FLUID DISTRIBUTORS FOR
STRUCTURED PACKING COLUMNS

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The structured packing columns need more elaborate auxiliaries
devices than those used for random packing. A new concept in liquid and
gas flow distributors is presented in this Communication, and some different
examples of successful industrial application, in operation today.

1.- INTRODUCTION.

The flow distribution in liquid-gas columns always was a sensitive
point in the efficiency of the packing columns. The structured packing
columns need more elaborate auxiliary devices than these used for random
packing columns.

The higher efficiency of the structured packing, in comparison with
other internals, imposes a better conception of flows distribution in the
column. However, the particular geometry of the structured packing allows
an easy solution to this problem. It is time to speak about the specific
auxiliaries for structured packing, avoiding the mixture of modern internals
of the 70's with distributors 50 years old.
Different problems of structured packing column malfunctions, reported or not in the open literature, were originated for the flows distribution. These troubles were usually more dramatic in revamped columns, where a significative increase in the column throughput or/and the product specification was expected. However, the result was a loss in the column efficiency at the first trial, Kurtz (1).

In general, the commercially available liquid distributors, which are designed for structured packing columns today, are based on a primary conception, used for decades for random packings. With respect to the gas inlet flow, it was normally accepted that the gas did not need additional distribution, because of the bed pressure drop acts as flow distributor.

The greater efficiency of the structured packings compared with random ones, imposes the requeriments of a more elaborate solution for a flow distributors in the column. Moreover, the structured packing obeys to the principle "To maintain the flow configuration along the bed", that is, the good or the bad are the initial distribution of the liquid and gas flows at the inlets of the bed, will be remained for longer bed deep than for random packing. On the other hand, the particular geometry of the structured
packing allows an easy solution to this problem. It is time to speak about the specific auxiliaries for structured packing, avoiding the mixture of modern regular packing with obsolete distributors.

2.- LIQUID DISTRIBUTION.

The best liquid distributor for a packed column will fulfil these different requeriments:

- 1.- The largest number of liquid irrigation points at the column cross-section.
- 2.- Maximum homogeneity among the flow rates of the different liquid draining points, or induction of a controled non-homogeneous liquid distribution in the column cross-section, in order to correct the natural flow maldistribution of the bed.
- 3.- Operating flexibility (turndown).
- 4.- Avoid the generation of quantities of drops and mist, which will be entrained by the gaseous flow.
- 5.- Absence of splashing.
6.- Avoid the joining of the different liquid draining streams, prior they reach the packing bulk.
7.- Maximization of the gaseous flow cross-section, to reduce the gas pressure drop and liquid entrainment, in order to avoid strong disturbances by the gas flow on partitioned liquid.
8.- A satisfactory performance in the presence of foam. It means that the distributor device should neither promote the foam built-up nor propagate it in upward direction of the gas flow. As far as possible, a distributor should break the built-up foam.
9.- Allow the gases to disengage when the column feed stream is either flashing or in two-phase.
10.- A regular performance in the presence of scaling or fouling agents.
11.- Minimize the distributor height (especially in revamping cases, when the column height is limited).
12.- Be mechanically robust and easy to install into and remove from the column shell. It should resist the operative accidents of the column.
13.- Do not prone to scale or dirt deposition in its inner and outer surfaces.
14.- Do not prone to corrode, at inner and outer surfaces.
15.- Easy to clean and maintain.
16.- Retain its performance in emergency conditions, i.e., in partial breakdown or defective installation, in the presence of scaling or fouling, or partially breakdown device in cases of severe material corrosion.
17.- Do not produce column shutdown due to a mechanical deformation, which was originated in maintenance, cleaning or operational problems, such as pressure or thermal shocks.
18.- A period in operation without causing an equipment setup, allowing regular maintenance during the programed plant shutdowns.
19.- Reasonable cost in relation to the column, the processed substances and the construction material.

3.- LIQUID DISTRIBUTOR FOR STRUCTURED PACKING.

The key part of the new liquid distributor is presented in Figs. 1 and 2. A relevant fact is that the liquid reaches the packing sheets as a film flowing on a solid surface, that is, on an inclined solid plane, which finishes in a cord, resting on the packing top surface, so the liquid film is
discharging on the packing sheets in continuous film flow, instead of dripping and dropping. The liquid is spatially distributed on the column cross section by means of primary and secondary troughs, Fig. 1, or a primary and secondary pipes, Fig. 2. The final liquid distribution, the third step, takes place on the ramp surface, setting up a falling film on the inclined solid plane, which properly conduces the liquid to the packing sheets. The selection between pipes or troughs as gross liquid partitioner is based on the particular conditions of each case, that is, the available pressure of the liquid, presence of gases or flashing stream, solids in liquid, fouling possibility, etc.

This simple conception allows to fulfil all the premises above quoted for an optimal liquid distributor. The liquid neither splashes nor promotes drops or foam. Each solid contact of the distributor inclined plane cord with the packing sheet is equivalent to a double liquid drip point. Then, the number of irrigation points of the packing is one (sometimes two) order of magnitude with respect to the conventional drip or pan distributors. The inclined plane of the distributor, resting on the packing, also acts as bed retain. This design avoids the joining of the spatially distributed liquid streams, and the migration of liquid streams underbenefit the troughs. Experimental determination of distribution quality of this distributor with structured packing was made by Spekuljak (2).

For the case of trough as primary liquid partition device, the weirs instead holes should be prefered, because of their advantages, such as less prone to dirty and scale interferences and the major flow flexibility. In Fig. 3 the different increments of liquid heigth to obtain an increment in liquid flow are shown. For example, to increment the liquid rate twice, for a rectangular weir, the liquid heigth will be incremented only 1.59 times, in comparison with a hole, in which the liquid heigth will be incremented 4 times.
An usual mistake in revamping gas-liquid columns with structured packing was the lack of a gas distributor. The assumption that the gas flow is spontaneously distributed itself in the packing bed had to lead some troubles in revamped columns. This was the case of a demethanizer, reported by Kurtz (1). The lower pressure drop in structured packing, in particular at high pressure services, do not allow that the packing acts as an efficient gas flow distributor. This is because of the ratio of the pressure drop of the bed to kinetic energy at inlet nozzle of the gas for structured packing is much lower than for random packing beds or trays. Moreover, the high superficial liquid flow in this services produces a reversal entrainment, that is, the liquid drags down the vapor, contrary to the typical situation, at lower pressure, in which the gas entrains liquid. When a gas maldistribution occurs, in the cross-sectional spots of lower gas flow, the liquid drags down the gas phase, with severe consequences in mass transfer efficiency, Woodburn (5). The conclusion is that in gas-liquid services with structured packing, the bottom inlet gas has always to be distributed in the column cross-section.
5.- PACKING GEOMETRY EFFECTS.

As was said, the structured packing retains longer the inlets bed flows distribution quality, but not only the fluid distributors decide the flows distribution along the bed. Some geometrical variables of the packing exert influences on spatial distribution of the phases in the bed. The ratio [column diameter / pack height], the crimp height and angles, the packing sheet surface (smooth, grooved, punched, oxydized) and the mounting angle rotation of the packs, influence the liquid and gas paths along the bed. Hoek et al. (4) demonstrate that, due to the particular spatial configuration of packs rotated 90° each one with respect to both adjacents in axial direction, the flows retain areas of greater flow concentration. This effect is avoided with a rotation angle among the packs different from the traditionally accepted 90°. Moreover, this novel pack bed assembly induces a better liquid drainage from one pack to another, due to the different configuration of the contact point among the pack sheets (oblique, not perpendicular), modifying the liquid drainage rate of one sheet to the next down. Another effect is that for some packings, the contact angle between two packs different from 90°, allows more number of contact point solid-solid. This pack assembly conduces to lowering the liquid hold-up, and consequently, to an increase in column operative limits (flooding) and the gas pressure drop is reduced, Spekuljak (6).

6.- FEED BACK FROM INDUSTRIAL COLUMNS.

The distributors conception above described are working in a lot of structured packing columns for liquid-gas contact, in some cases for nearly a decade. There are reports about satisfactory performances at very different cases, such as Vacumm Towers and Asfalt Column, Spekuljak (3), at high pressure services, i. e., in a Depolimerizer butane-ethers column, operating at 10 atm., CO₂/MEA Removal, at 20 atm., other several columns revamped to increase capacity and diminish liquid entrainment, such as a Debutanizer revamp to increase the number of theoretical stages and throughput, among others.
7.- REFERENCES.