to develop a universal design of mass transfer devices.

Applications of contact devices determined by the properties shared mixtures working pressure in the apparatus by a pair of loads (gas) and liquids and the like

It designs mass-transfer devices must meet the following basic requirements: low cost, ease of maintenance, high protectivity, the most developed area of contact between the phases and the transmission efficiency of mass of substance from one phase to another, the stability of the regime in a wide range of loads, the maximum capacity for steam (gas) and liquid phase, the minimum flow resistance, structural strength and durability, etc.

Depending on the way the organization contact mass transfer device phases are usually divided into Belleville, packed, and the rotor (Figure 1) [1].

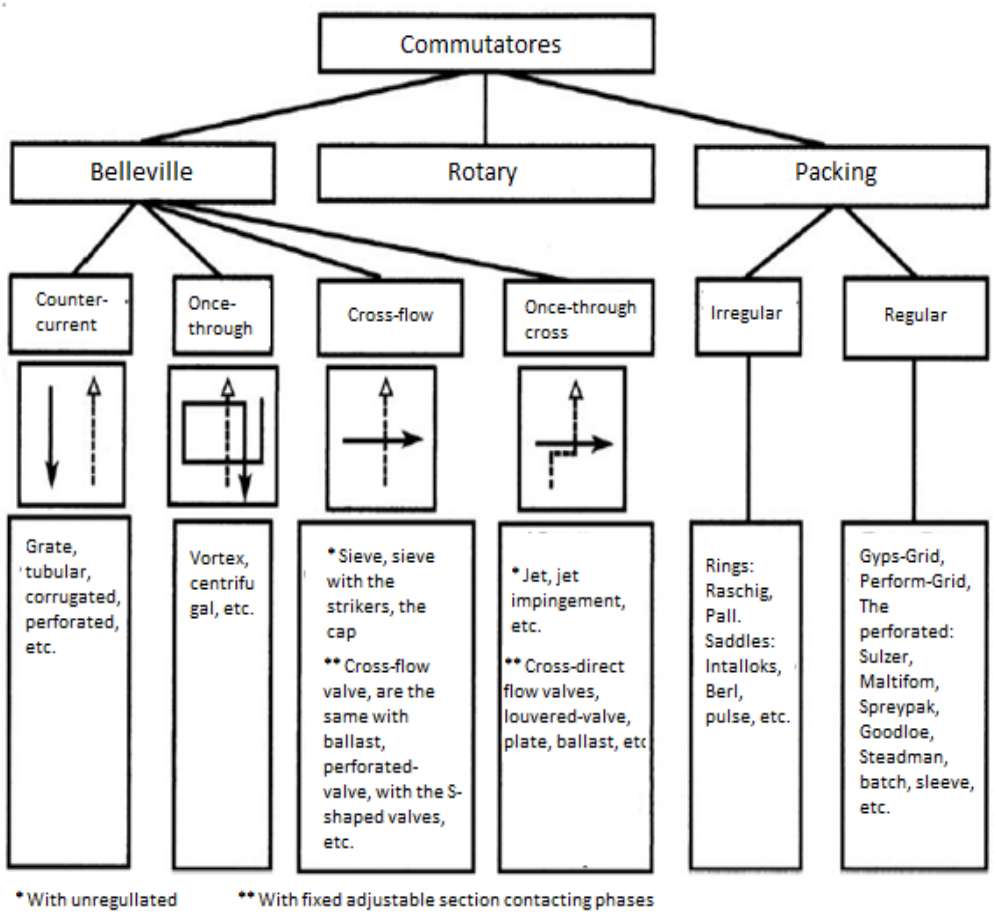


Figure 1 Classification of contact devices

About 60% of manufactured column apparatus for distillation and absorption are tray columns, packed the rest. Recently with the proper organization of the process fluid dynamics, often more economical than Belleville.

In [8], tower units are divided into Belleville, packed, and film.

Rotary film and due to the complexity and high manufacturing cost little used in the industry, so is not described here.

In the oil refining industry the most widely used devices are plate columns. In the plate column the mass transfer is performed by repeated contact of two phases. For this purpose it is equipped with special devices - plates, where mass transfer mainly occurs, except for a small mass transfer in the void volume of the column. Plates are mounted horizontally inside the column.

The distillation columns utilize plates of various designs, that differ greatly in performance and technical - economic data.

The assessment of plates usually takes into account the following indicators:

a) performance;

b) hydraulic resistance;

c) efficiency under different workloads;

d) the range of workloads in condition of high efficiency;

e) resistance of the theoretical plate to different workloads;

f) the ability to work in environments that are prone to the formation of encrustations, polymerization, etc.;

g) simplicity of construction, which is manifested in the complexity of manufacturing, installation and repair;

h) metal utilization.

Universal design Plates (as well as other universal mass transfer devices) does not exist. In most cases for the sufficient performance it is enough to have two or three above mentioned data (a, c and d). If they relatively different, the analyzed parameters f, g and h are taken. Indicators b, and e are of great importance for vacuum and multi-plate columns where the decisive role is played by the device resistance. Therefore, in many cases for the vacuum tower's bottom may be advantageous to use plates that have relatively low efficiency and low resistance. Crucial indicators when reconstructing columns are: a, b, c, d [2, 3].

However, at the moment, along with the most modern designs of plates there are plates (grooved, etc.) used. They provide obtainment of essential products, but can not be recommended for modern productions.

Construction and operation of the most common types of plates: bubble cap, and valve trays will be overviewed below.

Babble cap trays include trays with round caps, grooved and with S - shaped elements, etc. Plates with capsular caps have a relatively high efficiency (0.75-0.80) and operate over a wide range of capacities for gas. They can be used at unstable loads of liquid and vapor. The disadvantages of these plates are: significant metal content and complexity of manufacturing.

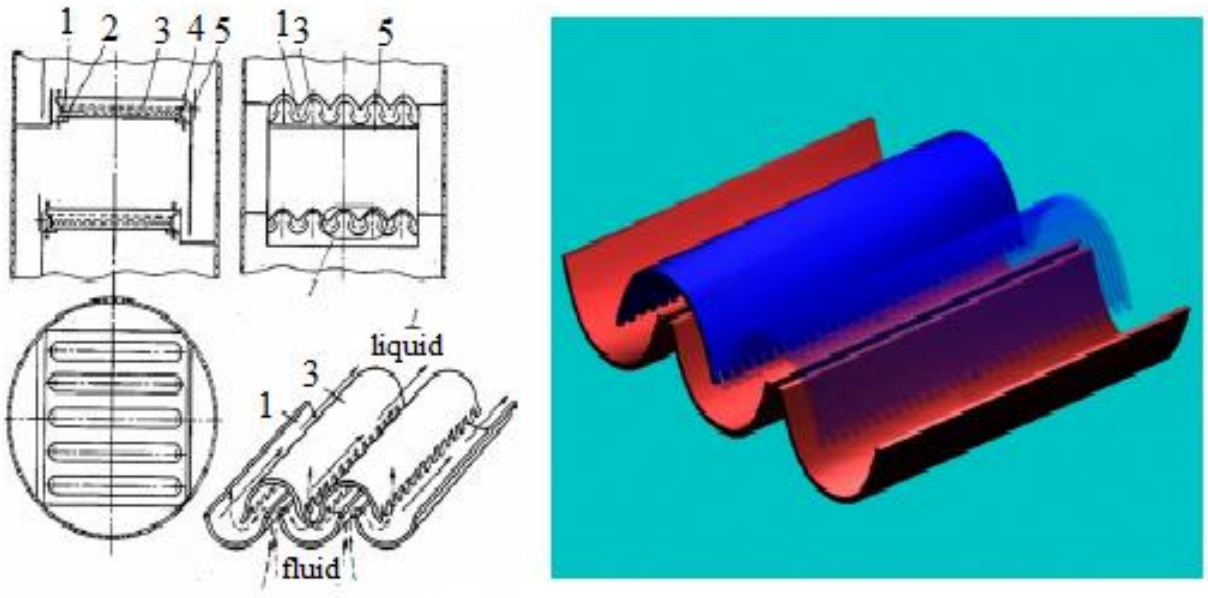
Thanks to ease of use and versatility the plates with capsular caps were recently considered as the best contact devices for distillation and absorption columns.

The disadvantages of bubble cap trays include: low thermal performance, relatively high flow resistance, large metal consumption, complexity and high cost of production.

The distillation apparatus of oil refineries utilize grooved plates (tunnel) caps (Figure 2).[1,3]

The main operational drawback of grooved plates is a small area of bubbling and incomplete use of cross-sectional area of the column to create a bubbling mirror.

Currently, in the refining columns plates with S-shaped elements 4 are used. Plates can be set up perpendicular to the direction of movement of the liquid on the plate. The S-shaped plates are the variety of bubble cap trays and consist of separate elements, each of which forms a cavity for both vapor and liquid.



1 – gutter; 2 – supporting rails; 3 – caps; 4 – pins; 5 – drainage

Figure 2 Plate with grooved (tunnel) caps

In separation processes under moderate pressure or vacuum the ballast plates with rectangular valve are very promising. The presence of the movable ballast ensures uniform opening of all valves with minimum load by steam and adjustable cross-motion transition from phase to parallel flow at high loads. As a result, the ballast plate has 15-20% higher separation efficiency in comparison with ballastless plate over the entire load range.

The use of rectangular valves instead of round valves allows approximately 30% reduction of metal use during their manufacture, and due to the large size of the valves (one rectangular valve equivalent to eight round valves).

In recent years the ballast plates become widespread, especially those that work in varying gas velocities, and are gradually replacing older designs of contact devices.

Valve Trays mass transfer column devices have a wide range of load by the gas (vapor), while maintaining a stable mass transfer efficiency. [3,4]

In these constructions, the gas substantially coming out from the valve in the form of a continuous thickened jet, which leads to restriction of surface area of contacting phases due to the leakage of part of gas without interacting with the fluid. This also increases the liquid entrainment from the plate due to high speed exiting gas-liquid jet from the surface layer. Additionally, the flow of gas is formed directly below the upper plane of the valve, whereby the lower adjacent plates to the layer of liquid is virtually eliminated from the interaction with the gas. In this case it is possible

for the fluid from the inlet to the plate to overflow threshold without the explicit participation in the mass transfer.

Thus, the formation of gas flow in a continuous jet emerging from the valve disc, limits the surface contact area of the phase and reduces the efficiency of mass transfer.

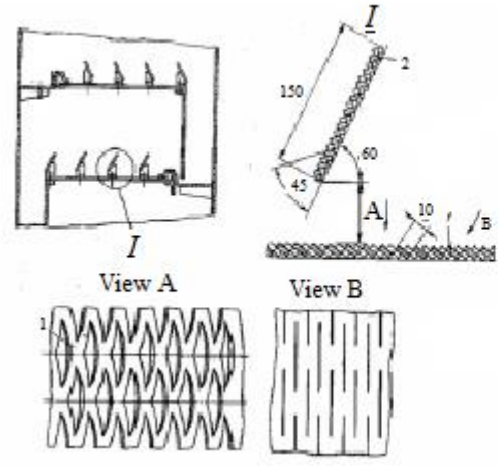
Besides, a common disadvantage is characteristic for all valves, revealed in valve fouling or coking, which cause them to “stick” and not function in a dynamic mode. [3-5]

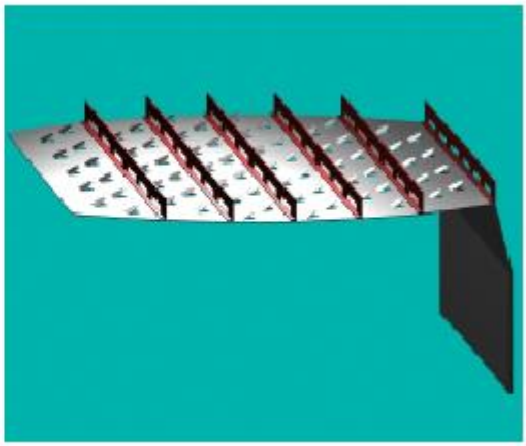
Disastrous plates type usually include perforated plates and lattice.

The advantage of the perforated plate - great free (i.e, engaged holes) cross-section of the plates, and, consequently, high steam output, ease of fabrication, low metal content. As steam production (gas), these plates 30-40% exceed the cap. Disadvantage - the high sensitivity to the installation accuracy. Devices with sieve trays is not recommended for use in polluted environments; this may cause clogging of the holes.

Sieve-valve disk provides a large range of stable operation at low flow resistance, making it suitable for the processes taking place in a vacuum.

The perforated plates with cut-drawn holes (Figure 3) are used in column apparatuses diameter 1200-4000 mm. These plates consist of separate sections that are made of a sheet of 2-3 mm thick expanded metal openings. Plate acts as a co-current jet. To reduce entrainment angle of 60 ° over the plate elements 2 mounted chisel.





a) sieve tray with prosechno- exhaust openings and baffle elements

b) sieve tray with perforated elements (punched perforation) with perforated vertical partitions

Figure 3 Various types of perforated plates with baffle elements

The free cross-section of dishes, selected from the conditions of the lack of "failure" of the fluid, must be large enough (at least 30% of the cross-section of the column) to plate possessed, low

hydraulic resistance. Allowing such plates are used in vacuum towers. The minimum distance between the plates in a column of 450 mm.

One of the technological progress in the refining industry - the creation of contact devices with high capacity for liquid and vapor, in particular the longitudinal and transverse partitioning.

It is known that increased performance plates phase when contacted in cocurrent. However, the continuous-flow motion and high speed steam (gas), the liquid is displaced toward the drain pocket, which complicates the work of dispensing devices. [1,3]

To compensate for the movement phase ramjet and exclusion of its spread to the entire plate can be mounted on a plate longitudinal and transverse partitions, providing a zigzag movement of the liquid on the plate from the overflow to the drain, as well as creating conditions for traffic flow vapor-liquid mixture on a plate or in opposite directions intersecting.

An example is longitudinally partitioned dish with perforated elements (Figure 3, b). On the canvas stamped plate punching, bent at an angle. Plate partitioned along the liquid flow by vertical partitions, and for creating a constant flow resistance across the perforated baffle plate.

The perforated plates are the most common as contact devices distillation columns of air separation units operating at low temperature.

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In the apparatus a small diameter is used S-shaped perforated plates (Figure 4). [1,3]

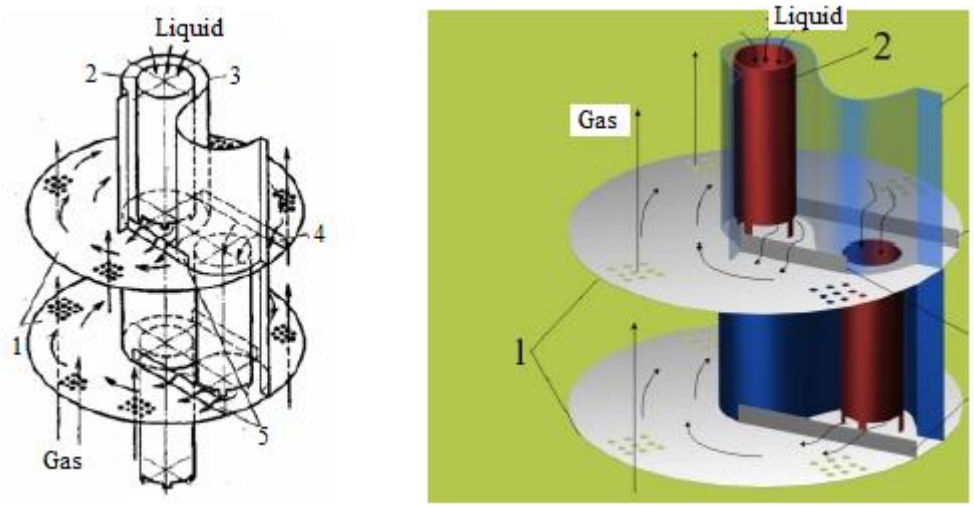

Figure 4 Perforated plate with an S-shaped baffle

The advantages of these dishes should be, above all, the simplicity of design and a low metal content. Further, trays have a greater liquid throughput and of sufficient width at the gap, can be used for the treatment of contaminated fluids which leave the sediment at the plate. On the effectiveness of failing grid plates are usually not inferior plates with overflow.

The disadvantages include a narrow range of stable operation and complexity of providing a uniform distribution of irrigation plates on the surface at the beginning of the process. Plates of this type are much more sensitive to a change on the liquid and vapor loadings and have a more narrow range of operating loads than the overflow dish with special devices. With a little steam load pressure of the vapor is not sufficient to form a liquid layer on a plate. At higher loads steam resistance to flow of liquid through the hole plates becomes so great that the foam fills almost all inter-poppet space and the normal flow of liquid from tray to tray is broken. This sharply increases the hydraulic resistance to flow of vapor. This mode of operation is called flooding and determines the limit steam and liquid load of the column. [1,3]

Thus, the large variety of poppet contact devices makes it difficult to choose the optimal design. Since, along with general requirements (high intensity per unit volume of the apparatus, its cost, etc.), a number of additional requirements can be set, which are determined by the specifics of production. For example, a large interval of stable operation with changing loads in phases, the efficiency of the tray to work in an environment of contaminated liquids, the ability to protect against corrosion, etc. Quite often, it is these characteristics that become prevalent when determining the suitability of a particular design for use in a particular process. [6]

References

1. Tekhnologiya i oborudovanie processov pererabotki nefti i gaza: uchebnoe posobie / S.A. Ahmetov [i dr.]; red. S.A. Ahmetov. [Technology and equipment of oil and gas refining processes: textbook / S.A. Akhmetov [and others]; ed. S.A. Akhmetov] - M .: Nedra, 2006. – 868 p.

2 Dytnerskij YU.I. Processy i apparaty himicheskoj tekhnologii. Ucheb. dlya vuzov: v 2-h kn.[Dytnersky Yu.I. Processes and devices of chemical technology. Textbook. for universities: in 2 books.] - M .: Chemistry, 1995. - 272 p.

3 Kuzeev I.R., Tukaeva R.B., Bayazitov M.I. Uchebno-metodicheskoe posobie: Rukovodstvo i sbornik zadaniya dlya vypolneniya SRS s elementami real'nyh ob"ektov: Uchebno-metodicheskoe posobie [Kuzeev I.R., Tukaeva R.B., Bayazitov M.I. Educational-methodical manual: Manual and collection of tasks for performing the CDS with elements of real objects: Educational-methodological manual.] - Ufa: Publishing house, 2008 - 189 p.

4 Spravochnik neftepererabotchika: Spravochnik / Pod red. G.A.Lastovkina, E.D.Radchenko, M.G.Rudina. [Refinery Handbook: Handbook / Ed. G.A.Lastovkina, E.D. Radchenko, M.G. Rudina.] - L .: Chemistry, 1986. - 648 p.

5. Ponikarov I.I., Gajnullin M.G. Mashiny i apparaty himicheskih proizvodstv i neftegazopererabotki: Uchebnik. [Ponikarov I.I., Gainullin M.G. Machines and devices for chemical production and oil and gas processing: Textbook.] - M.: Alfa-M, 2006.- 608 p.

6 Emelyanov A. B., Maltsev M.V., Popov V. B. Determination of the efficiency of disc mass transfer apparatus used in petrochemical production // Vestnik VSUI, 2017. - Vol.79. - № 2. - P. 176–179.