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UDC 663.551.41

RESEARCH OF PRESSURE DROP AND EFFICIENCY OF NEW DESIGN OF VALVE TRAY

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The article represents a new type of valve tray which is used in tray columns. This type is the result of optimization of the common valve tray. This article includes a design of a new type of the valve tray and experimental results of its efficiency and pressure drop which are illustrated in the diagrams.

Separation of mixtures is considered a major operation in the chemical industry and related branches of production. Separation processes based on the principles of mass transfer require effective columns to approach the perfect separation of mixtures. Trays, random packing, or structured packing can be used inside of columns. They use different mechanisms of mass transfer, but the main feature for all is a good approach to equilibrium through the generation of large amounts of interfacial area. This interfacial area results from the passage of vapor through the perforations of trays, or the spreading of liquid on the surface of packing [1]. The choice between a tray and backed column for a particular application can only be made with complete assurance by costing each design. However, this will not always be worthwhile, or necessary, and the choice can usually be made, on the basis or experience by considering main advantages and disadvantages of each type like. For example, tray column can be designed to handle a wider range of liquid and gas flow-rates than packed towers; packed columns are not suitable for very low liquid rates and the efficiency of tray can be predicted with more certainty than the equivalent term for packing and we usually get a higher efficiency in trays than in packing. For these and many others reasons, we have preferred column trays [4].

The bubble-cap tray is a flat perforated plate with risers around the holes, and caps in the form of inverted cups over the risers. The caps are usually equipped with slots or holes through which the vapor comes out. Sieve tray is a flat perforated plate. The most common type of tray is a valve tray [2]. In valve trays, perforations are covered by lift able caps. Vapor flows lift the caps, thus creating a flow area for the passage of vapor. The lifting cap directs the vapor to flow horizontally into the liquid, thus providing better mixing than it is possible in sieve trays.

Sieve and valve trays have comparable capacity, efficiency, entrainment, and pressure drop. Bubble-cap trays have lower capacity and efficiency, and higher entrainment and pressure drop than sieve and valve trays. The cost of bubble-cap trays is the highest. Sieve trays are the least expensive, but valve trays do not cost much higher than sieve trays. Maintenance, fouling tendency, and effects of corrosion are the least in sieve trays, although they are not much greater for valve trays. In general, bubble-cap trays are mainly used in special applications. For most other services, either sieve or valve trays are the best choice. Sieve trays have advantages when the service is fouling, or corrosive, or when turndown is unimportant, while valve trays are preferred when turndown is essential. With high energy costs, the energy saved during even short turndown periods usually justifies the relatively low cost difference between valve and sieve trays. This has made valve trays most popular in the industry [2, 3].

For these reasons we have chosen valve tray for developing and designing a new type of valve tray. We will pursue the following optimization goals: high efficiency, low moderate pressure drop, high capacity, and low cost.

Principle of work of the tray is shown at the following (Fig. a). The valves will move up and down in response to changing vapor flow rates. At normal flow rate, the valve is roughly in the middle position. At low vapor rates, the valve settles over the perforation and covers it to avoid liquid weeping. The valves should be heavy enough to prevent excessive opening at low vapor flow rate. As the vapor rate is increased, the valve (1) rises vertically. The upward movement of the valve is restricted by retaining cage (2). Liquid enters the tray from the down comer (3) of the tray above. The liquid entering the tray is aerated with vapor rising from the tray below to form froth on the tray. The froth flows across the tray until it reaches the outlet weir (4). The froth then flows over the weir into down comer, where the vapor is disengaged from the liquid.

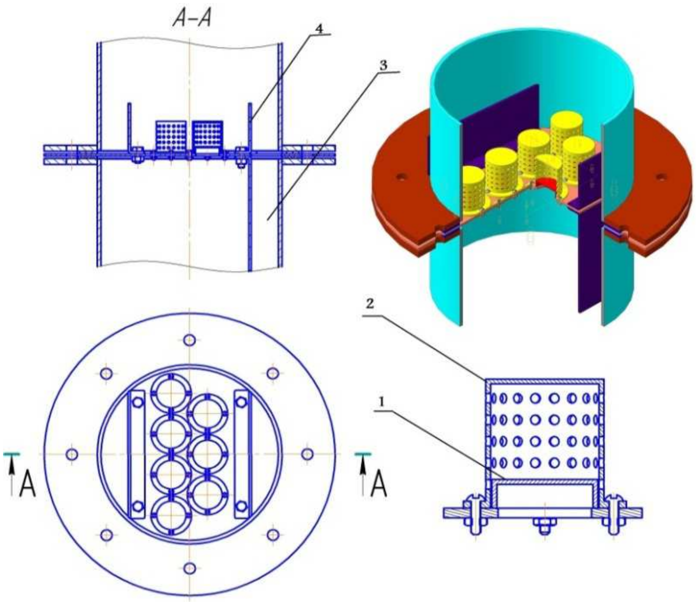

Fig. A

Experimental studies for designing valve trays were made on two models:

1. Desorption of (CO_2) from water
2. Evaporation of water from the tray

Pressure drop for tray is determined by a difference between static pressure above and below tray. Effectiveness of mass transfer could be determined by the changes upon liquids (p h), and humidity of air, in the entrance and outlet of the columns. During the experimental studies desorption (CO_2) of water efficiency valve tray can be determined by the equations (1) and (2):

$$E = \frac{C_{in} - C_{out}}{C_{in}} = 1 - 10^{-(ph_{out} - ph_{in})} \quad (1)$$

$$C = 2.69 \, . \, 10^{5-ph} \quad (2)$$

Such that C_{in}, C_{out}: concentrations (CO_2) in water in the column entrance and outlet ($^{kg}/_{m^3}$).

Efficiency of evaporation of water was determined on air-water system by basing on the humidity of air in the entrance and outlet of the column by the equation (3)[5]:

$$E = \frac{X_{out} - X_{in}}{X_{100} - X_{in}} \quad (3)$$

Such that X_{100}: absolute humidity of saturated steam ($^{kg}/_{m^3}$).

Experimental results are presented in Figures (1) (2) and (3).

From figure 3 a dependency may be noted that the pressure drop of the tray is within the range of 0.255-0.454 k pa at a gas speed less than 1.4 m/s.

The range of stable operation of the valve tray there is enhanced with increasing the air velocity from 0.65 to 1.36 m/s. When liquid flows down the column through down comer and then across the tray deck, while vapor flows upward through the liquid inventory on the tray. Then gas liquid dispersion-foam occurs on a tray. In this mode, the gas-liquid contacting occurs on a surface of the bubbles, the gas spray and liquid drops on the surface, which in large quantities over a bubbling layer are forming at the outlet of the gas bubbles from the bubble layer, and the destruction of their shells. In the foam surface mode phase contact on the tray is maximum contact.

The efficiency of tray ranges from 86.7% – 96.4% at desorption of (CO_2) (fig. 2) and 91% – 98% at evaporation of water (fig. 1). When comparing the effectiveness of different constructions trays, we can conclude that the efficiency of the new valve tray higher than the efficiency of other trays.

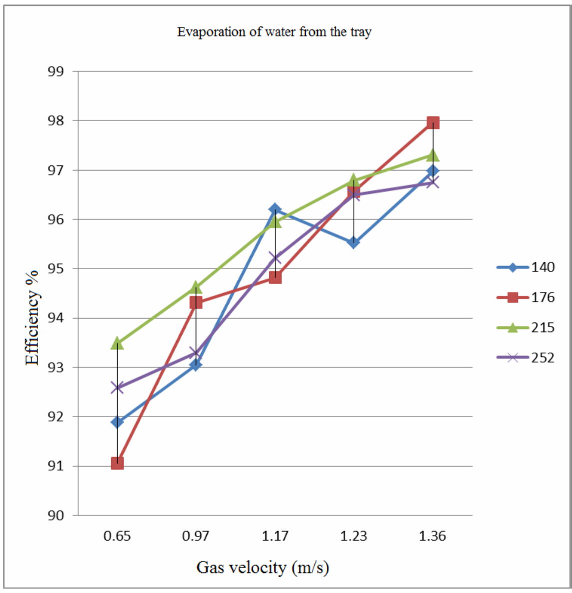

Fig. 1

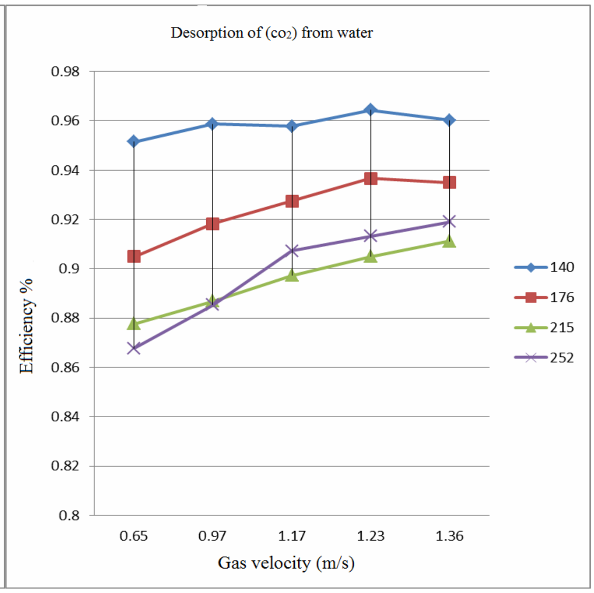

Fig. 2

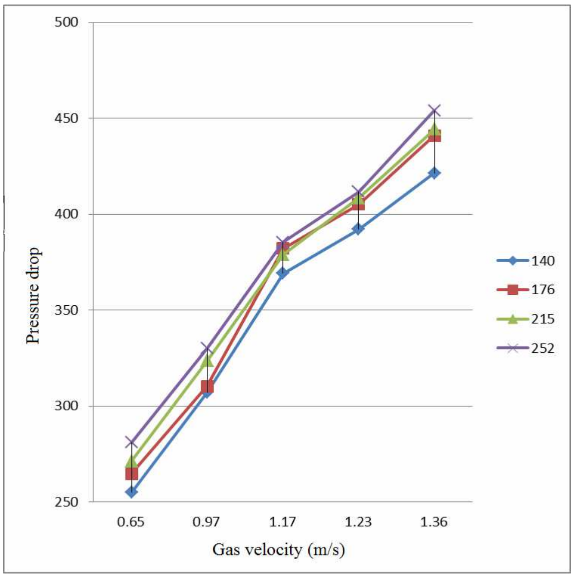

Fig. 3

Based on the studies, the following conclusions can be made:

1. The pressure drop value of the new valve tray developed is proportional to the square of the gas average velocity in the column range of (0.255–0.454) k pa.
2. The efficiency of the new valve tray, increases proportionally to the square of the gas average velocity in the column, with range (86.7- 96.4) % at desorption of (co_2) and (91-98)%at evaporation of water.
3. Tray has a wide range of stable operation, relatively low pressure drop and high efficiency, which makes extensive use of such trays for mass transfer processes.
4. The efficiency of the new valve tray doesn't dependent on the liquid flow rate in evaporation of water and this considered good properties on the work of column tray in the Chemical Industries.
5. We noted the quantity of entrainment is low to moderate in the new type when comparing with other trays, and this quantity increases proportionally with the gas velocity.

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UDC 355.58

NATURAL EMERGENCY SITUATIONS, CHARACTERISTIC REPUBLIC OF BELARUS FOR VITEBSK AREA

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The analysis of possible natural emergency situations, characteristic for Vitebsk area of Republic of Belarus is carried out. Numerous consequences of adverse weather conditions are considered. Population actions are specified during dangerous meteorological processes and the phenomena.

According to numerous observations in the Vitebsk region may be hazardous meteorological processes and phenomena (hurricane force winds, snow blizzards, whirlwinds of large diameter, thunderstorms), dangerous hydrological phenomena and processes (floods anthropogenic and natural), wildfires.

Hurricanes usually form in the equatorial zone. Their appearance is due to the uneven heating of different areas of the rotating earth. Equator is heated more poles – less. The heated air rises , forming a region of high pressure, which combined with the rotation of the earth, the air mass by friction surface layer, the influence of the moon and other planets causes the nucleation of vortices of large diameter (hundreds of kilometers), which moved into the northern and southern latitudes and eventually scattered. Wind speed in the surface layer of such a vortex of hurricane force reaches 200 km / h and more.

Ravages of strong winds intensified loss of heavy rains, flying through the air objects. On the approximation of strong winds population notified storm warning. Upon receipt of such notice must close the windows, doors, hold fixing work, swept away by the wind objects sturdy shelter in the building.

With the approach of winter snowstorms is recommended that a number of the activities listed above, as well as stock up on food and water.

Vortices of large diameter – is an air funnel diameter 100 – 1500 m with a pressure drop between the center and the periphery to 8 kPa, which descended from the cloud , leave the terrain wide swath of destruction a few tens or hundreds of meters and a length of several hundred meters to tens of kilometers or more. These vortices cause very great destruction: scratching trees, destroy buildings, rip and move large objects on the ground . In the equatorial zone, these vortices are called tornadoes.

Approximation of such vortices cannot be long-term forecasting. In this case, you have to be very attentive. Seeing the approaching cloud of dust, the impending destruction of the countryside in a narrow band, you need to determine the direction of the vortex, quickly leave the area of his actions and thus save themselves. Rain – quite widespread and atmospheric phenomena associated with electrical discharges – lightning. The magnitude of the electric lightningtion is 20 – 30 Cl, in very rare cases up to 80 Kl, the force of the discharge current is 200 kA, temperatures up to 40,000°C. Teaching Stock thundercloud has a length of about 2 km, and the duration of the lightning cycle is 30 minutes or more. Lightning strikes cause destruction, causing fires, often lightning killing people and animals.

Ball lightning is in the form of a luminous ball of diameter 20 – 30 cm, driving on the rough path with silent disappearance or explosion, causing damage and casualties. With the approaching storm need to perform the same action (meropriyament), and that the approach of strong winds. Particular attention should be paid to the drafts, because of which the room can get a fireball.

The most dangerous places where you cannot hide from the rain during a thunderstorm are:

– Stand-alone buildings, trees, especially with a strong roofing system, oak, poplar, etc. (out of 100 lightning strikes 54 parishes in oak, poplar, on 24, 10 on the fir, pine 6 to 3 on the beach, lime and 2 for 1 on acacia).

– The hills with dense soils.

– Areas surrounding the lightning rod, etc.

During a thunderstorm, you cannot move on with protruding objects such as shoulder braid, forks, etc. You cannot swim during a thunderstorm. Upon detection of a fireball in any case cannot be run because the air flow can captivate her for a bit and call themselves. It is necessary to determine the trajectory of its total travel and without causing airflow exit zone location.