

EFFECT OF CORRUGATION OVER ASME BPE SPECIFICATIONS

Drainability

In section **SD-3.12**, some specifications are given in order to fulfill with ASME BPE drainability requirements. Specifically, in **SD-3.12.1**, some requirements are given in order to achieve gravity drainage. The complete subsection **SD-3.12.1** is written below:

SD-3.12.1 For the purpose of sterility and cleaning, gravity is an effective way to facilitate drainage. To achieve gravity drainage, lines should be pitched to designated points at a specific slope. Refer to Nonmandatory Appendix C for suggested method of slope measurement. For gravity-drained piping/tubing systems, the owner/user may define the system slope in accordance with one of the designations listed in Table SD-3. Gravity-drained piping/tubing systems shall have a continuous pitch that is equal to or greater than the slope designation. Line sections up to 10 in. (25 cm) in length (or longer with advance approval of owner/user) that are level or have a positive slope less than the slope designation are acceptable if the section is fitting-bound.

The system's process requirements should be considered in the selection of slope designation.

- (a) Product-contact lines should be sloped to minimize pooling of product in the system.
- (b) Lines that are steam sterilized in-place should be sloped to facilitate gravity drainage of condensate.
- (c) Lines that are cleaned in-place should be sloped to facilitate gravity drainage of cleaning fluids.

The physical characteristics of the system (e.g., line size, materials, fluid viscosity, fluid surface tension) will influence drainability at a given slope and should also be considered. The owner/user may apply additional criteria in the selection of slope designation to address issues such as product recovery or maintenance. Fluid retention due to capillary action should be considered when using tubing less than 3/4 in. (20 mm). System leveling should be considered for mobile equipment that is gravity drained.

The summary of this subsection is that the gravity is an effective way to facilitate drainage provided that the lines are pitched at a specific slope given in table SD-3. The physical characteristics of the system (size, fluid viscosity, fluid surface tension) will influence drainability and they should also be considered. In fact for tubes less than 20 mm, fluid retention due to capillarity action should be considered.

Therefore, due to the several factors which influence on gravity drainage, not all tubes and pipes (smooth or corrugated) can be fully gravity drained.

Specifically for corrugated tubes, unless the heat exchanger is vertically mounted, complete gravity drainability cannot be achieved, but ASME BPE drainability requirements can be achieved according to subsection **SD-3.12.5** which says the following:

SD-3.12.5 Systems or equipment that cannot be gravity-drained shall utilize forced expulsion with pressurized gas where line drainability is required.

In summary, corrugated tubes fulfill ASME BPE drainability requirements since pressurized gas can be used for that purpose. Vacuum could also be applied in order to achieve complete drainability.

Roughness

For pharmaceutical applications, ASME BPE tubes with a specified internal roughness are fitted. These tubes are corrugated in order to achieve a turbulent flow pattern with the goal of increasing the heat transfer and decreasing the deposits. This corrugation is done with a solid metallic wheel which is in contact with the external tube surface, pushing with a calculated pressure to obtain the required corrugation depth. Since the internal (and polished) tube surface is not touch during corrugation, so the inner roughness won't change after corrugation. In the below picture, the internal surface of a corrugated tube is shown.



Contamination

As it's widely known, turbulent flow is easily achieved with corrugated tubes since the corrugation increases the fluid turbulence and therefore decreases the deposit and fouling. Therefore, the corrugation won't increase the inner tubes contamination but on the contrary, it will make its formation more difficult.



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