

USE OF PROPANE/WATER FRACTIONATOR
TO SUPPLY DRY PROPANE

DESCRIPTION OF THE INVENTION

Very dry propane required in dewaxing operations such as for the washing of wax cakes on filters is obtained by fractionating wet propane from a deasphalted oil recovery unit of a propane deasphalter in a propane-water fractionator. The wet propane feed to the propane-water fractionator furnishes the heat needed to run the fractionator.

BACKGROUND OF THE INVENTION

In a propane dewaxing unit, liquid propane streams employed for certain applications, such as for washing the wax cake on filters must be very dry. Any water in the propane would separate out as ice or propane hydrate at the low temperature employed in the filtration steps. These ice or propane hydrate solids plug or add significantly to the pressure drop through the equipment.

In dewaxing plants employing propane as a solvent, the propane is segregated into two streams, a wet stream and a dry stream. Any wet propane bled into a dry circuit as make-up solvent is usually sent through an adsorbent bed such as calcium chloride to remove the water. Such beds are disadvantageous since they require periodic replacement and further, any chlorides entrained with the propane can possibly cause chloride corrosion in the equipment handling wet propane. Further, adsorbent beds may not reduce the water content of the propane to a sufficiently low level. Alternatively, wet propane can be blended into dry

propane with an antifreeze added. The typical antifreeze used is methanol. The use of such antifreeze additives, however, adds extra operating costs.

Dry propane can be secured through distillation. However, this is not advantageous since distillation consumes energy, e.g. steam or separate furnace to supply heat to the reboiler of the drying column, and also requires additional equipment such as water cooling equipment to condense the water in the overhead.

U. S. Patent No. 2,672,034 is directed to dehydration of liquefied petroleum gas, particularly propane and butane, by a process involving distillation and flashing. A water-hydrocarbon stream is distilled to form an overhead fraction containing substantially all the water. This overhead fraction is condensed to form a hydrocarbon phase and a water phase. The water phase is separated and the hydrocarbon stream is subjected to simple flashing to remove additional quantities of water. The distillation tower appears to be heated conventionally. The flashing drums operate on the basis of reducing the pressure, yielding a liquid hydrocarbon phase and a gas phase (water).

U. S. Patent No. 3,083,147 describes dehydration of propane by distillation and side stream recovery. Hydrocarbon feed, such as natural gasoline, is introduced into a tower. Vapors which pass overhead are condensed and condensate is passed to a reflux accumulator from which are withdrawn a water layer (to discard) and a light hydrocarbon layer. Part of the hydrocarbon layer is passed back to the tower to serve as reflux, while the remainder goes to storage. The reboiler is powered by tower bottoms (i.e., the 'depro-

panized feed). Alternatively, all of the hydrocarbon layer from the reflux accumulator can be passed to the top of the tower to serve as reflux, with the fraction being sent to storage being the liquid overflow from the top plate of the tower; this recovered fraction being of even lower water content than the fraction recovered directly from the reflux accumulator. Finally, if the hydrocarbon layer from the reflux condenser is cooled and sent to a hydrocarbon/water separator before being sent to the tower as reflux, the recovered overflow stream is of yet still lower water content.

U. S. Patent No. 3,318,803 describes a distillation drying process involving feeding a wet hydrocarbon feed into a fractionator column, recovering a vapor overhead stream, introducing a liquid water stream into contact with the overhead vapor stream, condensing the resulting mixture, permitting the mixture to separate into a liquid wet feed phase and a liquid water phase, recycling the liquid wet feed phase to the fractionator as reflux, recycling part of the liquid water phase into contact with the vapor overheads, withdrawing liquid water from the separator vessel and recovering liquid dry stream from the bottom of the fractionator tower. Practice of this process sequence prevents the suspension of water microdroplets in the hydrocarbon phase.

U. S. Patent No. 3,622,494 describes spraying cold make-up propane into the vapor space of dewaxing chillers. This make-up propane is taken from the propane storage drum and/or the dewaxed oil recovery high pressure flash drum overhead.

U. S. Patent No. 4,162,272 describes the production of dry liquid propane substantially free from HF and organic fluorides. The propane is subjected to a drying operation involving a distillation-drying operation in which an overhead of sodium fluoride in water is recovered and disposed of as desired, while bottoms from the distillation are recovered as dry propane. The distillation tower is heated, either by a heater or a reboiler.

None of these references teach, suggest or imply that dry propane can be obtained by fractionating wet propane from a deasphalted oil recovery unit of a propane deasphalter in a propane-water fractionator wherein the wet propane feed to the propane-water fractionator furnishes the heat needed to run the fractionator.

DESCRIPTION OF THE FIGURE

Figure 1 is a schematic of the process of the present invention utilizing water wet propane from a deasphalter as both feed and heat source to produce dry propane.

PRESENT INVENTION

The present invention provides a process for providing dry propane for use in low temperature applications in dewaxing operations which process consists of fractionating in a water/propane fractionator wet propane from a deasphalted oil recovery unit of a propane deasphalter which wet propane has a water content of 2000 mole ppm or less and is at a pressure above that maintained in the water/ propane fractionator, where the fractionator operates at a temperature in the range of from 100°F to 140°F (37.8°C to 60°C), wherein the entire

heat to operate the fractionator is supplied by a portion of the hot, wet propane from the deasphalter, and which hot, wet propane is at a temperature above the temperature in the fractionator, and wherein the dry propane is recovered as a product stream directly from the fractionator.

The preferred process is described hereafter.

It has been discovered that the hot, either condensed or uncondensed, propane from a deasphalted oil recovery unit can be used as a heat source for a drying tower to supply dry propane solvent for use in a propane dewaxing operation. The hot, wet propane serves as both the feed to the drying tower and the heat source for running the drying tower. This is particularly advantageous since in those instances where the propane is taken as a vapor it must be condensed in the normal course of operation. Therefore, the heat it supplies to the reboiler and to the cooling water needed to condense the drier overhead is equal to the heat which would have to be rejected from the wet propane if no propane drying were integrated into the circuit. Thus, the utilities for the propane drier do not constitute an increase in the overall utility consumption for the two units.

The wet propane stream from the deasphalted oil recovery unit of a deasphalting plant is the propane stream of choice for use in the present process since this stream has a water content of 2000 mole ppm or less, which is soluble in the oil-feed/propane treater tower and which would be vaporized in the high pressure flash tower of the DAO recovery section. Selection of the proper wet propane stream is critical. It is well known that propane and water will vaporize and separate from a water-lean propane

liquid. However, the desired separation can only be achieved if the water content of the feed is below the limit at which a separate liquid phase would form at the conditions prevailing in the fractionator. For operating conditions in accordance with the process of the invention this limit is 2,000 mole ppm of water in the propane feed stream. The wet propane stream from the deasphalted oil high pressure flash tower of the deasphalted unit is normally below this limit, and is thus a satisfactory feed stream, because at two locations in the deasphalter water is removed in such a way as to lower the water content in the DAO circuit: in the propane solvent accumulator (surge) drum any excess liquid water above the solubility limit at moderate temperature separates out and is drained from the propane stream going to the treater tower; and, in the treater tower, any remaining free water coming in with the residuum feed will drop out and leave with the asphalt phase and not be present in the DAO overheads. Oil in the DAO solution phase coming out of the top of the treater tower would tend to reject free water from the predominantly propane phase.

This wet propane stream is both the feed stream and heat source for the wet propane fractionator which constitutes the present invention.

The wet propane stream from the deasphalted oil recovery unit is fed to a water/propane fractionator. There its heat is used to reboil and strip water from the propane. The feed stream can be either all vapor or a warm propane liquid condensed at a higher pressure than that at which the fractionator operates.

Note in Table I that the wet propane feed is hot liquid, as obtained from a high pressure separator. Streams 4, 4B and 4D could also be vapors. The actual condensation temperature or condensing temperature in the reboiler should be above the drier tower temperature.

A computer simulation was run in which a warm propane liquid condensed at a higher pressure than the fractionator operates at was considered the feed and heat source. Redlich Kwong coefficients were employed to represent the propane/water equilibrium. The results from the computer simulation are presented in Table I.

Dry propane containing only about 5 wt. ppm water is readily produced using 5 stages and a reboiler. The 5 wt. ppm water level is that needed to avoid precipitation of ice or propane hydrate at the -30°F operating temperature encountered in the dry propane circuit of a propane dewaxing unit.

Table I indicates that the fractionator operates isothermally. The fractionator can be controlled by careful regulation of the heat input to the reboiler via the measured flow ratio of overheads/feed, bottoms/feed or even overheads/bottoms. Most effective control, however, is achieved by careful manipulation of the flow ratio of overheads/feed.

The fractionator should be operable at a gauge pressure between 200 psig (1.379 kPa) to 500 psig (3.448 kPa). The operating temperature is in the

range of from 100 to 140°F (37.8 to 60°C) which is typically at the boiling point of propane or more typically that of the solvent propane mixture normally used, which often contains small amounts of ethane and butane contaminants.

The wet feed can be used to reboil the fractionator simply because its dew and bubble point temperatures will always be higher than those of the solvent in the tower. This is so because the feed stream must be at a higher pressure simply to get into the tower.

TABLE I

HEAT AND MATERIAL BALANCE

FOR PROPANE/WATER STRIPPING TOWER - 1,000 BPSD(1) PRODUCT

Stream Number	4	4B	4A	4C	7
Description	HP(2) Propane From Condenser	Hot Feed to Reboiler	Feed to Tower	C ₃ Used as Heat Source from Reboiler	Liquid to Reboiler
Temperature, °C (°F)	73.9 (165.000)	73.9 (165.000)	73.9 (165.000)	55.8 (132.365)	50.6 (123.014)
Pressure MPa (PSIA)	2.965 (430.000)	2.965 (430.000)	2.965 (430.000)	2.869 (420.000)	1.729 (250.750)
Mole Fraction Vaporized	0.0	0.0	0.0	0.0	0.0
Enthalpy GJ/h (megabtu/hr)	26.873 (25.47223)	10.57 (10.01498)	6.433 (6.09784)	9.641 (9.13797)	4.176 (3.95846)
Flow Rate Mol kg.mol/h (lb-moles/hr @ STP)	853.04 (1880.59985)	335.4 (739.39990)	204.2 (450.19995)	335.4 (739.39990)	148.99 (328.45923)
Flow Rate Wt Mg/h (kilo lbs/hr @ STP)	37.58 (82.84125)	14.77 (32.57088)	8.99 (19.83150)	14.77 (32.57088)	6.57 (14.48192)
Flow Rate Vap Mm ³ /day (megascf/day @ STP)	- (-)	- (-)	- (-)	- (-)	- (-)
Flow Rate Liq. Km ³ /day (bbl/sday @ STP)	1.778 (11172.5977)	0.699 (4392.75391)	0.426 (2674.62769)	0.699 (4392.75391)	0.311 (1954.28735)
Flow Rate Liq. m ³ /min (US gal/min @ COND)	1.591 (419.75195)	0.625 (165.03516)	0.381 (100.48526)	0.558 (147.18417)	0.245 (64.70012)
Flow Rate Vap. m ³ /s (ft ³ /sec @ COND)	- (-)	- (-)	- (-)	- (-)	- (-)
Density g/cm ³ (lb/US gal @ COND*)	0.394 (3.28929)	0.394 (3.28928)	0.394 (3.28928)	0.442 (3.68822)	0.447 (3.73123)
Density g/cm ³ (lb/ft ³ @ COND*)	0.394 (24.60570)	0.394 (24.60567)	0.394 (24.60567)	0.442 (27.58992)	0.447 (27.91214)

(1) BPSD = Barrels per stream day (2) HP = high pressure (3) Mole Avg. = molecular average

* COND = prevailing conditions

TABLE I - Continuation 1

Stream Number	4	4B	4A	7
Description	HP(2) Propane From Condenser	Hot Feed to Reboiler	Feed to Tower	C ₃ Used on Heat Source from Reboiler
Vapor Compressibility	-	-	-	-
Viscosity MPa.s (cp @ COND*)	53.93 (0.05393)	53.93 (0.05393)	53.93 (0.05393)	70.95 (0.07095)
Surface Tension (dynes/cm @ COND*)	-	-	-	-
Molecular Weight	44.05040	44.05042	44.05042	44.09958
Density g/cm ³ @ 15.6°C (lb/US gal @ 60°C)	0.508 (4.23696)	0.508 (4.23696)	0.508 (4.23696)	0.508 (4.23535)
Viscosity Mm ² /s @ 36.9°C (cs @ 100°F)	0.1732 (0.17320)	0.1732 (0.17320)	0.1732 (0.17320)	0.1723 (0.17230)
Viscosity Mm ² s @ 98.9°C (cs @ 210°F)	0.1046 (0.10463)	0.1046 (0.10463)	0.1046 (0.10463)	0.1039 (0.10387)
Mole Avg Boiling Point(3) °C (°F)	-41.8 (-43.244)	-41.8 (-43.244)	-41.8 (-43.244)	-42.07 (-43.726)
Mean Avg Boiling Point °C (°F)	-	-	-	-
Pseudo Crit. Temp. °C (°F)	97.2 (206.959)	97.2 (206.959)	97.2 (206.959)	96.7 (206.018)
Pseudo Crit. Pressure (ATMS)	42.255	42.255	42.255	41.923
Characterization Factor	-	-	-	-
Composition in kg/h (kilo.lbs/hr)				
Propane	37.55 (82.77686)	14.76 (32.54555)	8.99 (19.81607)	6.57 (14.48483)
Water in Solution	0.029 (0.06439)	0.011 (0.02532)	0.007 (0.01541)	0.000041 (0.00009)
H ₂ O	0.0	0.0	0.0	0.0

(1) BPSD = Barrels per stream day
* COND = prevailing conditions

(2) HP = high pressure

(3) Mole Avg. = molecular average

TABLE I - Continuation 2

Stream Number	8	8	10	9	11
Description	Vapor From Reboiler	Liquid from Reboiler	Overhead From Tower	Dry Propane Product	Propane to Wet C3 Condenser
Temperature °F	123.019	123.019	122.477	123.019	122.301
(°C)	(50.57)	(50.57)	(50.27)	(50.57)	(50.17)
Pressure MPa	1.729	1.729	1.724	1.729	1.724
(PSIA)	(250.750)	(250.750)	(250.000)	(250.750)	(250.000)
Mole Fraction Vaporized	1.00000	0.0	1.00000	0.0	0.30222
Enthalp. GJ/h	2.967	2.135	5.233	2.135	24.738
(megabtu/hr)	(2.81161)	(2.02385)	(4.95098)	(2.02385)	(23.44835)
Flow Rate kg.mol/h	72.82	76.17	128.04	76.17	776.87
(lb-moles/hr @ STP)	(160.52866)	(167.93074)	(282.26929)	(167.93074)	(1712.66919)
Flow Rate kg/h	3.21	3.36	5.64	3.36	34.22
(kilo.lbs/hr @ STP)	(7.07920)	(7.40573)	(12.42578)	(4.40573)	(75.43553)
Flow Rate Mm ³ /day	0.041	-	0.073	-	-
(Vap. mega SCF/SDay @ STP)	(1.46201)	(-)	(2.57076)	(-)	(-)
Flow Rate Liq m ³ /day	-	159.05	-	159.05	-
(bbl/sday @ STP)	(-)	(999.17407)	(-)	(999.17407)	(-)
Flow Rate Liq liter/min	-	125.22	-	125.22	-
(US gal/min @ COND)	(-)	(33.07990)	(-)	(33.07990)	(-)
Flow Rate Vap liter/sec	22.78	-	40.13	-	88.29
(ft ³ /sec @ COND)	(0.80437)	(-)	(1.41713)	(-)	(3.11791)
Density g/cm ³	-	0.447	-	0.447	-
(lb/US gal @ COND)	(-)	(3.73123)	(-)	(3.7313)	(-)
Density g/cm ³	0.039	0.447	0.039	0.447	0.108
(lb/ft ³ @ COND)	(2.44609)	(27.91165)	(2.43702)	(27.91165)	(6.72057)
Vapor Compressibility	0.72298	-	0.72288	-	-
Viscosity MPa/s	9.94	70.94	9.93	70.94	20.25
(cp @ COND)	(0.00994)	(0.07094)	(0.00993)	(0.07094)	(0.02025)
Surface Tension (dynes/cm @ COND)	-	-	-	-	38.2718

TABLE I - Continuation 3

Stream Number Description	8		8		10		9		11	
	Vapor From Reboiler		Liquid From Reboiler		Overhead From Tower		Dry Propane Product		Propane to Wet C3 Condenser	
Molecular Weight	44.09927		44.09988		44.02100		44.09988		44.04556	
Density g/cm ³	-		0.508		-		0.508		-	
(lb/US gal @ 60°F, 15.6°C)	(-)		(4.23534)		(-)		(4.23534)		(-)	
Viscosity Mm ³ @ 36.9°C	-		0.17229		-		0.17229		-	
(cs @ 100°F)	(-)		(0.17229)		(-)		(0.17229)		(-)	
Viscosity Mm ² /s @ 98.9°C	-		0.10387		-		0.10387		-	
(cs @ 210°F)	(-)		(0.10387)		(-)		(0.10387)		(-)	
Mole Avg Boiling Point °C	-42.07		-42.07		-41.64		-42.07		-41.78	
(°F)	(-43.723)		(-43.729)		(-42.956)		(-43.729)		(-43.197)	
Mean Avg Boiling Point °C	-		-		-		-		-	
(°F)	(-)		(-)		(-)		(-)		(-)	
Pseudo Crit. Temp. °C	96.68		96.74		97.51		96.73		97.25	
(°F)	(206.024)		(206.013)		(207.522)		(206.013)		(207.052)	
Pseudo Crit. Pressure (ATMS)	41.925		41.921		42.454		41.921		42.288	
Characterization Factor	-		-		-		-		-	
Composition in Kilo.lbs/Hr (kg/h)										
Propane	3.21		3.36		5.63		3.36		34.19	
	(7.07912)		(7.40571)		(12.41038)		(7.40571)		(75.37115)	
Water in Solution mg/h	36.2		9.0		6.98 (g/h)		9.0		29.2 (g/h)	
	(0.00008)		(0.00002)		(0.01540)		(0.00002)		(0.06437)	
H ₂ O	0.0		0.0		0.0		0.0		0.0	

DESCRIPTION OF THE FIGURES

Figure 1 is a schematic showing the wet propane stream coming from a deasphalted oil recovery unit, a water-propane fractionator, and the dry propane which can be used, for example, as wax cake wash solvent in a dewaxing operation.

Standard pieces of equipment, such as pumps, valves, meters, etc. have been omitted for the sake of clarity. Location and function of these various units is within the skill of the practitioner for sizing, placement and operation.

In Figure 1 deasphalted oil and propane from the deasphalting unit treater tower is passed via line (1) to a separator (2) wherein the DAO and propane are split into a DAO stream, recovered via line (3), and a wet propane stream, recovered via line (4). Normally this wet propane is condensed at high pressure, cooled and passed straight back to the deasphalter treater via booster pump facilities. In the present invention a portion of the wet propane is fed to a water-propane fractionator (5) via line (4A). The wet propane stream contains a significant quantity of heat and this heat is employed as the sole source of the energy required to power the fractionator. Wet propane via line (4B) is fed to heat exchanger (6) wherein it is used to reboil propane drawn from unit (5) via line (7). The reboiled propane from heat exchanger (6) is fed back to the fractionator (5) via line (8). This hot propane provides heat in the fractionator which strips the water from the wet propane, resulting in the production of a dry propane stream, recovered via line (9). A wet propane stream, recovered via line (10), is sent to a

lower pressure wet propane condenser associated with a propane dewaxing unit. The wet propane used to provide heat in heat exchanger (6) is fed via line (4C) to combine with line (4D) into line (11) which is the combined wet propane sent to a wet propane condenser or subcooler associated with the deasphalter. The propane recovered via line (9) can be chilled and used as batch chiller make-up propane in propane dewaxing operations or as solvent to wash wax cakes deposited on filters.

Note in Figure 1 that a propane condenser is shown on line (4), in which case the liquid in line (11) would be sent to a subcooler. The invention would work just as well if the condenser were placed on line (4A), in which case the predominantly vapor stream in line 11 would be sent to a combined condenser and subcooler.

Those knowledgeable in the art will note that the flow of dry propane to the dewaxer would lead to a deficiency of propane solvent at the deasphalter. Such a deficiency at the deasphalter can be avoided by transferring to the deasphalter a propane flow amounting to the propane flows in lines 9 and 10.

NOTES

Temperature expressed in °F is converted to equivalent °C by subtracting 32 and then dividing by 1.8.

Gauge pressure in pounds per square inch gauge (psig) is converted to equivalent kPa by multiplying by 6.895.

Mass expressed in pounds (Lb) is converted to equivalent kg by multiplying by 0.4536.

Liquid volume in U.S. gallon is converted to equivalent liter by multiplying by 3.785.

Volume expressed in cubic feet (ft³) is converted to equivalent liter by multiplying by 28.316.

Dynamic viscosity in centipoise (cp) is converted to equivalent Pa.s by multiplying by 1×10^{-3} .



CLAIMS

1. A process for providing dry propane for use in low temperature applications in dewaxing operations which process consists of fractionating in a water/propane fractionator wet propane from a deasphalted oil recovery unit of a propane deasphalter which wet propane has a water content of 2000 mole ppm or less and is at a pressure above that maintained in the water/propane fractionator, wherein the fractionator operates at a temperature in the range of from 100°F to 140°F (37.8°C to 60°C), wherein the entire heat to operate the fractionator is supplied by a portion of the hot, wet propane from the deasphalter, and which hot, wet propane is at a temperature above the temperature in the fractionator and wherein the dry propane is recovered as a product stream directly from the fractionator.

2. The process of claim 1 wherein the conditions in the water/propane fractionator, which operates isothermally, are controlled by manipulating the flow ratio of overheads to feed.

3. The process of claim 1 or claim 2 wherein the wet propane from the deasphalted oil recovery unit is either in the condensed liquid or vapor state.

4. A process as in any one of claims 1 to 3 substantially as described.



- 16 -

5. A process for providing dry propane for use in low temperature applications in dewaxing operations substantially as described with reference to Figure 1 of the accompanying drawings.
