

# Practical Distillation Technology – course outline

NB: this is a provisional course outline and may be subject to change.

## Avoiding fractionation pitfalls

- Vapour-liquid equilibrium (VLE) – key concepts and simulation traps; should we believe the simulation?
- Issues with close-boilers and non-idealities – why some heavy components go up while the simulation thinks they go down.
- VLE data – to trust or not to trust? Are distillation trays ideal stages? Reflux-stages relationship
- Multi-component distillation – composition profiles; side-draws; accumulation; and cycling problems. What you need to watch out for.

## Troubleshooting distillation simulations

- Does your simulation reflect the real world?
- How poor simulation leads to incorrect problem diagnosis.
- What validation checks are needed? How far should we go?
- Sensitivity analysis and graphics for simulation troubleshooting – useful hints

## Tray hydraulics and limits

- Visualisation of vapour-liquid dispersions on trays, flooding, entrainment, weeping, dumping.
- Flood mechanisms – jet (entrainment), system limit, downcomer backup, downcomer choke. Which one limits your tower capacity?
- Common tray types – sieve, moving valve, fixed valve, sheds, pros and cons. Which works well in fouling applications?
- Small holes, valves – benefits and traps
- Flood – what causes it, what affects it, and how to predict it. Are the predictions reliable?
- Tray efficiency – are simulation predictions reliable? Can it be enhanced by tray modification?

## Troubleshooting tray towers

- Flooding and foaming symptoms – high dPs, reduced bottoms, others. Which can be trusted?
- Liquid and vapour sensitivity and other field tests – identifying the correct flood mechanism and ruling out incorrect theories.
- Gamma scans – application for diagnosing flood, missing and damaged trays, foaming, and downcomer flooding. How to combine gamma scans with process checks to get the most out of the scans. Do gamma scans ever lie?

## Troubleshooting packed towers

- Rules of thumb for flood pressure drop and packing efficiency
- Simulation hydraulic calculations – to trust or not to trust? Grid gamma scanning for detecting maldistribution, damage, distributor malfunction.
- Distributor overflow – death for packed beds, how to diagnose and avoid. Some dos and don'ts for distributors. Can poor distributor feeding bottleneck towers?
- Circumferential surface temperature surveys – how to conduct and the hidden secrets they reveal.
- Neutron backscatter and CAT scans – when are they useful?

## De-bottlenecking

- State-of-the-art trays and packings – strengths and weaknesses. Factors that favour trays and factors that favour packings.
- The pressure drop bonanza – why packings win in non-fouling vacuum services and in compressor suction.
- Pitfalls unique to structured packings – high pressure application, oxidation, shutdown fires.
- High-capacity trays (eg Superfrac, VG Plus, MD) – principles, tricks, and traps. Do they really give 30% more capacity than conventionals?

## Distillation control

- Assembling control loops into an overall scheme – what works, which is better, what causes instability, and what impairs efficiency.
- The three most common causes of control assembly failure – no material balance control, fighting between temperature controllers, and level control on a small stream. Tips for avoiding problems.
- Best temperature control location – is there a reliable method for finding it? How can a temperature controller be fooled?
- Reboiler, condenser, and pressure controls – which loops work and which misbehave. How dead pockets in vapour overhead lines interfere with controls.
- Understanding flooded condensers and hot vapour bypasses – why some work while others don't. Control systems that did not work.

## Avoiding tower malfunctions

- The 10 most common causes of distillation malfunctions – what trouble should we look for and prevent?
- Points of transition (feeds, draws, tower base) – why these are some of the worst tower bottlenecks; how they are diagnosed and remedied.
- High tower base levels – how they induce premature flood, tray/packing damage and column overfills, and how you can prevent. Instrument issues at the tower base: what to watch out for.
- Tray/packing damage – pressure surges due to water entering a tower full of hot oil or insoluble organics, other sources of tray damage and ways to avoid.
- Some commissioning and startup watchouts – pre-startup inspection, blinding and unblinding, reverse flow, steam-water operation, washing, rapid pressuring/depressuring.
- Chimney trays – do's, don'ts and how they bottleneck towers.
- Liquid outlets – choking in sidedraw rundown lines and how it restricts tower capacity. Why must self-venting flow be assured in the presence of entrained vapour? Siphon formation.
- Kettle and once-through thermosiphon reboilers – how they bottleneck towers.