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Results 1 to 10 of 10

**Thread: Design of vapor-liquid separator (knockout drum, flash drum)**

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07-25-2006

#1

**mbeychok**  
 Junior Member  
 Join Date: Jul 2006  
 Answers: 5

**Design of vapor-liquid separator (knockout drum, flash drum)**

**In Metric units:**

A vapor-liquid separator drum is a vertical vessel into which a liquid and vapor mixture (or a flashing liquid) is fed and wherein the liquid is separated by gravity, falls to the bottom of the vessel, and is withdrawn. The vapor travels upward at a design velocity which minimizes the entrainment of any liquid droplets in the vapor as it exits the top of the vessel.

The size a vapor-liquid separator drum (or knock-out pot, or flash drum, or compressor suction drum) should be dictated by the anticipated flow rate of vapor and liquid from the drum. The following sizing methodology is based on the assumption that those flow rates are known.

Use a vertical pressure vessel with a length-to-diameter ratio of about 3 to 4, and size the vessel to provide about 5 minutes of liquid inventory between the normal liquid level and the bottom of the vessel (with the normal liquid level being at about the vessel's half-full level).

Calculate the vessel diameter by the Souders-Brown equation to determine the maximum allowable vapor velocity:

$$V = (k) [(dL - dV) / dV]^{0.5}$$

where:  
 V = maximum allowable vapor velocity, m/sec  
 dL = liquid density, kg/m<sup>3</sup>  
 dV = vapor density, kg/m<sup>3</sup>  
 k = 0.107 m/s (when the drum includes a de-entraining mesh pad)

Then A, the cross-sectional area of the drum, in m<sup>2</sup> = (vapor flow rate, in m<sup>3</sup>/s) / (vapor velocity V, in m/s)

and D, the drum diameter, in m = (4 A / 3.1416)<sup>0.5</sup>

The GPSA Engineering [Data](#) Book recommends the following k values for vertical drums with horizontal mesh pads (at the denoted operating pressures):

0 barg: 0.107 m/s  
 7 barg: 0.107 m/s  
 21 barg: 0.101 m/s  
 42 barg: 0.092 m/s  
 63 barg: 0.083 m/s  
 105 barg: 0.065 m/s

GPSA Notes:  
 1. K = 0.107 at 7 barg; subtract 0.003 for every 7 bar above 7 barg  
 2. For glycol or amine [solutions](#), multiply above K values by 0.6 – 0.8.  
 3. Typically use one-half of the above K values for approximate sizing of vertical separators without mesh pads.  
 4. For compressor suction scrubbers and expander inlet separators, multiply K by 0.7 – 0.8

The drum should have a vapor outlet at the top, liquid outlet at the bottom, and feed inlet at somewhat above the half-full level. At the vapor outlet, provide a de-entraining mesh pad within the drum such that the vapor must pass through that mesh before it can leave the drum. Depending upon how much liquid flow you expect, the liquid outlet line should probably have a level control valve.

As for the mechanical design of the drum (i.e., materials of construction, wall thickness, corrosion allowance, etc.), use the same methodology as for any pressure vessel.

Milt Beychok  
 (Visit me at [www.air-dispersion.com](http://www.air-dispersion.com))

09-18-2006

#2

sripri

Contributing Member

Join Date: Jul 2006  
Answers: 93

### Re: Design of vapor-liquid separator (knockout drum, flash drum)

Very detailed explanation on vapor-liquid separator . It surely would help all reading this discussion. Thanks mbyechok for posting the same.

Reply With Quote

11-12-2006

#3

mailtoamol1

Junior Member

Join Date: Nov 2006  
Answers: 2

### Re: Design of vapor-liquid separator (knockout drum, flash drum)

i need to design the vertical vapor liquid seperator for the following compositionof CNG  
compositon is  
Carbon Dioxide: 0.038  
Methane: 0.91  
Ethane: 0.0452  
propane: 0.0055  
n-Butane: 0.0002  
n-Hexane: .0011

Critical temperaur and pressure are  
critical temperature: 201.301 K  
critical pressure: 4714.462 kPa  
Molecular weight: 17.97 kg/kg-mole

the problem with me is how to find the liquid density for the operating condition

Please advice

Reply With Quote

11-12-2006

#4

mbeychok

Junior Member

Join Date: Jul 2006  
Answers: 5

### Re: Design of vapor-liquid separator (knockout drum, flash drum)

mailtoamol1:

You really must [learn](#) to express your problems better!! Are those compositions expressed as mol percent for the CNG in the vapor phase? If not, what are the units?

I assume that you know how to calculate the gas density using the ideal gas [law](#) corrected by the compressibilty factor ... or by using some more sophisticated equation of state.

I hope you understand the the liquid density in the Souders-Brown equation is **not the density of the CNG as a liquid**. It is the density of any liquid that might be present with the gas stream ... perhaps water or perhaps some heavier hydrocarbons. It may be a continuously present liquid or perhaps only an intermittent slug of liquid that may occur from time to time. You will have to work out that part for yourself.

What are your operating pressure and temperature and why did you present the critical pressure and temperature of the CNG? Are trying to say that your operating conditions are close to the critical conditions of the gas? If so, then you may want to use a more sophisticated equation of state or other method to get the gas density (rather than the ideal gas law and compressibility factor).

*Last edited by mbeychok; 11-12-2006 at 06:34 AM.*

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11-12-2006

#5

mailtoamol1

Junior Member

Join Date: Nov 2006  
Answers: 2

### Re: Design of vapor-liquid separator (knockout drum, flash drum)

Thanks for reply  
i am giving my problem in detail

i need to design the vertical vapor liquid seperator for the following composition of CNG  
in terms of mole fraction is

Carbon Dioxide: 0.038  
Methane: 0.91  
Ethane: 0.0452  
propane: 0.0055  
n-Butane: 0.0002  
n-Hexane: .0011

operating temperature: 325.15 K  
operating pressure: 25108.8kPa

Critical temperaur and pressure are

critical temperature: 201.301 K  
critical pressure: 4714.462 kPa  
Molecular weight: 17.97 kg/kg-mole

the problem with me is how to find the liquid density for the operating condition

Please advice

Reply With Quote

11-12-2006

#6

**mbeychok**

Junior Member



Join Date: Jul 2006

Answers: 5

**Re: Design of vapor-liquid separator (knockout drum, flash drum)**

mailtoamol1:

What liquid are you talking about? As I said before, the liquid in the Souders-Brown equation is not the CNG for your case. It is whatever liquid that you are trying to separate from the CNG, such as water or occasional slugs of higher molecular weight hydrocarbons.

Your operating conditions are obviously above the critical conditions ... so you will also have a problem of determining the gas density, as I also said before.

Sorry, I can't help you any further. I doubt that the Souders-Brown equation even applies at conditions above the critical point.

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04-15-2008

#7

**dancho**

Junior Member



Join Date: Apr 2008

Answers: 1

**Re: Design of vapor-liquid separator (knockout drum, flash drum)**

Hi, I was wondering if anyone has experience with oils slugs in natural gas distribution piping. The line is too small to pig, so field workers have been blowing off gas through a small drum to purge the line, but this is potentially dangerous and messy. I have been [researching](#) into knock out drums and I want to size it down for portable use, possibly fitting it with a mist eliminator and a flame arrestor.

Has anyone had the similar problem? or knows of a product/solution used in industry? Thanks!

Reply With Quote

05-17-2009

#8

**amir\_jkh2002**

Junior Member



Join Date: May 2009

Answers: 1

**Re: Design of vapor-liquid separator (knockout drum, flash drum)**

hi, i was wondering if anyone has experience about location of knock out drum. generally, it is located near the flare boom, but in our [project](#) flare is higher than wellhead facility, therefore, we have negative slop toward K.O. Drum. what should i do about it?

Reply With Quote

10-29-2009

#9

**erranjana15**

Junior Member



Join Date: Oct 2009

Answers: 1

**Re: Design of vapor-liquid separator (knockout drum, flash drum)**

Hi,  
i want to know that how we calculate the liquid density and gas density in the given composition of the feed?

Reply With Quote

12-17-2010

#10

**nazir3003**

Junior Member



Join Date: Dec 2010

Answers: 1

**Re: Design of vapor-liquid separator (knockout drum, flash drum)**

Thanks a lot for the information to design a flash drum separator.

i want to design a gas-liquid separator. i followed your steps but how can i find the [cost](#) of such a separator. Please inform me about the costing.

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