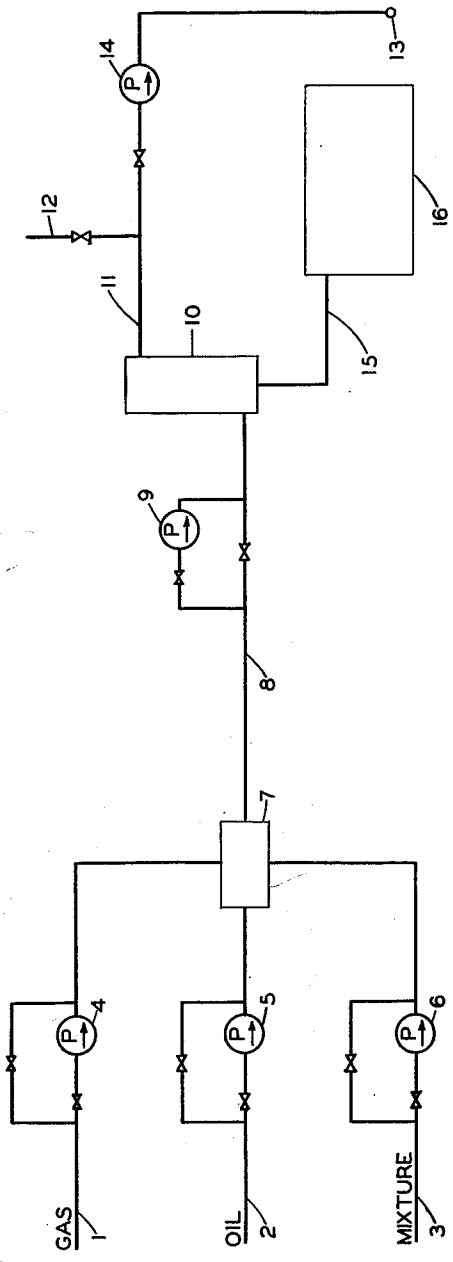
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TRANSPORTATION OF OIL AND GAS VAPORS IN A PIPE LINE

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INVENTOR
F.J. HARLOW

BY
Hudson, Young, Linkey + Yinger
ATTORNEYS

196. MINERAL OILS
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TRANSPORTATION OF OIL AND GAS VAPORS IN A PIPE LINE

Frederick J. Harlow, Bartlesville, Okla., assignor to Phillips Petroleum Company, a corporation of Delaware

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3 Claims. (Cl. 196—1)

This invention relates to the transportation of fluid hydrocarbons through pipe lines. More particularly, it relates to transportation of oil through the use of the retrograde condensation phenomenon.

Retrograde condensation is becoming of considerable importance to the oil industry in the recovery of liquid fractions from what is commonly known as distillate wells. It has been established that the oil and gas found in these distillate wells, at extremely high bottom hole pressures, are not in liquid form independent of each other but are in the form of oil vapor combined with the gas. This especially applies to the oil. In other words the gas and the oil are in vapor equilibrium at the pressures encountered in the well. It is further found that at certain critical points an immediate change takes place where the oil condenses out of the oil-gas vapors and the gas and oil may be recovered in their respective forms. In the present invention, the same condition as exists in the distillate wells is created in the pipe line by the introduction of high pressure gas, which may be either dry or wet, and by wet gas is meant that having oil or gasoline fractions combined with it and by dry gas is meant gas which is either residue from a gasoline plant or from a dry gas well, having little or no liquid content.

Through observations made in the production of the so-called "distillate" type wells, the oil industry is quite familiar with the phenomenon of retrograde condensation. Retrograde condensation is a process wherein a condensate is procured by pressure reduction at constant temperature; retrograde vaporization is the reverse of this process. Before retrograde condensation can take place it is necessary that there first be retrograde vaporization.

One of the objects of my invention is to make use of the phenomenon of retrograde condensation or its reverse, retrograde vaporization, in the transportation of petroleum products.

A further object of this invention is to transport mixtures of petroleum hydrocarbons in the vapor phase, by producing conditions in the pipe line similar to those encountered in reservoirs of the distillate type.

Another object is to transport petroleum fractions normally liquid together with gas as a mixture in the vapor phase or single phase. Still another object is to transport this mixture to the refinery, so that all refining and separating operations can be carried on at one place.

A still further object is the conservation of energy released by petroleum gases upon expansion.

Other objects and advantages will be apparent from the following specification.

My invention utilizes the phenomenon of retrograde vaporization and its reverse, retrograde condensation, in the transportation of hydrocarbon mixtures. In practicing my invention, the hydrocarbon gas and oil to be transported are subjected to high pressures and mixed. The pressures used are of such order of magnitude that upon mixing, retrograde vaporization of the oil takes place, whereupon the mixture is in the single phase region. This mixture is then transported to the refinery through pipe lines designed to carry the high pressures involved. In many instances, retrograde vaporization has already taken place within the reservoir from which gas is being produced. In these instances, the gas may be introduced directly into the pipe line, or may be further compressed and additional oil or gas added, to bring the mixture within the single-phase region. After mixing has taken place, the mixture, still maintained at high pressure, flows into and through the pipe line to the refinery where the pressure energy and retrograde characteristics are utilized in fractionating operations.

When the retrograde condition is duplicated, many advantages are apparent, for example, it will be possible to force wet or dry gas into a pipe line carrying oil, which gas at high pressure will vaporize the oil and the combined oil-gas vapors carried to a refinery where either by pressure reduction, application of refrigeration or mechanical expansion, the oil can be returned to its liquid state.

Still other advantages are apparent, for example, it is possible to transport oil and gas as a single phase fluid mixture having advantageous properties. The heat exchange rate of this fluid mixture is much higher than that of an ordinary gas, so that any heat exchangers used will have high efficiencies. The tendency of liquids to form gums or tars on the surface of pipes or equipment is eliminated by this method. The fluid may be separated into hydrocarbon fractions of different boiling ranges by making use of the phenomenon of retrograde condensation at the refinery.

The accompanying drawing shows diagrammatically an apparatus in which my method may be carried out.

The composition of the product shipped will depend upon the nature of the constituents sup-

plied by the field and the temperatures and pressures at which it is economical to operate. The numeral 1 represents the field gas supply line; numeral 2, the field oil supply line; numeral 3, the field mixture supply line. Any or all of these lines may be present at the field, depending upon the nature of the reservoirs being produced. Suitable pumps or compressors 4, 5, and 6 are provided if necessary to raise the pressure of these constituents prior to mixing in a mixing chamber 7. From the mixing chamber the mixture passes through pipe line 8 for transportation. If necessary, a compressor 9 is provided at some point along pipe line 8 to help force the mixture through the pipe line. At the refinery the mixture from pipe line 8 enters a separation plant 10 in which the gaseous hydrocarbons are separated from the liquid hydrocarbons. Separation plant 10 may apply the principles of retrograde condensation in fractionating the fluid. By reducing the pressure of the fluid in several stages, the liquid may not only be separated from the gas, but may also be separated into fractions of different boiling point characteristics. Gas leaving separation plant 10 through line 11 may be drawn off for fuel through line 12 or it may be pumped back into the oil sand through well 13 by means of compressor 14. Liquids recovered in the recovery operation of the separation plant 10 are drawn off through line 15 and passed to the refinery 16 for further processing.

By maintaining the high pressures occurring naturally in the oil or gas producing formations, the potential energy due to this high pressure may be utilized to aid in the transportation of the fluid through the pipe line or to provide power at the refinery to aid in the separation and refining of the petroleum hydrocarbons. By conserving these pressures as much as possible during the transportation and separation of petroleum products, the work required for compression of the gases for recycle operations or field repressuring is considerably decreased.

The retrograde condensation point has been established at from 800 to 1100 pounds gauge pressure which means that the residual gas pressure when retrograde condensation is employed is sufficiently high to generate considerable refrigeration by direct expansion which may also be employed to considerable advantage in the refinery. The application of this novel idea of the transportation of gas and oil in the same pipe line at pressures high enough to vaporize the oil will allow the pipe line to transport both oil and fuel for the refinery. It will also allow the vapor pressure to be recovered in the form of mechanical energy and will, as pointed out above, supply considerable refrigeration.

It is understood that several steps of the process as described herein may be varied, within the limits of the claims, without departing from the spirit of the invention as set forth in said claims.

I claim:

1. The method of transporting hydrocarbon products to a refinery comprising subjecting a supply of gas and a supply of oil to a pressure above the retrograde vaporization point of the oil, mixing the oil and gas at said pressure to form a vapor, transporting the mixture through the pipe line to the refinery in the vapor phase and then separating the hydrocarbon products into hydrocarbon fractions of different boiling ranges by lowering the pressure on the same to the retrograde condensation point.

2. The method of transporting hydrocarbon products to a refinery comprising subjecting a supply of gas and a supply of oil to a pressure above the retrograde vaporization point of the oil, mixing the oil and gas at said pressure to form a vapor, transporting the mixture through the pipe line to the refinery in the vapor phase, maintaining the pressure on the vapor along the pipe line and then separating the hydrocarbon products into hydrocarbon fractions of different boiling ranges by lowering the pressure on the same to the retrograde condensation point.

3. The method of transporting hydrocarbon products to a refinery comprising subjecting a supply of gas and a supply of oil to a pressure above the retrograde vaporization point of the oil, mixing the oil and gas at said pressure to form a vapor, mixing the vapor thus formed with vapor from a well above the retrograde vaporization point, transporting the mixture through the pipe line to the refinery in the vapor phase, maintaining the pressure on the vapor along the pipe line and then separating the hydrocarbon products into hydrocarbon fractions of different boiling ranges by lowering the pressure on the same to the retrograde condensation point.

FREDERICK J. HARLOW.