Troubleshooting Distillation Systems
Problems with Piping

Piping mistakes often affect the functioning of chemical plants. This article examines cases of some such errors.

Wrong selection of gasket

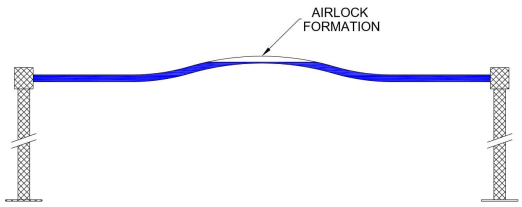
AF-120 type gaskets were used in piping of batch distillation plant. The feed contained a small quantity of toluene, which was earlier ignored as negligible. However, when distillation started, toluene accumulated at column top. The concentrations increased until it damaged the nitrile rubber binder of the gasket. The gaskets had to be changed to PTFE gaskets.

Thermal stress

Piping had been installed without accounting for thermal expansion and stress. When hot fluid flowed through the pipes, their lengths increased, and when the pipes returned to ambient temperature, they contracted. This differential expansion resulted in stresses that distorted the pipe. The problem was solved by providing suitable expansion joints.

Formation of U-seals

A significant length of pipe was running between two supports. However, it had accidentally formed a reverse U-seal along its length. This resulted in an airlock formation which significantly reduced flowrate. This is a common problem in piping. The problem was solved by ensuring that pipe slopes continuously downwards towards the direction of flow.

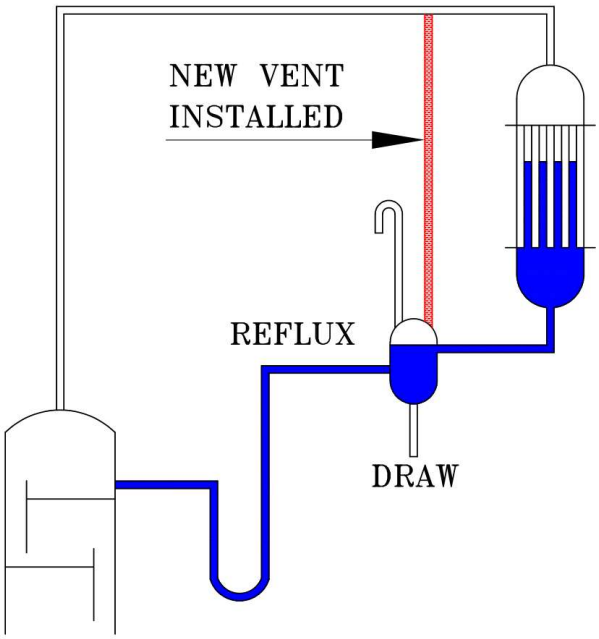


Underestimation of pressure drop

Length and number of fittings of a distillate pipe had been underestimated, and, so, actual equivalent length was higher than estimated. Thus, actual pressure drop (ΔP) was higher, sufficient head was not available to overcome it, and the flow got restricted. In this case, the distillate even backed up into the condenser and column. The plant had to be shut down and distillate piping changed to higher diameter.

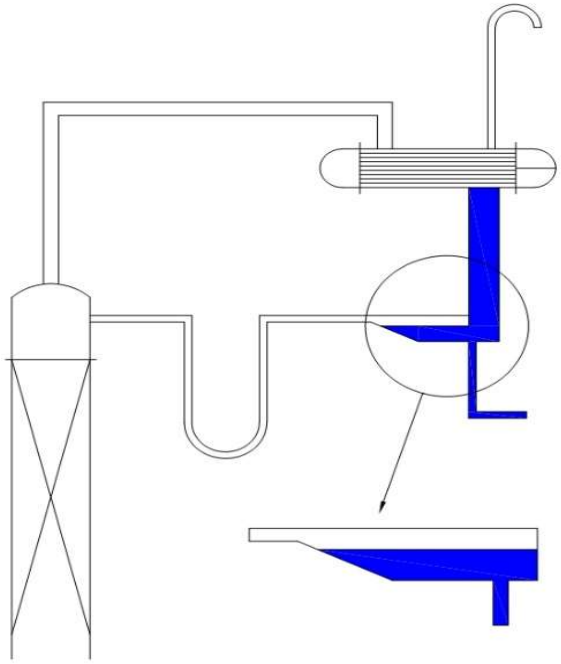
Improper pressure equalisation

Vertical condenser of a distillation column was vented only via the reflux drum. During distillation, when condensate level in the drum rose, it separated the vapour spaces of condenser and drum. As a result, condenser could not vent. Now, partial vacuum was generated in the condenser, when vapour condensed in it. This created suction that pulled up liquid - instead of letting it flow down to the column. After level reached a certain height, hydrostatic head overcame the pressure differential, and reflux rushed into the column. Pressure equalisation line was provided to the reflux pot, which eliminated this problem.



Wrong selection of fitting

In a distillation column, reflux stopped completely at lower turndown, though control valves were working properly. It was found that an eccentric reducer was used in the condensate pipeline and draw was tapped from underside of the reducer. When flows were turned down, all of the condensate went to draw and upper part of the pipe (which went to reflux) became empty. The eccentric reducer was eliminated, and sizes of nozzles and condensate piping were made the same.



Other common problems

- Wrong Selection of MoC: If MoC of pipes and fittings is not appropriate, then there could be corrosion / erosion problems. Furthermore, if the piping is of polymeric materials, like HDPE, some solvents can damage them, and care must be taken not to use them for such flows.

- Valve selection and installation: Valves should be selected suitable for their function in plant. This could be isolation, throttling, regulation of flow, pressure regulation etc. Valves can also be with socket welded, threaded, or flanged ends. Spring loaded non-return valves should be installed along given direction of flow.

- Drains and Air vents: Drain valves have to be provided at low spots like U-seal bottom to drain the system at shutdown. This is to prevent accumulation of hazardous material in the piping. Similarly, air vents are required at spots where air is likely to accumulate - such as intentional or accidental reverse U-seals.

- Water hammer: Improper steam traps lead accumulation of condensate, which can cause water hammer in pipes. This can also happen in pipes carrying organic vapour, which can partially condense within the pipe due to poor insulation

- Connecting equipment with different operating pressures. One example is when liquid from vacuum receivers is pumped to an atmospheric column with a centrifugal pump. When the pump is switched off, liquid could flow back in the reverse direction. To prevent this, U-seal of appropriate length should be provided in the discharge pipe.

- Inadequate insulation: Piping has to be properly insulated to maintain temperature of flowing fluid. This can be cold or hot insulation. There have been cases where non-insulated pipes were routed close to a hot equipment and the fluid became heated.

- Selection of fittings: Pipe fittings – bends, elbows, reducers, tees etc – have to be properly selected. One example of wrongly selected eccentric reducer is given above. Long-radius elbows have lower pressure drop than short-radius bends. For fluids with suspended solids, the solids can accumulate in the bends due to centrifugal forces, so long-radius elbows are preferable.