Oil & Gas Separation - Number of stages and stage pressures

S M Kumar
Process Design Consultant

Direct Query: Oil & Gas Plant: Multistage Separators. How one decides the number of stages and individual stage pressures.

Response: We stabilize oil to meet its RVP spec for storage and transport in tankers. That is bring its true vapour pressure to atmospheric to avoid further emission/ HC release.

Unfollow S M   If you flash oil in one stage at atmospheric pressure, you will lose a lot of its dissolved gas. HC in liquid form is more valuable than when it is in gaseous form. Rule of thumb: Each BTU in liquid is worth twice that in gas. Varies based on gas and oil price in a given location. More the stages as in a column, higher the liquid yield as it allows more of C4s and C5s stay in liquid. Columns are likely to be fouled in this service as oil from earth carries lot of well mud and dirt. [Note: In a refinery, large storage tanks used before processing allow the muck to settle first.]

We need to keep oil field operation simple. Usually 2 stages are selected. One at HP closer to the upper limit of 150# piping, that is 10-12 bar; and another LP Stage operating at as low a pressure as possible to meet the LCV drop + liquid static head if there is a storage tank downstream. You run simulation varying the HP Stage pressure in 3 steps; varying the LP stage pressure for each of the 3 HP stage pressure and plot a graph to determine the maximum liquid yield; hence the ideal HP and LP stage pressure. Note: This assumes oil is flared or its compressor horsepower influence is ignored.

If you bring the compressor HP into the picture, the individual stage pressures will be more.

Read more in Google Book. Search books.google.com/books?isbn=0878143548. Francis S. Manning, Richard E. Thompson, Richard E. Thompson (Ph.D.) - 1995 - Technology & Engineering. Chapter 9 on how it all plays out for a given GOR; onshore / offshore.

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Oluseyi Ogunrinola
Lead Project Engineer at Pan Ocean Oil Corporation

Oluseyi

I remember each time i hold a plastic bottle of carbonated drink. I crack it open gradually to relief the gas so that i don't loose my drink to turbulence. This is pretty much the same with high pressure two-phase fluid coming from the reservoir into the separator. If an attempt is made to remove the gas all at a single go. turbulent effect will result in a massive heavier component carry over, the residence time required to effect phase separation will not be met and recovery will not be optimised. Its also unlikely that the RVP requirement will be met as earlier pointed out by Kumar. As to the number stage kumar is absolutely right. I have seen an empirical equation which can be used to predict the number of stages necessary for separation. The number of stages may also be determined by using any of the commercial software with appropriate emperical correlation.

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Murali Muthu
Senior Process Engineer at Tebodin Middle East

In general, the stage separation is used to maximize liquid production and minimize compressor

Murali   power.

The reason for the icreased oil production is "The tendency of any one component in the process stream to flash to the vapor phase depends on its partial pressure. If the pressure in the vessel is high, the partial pressure of the component is relatively high and the molecules of that component will tend toward the liquid phase. As the separator pressure is increased, the liquid flow rate out of the separator increases. hence the first stage shall be of higher pressure, for the subsequent stages the light hydrocarbons molecules that flash are removed at relatively high pressure as soon as they are formed and the partial pressure of the intermediate components is maximized at each stage."

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Fedi Abdeljawed
Process Engineer at OMV

I guess also the number of stage is related to avoid hydrate formation if we increase pressure from 50 bar to 10 bar it is required to

INITIAL SEPARATOR PRESSURE: psig NUMBER of STAGES
25 –125 1
125 –300 1 or 2
300 –500 2
500 –700 2 or 3

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Fedi

David Babarinde Alabi
Process & Flow Assurance Engineer

Agree with comments made by Seyi. Moreover, I have seen the recommendations below in my studies and it depends on the pressure of the first stage separator:
1st separator pressure of 1.5 - 9 bara = 1 stage
1st separator pressure of 9 - 20 bara = 1 to 2 stages
1st separator pressure of 20 - 35 bara = 2 stages
1st separator pressure of 35 - 50 bara = 2 to 3 stages (4 stages if flowrate is in excess of 100,000 bpd of stock tank oil.

The pressure ratio per stage can be calculated using the relation: $(Po/Patm)^{1/n}$, where Po is the first separator pressure, Ps atmospheric pressure and n is the number of stages.

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David
Babarinde

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