

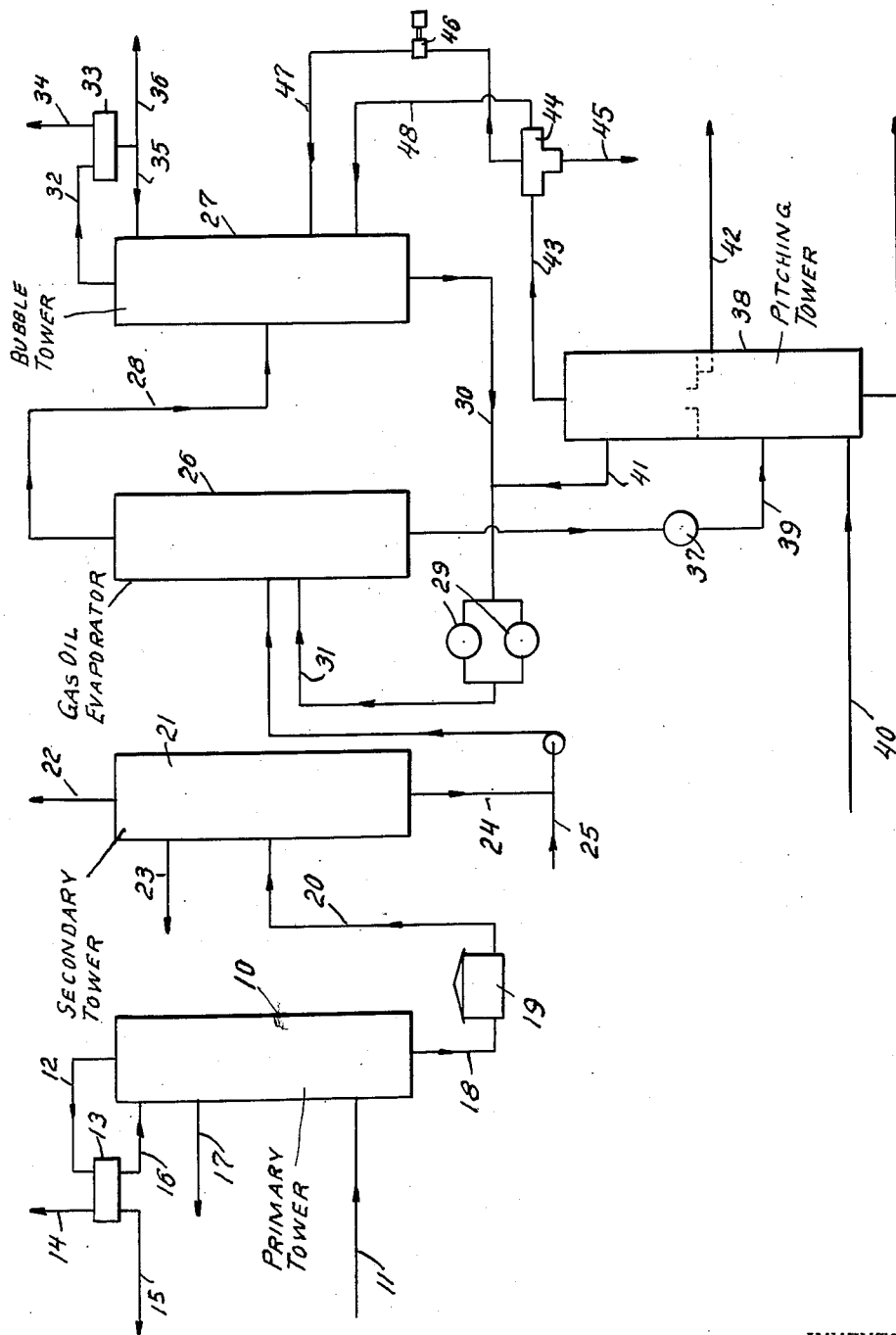
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CONVERSION OF HEAVY HYDROCARBONS

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CONVERSION OF HEAVY HYDROCARBONS

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1 Claim. (Cl. 196—50)

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My invention relates to improvements in the conversion of heavy hydrocarbon oils. More particularly, my invention resides in an improved method for operating thermal cracking units charging residual stocks so as to increase conversion while effecting heat economies.

The disproportionate demand for gasoline and light fuels as compared to heavy fuels and residual products puts petroleum refiners under heavy pressure to produce the maximum obtainable yields of specification quality gasoline and distillate fuels from crude oil stocks while minimizing production of the less valuable heavy fuels and residual stocks. Tremendous quantities of the latter, however, are inherently produced in refining crude oil and in cracking heavy oils to light oils. Crude oil ordinarily contains substantial quantities of heavy ends which are asphaltic or coke-forming in nature. Cracking oil to produce lighter and more desirable molecular aggregations also inherently produces molecular combinations of heavy coke-like or coke-forming materials under the pyrolytic conditions involved. As a consequence, refiners find the problem of mere disposal of heavy residual materials in view of their quantity an extreme problem in times of peak demands for gasoline and light fuels.

In application Serial No. 136,069, filed December 28, 1949, of Harry Louis Pelzer a method is described for reducing heavy oils to pitch which as residuum represents a substantial reduction compared to the quantities of tar or heavy oils produced in conventional cracking operations. Because of its high melting point and easy pulverizability the pitch product represents a more desirable product without requiring the costly removal and handling of petroleum coke. At the same time, improved yields of gas oil are obtained. I have now found that this pitching process may be adapted with particular advantage to combination with ordinary thermal cracking systems charging residual stocks which utilize a tar separator between the heating or cracking zone and the fractionating zone and which charge clean cycle oil or mixed feed to the heating zone. I have found that the combination results in significant heat savings and in higher conversion by improving the quality and quantity of cycle stock available within the cracking system.

According to my invention, tar separated from the gas oil evaporator or tar separator of a thermal unit charging residual stock is charged to a tower operated under pitching conditions to produce maximum overhead of heavy gas oil and about a 300° F. ring and ball M. P. or higher

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pitch. The tower is operated at a flash temperature of about 790° to 830° F., advantageously about 800° to 850° F., utilizing steam to reduce the hydrocarbon partial pressure and cool the tower boot below about 650° F. An intermediate black oil heater may be employed, if the tar separator temperature is low. In any event, the sensible heat of the evaporator bottoms is utilized and a high yield of gas oil is stripped out without tower coking. Light overhead is separated to gas, water and gasoline. A light gas-oil cut is advantageously withdrawn for use as a cutter stock or to net gas oil make in order to reduce the recirculation of highly cyclic and refractory oil within the cracking system. The bulk of the gas oil produced, however, is returned to the cracking heaters as mixed feed with the ordinary cycle stock from the cracking unit fractionator.

In thermal cracking, recycle of gas oil is limited by decline in conversion when a point of diminishing return is reached in the concentration of refractory cyclic stock recirculating within the unit. Some of the lighter more refractory gas oil, therefore, is usually withdrawn. On the other hand, useful convertible stock is lost to tar in the tar separation. Where a tar separator is utilized perhaps as broad a gas oil cut at 400°–800° F. may be recovered as distillate for recycle to the cracking heaters. According to my invention, however, more gas oil, for example, a 400° to 900° F. cut, of useful cracking stock quality may be recovered for recycle while a proportionate quantity of unsatisfactory refractory stock may be withdrawn so that the quality of mixed feed to the cracking heater and hence the conversion is significantly improved.

My invention will be better understood by reference to the accompanying drawing which represents conventionally and schematically a simplified flow plan of my process. In the drawing crude oil or a reduced crude oil stock is charged to primary tower 10 through line 11. Gasoline and lighter are taken overhead by line 12 to receiver 13 from which gas is removed by line 14, gasoline is removed by line 15, and reflux is returned to the tower top through line 16. The kerosene or light oil cut may be taken as a side stream through line 17. The bottoms is charged by line 18 through heater 19 and line 20 to secondary tower 21. A diesel or light gas oil cut is taken overhead from tower 21 through line 22 while a heavier gas oil cut may be taken through line 23.

Reduced crude is delivered from the bottom of tower 21 through line 24 together with any extraneous feed, charged through line 25, through

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a heater and to gas oil evaporator 26 of the cracking system. Overhead from evaporator 25 is passed to bubble tower 27 through line 28. Clean cycle stock is charged to cracking heaters 29 from the bottom of bubble tower 27 through line 30 and is returned to gas oil evaporator 26 by means of line 31. Gasoline and gas made in the cracking process are taken overhead from bubble tower 27 by line 32 to receiving drum 33. Gas is removed through line 34, reflux is returned to the tower top through line 35 and product is taken through line 36.

According to my invention a bottom stream is taken from gas oil evaporator 26 and is passed through heater 37 in which it is raised to a temperature approximately 850° to 950° F. The evaporator bottoms is held in the heater for a period of time sufficient under these temperature conditions to limit the percent crack (in terms of 400° F. end point and lighter) to 10% or less. The hot evaporator bottoms are then flashed into pitching tower 38 through line 39. Pitching tower 38 is advantageously divided into a lower flash section and an upper fractionating section. Steam is introduced to the bottom of tower 38 through line 40. Sufficient steam is introduced to the tower to cool the tower boot below coking conditions and to reduce the hydrocarbon partial pressure in the tower.

In general, about 10 to 25% by weight of steam on the feed is required, with a flash temperature of 790° to 880° F. The tower boot temperature should be maintained below approximately 650° F. to prevent coking, which, however, depends somewhat on the size of the unit. The lower portion of the tower is advantageously baffled so as to improve heat transfer between the steam and the charge in the tower. With a large unit, obviously the residence time of the oil on the tower wall will be less so that the tendency to coke is reduced. The tower is operated at approximately atmospheric pressure and up to about 10 p. s. i. g. The gas oil is flashed from the feed and produced either as side stream cuts taken through lines 41 and 42 or is taken overhead through line 43. As shown, heavy gas oil produced is taken as a fuel oil blending stock while the lighter gas oil through line 41 is returned to the cracking system in admixture with the clean oil recycled from bubble tower 27 through line 30 to cracking heaters 29. Also, as shown, bubble tower 27 is utilized as a fractionator for light products produced in the pitching tower with the accompanying heat economies. The light products passing overhead through line 43 are collected in receiver 44 from which water is removed as bottoms through line 45. Gaseous materials from receiver 44 are compressed by compressors 46 and are delivered to tower 27 through line 47. Light gas oil collected from receiver 44 is delivered to tower 27 through line 48 for re-cracking in the thermal cracking system.

The following example of an operation embodying my invention in comparison with a similar run in a thermal cracking unit charging a residual stock and utilizing a vacuum evaporator to produce heavy cycle oil will further illustrate the principles underlying my invention. The gas oil evaporator tower bottoms are flashed to the pitching tower at a flash temperature of 820° F. Steam at 230° F. in the amount of 34,400 pounds per hour is introduced to the bottom of the pitching tower. The tower bottom tempera-

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ture is maintained at 570° F. and the tower top temperature is maintained at 650° F. The crude oil charged to the combination crude running and thermal cracking unit is advantageously heated by indirect exchange in the top of the pitching tower. A water condenser may also be utilized in the tower top to act as a partial condenser. The tower is operated at 2 p. s. i. g. Fifty-seven thousand scf./hr. of gas are removed from the overhead receiver which is held at 100° F. and atmospheric pressure, for delivery to the cracking unit bubble tower. Twenty-four barrels per hour of light gas oil similarly are delivered from the overhead receiver to the bubble tower. The light gas oil side stream from the pitching tower produces 95 barrels per hour to net yield. Three hundred fifty-five barrels per hour of heavy gas oil are removed through a 250° F. condenser and charged to the cracking still heaters. A portion of the side stream may be returned to the pitching tower as reflux. One hundred thirty barrels per hour of pitch are produced as product. A comparison of the yields operating with pitching as against conventional vacuum evaporation of tar operated at maximum tower top temperature which will avoid coking follows:

Table I

	With Vacuum Evaporator	With Pitcher
Dry Gas..... M C. F./H.	122	154
Bubble Tower Overhead..... B./H.	193	220
Bubble Tower Side Stream..... B./H.	113	113
Pitcher Side Stream..... B./H.	0	195
Vacuum Evaporator Bottoms..... B./H.	357	0
Pitch..... B./H.	0	130

I claim:

In a hydrocarbon thermal cracking process charging a straight run residual stock and employing a tar separator between the cracking zone and the fractionating zone, the improvement which comprises heating tar bottoms from the separator at about 850° to 950° F. under cracking conditions for a period of time sufficient to limit cracking to less than 10% by weight, based on the 400° F. end point and lighter hydrocarbons, charging the so-treated tar bottoms to a pitching tower at about 790° to 880° F. and at approximately atmospheric pressure with about 10 to 25% by weight of steam on the feed, maintaining the boot temperature of the pitching tower at below approximately 650° F., separating water and light products overhead, removing heavy pitch as bottoms, recovering gas oil as distillate and returning gas oil to the cracking system as cycle oil stock.

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