# Breaking free from phase separation constraints: Part two

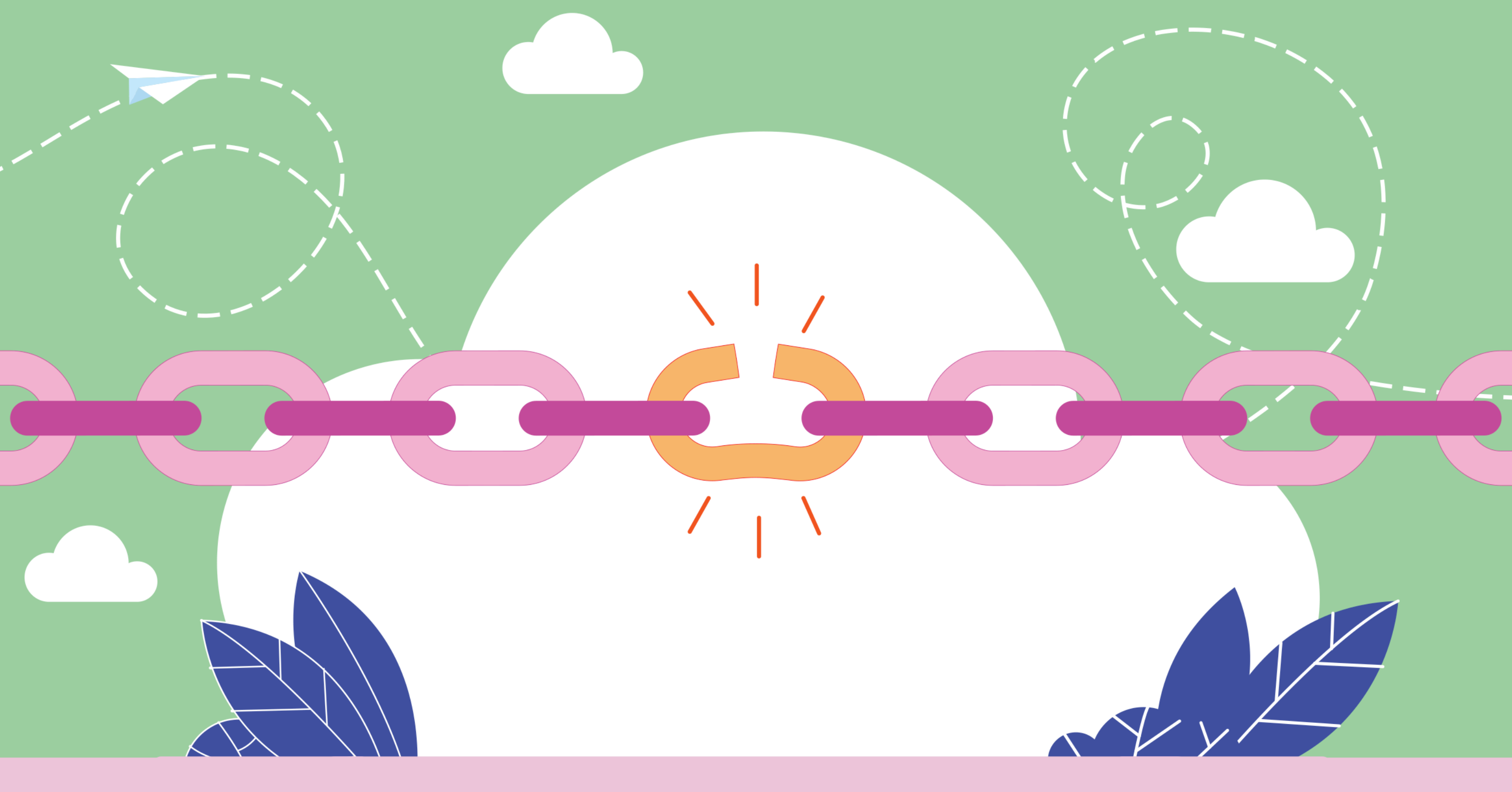
In the second part of a two-part article, **Wim Moyson and Tom Ralston, Kranji Solutions Pte Ltd**, outline further experiences in troubleshooting LNG processes, looking at particular concerns in the natural gas liquids recovery process, and drawing some important general conclusions relating to all key stages of LNG.

Part one of this two-part article explored case studies carried out by Kranji Solutions involving LNG pre-treatment and main liquefaction processes.

In this second part, the article will look at a third case, where Kranji Solution's flow analysis expertise was applied to evaluate the adequacy of flow conditions in a key part of the natural gas liquid (NGL) recovery process.

## Case 3: NGL recovery fractionator column – design review

In addition to the phase separation applications described in part one of this article, Kranji Solutions has also been



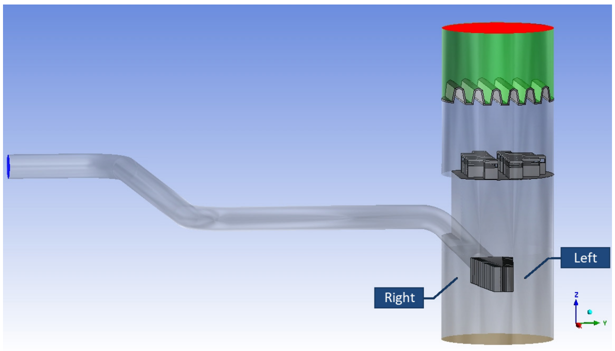



**Figure 1.** CFD model geometry on inlet section of NGL stabiliser column.

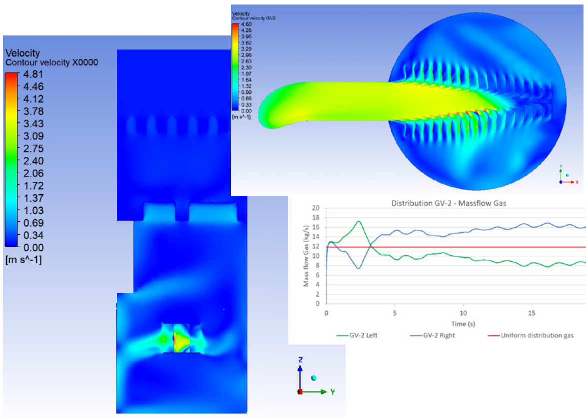



**Figure 2.** Gas flow distribution at inlet section.

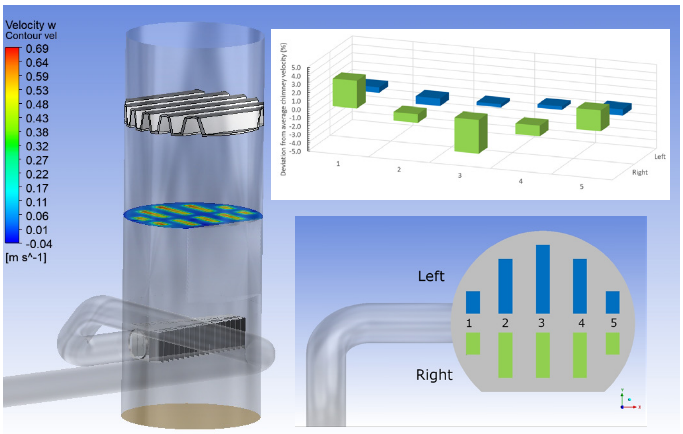



**Figure 3.** Gas flow distribution at chimney tray.

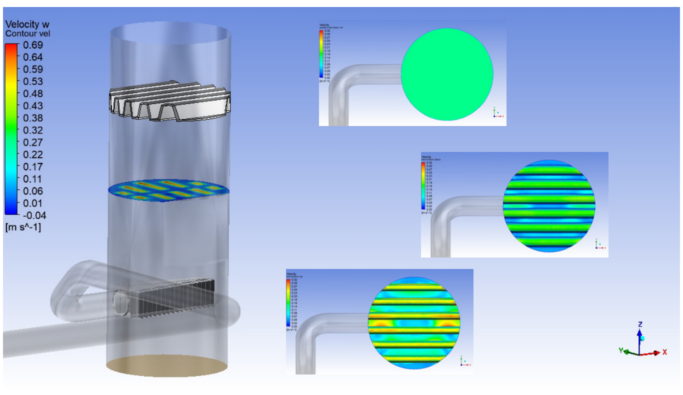



**Figure 4.** Gas flow distribution within packed bed.

commissioned by operators, engineering contractors, and equipment vendors to perform independent design verification studies for columns and their internals in NGL recovery and fractionation units associated with LNG facilities. An example of this work was the CFD review conducted to assess the gas flow distribution within the inlet section of an NGL stabiliser column, for a newbuild LNG project in North America.

The CFD model included upstream piping geometry, vane type inlet device, chimney tray deck, and the bottom section of the packed bed with a multi-beam gas injection support plate (Figure 1).

The analysis revealed a somewhat biased gas flow distribution within the inlet section, with preferential flow to the right-hand side, defined as right when viewed from the inlet nozzle into the column (Figure 2).

Numerous LNG facilities have experienced fatigue-related failures of inlet devices resulting from vibrations induced by unstable and transient flow conditions. In this case, the left-right flow distribution across the vane type inlet device was monitored over time to evaluate cyclic pressure loading on the individual vane blades. This data enabled a fatigue assessment, incorporating flow-induced vibration analysis coupled with finite element modelling, to quantify the inlet device structural integrity under operational conditions.

To quantify the preferential flow effect at the inlet section, the gas flow rate through each chimney was monitored over time, and deviations from the overall average chimney velocity were evaluated (Figure 3). Across all chimneys, the deviation from the mean flow was found to be less than 5%, indicating that the flow distribution between chimneys was acceptable for good mass-transfer performance.

Further evaluation of the flow distribution over the perforated multi-beam support plate and into the packed bed was performed (Figure 4). Comparison of velocity profiles at successive elevations shows progressive improvement in flow uniformity through the support plate and into the packed section. The lower 1 m of the packed bed was included in the simulation and results demonstrate that the gas velocity profile is fully uniform at this height, with the maximum velocity being less than 1% above the mean.

Overall, the CFD analysis confirmed a well-balanced gas distribution throughout the inlet section of the NGL stabiliser column (Figure 4). These findings validate the effectiveness of the column internal configuration and confirm the adequacy of the current design for stable and efficient operation.

## Remedial solutions

Referring back to part one of this two-part article, Kranji Solutions is often involved in developing remediation solutions. Where retrofit modifications are proposed, these are generally required without replacement of vessels or modification of connected pipework.

Case 1: Kranji Solutions' study demonstrated the requirement for an anti-swirl element, immediately upstream of inlet and the need for replacement of the inlet diverter arrangement with a vane-type inlet device. Like other separators encountered by Kranji Solutions, this vessel would have also benefited from a more generous length of horizontal pipe at inlet. Its operating envelope could have been extended through a retrofit by repositioning the inlet device to a lower elevation in the vessel using internal ducting. Such a reconfiguration would allow provision of higher performance demisting technology.

Case 2: The internals could be re-configured as shown in Figure 5. On the left, the original configuration with a highly-undesirable arrangement of two-bank gas box is shown. Superficially, this would appear to offer sufficient flow area for adequate demisting performance; however, constraining the gas flow into a small cross section to feed either bank promotes significant mal-distribution.

On the right of Figure 5 is a retrofit arrangement frequently recommended by the Kranji Solutions team's phase separation experts. This promotes good distribution of gas flow through the combination of agglomerator and demisting cyclones. In addition, an anti-re-entrainment device would be recommended to minimise the interaction of the incoming gas with the surface of collected liquid.

Case 3: Verification confirmed the adequacy of the proposed design. In many cases Kranji Solutions will recommend retrofit options for existing vessels where mal-performance has been identified. These recommendations are always verified by CFD simulation of the remedial arrangements, often in combination with MySep software performance evaluations. Many instances of field confirmation of performance are cited by Kranji Solutions' customer references.

## Conclusions and recommendations

The case studies outlined in part one (published in the December 2025 issue of *LNG Industry*)[2] and in part two here all relate to LNG processes; however, the problems encountered are all too common across upstream oil and gas production, midstream gas processing, LNG, and refining.

Other common issues for LNG processes, encountered by Kranji Solutions, are important to list:

1. Operators often report issues in gas sweetening units where off-spec product gas or excessive consumption of solvents result from foaming in amine contactors. This is usually the result of excessive carry-over of hydrocarbons into the contactor.

2. Similar issues to those listed in the first point (above) are experienced on glycol contactors in dehydration units.

3. In large baseload LNG processes where the feed gas has a high concentration of hydrogen sulfide, sulfur recovery units (SRUs) can experience issues with separation equipment on the process side of SRU sulfur condensers, with carry-over of liquid sulfur presenting corrosion issues in the tail-gas treatment units.

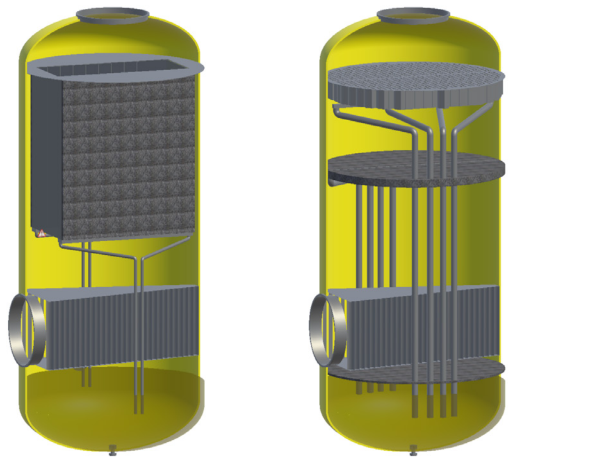



**Figure 5.** Original and preferred optimum design by MySep software.

4. Kranji Solutions' multi-phase CFD experience has also been applied to water-side corrosion issues in SRU sulfur condensers.[1] Such experience reported on large scale gas export plant would be equally relevant to similar units in LNG processes with SRUs.

Poor design and performance of separation equipment often stems from application of crude, criteria-base sizing practices that fail to consider:

- Inlet piping configuration and biased flow effects.

- Inlet stream phase conditions, including mist fractions and droplet size distributions.

- Flow maldistribution in gravity section and demisting sections of separation equipment.

- Flow distribution resulting in re-entrainment from the surface of collected liquids.

- Separation efficiency and liquid handling capacity of demisting equipment.

Many of these problems can be avoided at the design stage, by adoption of the good practice and incremental separation analysis provided in MySep Studio and MySep Engine software. Adopted by many leading operating companies and the premier engineering contractors, these provide an industry-wide recognised standard approach for separator design. MySep is also acknowledged also for off-line rating of operating separation equipment and for rigorous separation modelling in process digital twins. **LNG**

## References


1. RALSTON, T., SINGAPORE WALA, A. A., and VAN-VORSELEN, M., 'Understanding Heat Transfer and Complex Buoyancy Driven Circulation in Sulphur Condensers', *ADIPEC*, (November 2020), SPE-203107-MS.
2. MOYSON, W. and RALSTON, T., 'Breaking free from phase separation constraints', *LNG Industry*, (December 2025), pp.43 – 46.