WATER PURGE TO WASTE HEAT EXCHANGERS

Filed Dec. 8, 1947

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The present invention relates to improvements in the conversion of hydrocarbons and more particularly, to a novel method of preventing decomposition and deposition of carbonaceous materials in the equipment by heat quenching purge streams following conversion periods.

In the prior art, the cracking of hydrocarbons in the presence of a solid catalyst has been practiced by employing various forms of cyclic processes involving several steps such as a hydrocarbon conversion step, a catalyst purging step and a catalyst regeneration step. One of the problems encountered in the practice of such cyclic processes has been to prevent excessive carbon or other coke-like materials from plugging or unduly restricting the transfer lines and other equipment through which the cracked hydrocarbon effluent is passed and thereby to avoid unduly frequent shutdown cleaning periods. Based on the belief that this coking occurs during the hydrocarbon conversion step, it has been common practice in the art to quench the cracked products just prior to their effluence from the cracking zone. According to another belief that coking occurs as well during the regeneration step, it has been suggested that the number of cycles which a unit can be operated between shutdown cleaning periods can be increased by adsorbing coke-forming materials from the hot effluent regeneration gases. Thus, the prior art seems to have sought to solve the cracking of equipment problem by quenching the effluent cracked hydrocarbon products from a conversion zone or by adsorbing coke-forming materials from effluent regeneration gases. Notwithstanding the foregoing expediencies, coking of equipment still has been found to occur at such a rate as to necessitate shutdowns for cleaning at undesirably frequent intervals.

Any solution or even any partial solution of the coking problem, which is still constantly present and which is even now the object of the efforts of a great many workers in the art, has been considered a highly desirable and beneficial advance in the art. Accordingly, the art has continually sought to further retard or minimize the coking of apparatus in cyclic catalytic hydrocarbon conversion processes.

The present invention has found that a substantial proportion of coking of equipment actually has been occurring during the catalyst purging step which follows the hydrocarbon conversion step but which precedes the catalyst regeneration step. Thus it has been found that heavy oils which might remain in the equipment after cessation of the hydrocarbon conversion step or which might have been removed during the purge step tend to distill to coke in the presence of the hot effluent purge gases. This discovery is contrary to the teachings which can be derived from prior art as it exists today. According to this invention, it has been found that by drastically quenching the effluent purge materials from the catalyst zone the coking of equipment problem is substantially solved. Furthermore, it has been found in some instances when quenching of the effluent purge stream was practiced that the coking problem was solved to a considerable extent even in the utter absence of quenching during the hydrocarbon conversion step.

It is, therefore, an object of this invention to provide a process for preventing deposition of coke and heavy oils in catalytic conversion processes. It is a further object of this invention to provide a process for quenching a steam purge effluent following a catalytic conversion process to prevent the deposition of coke and heavy oils on and to clean the surfaces of equipment following conversion chambers of catalytic processes. Other objects will be apparent to those familiar with the art from the accompanying discussion and drawings.

In the usual manner of operation a body of catalyst may be used satisfactorily for hydrocarbon conversion for a period from several minutes to several hours before it is deactivated to such an extent that it requires regeneration. Conventionally two or more catalyst chambers are employed so that one or more may be used for conversion while the others are being regenerated and thus continuous conversion may be maintained. Either continuously or intermittently during the cycle of conversion and regeneration carbonaceous deposits are laid down on the transfer lines and equipment following the conversion zone and must be removed periodically. Ordinarily, a relatively short period of time, such as from six to ten minutes, is employed to purge the catalyst chamber of any residual reactive vapors following the catalytic conversion of hydrocarbons before regenerating the catalyst and I have now found that quenching the purge effluent during this brief period and cooling the purge effluent to a temperature at which any hydrocarbon vapor or fluid will not be substantially further cracked or vaporized is sufficient to eliminate any substantial deposition of carbon or heavy oils on
the surfaces of the transfer lines, heat exchangers, and other equipment following the conversion chambers. This quench may be either conventional oil or water fluid, preferably oil, water. Preferably, a sufficient amount of water is injected to furnish the required cooling of the purge effluent so that any oil trapped in the exchanger will not be vaporized to dryness by the hot purge fluid, thereby leaving residual carbon and tars on the exchanger tubes, and to provide a washing action on the surface of the lines and tubes of the heat exchanger. Although the exact function of the quench is not known, it is believed that in addition to cooling and liquefying the hydrocarbon vapors which are present in the purge, the quench also washes the surfaces of the lines and tubes of any heavy oils which may be adhering thereto from the product effluent during the process cycle. Another advantage and function of the quench is to provide a temperature shock by the sudden cooling of the lines and heat exchange tubes and, thereby, to loosen any coke that may be deposited thereon. The quench is then preferably present in sufficient quantity to decoke and to wash the lines and tubes clean of this loosened coke as well as any heavy oils adhering thereto. However, regardless of the selection of the quenching medium, it has been found that an effective elimination of the presence of coke and carbonaceous deposition has been realized by quenching only the purge effluent. This is particularly advantageous and preferable to the conventional continuous quench of the product effluent in that a smaller amount of quenching material is required with a consequent smaller amount of equipment and also, since there is a diminution of the load on the fractionating system, a fractionating system of smaller operating capacity is required. The supplemental extraneous load on the fractionator is lessened when the amount of quench material is reduced and furthermore the quench material is only added to the purge effluent. It may be desirable to disperse entirely with the fractionation of the quenched purge effluent when the content of valuable hydrocarbons therein is negligible, or fractionation of the purge effluent may be practiced to recover the quenching medium for recycle. Thus, the quenching is conducted for a shorter and more effective period and consequently requires less attention and regulation. Furthermore the use of quenching on the purge effluent is more effective and economical than the usual method of employing a quench continuously on the conversion effluent.

A better understanding of the invention may be had by reference to the drawing in which feed to a conversion process is introduced through lines 10 and 11 into a reactor 12. Conversion products are withdrawn through a line 14 into a heat exchanger 16 and by a line 18 into a fractionator 18. Lighter products are removed overhead from the fractionator through a line 18 and heavier products are removed through a line 20. Heat may be supplied to the fractionator from a heating coil 22, as required. At the end of a conversion period when it is desirable to regenerate the catalyst or stop the conversion process, catalyst in the reactor may be purged of residual reactants and products by superheated vapors, such as steam, introduced by lines 25 and 11. Water or oil for quenching the purge effluent to a temperature to terminate reaction and to wash the walls of the equipment may be introduced through a line 29 into the purge effluent immediately after the reactor and/or into the lower part of the reactor by a line 27 and dispersing means 23. The quenched purge effluent may be removed from the system by a line 31 after passing through the heat exchanger or may be introduced through line 16 into the fractionator for separation. In the preferred embodiment in which water is employed as the quenching medium, it is desirable to allow a separation of the water and hydrocarbon products as in a separator 30 from which the water is withdrawn from a lower layer through line 31 and an upper hydrocarbon layer is withdrawn through line 16 to the fractionator.

During tests of the present invention, it was found that this method of operation is highly efficient and effective. In comparative runs with and without employing the quench in a hydrocarbon cracking conversion process, it was found that without the quench on the purge it was possible to operate satisfactorily for an average of only about 20 days before it was necessary to disassemble and to decock a waste heat exchanger following the reactor as compared with an average satisfactory continuous operation period of 60 days when quenching was practiced on the purge effluent alone. Thus it is shown that, although the purge effluent was changed many times during each continuous period of use, it was possible to operate at least three times as long before it became necessary to disassemble and decock the equipment following the conversion chamber when quenching is employed in the purge.

Reasonable variation and modification are possible within the scope of the foregoing disclosure and the appended claims to the invention the essence of which is that coke deposition in equipment contacting fluid effluents from a hydrocarbon conversion zone can be substantially prevented by quenching only the purge gas effluent which flows for only a short period of time from said zone whereby it is not necessary to treat in any manner the converted hydrocarbon effluent products or the effluent regeneration gas, both of which flow for a long period of time from said zone in order to prevent coke deposition in the said equipment.

I claim:

1. In a catalytic hydrocarbon conversion process wherein carbonaceous material deposited on a catalyst during a conversion step is removed by burning with oxygen-containing gas in a subsequent regeneration step and wherein after the conversion step but prior to the regeneration step there is a purging step employing an oxygen-free purging medium to remove residual hydrocarbons, the improvement which comprises quenching the effluent purge products resulting from said purge step with a quenching medium in an amount sufficient to substantially lower the temperature of said purge effluent thus to prevent substantially the coking and concomitant plugging of equipment in which the purge effluent is handled.

2. In a catalytic hydrocarbon conversion process wherein carbonaceous material deposited on a catalyst during a conversion step is removed by burning with oxygen-containing gas in a subsequent regeneration step and wherein after the conversion step but prior to the regeneration step there is a purging step employing an oxygen-free purging medium to remove residual hydrocarbons, the improvement which comprises quenching the effluent purge products resulting from said purge step with a quenching medium in an amount...
sufficient to substantially lower the temperature of said purge effluent and to wash free of carbonaceous deposits and heavy oils the walls of equipment contacting said purge effluent thus to prevent substantially the coking and concomitant plugging of said equipment.

3. In a catalytic hydrocarbon conversion process wherein carbonaceous material deposited on a catalyst during a conversion step is removed by burning with oxygen-containing gas in a subsequent regeneration step and wherein after the conversion step but prior to the regeneration step there is a purging step employing an oxygen-free purging medium to remove residual hydrocarbons, the improvement which comprises quenching the effluent purge products resulting from said purge step with a liquid hydrocarbon oil in an amount sufficient to substantially lower the temperature of said purge effluent thus to prevent substantially the coking and concomitant plugging of equipment in which the purge effluent is handled.

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The following references are of record in the file of this patent:

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