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METHOD OF BURNING COKE FROM
HEATER TUBES

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This invention relates to a method of removing coke or carbonaceous deposits from the inner walls of tubular heaters in oil distilling or cracking systems, which are externally fired and which carry a stream of petroleum or a fraction thereof to be heated or cracked and during which coke is formed and deposited on the tube walls.

The invention is particularly concerned with the removal of coke deposited in oil heater tubes as the result of the cracking of heavy oils therein, by subjecting the coke to the heat of a localized flame in the presence of an oxygen-containing gas. It has been found that the coke deposited in oil heater tubes as the result of cracking light oils of the character of gas oil may successfully be burned from the tubes after the ordinary steaming of the tubes to purge them of oil vapors, as commonly practiced in the industry when shutting down a cracking unit. This method of burning the coke deposit from the tubes may be carried out in accordance with the teaching of Davis Patent No. 1,901,803. However, where heavy oils are subjected to heating and cracking in tubular heaters, it has been found that mere purging of the tubes with steam is insufficient to condition the coke so that it may successfully be removed by the burning operation. In such cases the coke has been found to contain substantial amounts of the heavy oil or tars, and when the burning operation is attempted on such deposits of coke excessive amounts of oxygen are consumed and local overheating of the tubes may result.

I have found that it is possible to so condition the coke deposited as the result of heating and cracking heavy oils as to enable it to readily be burned out of the tubes by means of a localized flame in the presence of oxygen-containing gas, such as air or air plus oxygen, as disclosed in the aforesaid Davis patent.

One method of accomplishing these ends consists essentially in the following steps:

(a) Passing a relatively clean light oil, such as gas oil, through the tubes after shutting off the supply of heavy charge oil while maintaining the firing of the furnace;

(b) Discontinuing the supply of gas oil to the tubes and cutting out the fires in the heater;

(c) Introducing steam into the tubes while still hot and steaming until substantially no oil vapors are evolved;

(d) Removing headers, return bends or the like and burning the coke from the tubes by the method mentioned above.

An alternative method of accomplishing the desired results may consist essentially in the following steps:

(1) Cutting out the fires in the furnace and discontinuing the charge of heavy oil to the tubes;

(2) Steaming the tubes while hot until substantially no further oil vapors are evolved;

(3) Discontinuing the steaming and passing hot water through the tubes;

(4) Cutting off the water supply; removing headers, return bends, etc., and burning the coke from the tubes in accordance with the method described.

Coke deposits resulting from the cracking of heavy crude, reduced crude or residual oils have been found to contain from 3–7% of oil by extracting the same with benzol. When such large proportions of heavy oil remain in the coke, the deposit is removed by burning at a very slow rate with the generation of a great deal of heat, causing the tube to become overheated. Such oily coke is also rather gummy and does not permit ready passage of the burner head. I have discovered that if the oil content of the coke is reduced to about 2% or less, preferably not more than 1½%, the burning of the coke from the tubes may successfully be practiced in the presence of oxygen-containing gas. The removal of the excess of heavy oil from the coke deposit may readily be accomplished by the practice of my invention.

In order to more fully describe the use of my invention, the following specific examples are given:

The tubular oil heater had been in operation in the cracking of fuel oil or a heavy crude. After substantial deposits of coke had been formed in the tubes, the heavy charge stock was discontinued and a clean gas oil was passed through the tubes for a period of about 3 hours before cutting the fires in the furnace. The fires were discontinued and immediately thereafter the tubes were steamed for a period of about 3 hours. In case the coke deposit was particularly heavy, the steaming was continued for a longer period, up to about 8 hours. The steaming ordinarily was carried on until substantially no further oil vapors were evolved. Then the return bends or junction boxes were removed from the tubes and a fuel gas burner slowly passed through each tube, while supplying a current of oxygen or air through the tubes. The velocity of the oxygen-containing gas was sufficient to break out and force out the coke, which was continuously dis-

lodged and disintegrated by the flame of the burner. The coke that was dislodged and disintegrated from the tube walls by the action of the flame and the air or oxygen jet was continuously blown out of the end of the tube ahead of the burner. The proportions of air, fuel gas and oxygen were regulated to suit the particular conditions encountered, as evidenced by the appearance of the material leaving the end of the tube and by observation of the outside of the tube walls.

It is not known whether the steam in the conditioning step merely dries out the coke or whether there is some additional beneficial effect. It is possible that moisture is deposited in the pores of the coke during steaming, which may greatly accelerate the spalling off or disintegration of the coke during the heating and burning step. However, it is observed in the operation of the process that a portion of the coke is ejected from the tubes in the form of fine incandescent particles, and that a larger portion is not incandescent and consists of much larger particles of the order of small chips or chunks.

In the alternative method of operation, the fires were cut and the charge of heavy oil continued for 20 to 30 minutes, after which it was shut off. As soon as the pressure in the heater dropped sufficiently to permit introduction of high pressure steam (150-200 lbs. per sq. in.) from the plant mains, the steam was cut into the heater and the tubes steamed for a period of 3 to 4 hours, or until no further oil vapors were discharged. Then the steam was shut off and water at a temperature of about 150-200° F. was pumped through the heater for a period of about 30 to 45 minutes at a rate of about 100 gallons per minute. The water supply was shut off and the return bends and the like removed. The tubes were then in condition to be burned out in accordance with the procedure already described.

By either of the methods described above it has been found possible to reduce the heavy oil content of the coke deposited in the tubes to less than 2%, as determined by extraction with benzol. As a result, the heavy coke deposit formed in the cracking of heavy oils could successfully and economically be removed by the

use of a burner in the presence of a stream of oxygen-containing gas, without damage to the tubes. Such conditioning of the coke permitted the burner to be advanced through the tubes in a progressive manner and at a substantially constant rate, while securing substantially complete removal of the coke. This method of removing coke deposited in the treating of heavy oils has been found to possess marked advantages over previously known methods which employ mechanical devices. Not only are the tubes saved from mechanical abrasion and shock, but very substantial savings in time, materials and labor may be effected.

Obviously many modifications and variations of the invention, as hereinbefore set forth, may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. The method of reconditioning oil heater tubes containing coke deposited therein during oil heating operations, which comprises passing a relatively clean and light oil through the tubes for a period of several hours while continuing the heating operation, discontinuing the heating and while the tubes are hot steaming to remove oil and to dry the coke therein, then directing a localized flame in progressive manner through the tubes while simultaneously passing an oxygen-containing gas therethrough.

2. The method of reconditioning oil heater tubes containing coke deposited therein during oil heating operations in which the oil heated is a heavy oil, which comprises passing a relatively clean and light oil through the tubes for several hours while continuing the heating operation to displace the heavy oil from the tubes and to dissolve and remove heavy oil from the coke, discontinuing the heating and while the tubes are hot passing steam through the tubes for a period of several hours to displace the light oil from the tubes and the coke therein, then directing a localized flame in progressive manner through the tubes while simultaneously passing an oxygen-containing gas therethrough.

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