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REMOVAL OF COKE FROM TUBES

Philip S. Fay, Lyndhurst, Ohio, assignor to The Standard Oil Company, Cleveland, Ohio, a corporation of Ohio

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The present invention relates to a method for removing coke deposits from the bore of a coked tube.

In the operation of many furnaces the stock to be heated passes through tubes which are heated through radiation or convection by hot furnace gases or in some cases by direct flames. When the stock to be heated is petroleum, a fraction thereof or other hydrocarbon fluid, serious trouble is encountered due to the fact that coke deposits form on the inner surfaces of the tubes. The coke is a poor heat conductor, and therefor as the coke is deposited on the inside surface of the tube, the temperature in the tubes rises, and it continues to rise as coke is deposited until finally the tube attains the temperature of the furnace or it bursts. In practice, therefore, thermocouples are often mounted on the outside surface of the tubes and when the temperature of the tube becomes higher than the safety limit imposed by the tube material, the operation is terminated and the tubes are cleaned. One of the oldest methods of removing the coke lining from the tubes comprises the cutting away of the coke from the tubes by mechanical reamers. Other methods for removing coke from the bore of tubes have also been used with varying success. However, the tubes often become so heavily coked that they cannot be cleaned by any of the known methods and therefore must be discarded although they are otherwise quite sound and serviceable.

It is an object of the present invention to provide a method for removing coke from the bore of coked furnace tubes which method is satisfactory whether the tube is heavily coked or only lightly coked.

It is a further object of this invention to provide a method of the above description which is rapid, economical and efficient.

It is still another object of the invention to provide a method for removing coke from very heavily coked furnace tubes that cannot be cleaned by conventional methods.

According to this invention it has been found that such coke deposits may be removed or have their removal facilitated by subjecting the coke layer to the physical shock of an explosive detonation. Such an explosive detonation, as contemplated by this invention, has the effect of fracturing or otherwise altering the hard structure of the coke thereby loosening it from the walls of the tube.

In the past, insofar as I am aware, explosive materials have been utilized only for removing obstructions from pipes. It has been proposed, for example (Patent No. 144,843) to remove obstructions from gas pipes in which a plug is screwed into the end of the gas pipe, the plug being formed with a chamber for gun powder and a nipple upon which a percussion cap is placed. When the percussion cap is detonated, an explosion of the powder follows and the fluid pressure created by the explosion blows any obstructions out of the pipe. A means for cleaning service pipes has also been proposed (Patent No. 1,388,854) in which a cartridge is employed to ignite

a roll of nitro-cellulose which produces a large volume of gas the pressure of which ejects liquid from a length of the pipe and serves to clear any obstructions. These methods in which fluid pressure is utilized to clean obstructions from pipes bear no similarity to the application of a shock to a layer of coke or similar material in the bore of a pipe in order to fracture the coke and facilitate its removal from the pipe.

In the petroleum art, it has been proposed to remove coke from a soaking drum (Patent No. 1,927,052) by providing a plurality of rows of apertures about the circumference thereof, through which a drill may be inserted to drill holes for the reception of explosive charges. Explosive charges are then placed in the holes and then detonated and by this means an increment or section of coke is blasted out of the soaking drum. By repeating this operation, successive increments of coke are similarly removed from the drum. The holes must be welded or otherwise closed before the drum is reused. This proposal does not suggest the use of an explosive material to clean an elongated member of relatively small diameter compared to its length, such as a furnace pipe. Obviously moreover, the proposal could not be applied to furnace tubes since there would be no feasible way in which the holes could be drilled if the tubes were in a furnace. Furthermore, it is apparent that it would be a time-consuming and costly operation to drill furnace tubes since only a relatively small increment of coke could be removed from a furnace tube with each detonation of the explosive material.

The method of the present invention has the advantages of being simple, convenient, economical and efficient.

The method of this invention comprises detonating an explosive material within the bore of a coked furnace tube whereby the coke is subjected to shock and loosened from the walls of the tube. Preferably the explosive material is distributed substantially along the entire length of the portion of the tube from which the coke is to be removed. In order to accomplish this purpose a convenient form of explosive material is an explosive cord such as, for instance, "Primacord" (a commercially available material comprising a cord about ¼ inch in diameter with a braided waterproof covering and a core of white crystalline pentaerythritol tetranitrate). Other types of explosive materials, however, are also suitable. For instance, a series of blasting caps or similar small explosive units connected by a fuse or by electrical wiring can be employed to create a plurality of simultaneous or successive detonations. Any other type of elongated explosive material that is capable of being inserted inside the bore of a furnace tube can also be employed.

The positioning of the explosive material inside the tube is not critical. For example, one or more strands of explosive material may be threaded loosely within the tube and then detonated. Alternatively, a tight spiral of the explosive cord may be fitted into the tube and then detonated. Another method of positioning the explosive material inside of the tube comprises winding an elongated explosive material on a mandrel, inserting the assembly in the tube and detonating the explosive material. Other means of positioning the explosive material within the tube will be apparent to those skilled in the art.

The method of this invention may advantageously be employed in conjunction with conventional methods of cleaning furnace tubes. For example, if a tube is so heavily coked that mechanical reaming is not practicable, the method of this invention may be used to remove part of the coke and loosen the remainder so that mechanical cleaning is made possible. However, the method of this invention is capable of removing all of the coke deposits from a coked tube but in some cases a plurality of ex-

plosive treatments may be required depending upon how badly the tube is coked.

In order to illustrate the method of this invention and the advantages thereof the following examples are given.

Example 1

A badly coked furnace tube having an inside layer of coke about ½ to ¾ inch thick and so heavily coked that mechanical reaming was impracticable was elected for cleaning. A single strand of Primacord was inserted loosely along the length of the inside of the tube and then detonated. The explosion of the Primacord removed patches of coke throughout the length of the tube, the effect being particularly noticeable where the cord was in contact with the coke lining. The explosion had the effect of fracturing or otherwise altering the hard structure of the coke that remained, because it was loose enough to be removed by mechanical reaming.

Example 2

The tube that is treated in this example was coked similarly to the tube of Example 1. A tight spiral of Primacord was fitted into the tube. The explosion of the Primacord removed almost all of the coke from the area in which it was inserted. The remaining chunks of coke were picked out by hand.

Example 3

A loose spiral of Primacord was wound on a steel mandrel and this assembly was inserted into the open end of a heavily coked furnace tube and the Primacord was then detonated. This had the effect of bringing the explosive into closer contact with the coke throughout the periphery of the coke surface along the inside of the tube. This procedure was repeated twice more within the tube. After the three explosions most of the coke deposit was still in place but after standing for an hour the coke dropped out spontaneously leaving the tube clean and unharmed.

Example 4

A coked furnace tube having a coke deposit about ¾ to 1 inch thick and a clear bore of less than 1½ inches was selected for cleaning. A double strand of Primacord was threaded the entire length of the tube and was then detonated. The explosion blew out much of the softer, looser coke, leaving a bore of more than 2 inches. The tube did not clear itself on standing although some of the coke deposit flaked off. A second double strand of Primacord was fired within the tube and this succeeded in removing another large quantity of the coke. A loose spiral of Primacord was then inserted in the bore of the tube and detonated. This last explosion cleaned the pipe of much of the coke and the layer of coke that remained was only about ½ inch thick. The remaining layer of coke was easily removed by reaming.

The examples of this invention have been given primarily for the purpose of illustration and it is intended to cover all changes and modifications which do not depart from the spirit and scope of the appended claims.

I claim:

1. A method of removing coke deposits from the bore of a coked tube which comprises distributing an explosive material inside the tube substantially along the entire length of that portion of the tube from which the coke is to be removed and detonating said explosive material inside the bore of said tube whereby the coke is subjected to physical shock.

2. A method of claim 1 in which the explosion is of such strength as to loosen at least a part of the coke and at least partially remove the coke.

3. A method of claim 1 in which the detonation is repeated in the cleaning of heavily coked tubes which are not cleaned by a single detonation.

4. A method according to claim 1 in which the explosive material is in the form of a cord.

5. A method according to claim 1 in which the explosive material is an explosive cord and is positioned spirally within the tube.

6. The method of claim 1 in which the explosive material is distributed inside the tube by being wound spirally on a mandrel which extends along the entire length of that portion of the tube from which the coke is to be removed.

References Cited in the file of this patent

UNITED STATES PATENTS

144,843	Goldsmith et al.	Nov. 25, 1873
1,388,854	Dezendorf	Aug. 30, 1921
2,367,206	Davis	Jan. 16, 1945