SEPARATORS: IMPACT & MITIGATION OF HIGH INLET/OUTLET VELOCITY

There are well established industry rules and guidelines (such as API guides, Shell DEP's and NORSOK Standards) for the design of new separators and inlet/outlet devices when it comes to feed inlet and gas/liquid outlet velocity and momentum. They provide a broad consensus on the maximum allowable loadings for different layouts and devices.

This is fine for most new installations where the flow rates are predictable and steady, however there are many situations where the designer will be faced with conditions outside (exceeding) these limits and where it is not possible to change the vessel nozzle size to accommodate the guidelines. Examples would be retrofits for capacity enhancement, reductions in operating pressure, short term surges, relief or flare systems, etc.

This Technical Bulletin aims to assist the designer in such instances by setting out the considerations to be borne in mind including the potential impact of high loadings on the operation, performance and integrity of the vessel and internals, as well as the ways such high loadings can be accommodated and mitigated to allow the vessel to operate in an acceptable manner.

IMPACT OF HIGH VELOCITY FLOWS

The energy of a fluid stream is proportional to the fluid density x square of its velocity. Thus as the flow rate increases there is an exponential increase in nozzle pressure drop and momentum energy which will cause:

- liquid break-up or shatter in any 2 phase flow inlet situations;
- long streams or jets of high velocity flow inside the vessel (both in and out);
- high mechanical forces on any baffles, diffusers or distributors in the line of flow;
- potential disturbance of the liquid surface and re-entrainment, combined with poor distribution or recirculation of both gas and liquid flows inside the vessel.

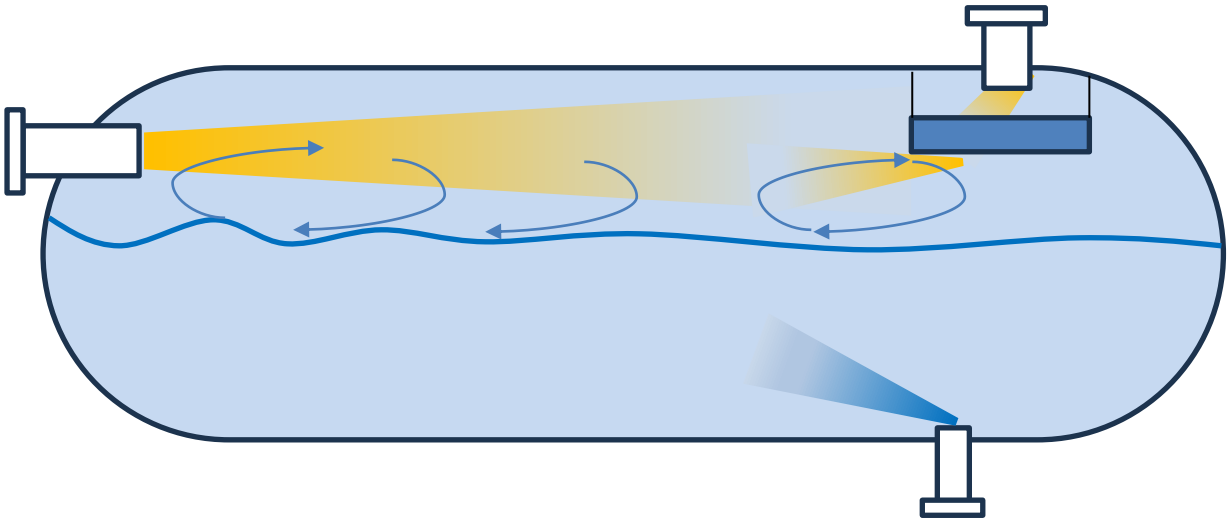

Fig.1: High Velocity Channelling in Inlet and Outlet Regions

ACCOMMODATING HIGH FLOWS

In some cases it may be possible to accept or accommodate abnormally high flow through a separator vessel, by reviewing the impact and ensuring that any deterioration in performance, increase in mechanical loading, or control instability is manageable. For example:

- Increased carryover is acceptable because it will be captured in a downstream vessel;
- Higher pressure drop or additional liquid interface turbulence does not cause control or operational problems and residence times remain acceptable;
- Any internal parts are sufficiently robust to handle the extra load.

If this is not the case, then the impact needs to be addressed.

MITIGATING THE IMPACT OF HIGH FLOWS

This requires a methodical approach, examining each aspect of the vessel's design from inlet piping through to the various outlets. This should cover:

Inlet pipework arrangement	Increased flow will exacerbate any swirl entering the vessel caused by elbows or poor layout upstream of the inlet nozzle. In severe cases consider flow straighteners at the inlet nozzle flange.
Inlet nozzle and inlet device	Check the pressure drop and install a suitable diffuser style device, oversized if necessary and mechanically robust enough for the momentum dissipation and/or slugs. Check the liquid surface tension, as low ST can result in very fine droplet creation or foaming, needing different inlet devices or additional anti-foam packs.
Liquid baffles and coalescer packs	Has the liquid velocity increased by an amount that may lead to channelling and short-circuiting so that liquid/liquid or liquid-gas separation is compromised too far? If so, consider installing baffles and coalescer packs.
Bulk gas space	Is the gas distribution and bulk velocity sufficient to allow bulk liquid dropout prior to the outlet demister arrangement or outlet nozzle? If there is a risk of overloading the demister with liquid, consider an additional device upstream or a modified (high capacity) style of mist eliminator. Also check the liquid drain hydraulics from the demister.
Outlet nozzles (gas/liquid)	If the exit velocity is too high there will be channelling which means separation is compromised, so fit vortex breakers or outlet baffles to locally distribute the flow across the vessel.