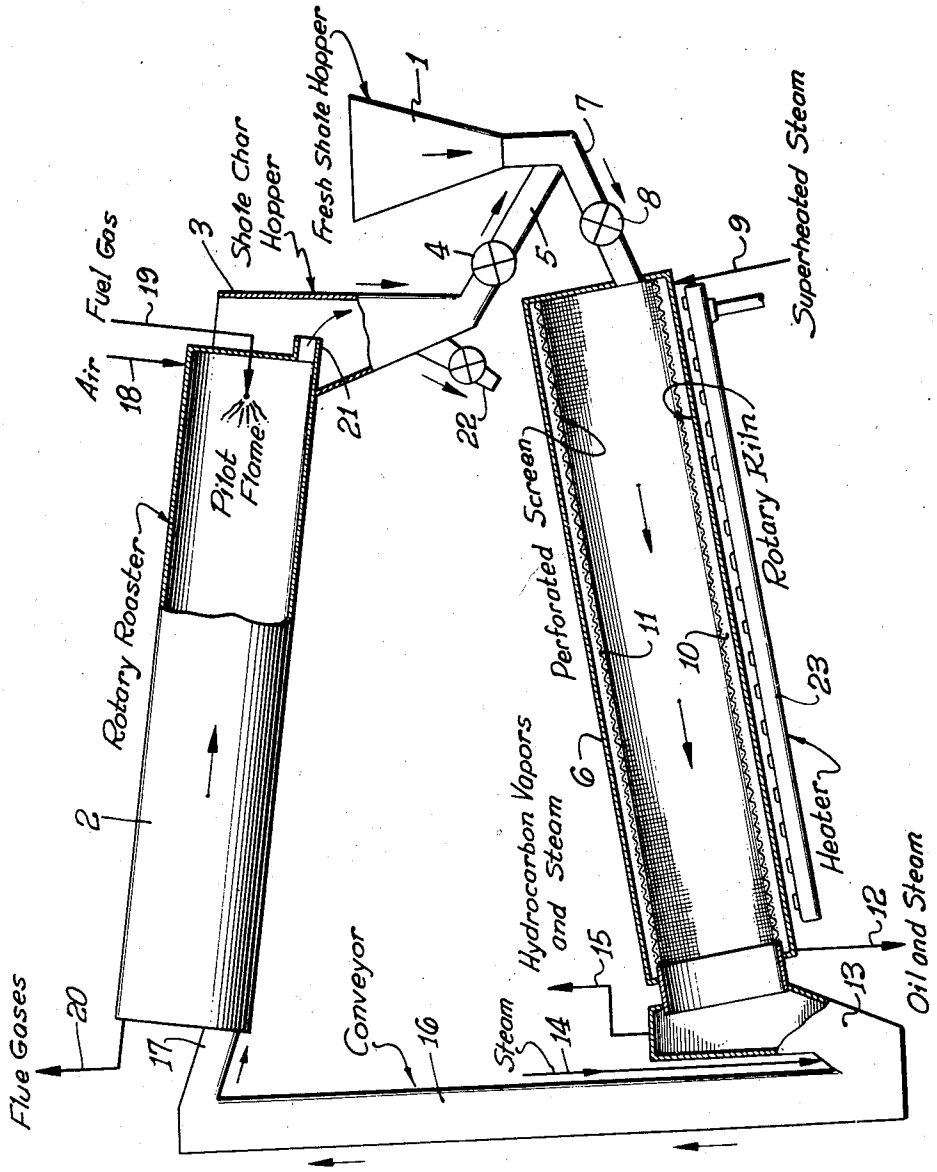
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METHOD AND APPARATUS FOR EDUCTING OIL FROM SHALE BY UTILIZING HOT SPENT SHALE

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METHOD AND APPARATUS FOR EDUCTING OIL FROM SHALE BY UTILIZING HOT SPENT SHALE

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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 roasted and the oil removed from the solid material without the detrimental effect of coking. In accordance with the present invention, oil-bearing shales are broken up into relatively small fragments passed through a rotary kiln employing a recycle of heated shale char and then handled in a manner to recover the hydrocarbon vapors and oil.

It is well known in the art to recover oils from solid oil-bearing materials, particularly to recover shale oil from oil-bearing shales. The recovery of the oil from the oil-bearing material may be accomplished by heating or roasting the oil-bearing shale at high temperatures sufficient to educt the oil and separate it from the material matter in a stationary roaster. These precesses have not been entirely satisfactory, because of their stationary nature and resulting effect of coking which requires periodic shut-downs to remove the coke. Other processes treat relatively large solid fragments. This is not entirely desirable since a considerable time of contact is necessary for the heat to penetrate the relatively large fragments of shale or other solid substances. As a result of the relatively long time of contact, an undesirably large amount of the hydrocarbon is converted to non-condensable gases.

I have discovered a process by which oil may be readily and efficiently recovered at high temperatures by the use of the sensible heat of spent shale from oil-bearing solid substances in a continuous operation with a resulting uniform treatment, without the detrimental effect of coking. 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 diagrammatic drawing illustrating one modification of the same.

Fresh shale, i. e., shale containing oil, from crushers and ball mills is introduced into fresh shale hopper 1, by means of a conveyor, elevator or any other suitable means. The fresh crushed shale in fresh shale hopper 1 is heated and prevented from adhering to the vessels, etc. and agglomerating by the introduction of hot crushed shale char, i. e. spent shale, from rotary roaster 2 by means of shale char hopper 3, rotary valve 4 and line 5. The above mentioned mixture comprising fresh crushed shale and hot crushed shale char is introduced into rotary kiln 6 by means of line 7 and rotary valve 8. The shale in rotary kiln 6 is heated by means of the sensible heat of introduced hot crushed shale char, and educted by means of super-heated steam introduced into rotary kiln 6 by means of line 9 thus causing the kerogen in the shale to decompose and form oil and hydrocarbon vapors. The released oil and condensed steam will enter annular space 10 through perforated screen 11 and removed therefrom by means of line 12 and handled in any desired manner. The oil-free carbonaceous shale in rotary kiln 6 is introduced into conveyor box 13 by means of gravitation and rotation of said rotary kiln 6. The carbonaceous shale in conveyor box 13 is purged of any hydrocarbon vapors therein by means of steam introduced therein by means of line 14, thus releasing the occluded hydrocarbon vapors and steam therefrom which are removed by means of line 15 to be handled as desired. The carbonaceous shale is removed from conveyor box 13 by means of conveyor 16 and introduced into rotary roaster 2 by means of line 17. The above mentioned carbonaceous shale is rotated by means of rotary roaster 2, and carbon removed by burning with the aid of introduced air and fuel gas injected into rotary roaster 2 by means of lines 18 and 19, respectively. The flue gas produced in rotary roaster 2 is removed by means of line 20 to be disposed of as desired. The carbon-free shale or spent shale, in rotary roaster 2 is removed by means of line 21 and introduced into shale char hopper 3. A part of the hot spent shale is removed from shale char hopper 3 by means of line 22 and sent to a heat recovery unit (not shown), so as to produce steam for operational purposes. The remainder of the hot spent shale in shale char hopper 3 is introduced into fresh shale hopper 1 by means of rotary valve 4 and line 5 and thereby heats and prevents the adhering of freshly introduced shade, to the vessels, etc., agglomerating, as mentioned above.

A modification of the present invention is to fire rotary kiln 6 externally, such as by means of heater 23, this modification is only necessary where the combined sensible heat of introduced spent shale and superheated stripping steam is insufficient to educt all the hydrocarbons present in the fresh shale.

Another modification of the present invention is to introduce stones or steel balls, ranging in size from that of about one-half inch to that of

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about three inches, into rotary roaster 2, and thereafter continuously employed throughout the above mentioned cycle, to act as a crushing and heat carrying medium for the fresh shale introduced into rotary kiln 6.

The process of the present invention may be widely varied. The invention may be adopted for the recovery of oils from any solid substance, but is particularly directed to the recovery of shale oil from oil-bearing shales.

In the practice of my invention, as shown above, the fragments of fresh shale introduced into rotary kiln 6 in conjunction with hot spent shale from rotary roaster 2 is heated to the desired temperature by means of the above mentioned hot spent shale and superheated stripping steam introduced therein. The continual revolving, of rotary kiln 6 will cause the shale to break up and thereby facilitate the eduction of the hydrocarbon constituents and prevent any coking therein.

The average fragmentary size of the shale may be between that of granules of about ⅛ inch and that of lumps of about 1½ inches. For the preferred operation, sizes between about ¼ inch to about ½ inch are most suitable.

The temperature required for the proper eduction of the shale in rotary kiln 6 may be between about 800° F. and about 1800° F., depending on the type of shale employed and the products desired. Temperatures between about 900° F. and about 1100° F. are suitable for most operations.

The roasting time required for reasonably complete eduction may be as low as 30 minutes or less, and generally will not exceed about 6 hours.

The amount of superheated steam introduced through line 9 is controlled to obtain the proper degree of oil stripping in rotary kiln 6 taking into consideration the temperatures within the kiln, the type of shale being educted and the desired products.

The flow rate of introduced shale in rotary kiln is governed by the degree of eduction of the carbonaceous shale dropped into conveyor box 13. The rate of flow may be increased or decreased by adjusting the pitch and revolutions per minute of said rotary kiln.

The foregoing description of my invention is not to be taken as limiting my invention but only as illustrative thereof since many variations may be made by those skilled in the art without departing from the scope of the following claims.

I claim:

1. An apparatus for separating oil from oil shale which comprises a shale hopper, means for commingling hot spent shale with fresh oil shale, an inclined rotary eduction retort communicating with said shale hopper, means for introducing commingled hot spent shale and hot oil shale plus steel balls into said inclined rotary eduction retort, said hot spent shale and hot steel balls being introduced in direct heat exchange with said fresh shale, means for introducing superheated eduction steam into said inclined rotary eduction retort, means for externally heating said inclined rotary eduction retort, means for educting shale oil and hydrocarbon gases from said oil shale in said inclined rotary eduction retort, means for separating said educted shale oil and hydrocarbon gases from carbonaceous shales in said inclined rotary eduction retort, means for removing said hydrocarbon gases from said inclined rotary eduction retort, means for removing said shale oil from said inclined rotary eduction retort, means for removing said carbonaceous shale and steel balls from said inclined rotary eduction retort, an inclined rotary roaster communicating with said inclined rotary eduction retort, means for introducing said carbonaceous shale and steel balls nito said inclined rotary roaster, means for burning said carbonaceous shale in said inclined rotary roaster, means for separating flue gases from spent shale in said inclined rotary roaster, and means for removing said spent shale and steel balls from said inclined rotary roaster.

2. An apparatus for the recovery of shale oil from oil shale which comprises two oppositely inclined rotary kilns, one located above the other, means for removing hot spent shale from the lower end of said upper kiln, means for introducing a portion of said removed hot spent shale, fresh shale, and superheated steam into the upper end of said lower kiln, means for separating liquid oil and gaseous hydrocarbons from said shale during its passage through said lower kiln, means for separately withdrawing said liquid oil, said gaseous hydrocarbons, and educted carbonaceous shale from the lower end of said lower kiln, means for contacting said educted carbonaceous shale with steam so as to purge residual hydrocarbons therefrom, means for elevating the resulting hot carbonaceous shale to the upper end of said upper kiln, means for introducing air into the lower end of said upper kiln so as to contact said hot carbonaceous shale and burn the carbonaceous material therefrom, and means for removing the gaseous products of combustion from the upper end of said upper kiln.

3. An apparatus according to claim 2 in which the means for separating the liquid oil from the shale in the lower kiln comprises a perforated lining located within the outer shell of said kiln.

4. An apparatus according to claim 2 in which the lower rotary kiln is supplied with means for external heating thereof.

5. An apparatus for the recovery of shale oil from oil shale which comprises an inclined rotary retort, an inclined rotary roaster, means for removing hot spent shale from said roaster, means for introducing a portion of said removed hot spent shale, fresh oil shale, and superheated steam into said retort, means for separating liquid oil from gaseous hydrocarbons and from shale during its passage through said retort, means for separately withdrawing said liquid oil, said gaseous hydrocarbons, and educted carbonaceous shale from the said retort, means for contacting said separated educted carbonaceous shale with steam so as to purge residual hydrocarbons therefrom, means for introducing said purged carbonaceous shale into said roaster, means for introducing air into said roaster so as to contact said purged carbonaceous shale and burn the carbonaceous material therefrom to form said spent hot shale, and means for removing the gaseous products of combustion from said roaster.

6. An apparatus for the recovery of shale oil from oil shale which comprises an inclined rotary retort, an inclined rotary roaster, means for removing hot spent shale from said roaster, means for introducing a portion of said removed hot spent shale, fresh oil shale, and superheated steam into said retort, means for separating liquid oil from gaseous hydrocarbons during the passage of the shale through said retort, means for straining said liquid oil during its passage through said retort so as to separate it from said shale as formed, means for separately withdrawing said liquid oil, said gaseous

hydrocarbons, and educted carbonaceous shale from the said retort, means for introducing carbonaceous shale into said roaster, means for introducing air into said roaster so as to contact said carbonaceous shale and burn the carbonaceous material therefrom to form said hot spent shale, and means for removing the gaseous products of combustion from the said roaster.

7. An apparatus for the recovery of shale oil from oil shale which comprises a retort, a roaster, means for removing hot spent shale from said roaster, means for introducing a portion of said removed hot spent shale, fresh oil shale, and superheated steam into said retort, means for separating liquid oil from gaseous hydrocarbons during the passage of the shale through said retort, means for straining said liquid oil during its passage through said retort so as to separate it from said shale as formed, means for separately withdrawing said liquid oil, said gaseous hydrocarbons, and educted carbonaceous shale from the said retort, means for introducing carbonaceous shale into said roaster, means for introducing air into said roaster so as to contact said carbonaceous shale and burn the carbonaceous material therefrom to form said hot spent shale, and means for removing the gaseous products of combustion from the said roaster.

8. A method for the recovery of shale oil from oil shale which comprises heating fresh oil shale by commingling fresh shale with hot spent shale and contacting the mixture with superheated steam in an eduction zone so as to educt liquid oil as well as gaseous hydrocarbons from said shale, separating said liquid oil from said gaseous hydrocarbons in said eduction zone as formed, straining said liquid oil during its passage through said eduction zone so as to separate it from educted carbonaceous shale as formed, separately removing said liquid oil, said gaseous hydrocarbons and said educted carbonaceous shale from said eduction zone, contacting said carbonaceous shale with air in a combustion zone so as to burn the carbonaceous material therefrom and obtain a carbon free hot spent shale, and recycling a portion of said hot spent shale to heat said fresh oil shale as above.

9. A method for the recovery of shale oil from oil shale which comprises heating fresh oil shale by commingling fresh shale with hot spent shale and contacting the mixture with superheated steam in an eduction zone so as to educt liquid oil as well as gaseous hydrocarbons from said shale, separating said liquid oil from said gaseous hydrocarbons and from educted carbonaceous shale in said eduction zone as formed, separately removing said liquid oil, said gaseous hydrocarbons and said educted carbonaceous shale from said eduction zone, contacting said separated educted shale with steam so as to purge residual hydrocarbons therefrom and obtain a relatively oil free carbonaceous shale, contacting said purged carbonaceous shale with air in a combustion zone so as to burn the carbonaceous material therefrom and obtain a carbon free hot spent shale, and recycling a portion of said hot spent shale to heat said fresh oil shale as above.

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