Beyond API 2000 - Preventing Sudden Vacuum Collapse

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ABSTRACT

Vessels with condensible vapors present in the vapor space that are subjected to rapid cooling can experience rapid condensation and damaging vacuums. The cooling can be provided by an external deluge system, a heavy rain, or an internal quench. The rate of condensation is heavily dependant on the level of non-condensibles in the vapor space as well as other parameters.

The approach described in this paper is not necessary for most vessels since API 2000 is normally used to calculate vessel vacuum venting requirements. However, API 2000 states “An engineering review should be conducted for heated uninsulated tanks where the vapor space temperature is maintained above 120°F (48.9°C).” High vapor temperature, especially if that temperature approaches the normal boiling point of the vessel contents, tends to purge out non-condensibles from the vapor space. When the non-condensible concentration is very low, the condensing heat transfer coefficient on the inside of the vessel can be very high, making the vessel vulnerable to the rapid condensation scenarios described above.

As an illustration, suppose a vessel is being steamed out in preparation for maintenance. If the steam is left on long enough, nearly all of the non-condensibles can be purged out of the vessel. This makes the vessel very vulnerable to rapid condensation if for example the vessel is exposed to a sudden rain fall.

This paper explores the method used by Dow Chemical Company to calculate vacuum venting requirements for these rapid cooling scenarios. A simple Excel spreadsheet tool is used to estimate the required vacuum vent size. The tool can also be used to develop emergency procedures and for crisis response.