Gas Processing

Condensate Stabilization

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Composition of raw natural gas depends on the type, depth, and location of the reservoir and geology of the area. Most of the gas reservoirs contain some amount of heavy hydrocarbon components in its liquid state. This associated liquid hydrocarbon is called as hydrocarbon condensate. The hydrocarbon condensate contains large percentage of lighter components, which will flash off when the condensate is brought to atmospheric pressure. The recovered hydrocarbon condensate needs to be stabilized to avoid hydrocarbon flashing in storage tanks. Stabilization is a process of decreasing the amount of lighter components (C1 to C3) in the liquid phase. In other words, stabilization can be defined as a process that brings down the vapor pressure of the hydrocarbon liquid to the required specification. Stabilization of fluids from oil fields is called crude stabilization whereas for gas fields, it is called condensate stabilization. The objective of this article is to elaborate a method for the selection of a condensate stabilization technique for a specific application. Stabilization of condensate can be achieved through various techniques. However, this article discusses the techniques of Multistage Flashing and Stabilization by Distillation in detail

Process simulation model is developed for each of the cases multistage flasing and stabilization by distillation to identify the energy requirements and recovery factor. A typical case of condensate stabilization facility with feed capacity of 100 TPH is simulated to compare the above mentioned stabilization techniques. The landing pressure and temperature of the feed condensate is 50 bar (a) and 40 °C respectively. The feed has a Gas to Condensate Ratio (GCR) of 143. The required stabilized condensate vapor pressure specification is 86 kPa at 37.5 °C. The stabilized condensate is required at 2.5 bar (a) and 60 °C. The ambient temperature and cooling water temperature is considered as 50 °C and 40 °C respectively. Pressure drop across each heat exchanger is assumed as 50 kPa.

Base and Sensitivity cases are studied for comparison between stabilization techniques

Base Case: Without hydrocarbon recovery from flashed gas.

Sensitivity Case: With hydrocarbon recovery from flashed gas by compression.

The Base Case does not include gas compression and gas conditioning, where as the Sensitivity Case includes the compression of flashed gas to recover heavy hydrocarbons from the flashed gas. Flashed gas from condensate processing unit is compressed to 80 bar (a). Because of high pressure compression, most of the heavy hydrocarbons are recovered in compressor scrubbers as condensate and routed back to the condensate processing unit in the Sensitivity Case.

Operating pressure of the LP Separator (in multistage flashing technique) and the distillation column (in refluxed and non-refluxed stabilization technique) is considered as 3.5 bar (a). This helps to eliminate the requirement of export condensate pump and minimize the pre-heater duty. Operating pressure profile, considered in the case study, is tabulated in Table 1.

Stabilization Technique	Inlet Separator (Bar a)	HP Separator (Bar a)	MP Separator / Stabilizer Feed Drum (Bar a)	LP Separator (Bar a)	Stabilizer (Bar a)
Two Stage Flashing	NA	17	NA	3.5	NA
Three Stage Flashing	40	NA	12	3.5	NA
Four Stage Flashing	40	17	7	3.5	NA
Non-refluxed Stabilizer	40	NA	12	NA	3.5
Refluxed Stabilizer	40	NA	12	NA	3.5

Table 1: Comparison of Operating Pressure Profile in Condensate Processing Unit

The case study results are discussed in the following section.

Multistage Flashing

Multistage flashing is based on the principle of progressively lowering the pressure of condensate during each stage. This enhances the flashing of lighter components from condensate.

A schematic diagram for multistage flashing is shown in Figure 1.

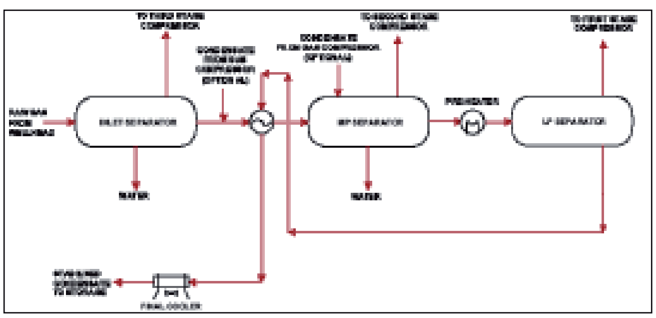

Figure 1: Typical Scheme for Stabilization by Multistage Separatio

Wellhead produced fluid is routed to the inlet separator where gas, condensate and produced water are separated. Condensate from the inlet separator is flashed in HP Separator. The condensate from HP Separator is routed to LP Separator via pre-heater. Lighter components present in the HP Separator outlet condensate are flashed in the LP Separator. The condensate gets stabilized due to higher temperature and reduced pressure at the LP Separator. The stabilized condensate from the LP Separator is routed to the storage tank via Feed/Stabilized Condensate Exchanger and Final Cooler.

Figure 4 depicts that as the number of flashing stages increase, heater duty decrease in both base and sensitivity cases. Figure 5 depicts that as number of flashing stage increases, liquid recovery increases in base case whereas in sensitivity case liquid recovery is independent of number of stages as heavy hydrocarbons are recovered from the flashed gas.

Figure 6 and 7 depicts that in sensitivity case compressor power and recovered condensate from compressor scrubbers decreases with increase in number of flashing stages. This indicates as number of flashing stage increases, heavy hydrocarbon content in the flashed gas decreases. However, an increase in number of stages results in requirement of additional equipments, piping, control system and space requirement which results in higher plant capital cost.

Hence, it is required to optimize the number of flashing stages based on a cost-benefit analysis. In the mentioned case study, three stages of flashing were found to be an optimum based on cost benefit analysis. Hence, Three Stage Flashing is compared with Distillation Stabilization technique.

Stabilization by Distillation

In this technique, unstabilized condensate is routed to a stabilizer column (distillation column) for condensate stabilization. These stabilizer columns are mainly of two types

- Non-refluxed Stabilizer
- Refluxed Stabilizer
- Non-refluxed Stabilizer

Non-refluxed Stabilizer is similar to a stripping column. A schematic diagram for the non-refluxed distillation column arrangement is shown in Figure 2. The stabilizer is a non-

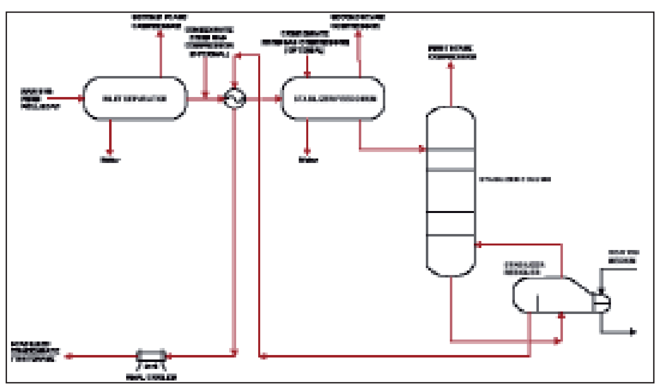

Figure 2: Typical Scheme for Stabilization by Non-refluxed Stabilizer

refluxed tray column.

The first two stages of separation are similar to multistage flashing. However in this process, unstabilized condensate from inlet separator is fed on / near the top tray of stabilizer via stabilizer feed drum. Stabilizer feed drum functions similar to the HP/MP Separator in the Multistage Flashing. Condensate stabilization takes place primarily in the stabilizer column instead of LP Separator.

Refluxed Stabilizer

Refluxed Stabilizer is similar to a conventional distillation column, which has both rectification and stripping section. Similar to the Non-Refluxed Stabilization technique, well head fluids are routed to inlet separator and condensate from inlet separator is routed to the stabilizer feed drum. Condensate from the stabilizer feed drum is fed to the stabilizer column via stabilizer feed/bottom exchanger. Location of condensate feed tray in the stabilizer column is at the tray where the temperature of the tray is equal to the temperature of feed.

A schematic diagram for Refluxed Stabilizer arrangement is shown in Figure 3.

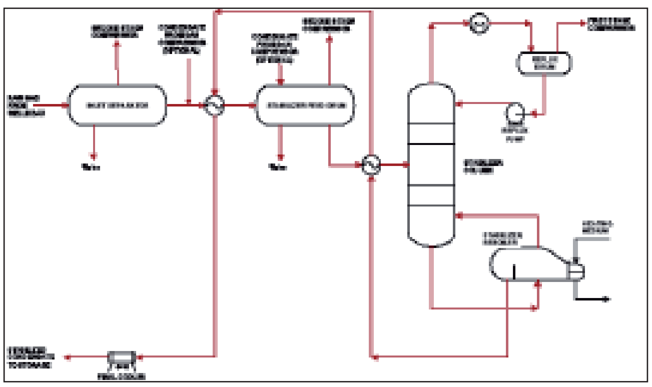

Figure 3: Typical Scheme for Stabilization by Conventional Refluxed Stabilizer

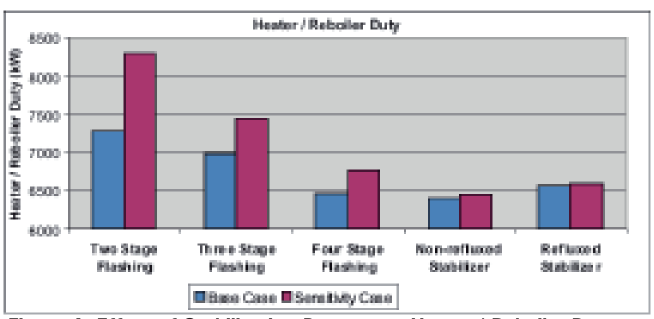

Figure 4: Effect of Stabilization Process on Heater / Reboiler Duty

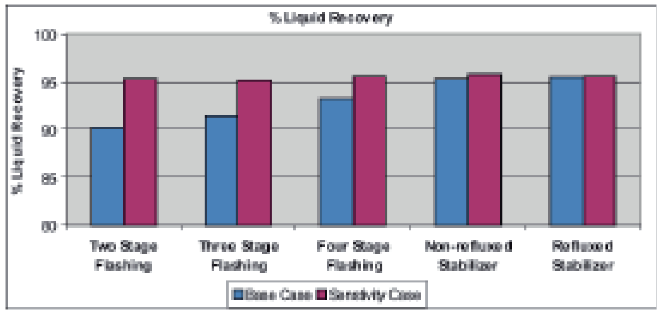

Figure 5: Effect of Stabilization Process on Liquid Recovery

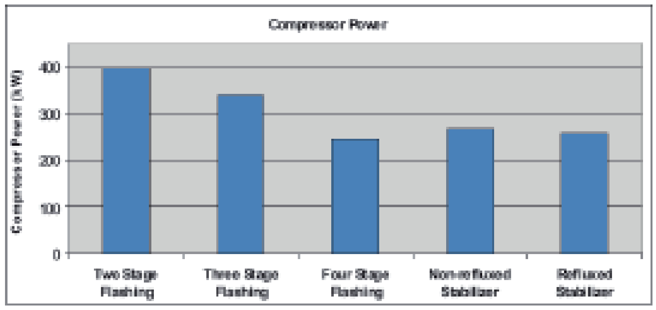

Figure 6: Effect of Stabilization Process on Compressor Power (Sensitivity Case)

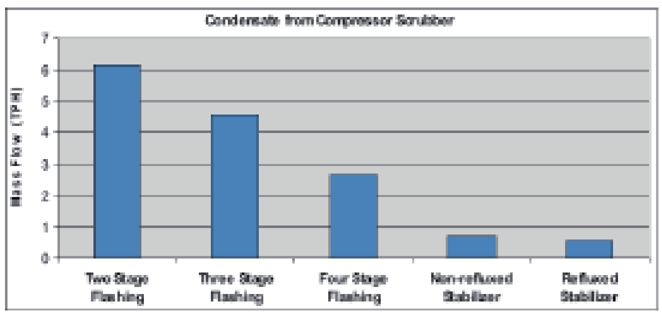

Figure 7: Effect of Stabilization Process on Condensate Recovered from Compressor Scrubbers (Sensitivity Case)

Refluxed stabilizer is a composite of rectification and stripping section, which helps to recover more intermediate components from the stabilizer overhead vapor when compared with Non-Refluxed Stabilization and Multistage flashing. However, extent of the liquid recovery will vary from case to case basis. Figure 5 depicts that there is no significant difference (i.e. 0.14 percent) in liquid recovery when compared with Non-refluxed stabilization

Refluxed Stabilization requires additional equipments (like overhead condenser, reflux drum, reflux pump etc), which will increase the unit cost and complexity of the control system when compared with Non-Refluxed Stabilization.

Comparison Between Stabilization Techniques

- Multistage Flashing is a much simpler process when compared to Refluxed and Non-Refluxed Stabilization.

- Heater / reboiler duty required for stabilization is substantially higher in Multistage flashing when compared to Refluxed and Non-Refluxed Stabilization. Figure 4 depicts that approx. Ten percent and 17 percent higher heater duty is required in Three Stage Flashing compared to Non-refluxed Stabilization in base and sensitivity case respectively.
- Figure 4 depicts that the heater / reboiler duty is more in sensitivity case compared to base case. This is due to the additional liquid that needs to be handled in sensitivity case. Figure 7 depicts that 4.6 percent additional recovered liquid need to be handled in Three Stage Flashing as against 0.5 percent in Refluxed Stabilization. This result in higher equipment sizes for identical plant capacity or lesser throughput for identical equipment sizes in Three Stage Flashing as against Refluxed Stabilization.
- Liquid recovery in base case is lower in Multistage Flashing when compared with Refluxed and Non-refluxed Stabilization. Figure 5 depicts that Non-refluxed Stabilization results in approx. 5 percent higher liquid recovery compared to Three Stage Flashing. However, Figure 5 depicts that in sensitivity case, liquid recovery is independent of the studied stabilization techniques. This is due to the recovery of heavy hydrocarbons in compressor scrubbers.
- Figure 6 depicts that in sensitivity case, Refluxed and Non-refluxed stabilization requires less compressor power when compared with Three Stage Flashing.
- Figure 7 depicts that recovered condensate from compressor scrubbers is less in Refluxed and Non-refluxed stabilization when compared with Multistage Flashing technique. This indicates flashed gas from Multistage Flashing contains higher amount of heavy hydrocarbon compared to Refluxed and Non-refluxed Stabilization. The same can be observed in Figure 4 by comparing the heater/reboiler duty in base and sensitivity case.
- However, in Refluxed and Non-Refluxed Stabilization additional equipments (like re-boiler, column) and utilities (like thermic fluid or fuel gas) are required which would increase the plant capital cost.

For the mentioned case study, Non-Refluxed Stabilization technique is selected based on a cost benefit analysis.

Conclusion

The hydrocarbon condensate stabilization is required to minimize the hydrocarbon losses from storage tanks. Most commonly used stabilization techniques are multistage flashing, Non-refluxed Distillation and conventional Refluxed Distillation. Selection of the stabilization technique shall be governed by parameters like reservoir conditions, fluid composition and specification of export condensate vapor pressure. Non-refluxed stabilization technique is suitable for many oil and gas plants as it increases the yield of stock tank liquid (liquid recovery) compared to multistage flashing stabilization technique. Conventional refluxed stabilizer increases the yield of stock tank liquid compared to the Non-refluxed stabilizer and multistage flashing technique. Process selection of the stabilization technique should be decided during the conceptual stage based on an overall cost benefit analysis. ■

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Rush to Join Solar Power Mission

News Delhi: Major national companies such as Oil and Natural Gas Corp. (ONGC), Indian Oil Corp. (IOC) and GAIL (India) Ltd are among the about 400 applicants who want to set up solar power units as part of India's efforts to promote clean energy.

Despondently, India has a power generation capacity of 164,508MW, of which only 16,429MW is generated through renewable sources such as solar energy. The Jawaharlal Nehru National Solar Mission aims to achieve 20,000MW of grid solar power and 2,000MW of off-grid solar applications. NTPC Vidyut Vyapar Nigam Ltd (NVVN), a subsidiary of state-run NTPC Ltd, has invited bids for solar plants that can generate 650MW of electricity. ONGC, OIL and GAIL, along with Lanco Infratech Ltd, Punj Lloyd Ltd, Gammon India Ltd, Acme Tele Power Ltd, Maharashtra State Power Generation Co. Ltd, Andhra Pradesh Power Generation Corporation Ltd (AP Genco), and Karnataka Power Corporation Ltd, among others, have submitted expressions of interest (EoIs).

Bansal, Chairman of IOC said, "Our future focus will be on clean energy. We aim to bring down the tariff in line with grid power."