

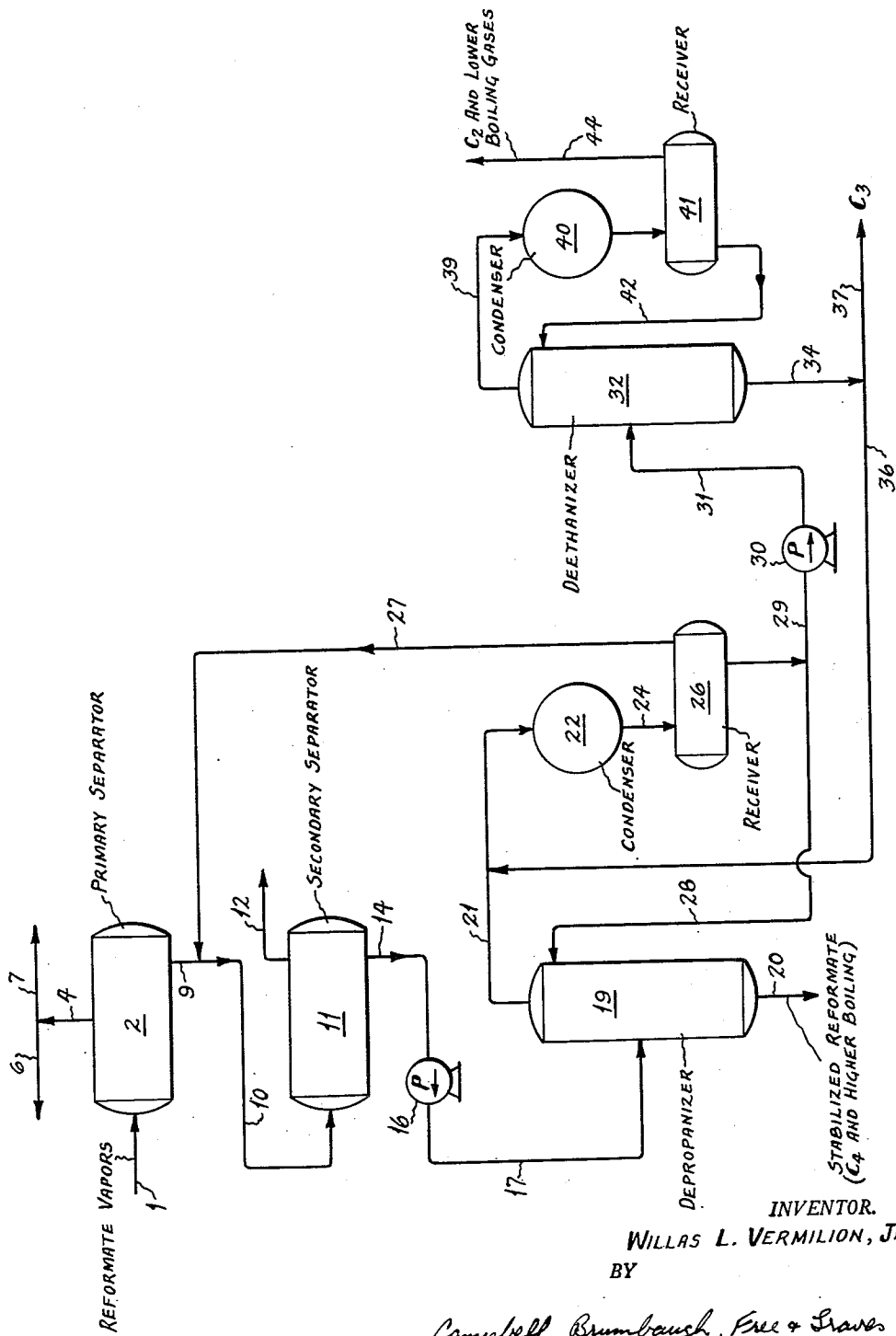
Sept. 10, 1957

W. L. VERMILION, JR

STABILIZATION METHOD

Filed Dec. 23, 1953

2,805,979



DE. INVENTOR.
WILLAS L. VERMILION, JR.
BY

Campbell, Brumbaugh, Free & Graves
ATTORNEYS

1

2,805,979

STABILIZATION METHOD

Willas L. Vermilion, Jr., Mentor, Ohio, assignor to The Standard Oil Company, Cleveland, Ohio, a corporation of Ohio

Application December 23, 1953, Serial No. 399,907

1 Claim. (Cl. 196—11)

The present invention relates to a method of stabilizing the condensible products of hydrocarbon reforming processes.

In catalytic hydrocarbon reforming processes, a term used herein to include hydroforming, a process primarily for dehydrogenating the naphthenes or saturated cyclic hydrocarbons in straight-run gasolines into aromatic compounds, and platforming, a relatively new catalytic reforming process utilizing a platinum catalyst for converting the naphthenes to aromatics, hydrocracking and isomerizing the paraffins, and virtually completely desulfurizing the hydrocarbons, the products leaving the reaction zone, hereinafter referred to as the reformat vapors, comprise mixtures of C₃, C₄ and higher boiling hydrocarbons, as well as gases such as hydrogen, hydrogen sulfide, methane and C₂ hydrocarbons, referred to in the art and in the present description as "non-condensable gases."

It is the general practice in the art to pass all or part of the reformat vapors through suitable heat exchangers and, after reducing the temperature and pressure thereon and thereby separating the bulk of the non-condensable gases from the condensible hydrocarbons, to subject the latter to stabilization. The stabilization step in effect involves passing the condensed hydrocarbons through one or a series of fractionating towers. One typical stabilization procedure, for example, is that of passing the condensed hydrocarbons under a pressure of say 300 p. s. i. g. into a depropanizer, a tower having a plurality of trays in which the contents are maintained at a considerably higher temperature at the bottom than at the top. The temperatures in the depropanizer are so adjusted that all of the C₃ and lower boiling hydrocarbons and other residual gases and an appreciable portion of the C₄ hydrocarbons are removed as overhead and the stabilized reformat, consisting of C₄ and lower boiling hydrocarbons, is removed at the bottom. The overhead is normally cooled to condense the C₃ and C₄ hydrocarbons and separate the lower boiling constituents, and the condensed C₃ and C₄ hydrocarbons are subjected to fractionation in a debutanizer to separate the C₃ hydrocarbons from the C₄ hydrocarbons and provide a supply of C₄ hydrocarbons for reflux to the depropanizer.

It has now been found that the stabilization of reformat vapors, particularly those containing a relatively high proportion of non-condensable gases, can be carried out much more effectively by interposing between the steps of (a) separating the bulk of the non-condensable gases from the bulk of the condensible hydrocarbons and (b) stabilizing the condensible hydrocarbons, the steps of reducing the pressure on the hydrocarbons condensed in the first step and thereafter increasing the pressure thereon to that at which stabilization is effected. By so reducing the pressure on the condensed hydrocarbons,

2

substantially all of the non-condensable gases that are dissolved in the condensed hydrocarbons can be removed at an early stage. This early removal of almost all of the non-condensable gases dissolved in the condensed hydrocarbons has a considerable number of advantages. One advantage is that the pressure required to operate the stabilizer is reduced and that consequently the loss of stabilized reformat is reduced to a minimum. Another is that the overhead from the stabilizer is made more readily condensible by recycling condensed C₃ hydrocarbons, which in turn makes it possible to substitute a propane reflux for a butane reflux to the stabilizer and thereby to eliminate the need for a debutanizer.

The advantages and utility of the invention will become further apparent from the following example, in which reference is made to the accompanying drawing:

EXAMPLE

Reformat vapors, at 450 p. s. i. g. and 900° F., comprising a mixture from a platformer of C₃, C₄ and higher boiling hydrocarbons with non-condensable gases such as hydrogen sulfide, hydrogen, methane and C₂ hydrocarbons, are passed through line 1 into a primary separator 2 wherein the temperature is reduced to 100° F. without any substantial change in pressure. The bulk of the non-condensable gases is removed by way of line 4, one portion thereof being recycled to the platformer by way of line 6, and the balance being passed to the platformer absorber by way of line 7. The bulk of the platformate is condensed and passed by way of lines 9 and 10 to a secondary separator 11 in which the pressure is reduced to 100 p. s. i. g. Almost all of the residual non-condensable gases dissolved in the condensed platformate are removed by way of line 12 to a low pressure thermal absorber or the like (not shown) and the condensed platformate, now substantially free from dissolved non-condensable gases, is passed by way of line 14, pump 16 (by means of which the pressure is increased to 250 p. s. i. g.), and line 17 to a depropanizer 19.

A stabilized platformate, consisting of C₄ and higher boiling hydrocarbons, is removed from the bottom by way of line 20 and C₃ and lower boiling hydrocarbons and any residual gases are removed as overhead by way of line 21. The overhead from the depropanizer 19 is subjected to condensation in a condenser 22 and passed by way of line 24 into a receiver 26. The non-condensed gases are recycled by way of line 27 to line 9 and the condensed gases are divided, one portion being refluxed to the depropanizer 19 by way of line 28 and the other portion being passed, by way of line 29, pump 30 (by means of which the pressure is raised to 500 p. s. i. g.) and line 31, into a deethanizer 32.

The bottoms of the deethanizer 32, consisting primarily of C₃ hydrocarbons, are removed by way of line 34, one portion thereof being recycled by way of line 36 to the line 21 to assist in condensing the overhead C₃ and lower boiling gases from the depropanizer 19, and the remainder being passed by way of line 37 to storage. The overhead from the deethanizer 32 passes by way of line 39 through a condenser 40 and from thence into a receiver 41 in which the condensed hydrocarbons are refluxed to the deethanizer 32 by way of line 42, and the non-condensed lower boiling gases are removed by way of line 44.

A material balance of the operation described is set forth below, the numbers of the column headings corresponding to the reference numerals on the drawing:

Material balance—mol/hour

	6	7	9	27	10	12	17	20	21	36	24	28	31	44	34	37
H ₂ S	1.03	0.14	0.2	0.1	0.3	0.1	0.2		0.7		0.7	0.5	0.1	0.1		
H ₂	6,471.5	884.0	26.0	3.2	29.2	25.9	3.3		3.8		3.8	0.5	0.1	0.1		
C ₁	418.5	57.1	9.4	5.1	14.5	8.4	6.1		10.9		10.9	4.8	1.0	1.0		
C ₂	302.5	41.3	34.0	21.5	55.5	12.7	42.8		152.8	1.4	154.2	110	22.7	19.9	2.8	1.4
C ₃	237.6	32.4	85.6	34.5	120.1	9.8	110.3	6.0	761.3	67.0	828.3	657	136.8	1.3	135.5	68.5
iC ₄	43.2	5.9	37.2	0.1	37.3	1.4	35.9	35.1	7.5	0.7	8.2	6.7	1.4		1.4	0.7
nC ₄	48.4	3.6	58.1	0.1	58.2	1.6	56.6	55.8	7.5	0.7	8.2	6.7	1.4		1.4	0.7
iC ₅	19.0	2.6	56.1		56.1	0.6	55.5	55.5								
nC ₅	10.3	1.4	37.7		37.7	0.3	37.4	37.4								
C ₆ +1	50.2	6.9	798.4		798.4	1.1	797.3	797.3								
340+ ²			177.8		177.8	0.2	177.6	177.6								
	7,602.23	1,038.34	1,320.5	64.6	1,385.1	62.1	1,323.0	1,164.7	944.5	69.8	1,014.3	786.2	163.5	22.5	141.1	71.3

¹ C₆ hydrocarbons plus hydrocarbons having boiling points up to 340° F.

² Hydrocarbons having boiling points above 340° F.

It will be noted that of the 26 mols/hour hydrogen dissolved in the platformate condensed in the primary separator 2 and the 3.2 mols/hour dissolved in said platformate by virtue of the recycling of gas from the receiver 26, 25.9 mols/hour, i. e., approximately 90%, is removed at the secondary separator 11 by way of line 12 leaving only 3.3 mols/hour of hydrogen dissolved in the platformate passed to the depropanizer 19. Furthermore, it will be noted as a direct result of the surprisingly effective removal of hydrogen, that the net amount of C₄ hydrocarbons in the overhead 21 from the depropanizer is merely 1.6 mols/hour, i. e., less than 0.8% of the C₄ hydrocarbons originally in the platformate vapors. It is also apparent that the yield of stabilized platformate, 1164.7 mols/hour, is surprisingly high in view of the 1320.5 mols of liquid separated in the primary separator 2.

It is to be understood that various modifications and applications of this method will readily occur to those skilled in the art upon reading this description. All such modifications and applications are intended to be included within the scope of the appended claims.

I claim:

In a method for recovering a stabilized gasoline and a liquefied gas principally comprising the C₃ hydrocarbons from the products of a catalytic hydrocarbon reforming operation, said products comprising a gaseous mixture, at elevated temperature and pressure, of C₁, C₂, C₃, and higher boiling hydrocarbons with a substantial quantity of hydrogen, the steps which comprise reducing the temperature of said products without substantially reducing the pressure thereon in a primary separation zone for liquefying and separating the bulk of the hydrogen and C₁ and C₂ hydrocarbons as gases from the bulk of the liquid C₃ and higher boiling hydrocarbons and residual dissolved hydrogen and C₁ and C₂ hydrocarbons, reduc-

ing the pressure on the liquefied product from said primary separation zone to a pressure below a depropanization pressure in a secondary separation zone whereby substantially all of the residual hydrogen is removed as a gas from said liquefied product without an appreciable loss of hydrocarbons boiling above the C₃ hydrocarbons, raising the pressure on the liquid product from said secondary separation zone to said depropanizing pressure, passing said liquid product at said depropanizing pressure to a first fractionation zone and adjusting the temperatures therein whereby substantially all of the C₁, C₂ and C₃ hydrocarbons are removed from said liquid product and substantially all of the C₄ hydrocarbons are retained in said liquid product, recovering said liquid product from the bottom of said first fractionation zone, condensing the overhead product from said first fractionation zone, recycling a portion of said condensed overhead product to said first fractionating zone, raising the pressure on the remainder of said condensed overhead product to a deethanization pressure and passing said remainder at said deethanization pressure to a second fractionation zone and adjusting the temperatures therein, recycling an appreciable portion of the bottom product from said second fractionation zone which comprises a major quantity of C₃ hydrocarbons, admixing said portion of the bottom product of said second fractionation zone with the overhead product of said first fractionation zone prior to said condensation step, and recovering the remainder of the bottom product from said second fractionation zone.

References Cited in the file of this patent

UNITED STATES PATENTS

2,073,073	Roberts	Mar. 9, 1937
2,666,019	Winn et al.	Jan. 12, 1954
2,719,816	Rich	Oct. 4, 1955