

UNITED STATES PATENT OFFICE

2,671,741

DECOKING AND CLEANING TUBULAR
HEATERS

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No Drawing. Application February 23, 1950,
Serial No. 145,922

4 Claims. (Cl. 134-2)

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This invention relates to the removal of coke or carbonaceous deposits from tubular heaters employed in the heat treatment of hydrocarbons and is concerned particularly with the removal of coke or carbonaceous deposits containing cer-
tain additional materials such as salts, paraffin wax and gum.

When hydrocarbon fluids are heated in tubular heaters, as either for ordinary distillation or for cracking, coke deposits will eventually be formed in the tubes and it becomes necessary to clean the tubes. Methods of removing the coke deposits have gone into extensive use in which the deposits are removed and the tubes cleaned by means of steam and air. In such methods of decoking the return bends or junction boxes are not disconnected from the tubes to gain access to the interior of the tubes; the steam and air are flowed through the tubes under the necessary conditions to effect the decoking. The tubes are heated externally and steam is passed through the tubes to effect the removal of a large portion of the deposit by spalling and air is then flowed through the tubes to effect burning and complete the cleaning operation. Frequently hydrocarbon oils, particularly many crude petroleum, contain material quantities of various salts and when such oils are processed substantial quantities of salt may be contained in the coke or carbonaceous formation which is deposited in the tubes. While the burning technique will remove the coke or carbon, it does not effect the removal of the salts with the result that after the usual decoking operation deleterious salt deposits remain in the tubes.

The present invention is concerned with the removal of the salts as well as the coke or carbonaceous material. The invention involves the discovery that by soaking the tubes with water at boiling temperature within the tubes prior to the decoking by burning a complete removal of deposited material may be accomplished.

In accordance with the invention water is charged to the tubular heater, the furnace is heated and the water is boiled out of the tubes. Furnace temperatures of the order of 400° F. are adapted to boil the water out of the tubes and apply the requisite temperature to the deposit on the inner surfaces of the tubes at which the salt material is leached out of the deposit.

As to the actual mechanism of the operation, it is believed that a portion of the salt may actually be carried from the tubes in the vaporized water either as small droplets of concentrated salt solution or possibly as vapors due to the partial

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pressure effect of the relatively large volume of boiling water. Conceivably all of the salt, perhaps the major portion, may not be removed in this manner. It appears that the boiling water dissolves the particles of salt which have been deposited along with the carbon and are bonded to the coke particles and when the water is evaporated salt which has been leached out of the coke may be redistributed and deposited over the coke surface. Whatever the exact mechanism may be the fact is that in the subsequent burning step the coke is readily removed and when the coke is removed by the burning the tube surfaces are found free from salt deposits. Satisfactory results will not be obtained merely by burning water through the tubes. Apparently the temperature reached in the coke film as the water is boiled out of the tubes is necessary for the proper reaction to release the salt from the deposit. By following the water soaking and boiling step with steam spalling and burning with air the tubes are completely cleaned.

The process disclosed herein is also adapted for removing from the tubes paraffin wax or gummy materials that may be deposited with the coke in the tubes. Thus, for example, in solvent refining and dewaxing operations it frequently happens that when oil which has been treated with solvent is passed through the heating coil deposits of paraffin wax or gum may be left in the tubes in addition to coke. By charging the tubes with water and applying heat to the external tube surfaces sufficient to vaporize the water, the waxy or gummy material is satisfactorily removed. The remaining deposit is then completely removed by steaming and burning with air. By removing the waxy or gummy deposits prior to the regular decoking operation it is possible to completely clean the tubes without the danger of overheating the tubes which would be likely to occur in the event that the burning was applied to the entire deposit including the wax or gum as well as the coke.

In a typical operation in accordance with the invention, a tubular heater is decoked and cleaned in a series of steps as follows:

1. The furnace fires are cut out and the tubular heater is steamed out.

2. Water is run through the tubular heater to wash out any oil or loose material which may be present in the tubes.

3. When the water being discharged through the tubular heater is clear the valve on the water inlet is closed. The valve on the heater outlet is left open. The fires are lit and the furnace

temperature is brought up to about 400° F. This temperature is maintained until all of the water is boiled out of the tubes.

4. Steam is then cut into the tubular heater and the furnace temperature is raised to 1300–1350° F. Spalling takes place as is indicated by coke particles present in the discharged steam. The operation is continued until the steam discharged is practically free from coke particles.

5. When the spalling of the coke ceases the furnace temperatures are reduced to about 1050° F. and the addition of air or oxygen-containing gas to the steam is started. The air rate is gradually increased and the steam decreased until only the air is flowing through the tubes. This completes the decoking and cleaning operation.

The time required for the water soaking and boiling step will vary somewhat with the size of the heater and tubes but in general when applying the operation to ordinary oil refinery equipment the soaking and boiling operation will require about 2 to 3 hours.

In the spalling operation with steam it is recommended that a pressure of about 60 to 70 pounds be maintained at the heater inlet during the early part of the spalling operation. As the temperature of the steam flowing through the tubes increases it is advantageous to reduce the steam rate until a pressure of only about 15 pounds is maintained at the inlet. This procedure is of benefit in avoiding excessive steam velocities through the tubes and the erosion which would thereby take place.

Although a preferred embodiment of the invention has been described herein, it will be understood that various changes and modifications may be made therein, while securing to a greater or less extent some or all of the benefits of the invention, without departing from the spirit and scope thereof.

I claim:

1. In the decoking and cleaning of tubular heaters containing coke and salts deposited therein from the heating of hydrocarbon oils containing salts, the process that comprises redistributing the salt content of the deposit by charging the tubular heater with water and applying to the external tube surfaces a temperature sufficient to effect vaporization of the water, passing steam through the tubes while applying

increased temperatures to the tubes to effect spalling of deposited material and finally passing air through the tubes maintained at a temperature sufficient to effect burning of remaining deposits so that the tubes are freed of both salt and coke deposits.

2. In the decoking and cleaning of tubular heaters containing coke and salts deposited therein from the heating of hydrocarbon oils containing salts, the process that comprises redistributing the salt content of the deposit by charging water to the tubular heater and applying to the external tube surfaces a temperature sufficient to effect vaporization of the water, and finally passing air through tubes maintained at a temperature sufficient to effect burning of the deposits so that the tubes are freed of both salt and coke deposits.

3. In the decoking and cleaning of tubular heaters containing coke and salts deposited therein from the heating of hydrocarbon oils containing salts, the process that comprises redistributing the salt content of the deposit by soaking the tubes with hot water and boiling out the water, and finally passing air through tubes maintained at a temperature sufficient to effect burning of the deposits so that the tubes are freed of both salt and coke deposits.

4. In the decoking and cleaning of tubular heaters containing coke and salts deposited therein from the heating of hydrocarbon oils containing salts, the process that comprises redistributing the salt content of the deposit by charging the tubular heater with water and applying to the external tube surfaces temperatures of the order of 400° F., and finally passing air through tubes maintained at a temperature sufficient to effect burning of the deposits so that the tubes are freed of both salt and coke deposits.

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