

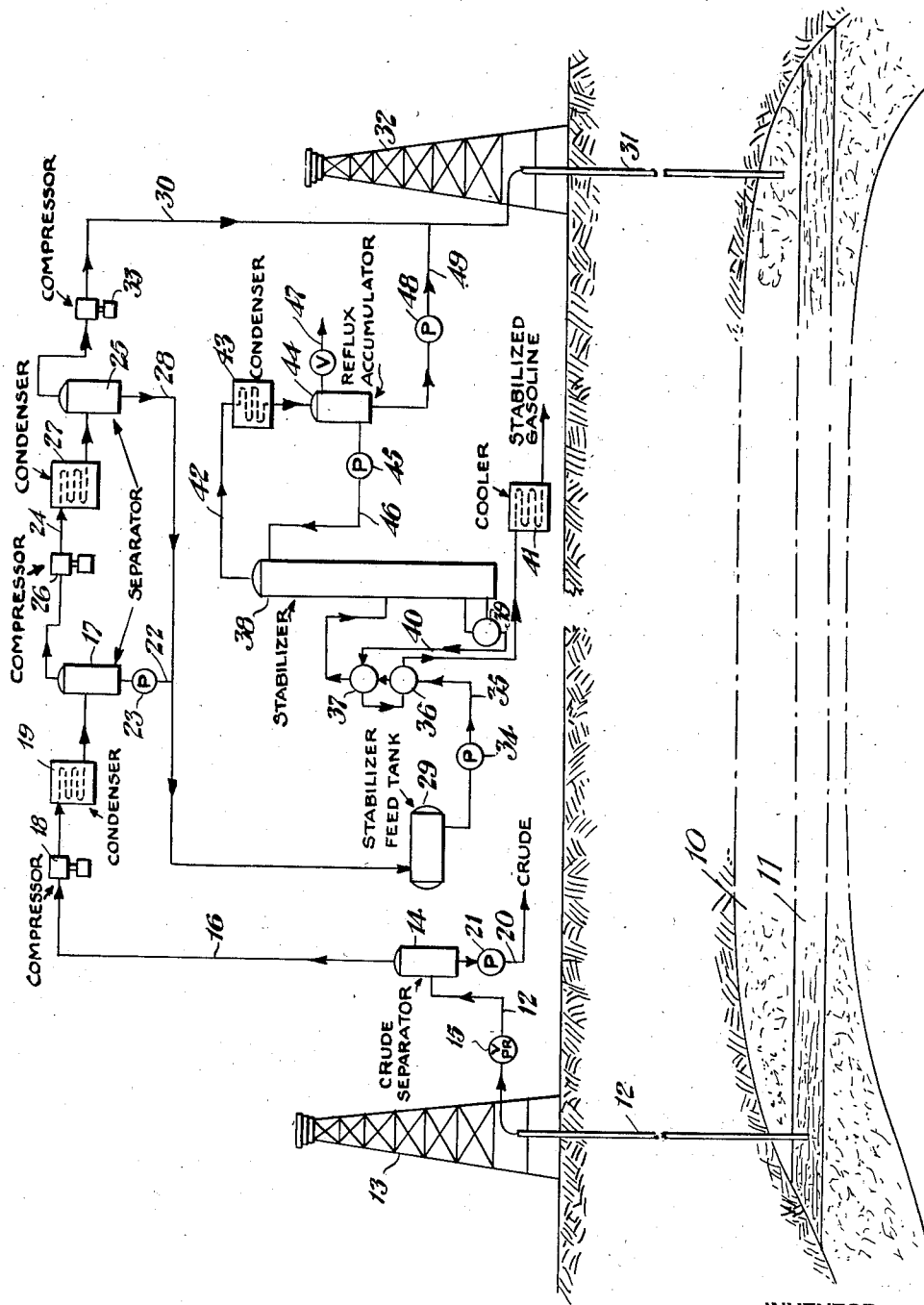
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EXTRACTION AND TREATMENT OF VOLATILE LIQUID HYDROCARBONS

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## EXTRACTION AND TREATMENT OF VOLATILE LIQUID HYDROCARBONS

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5 Claims. (Cl. 166—21)

This invention relates to the extraction and treatment of an excessively volatile liquid hydrocarbon fraction of the effluent hydrocarbons of a natural subterranean reservoir, and is particularly directed to an improved process whereby said liquid hydrocarbon fraction can be stabilized to yield a desired less volatile liquid hydrocarbon product and a normally gaseous residual product in a form which requires only inexpensive equipment to force its return to the subterranean reservoir.

An important step in the efficient recovery of petroleum and natural gas gasoline from a subterranean formation or reservoir consists in the return to the reservoir of any undesired normally gaseous hydrocarbons removed with the desired liquid products, since this repressuring operation prolongs the producing life of the reservoir by retarding the rate of pressure depletion. In reservoirs from which the removal of natural gas or petroleum is effected through flowing wells, reservoir pressure may be as high as four or five or more thousands of pounds per square inch. A substantial proportion of the fluids flowing from a producing well may consist of normally gaseous hydrocarbons, even when the well is producing substantial amounts of crude petroleum, and the first step in the recovery of the desired liquid products usually consists in effecting physical separation of gaseous and liquid hydrocarbons by reducing the pressure, temperature and velocity of the flowing stream. The pressure which is maintained in the initial gas-liquid separator depends upon the type of recovery operation employed, and may be as low as atmospheric and as high as 1500 or more pounds per square inch. A considerable volume of normally gaseous hydrocarbon remains dissolved in the separated liquid hydrocarbons, even when such liquid hydrocarbons are separated at a pressure as low as atmospheric. Final separation of the dissolved gaseous hydrocarbons is ordinarily effected by a so-called stabilizing or fractional distillation operation on the liquids. Since separation of the normally gaseous hydrocarbons from the liquid hydrocarbons takes place under a pressure much below that obtaining in the underground reservoir, reintroduction of the separated gaseous hydrocarbons to the reservoir normally requires the use of expensive gas compressing equipment to repressure the gas to reservoir pressure.

An object of this invention is to provide an improved process for recovering a stabilized hydrocarbon liquid as a product from effluent hydrocarbons of a subterranean natural gas and petroleum reservoir and for repressuring said reservoir with residue gases of the stabilizing operation.

Another object of this invention is to provide a process by means of which considerable savings can be effected in the cost of equipment necessary for delivering residual gaseous products of a gasoline recovery and stabilizing operation to a reservoir which is to be repressured and/or whose contents are to be, in part, replenished.

Other and further objects of this invention will appear from the following description, the accompanying drawing and the appended claims.

In general, in accomplishing the objects of this invention, a stabilizing operation upon an unstabilized liquid hydrocarbon product such as, for example, natural gasoline recovered from effluent hydrocarbons of a natural subterranean petroleum reservoir, is carried out at a pressure such that the residue product of the stabilizing operation will be obtained in a liquid state rather than in a gaseous state. Thus, it may be returned as a liquid rather than as a gas to a higher pressure reservoir, permitting the use of pumps rather than more costly compressors.

The accompanying drawing which forms part of the instant specification and is to be read in conjunction therewith illustrates one form of apparatus suitable for carrying out this invention as applied to the recovery of a stable natural gasoline from crude petroleum and to the repressuring of the reservoir forming the crude source with residual gases of the recovery-stabilizing operation.

Referring now more particularly to the drawing, crude petroleum in the natural stratum 11 of the natural subterranean petroleum reservoir 10 is forced under an existing pressure of, for example, from about 1000 to 1200 lbs. gage, upwardly through a pipe 12 of the well diagrammatically represented by the derrick 13 into the crude separator 14.

In view of the change in the hydrostatic head, the pressure on the crude at ground level will be considerably less, for example, 700 lbs. gage, and this is further reduced to substantially atmospheric pressure as the crude flows through the pressure relief valve 15 in transit to the separator 14.

The mixture of light gaseous vaporous hydrocarbons flashed from the crude is conducted from the separator 14 by a pipe 16 to a separator 17, being compressed, and, in part, condensed in

transit by the compressor 18 and condenser 19 respectively. The unvaporized portion of the crude in the separator 14 will obviously still contain a considerable amount of light hydrocarbons and in itself forms an excessively volatile liquid hydrocarbon product which is removed from the separator through the pipe 20 by means of the pump 21 and may be delivered elsewhere for further processing operations such as stabilizing, distillation, cracking, etc. for the recovery of the desired products.

The separator 17 is preferably maintained at a relatively low pressure of, for example, 30 to 40 lbs. gage, at which pressure the gaseous mixture coursing through the condenser 19 is partially condensed at a temperature of from 75 to 90° F. of the normally available cooling water. The condensate is removed through the pipe 22 by the pump 23 while the uncondensed constituents are conducted by the pipe 24 to a higher pressure separator 25 being compressed and cooled in transit by the compressor 26 and condenser 27 respectively.

The separator 25 is maintained at a pressure of, for example, about 225 lbs. gage so that most of the constituents of gasoline boiling range are condensed and discharged from the separator 25 through the pipe 28, together with the condensate from the separator 17, to the stabilizer feed tank 29.

The uncondensed constituents in the high pressure separator 25 are returned to the reservoir 10 through the pipe 30 and the pipe 31 of the well typified by the derrick 32. These uncondensed gaseous constituents issuing from the high pressure separator 25 are compressed by a compressor 33 to a pressure sufficient to permit their return in a gaseous stratum of the reservoir 10, for example, about 900 lbs. gage.

The unstabilized natural gasoline extracted in the separating zone from the effluent hydrocarbons of the reservoir is delivered from the feed tank 29 by means of a pump 34 through the pipe 35 and heat exchangers 36 and 37 to a stabilizer 38. The stabilizer 38 is equipped with the usual fractionating trays, baffle plates and the like and is operated so as to produce as a bottoms product a stable natural gasoline which is conducted from the stabilizer reboiler 39 by the pipe 40 through the exchangers 36 and 37 in indirect heat exchange therein with the stabilizer feed and finally through the cooler 41 to storage.

The overhead product of the stabilizer consisting mainly of undesired normally gaseous constituents removed from the stabilizer feed is conducted by the pipe 42 through the condenser 43 into the reflux accumulator 44 from which condensate is returned by the pump 45 through the pipe 46 to the stabilizer for reflux in the tower.

The pressure in the stabilizer 38, condenser 43, and reflux accumulator 44 is maintained at a value considerably above that heretofore maintained in such systems for the express purpose of effecting substantially complete condensation of the overhead product of the stabilizer which is thereby obtained in a liquid state. The minor uncondensed portion of the overhead product is discharged from the reflux accumulator 44 through the valved pipe 47. A pressure within the range of from about 350 lbs. gage to about 550 lbs. gage, for example about 450 lbs. gage, in the stabilizing zone will generally be found sufficient to effect the desired substantially com-

plete condensation of the overhead product. Thus, the residue product may be returned in a liquid state to the reservoir 10 to which it is pumped by the pump 48 via the pipes 49, 30 and 31.

In carrying out the stabilizing operation at a substantially increased pressure rather than at the lower customary pressures of 200 to 250 lbs. gage at which the major portion of the stabilizer overhead product would remain in a gaseous state, it is possible to employ a pump such as the pump 48 rather than the far more costly compressors. These would be necessary to compress the overhead product from a stabilizer pressure of 250 lbs. gage to 900 lbs. gage or higher required to recycle the residue product in a gaseous state to the reservoir 10.

In the foregoing explanation of the invention, the process has been described as applied to the recovery of a stabilized gasoline from natural gas which was originally associated with crude petroleum and physically separated therefrom at a low (substantially atmospheric) pressure in the separator 14. It should be understood, however, that the process of the present invention is also applicable to the recovery of a stabilized gasoline constituent from any "wet" natural gas effluent of a subterranean natural gas reservoir, and to the repressuring of said reservoir with residue gases of the stabilizing operation. The gasoline stabilizing part of the present process is applicable to the butane, pentane and higher boiling liquid hydrocarbon fraction of crude natural gas gasoline which may be separated from natural gas by retrograde condensation and/or by oil absorption at pressures considerably above atmospheric, for example at pressures of the order of 600-1500 lbs. per square inch. In fact, the separation of the crude gasoline fraction at such high pressures is the preferred practice in cases where the residue gas is recycled to the producing reservoir, because of the advantage of reduced recompressing cost for recycling the residue gas. When the operations for stripping the absorber oil and for stabilizing the recovered gasoline to remove undesired normally gaseous hydrocarbons such as methane, ethane and propane are carried out under pressure high enough so that a substantial proportion of said residue hydrocarbons are recovered as liquids in the condenser unit of the stabilizer, the cost of returning such residue hydrocarbons to the earth reservoir in accordance with the present process is relatively low because in liquid state such residue can be acted on by an ordinary liquid pump to force its return to the reservoir.

Having thus described the invention, what is claimed is:

1. A process of maintaining the rock pressure in a subterranean oil producing stratum or reservoir while removing oil therefrom and wherein gas is associated with and absorbed in the oil, comprising removing oil saturated with gas from the reservoir and releasing the pressure thereon to separate the gas from the oil, compressing and cooling the separated gas to raise its pressure above the pressure in the reservoir and to condense unstable gasoline from the hydrocarbon vapors in the gas, conducting the compressed gas back to the reservoir, stabilizing the condensed gasoline by fractional distillation under sufficient pressure to condense substantially all low boiling hydrocarbon vapors separated from the gasoline and pumping the condensate as a liquid into the

compressed gas to be returned in mixture therewith to the reservoir.

2. The process defined in claim 1 in which the gasoline is stabilized at a pressure of 350 to 550 pounds per inch gauge.

3. The process defined in claim 1 in which oil saturated with gas is removed from the reservoir at substantially rock pressure and the pressure on the oil reduced to substantially atmospheric pressure to separate gas from the oil.

4. The process defined in claim 1 in which the

separated gas is compressed and cooled in a series of stages to separate gasoline and lighter hydrocarbons and to raise the gas to the reservoir pressure.

5. The process defined in claim 1 in which the gasoline and light condensable vapors are removed from the gas separated from the oil at a pressure below 225 pounds per square inch so that the condensate separated will absorb a comparatively small amount of non-condensable gas.

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