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TIPS & TOOLS: Where To Set Liquid Levels

Problem:

- Intercooler is properly sized but carries over liquid.
- Shell and tube heat exchanger is carrying over liquid through the knockout drum.
- Intercooler moves (shakes) under full load of boosters.

Solution: Check the liquid level in the intercooler or the shell and tube heat exchanger. It is likely too high. The actual liquid level in the vessel is much higher than the liquid level observed in the float tree or level probe. Lowering the observed liquid level will alleviate the problem and not adversely affect subcooler or heat exchanger performance.

For purposes of illustration, an intercooler will be used, but the same principle applies to shell and tube heat exchangers.

Explanation: In vessels and heat exchangers, liquid levels are measured in float trees that are separate from the vessel or heat exchanger that they measure the level in. This is to keep splashing of liquid against the level controller or float switches to a minimum, resulting in a steady reading of liquid in the column. Liquid in the level column is not undergoing boiling nor does it have a gas passing through it, as in an intercooler. Thus, the level column is “reading” a solid column of liquid.

Oftentimes, liquid levels in intercoolers are set at the top of the subcooling coil, and in shell and tube heat exchangers they are set at the top of the tubes. This is too high a level setting because it results in the “actual” liquid level in the vessel being as much as twice as high as the “observed” reading in the column.

Why is there a difference between the observed level and the actual level?

Inside the liquid column, the density is that of solid ammonia liquid, say 40 pounds per cubic foot. However, inside the intercooler or heat exchanger the density is considerably less because of the vapor bubbling through the liquid. The density of the aggregate liquid/vapor solution inside the vessel is 50-65% of the density of the liquid. Therefore, if you observe the level to be 20” on a level column, the actual surface of the liquid inside the vessel is 32”-40”. When the level is set too high, it results in liquid carryover in heat exchangers and both liquid carryover and rocking of intercoolers.

Where should the liquid level be set?

Intercoolers: In intercoolers, the observed level should be set between 50 and 65% of the height of the coil, or 12" above the perforated plate if no coil exists. If superheat is noted in the high stage suction gas, then slowly increase the setting until superheat to the high stage compressors is 10°F. If movement or rocking of the vessel is observed, then the level is too high.

Refer to the manufacturers drawings of the vessel to determine coil dimensions – the connections on the vessel are not always a good indication of where the coil is.

Shell and Tube Exchanger: The proper level is 2/3 to 3/4 of the depth of the tubes. The best way to adjust the level is to observe the inlet and outlet temperatures, and run the lowest level possible to achieve desired performance, while keeping an eye on compressor superheat.

Figure 1. Observed vs Actual Level

