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METHOD OF CLEANING HEAT EXCHANGER SURFACES

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1 Claim. (Cl. 196—69)

This invention relates to the art of cleaning of metallic, ceramic and other surfaces fouled through contact with heated petroleum products in petroleum refinery processes. The invention relates particularly to the cleaning of petroleum refinery heat exchanger surfaces by the use of solvents such as furfural.

The processing of petroleum hydrocarbons such as distillation, condensation and cracking involves contacting the oil with heated surfaces of metal, ceramic materials and other materials. The cracking of the higher hydrocarbons, for example, usually involves preheating the oil to as high a temperature as possible by heat exchange with reaction products, then heating to about incipient cracking by passing through tubes subject to the direct heating effect of furnace gases, then passing to a zone of higher temperature wherein the thermal breakdown of the feed stock largely occurs. The products of the reaction are, as previously mentioned, passed through heat exchanger equipment to utilize the sensible heat in preheating the fresh feed. In such processing the temperature differential between the oil film upon the heat exchanger surface and the body of the liquid is considerable, especially in the steps of heating the oil. The film of oil immediately in contact with the surface is usually at a temperature sufficiently high to cause the complete breakdown to carbon and hydrogen of many hydrocarbons present and thus to cause the deposition of coke and highly carbonaceous compounds on the metallic surface. The coke is generally securely held to the surface on account of its admixture with the highly carbonaceous materials rendering removal of the layer, even by mechanical means, very troublesome.

The highly carbonaceous deposit on heat exchanger surfaces is highly disadvantageous in refinery processing. In the first place, the deposition acts as an insulating material and thus reduces considerably the heat conductivity. Furthermore, the initial formation of a deposit acts as an accelerator in the decomposition of the oil at the surface. Once the coke is formed on the surface, the material serves as an absorbent for further quantities of oil and thus causes a very rapid increase in coke formation. The removal, therefore, of coke and the highly carbonaceous materials as soon after formation as conveniently possible is highly desirable. The present invention is directed to a simple and effective means of cleaning heat exchanger surfaces, distillation towers, etc. of petroleum refinery equipment without the necessity of dismantling or the undertaking of any appreciable mechanical work.

The method of cleaning the surfaces is to employ a solvent for the removal of the highly carbonaceous binding materials in the deposit formed on the surface. The solvents employed are those which, as a class, have a preferential solvency for the aromatic type of hydrocarbons, such as furfural, phenol, nitrobenzene, chlorex, aniline, etc, of which furfural, nitrobenzene and phenol are preferred. Particularly effective and outstanding in its effect of cleaning petroleum refinery heat exchanger surfaces is furfural.

The solvents may be utilized in several ways for cleaning the surfaces. The solvents may be applied to the surface wholly in liquid phase as, for example, by passing a body of the liquid over the surface for a certain period of time; or it may be utilized partly in the liquid and partly in the vapor form by evaporating the solvent either in an external vessel or within the structure to be cleaned and then permitting the vapors to be condensed thereon; or its combination in the vapor or liquid state with steam by vaporizing the solvents in the presence of steam and contacting the equipment with the mixture. When the surface of the equipment to be cleaned is also contaminated with heavy hydrocarbons, it is usual to wash first the fouled surface with a light hydrocarbon to remove as much of the heavy hydrocarbons as possible and then to circulate the cleaning solvent through the equipment at a temperature of 200° F. or higher; the temperature of treatment being determined by the nature of the solvent employed, especially its solvency and boiling point, and by the resistance of the deposit to the resolution.

In one form of the invention as applied to the cleaning of heat exchange equipment used in preheating a distillate feed to a cracking coil, the preferred method consists in disconnecting the exchanger feed lines and washing the surfaces with a light naphtha. The exchanger is then connected to a furfural reservoir, a pump and a heating coil. The furfural is pumped from the reservoir through the heating coil where it is at least partially vaporized and then through the heat exchanger. The furfural then passes to the reservoir and is recycled through the exchanger until the carbonaceous material has been loosened from the metallic surfaces and largely removed. If desired, a filter may be included in the circuit to remove the insoluble carbon. The exchanger is then flushed with an additional quantity of light naphtha to recover completely the furfural

solvent and to wash out further quantities of carbon which may be loosened from the exchanger surfaces but still remaining in the exchanger. In a further embodiment of the invention the cleaning of distillation equipment is generally effected by vaporizing the solvent, generally furfural, in the still and then allowing the vapors to condense upon the fouled surfaces.

In general, the contacting of the fouled surfaces with furfural for about an hour is usually satisfactory, but this period may be longer or shorter depending upon the actual nature of the deposit to be removed. In the use of furfural, it is noticeable that the heavy hydrocarbons are extracted from the deposit and the coke is left in a granular and easily removable form. Sometimes it is advantageous to employ a light hydrocarbon solvent, such as a solvent naphtha, to remove the granular coke after the treatment with furfural. It has been found with furfural that the liquid may be used many times in the cleaning of the equipment but that ultimately it becomes saturated with the heavy hydrocarbons and it is required that the furfural be recovered from the contaminated liquid by distillation. Oftentimes it is desirable to include in the solvent system a filter which removes the granular materials suspended in the solvent.

It is evident from the description of embodiments of the invention that small quantities of the solvent can be advantageously employed to clean relatively inaccessible surfaces without the necessity of dismantling any equipment. Usually it is found most effective to heat and vaporize the solvent in the equipment to be cleaned and to pass the cooled liquid through a filter before using a second time.

It is appreciated that in the prior art, heat exchanger surfaces have been cleaned by procedures similar to that of the present invention. In the prior art it has been known to employ solvents for the asphaltenes and carbenes such as carbon disulfide and carbon tetrachloride and to combine the use of such liquids with the action of abrasives. The present use of solvent liquids having a selective solvency for aromatics, and particularly furfural, is distinguishable from these prior art processes in the much more advantageous effect accomplished by the use of the solvents of this type. The reason for the particular effectiveness of the solvents of this invention is not definitely known but actual processing has demonstrated the higher capacity of the solvents of this invention over those previously employed for the highly carbonaceous materials binding the carbon to the heat exchanger surfaces. Furthermore, the carbon, after the removal of the highly carbonaceous binding agent, is easily removable by mechanical means and even by washing with a light hydrocarbon liquid.

From results obtained with various solvents, it seems clear that the heavy oil acting to cement the carbonaceous deposit together is highly aromatic in nature and is appreciably more soluble in solvents having a preferential solubility for aromatics than in asphalt solvents. If a badly coked surface is subjected to an extensive washing with solvents such as carbon disulfide, carbon tetrachloride, naphtha, etc., only a portion of the carbon will be loosened and washed from the surface. Washing with phenol, nitrobenzene, aniline, cresol, beta, beta dichlorethyl ether, etc., will remove a major portion of the coke but washing with furfural as the most effective solvent of the group, will remove substantially all.

Although the present invention has been described in connection with specific applications thereof, it is not intended that the application shall be limited thereby, but shall be determined solely by the following claim or its equivalents.

What is claimed is:

A process for cleaning surfaces of petroleum refinery distillation equipment contaminated by highly carbonaceous material and bonded by heavy hydrocarbons soluble in solvents for aromatic type hydrocarbons which consists in washing said surfaces with a light petroleum naphtha to remove as much as possible of the heavy hydrocarbons, then vaporizing furfural in said distillation equipment, allowing the furfural vapor to condense upon the fouled surfaces, and mechanically treating the said surfaces to remove any adherent solid material.

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