

C. E. HEMMINGER
SHALE OIL DISTILLATION
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Charles E. Hemminger Inventor
By P. L. Young Attorney

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SHALE OIL DISTILLATION

Charles E. Hemminger, Westfield, N. J., assignor
to Standard Oil Development Company, a corporation of Delaware

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1 Claim. (Cl. 202—15)

The present invention relates to the recovery of oil from shales and the like. The invention is particularly directed to an improved process in which oil-bearing shales are heated quickly and the oil removed from the solid material with a minimum of destructive pyrolysis. In accordance with the present invention, oil-bearing shales are powdered, suspended in a stream of gas, passed through externally fired tubes and then handled in a manner to recover the distilled oil.

It is well known in the art to recover oils from solid oil-bearing materials, particularly to recover petroleum oils from petroleum oil-bearing shales. The recovery of the oil from the oil-bearing material may be accomplished by suspending the solid material in a liquid medium and then raising the same to distilling temperatures. These processes have not been entirely satisfactory since the liquid medium constitutes a rather large heat reservoir which prohibits raising the temperature of the oil readily and quickly to distilling temperatures. Other processes treat relatively large solid particles. This is not entirely desirable since a considerable time of contact is necessary for the heat to penetrate the relatively large particles of shale or other solid substance. As a result of the relatively long time of contact, the hydrocarbons are converted to non-condensable gases. It has also been suggested that pulverized materials be dropped through heating gas streams. This operation does not give a rapid rate of heat transfer since a stagnant film forms about the shale particles, preventing satisfactory heat transfer. Various extraction operations have also been suggested.

I have now discovered a process by which oil may be readily and efficiently recovered from oil-bearing solid substances. My process overcomes previous inherent difficulties present in processes employed for the removal and recovery of oils from shales and the like, and permits a maximum recovery of the oils with a minimum decomposition of the same.

The process of my invention may be readily understood by reference to the attached drawing illustrating one modification of the same. Oil shale is introduced into grinder or crushing unit 1 by means of line 2 which may comprise any suitable belt or equivalent conveyor. The shale in unit 1 is powdered to the desired extent and then passed to bin 3 by means of line 4. The powdered shale is withdrawn from bin 3 by means of screw conveyor 5 and passed to mixer 6 in which the powdered oil shale contacts hot

suspension gases which are introduced into mixer 6 by means of line 7. These gases are heated to any desired extent by means of heating unit 7'. The colloidal suspension of powdered oil shale in suspension gases is withdrawn from mixer 6 by means of line 8, passed through heat exchanger 9 and then passed through externally fired tubes 10 in furnace 11. The heated mixture is withdrawn from furnace 11 by means of line 12 and introduced into a cyclone or equivalent separator 13. The solid material is subjected to stripping by superheated steam which is introduced into stripping unit 15 by means of line 16. It is to be understood that super-heated recycled vapors may also be utilized as a stripping medium. The solid material free of oil is withdrawn from stripping unit 15 by means of line 17 and handled in any manner desirable. A preferred modification of the present invention is to introduce the hot stripped shale into burning unit 18 and to introduce a sufficient quantity of air by means of line 35 to completely burn the carbonaceous material from the shale. The hot shale is then preferably passed through heat exchanger 9 in which the burned shale will raise the temperature of oil shale in suspension gases. The spent oil shale may then be withdrawn from the system by means of line 19 and disposed of in any desirable manner. The suspension gases and distilled oils are removed from cyclone separator 13 by means of line 20 and combined with stripped oils and stripping gases which are removed from stripping unit 15 by means of line 21. The entire vaporous mixture is then passed through cooler 22 and introduced into fractionating unit 23 in which the stripping gases are separated from the recovered oils. The stripping gases and suspension gases are removed overhead from distillation unit 23 by means of line 24, while the condensed distilled oils are removed by means of line 25 and handled in any manner desirable. A modification of the present invention is to treat the condensed oils removed by means of line 25 in a manner to form relatively higher and relatively lower boiling fractions. This may be accomplished by combining a portion of the spent oil shale which is removed by means of line 26 with the condensed oil withdrawn from unit 23. The mixture is heated in heating unit 27 under cracking conditions and then passed into separation unit 28 in which the shale is separated from the cracked oil and withdrawn by means of line 29. The cracked oil is withdrawn from unit 28 by means of line 30, passed to distillation unit 31 in which the rela-

tively lower boiling fractions are separated from the relatively higher boiling fractions. The respective fractions are removed by means of lines 32 and 33 respectively.

The process of the present invention may be widely varied. The invention may be adapted for the recovery of oils from any solid substance and is particularly directed to the recovery of petroleum oils from petroleum oil-bearing shales. An essential feature of the present invention is that the oil-bearing shales are powdered and suspended in suspension gases which permits a ready and rapid increase in temperature and minimizes any tendency of the oil vapors to be overcracked. The extent to which the oil shale is powdered may vary somewhat, depending upon the particular oil shale being treated, the oil concentration, as well as upon other operating conditions. In general, the oil shale is powdered in the range from 100 to 500 mesh. It is preferred that the oil shale be powdered so that more than 50% will pass through a 300 mesh screen.

The powdered oil shale is mixed with a sufficient quantity of suspension gases so that a desirable suspension of the powdered shale in the gases is secured. In general, approximately 8 pounds to 10 pounds of powdered shale per cubic foot of suspension gases is satisfactory. The suspension gases employed likewise may vary considerably and may comprise any inert gas which may be readily separated from the oil and which will not enter into the reaction, as for example, nitrogen, recycled or light hydrocarbon gases, or similar gases. However, in general, it is preferred to employ super-heated steam. The temperature of the suspension gases likewise may vary considerably. In general, the temperature of the suspension gases should be in the range from about 100° F. to 1500° F., preferably in the range from about 1000° F. to 1200° F. The suspension gases containing the powdered oil shale are preferably preheated before introducing the same into the furnace in which the temperature is finally brought up to the distilling range. The preheating operation of the gases is preferably secured in the manner described, i. e., by burning the carbonaceous material from the spent oil shale.

The velocity of the suspension gases is sufficient so that substantially no precipitation of the oil shale occurs prior to the cyclone separator. In general, the velocity is in the range from 10 feet to 50 feet per second. The temperature maintained in furnace 11 will depend upon the character of the powdered shale, the oil content of the shale, the volume of suspension gases used, as well as upon the velocity of the suspension gases. In general, the temperature in the furnace is so adjusted that the suspension gases containing the oil shale are removed from the furnace at a temperature from about 800° F. to 1100° F., preferably in the range above 900° F.

The length of time the suspension of oil shale is maintained at this distilling temperature will likewise depend upon the above enumerated fac-

tors. In general, the oil shale is maintained under distilling conditions for a time period not exceeding about 50 seconds, in which a moderate temperature in the range of about 900° F. to 1000° F. is employed. When employing these temperatures, it is preferred that the time the oil shale is exposed to distillation conditions not exceed about 25 seconds. The relatively short time period is an essential feature which is permitted by the method of recovery of the present invention. The oil is substantially fully recovered when distilled in accordance with the present invention, and the short time period in which the oils are maintained under distillation conditions substantially eliminates the tendency of the oil to deteriorate into undesirable products.

In general, the gases removed from the furnace are under a pressure from about 2 pounds to 50 pounds per square inch and are passed through pressure release valve 40 after the cyclone separator.

The process of the present invention possesses marked advantages over known processes in which the time period required to penetrate the relatively large particles is relatively high and the heating of the same non-uniform. The present process also possesses marked advantages over liquid mediums since a relatively small amount of oil is necessary to raise the conducting medium to distilling and cracking temperatures. Also, by using a non-liquid medium, a better separation is secured between the solid shale and the separated oils. Another distinct material improvement secured by the present process is that the powdered shale is suspended in a vapor such as steam or recycled gas so that the vaporization is aided by a low partial pressure over the shale and the cracking occurs in the vapor phase.

The process of the present invention is not to be limited by any theory or mode of operation, but only in and by the following claim in which it is desired to claim all novelty in so far as the prior art permits.

I claim:

Process for the recovery of oils from oil-bearing shales comprising powdering said shale in a manner that more than 50% of the shale will pass through 300 mesh screen, suspending the same in inert suspension gases, heating the same as a confined stream to a temperature in the range from about 800° F. to 1100° F., maintaining the suspension gas containing the powdered shale at this temperature for a time period not exceeding about 25 seconds, removing the gaseous mixture comprising suspension gases and distilled oils from the spent shale, separating the distilled oils from the suspension gases without substantially cooling the mixture so that a dry separation is effected, burning the carbonaceous materials from said spent shale and handling the same in heat exchanging equipment to preheat the suspension gases containing the powdered shale.

CHARLES E. HEMMINGER.