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FREEZE-PROOFING OF COKE

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This invention relates to preventing formation of ice-coke masses during shipment of coke in railroad cars.

Frozen coke may cause considerable difficulty when railroad cars containing the same are unloaded in cold or below-freezing weather by blocking or obstructing flow or egress of coke from the discharge outlets thereof. The difficulty or trouble is generally caused by the coke pieces in a lower portion of the car being frozen into a solid or continuous ice-coke mass, which acts to block or prevent flow of coke from other regions of the car through the car outlets. While only a minor percentage of the total coke pieces may be agglomerated, virtually none of the coke can be unloaded until the continuous ice-coke mass or masses blocking the discharge outlets are removed. Access to the frozen or agglomerated coke from the open top of the car is prevented by the large mass or considerable height of coke situated above this agglomerated coke. Difficulty in the unloading of railroad cars containing the frozen coke frequently disrupts blast furnace operations resulting in costly delays, demurrage charges, and excessive requirements of hand labor with hammers and picks.

An object of the present invention is to provide a simple, efficient, economical method of freeze-proofing coke during shipment in bulk in railroad cars.

Another object is to prevent formation of ice-coke masses in railroad cars which would otherwise have to be broken up by hand.

Other objects and advantages will be apparent as the invention is hereafter described in detail. Blocking or obstructing of discharge outlets of railroad hopper cars transporting coke by continuous ice-coke masses is believed caused by one of the following two sets of conditions. In the production of coke, red hot coke is quenched with water to cool it to a temperature below its ignition point. The quenched coke is then loaded into railroad hopper cars typically at a temperature of about 100° C. Coke immediately adjacent the metallic shell of the car tends to cool faster than coke in the interior of the mass in the upper portion of the car, which remains relatively warm. Consequently, snow or sleet falling upon the top surface of the coke mass in the railroad car within a non-lengthy or short period after coke loading is generally melted, and any rain falling on the top surface of the mass within this period remains liquid and unfrozen. Water resulting from the melting snow or sleet or rain then trickles or passes downwardly into the lower or outer portions of the car where the cooler coke is located. This water usually freezs in the lower or outer portions of the coke mass if the ambient temperature is below the freezing point of water. Or, secondly, the loaded cars of coke may be exposed first to rainfall at above-freezing temperature and thereafter to below-freezing temperatures, due to either movement of the cars or changes in weather conditions. Consequently, the water percolating or dripping downwardly through the coke mass in the cars is cooled to a temperature below its freezing point. The changing temperature conditions render the metallic shell and bottom of the car relatively colder than the coke mass as a whole, so that the dripping water forms ice in the bottom and outer portions of the coke mass first. Further dripping of water tends to fill up voids and agglomerate or render continuous the mixture of ice and coke previously formed.

In accordance with the invention, a wetting agent is applied to the top surface only of a bulk mass of considerable depth of normally free-flowing coke pieces contained or located in an open-top railroad car. Consequently, water which may contact the top surface of the top-treated mass as a result of normal fall of rain, snow, sleet, etc., passes into the pores in the interior of coke pieces in the upper portion of the mass, and freezes substantially harmlessly therein at low or below-freezing temperature. Surprisingly, passage of substantial quantities of water into the lower portion of the mass is thereby prevented and, consequently, agglomeration of individual coke pieces in the lower portion of the mass due to freezing of water at below-freezing temperature with resultant obstructing or blocking of flow or egress of coke pieces through the lower or bottom discharge outlet of the railroad car (during unloading) is avoided or prevented.

The wetting agent or surface active agent is applied to only the top surface preferably in minor amount, e.g., from about .05 to 2 pounds of wetting agent per one ton of coke, preferably from about 0.1 to 0.5 pound of agent per one ton of coke. While considerably larger amounts of wetting agent could be utilized, no significant advantage would be attained thereby and the larger or greater amounts would be disadvantageous from an economic standpoint. Use of amounts substantially less than .05 pound per ton of coke should be avoided to insure avoidance or prevention of obstructing or blocking egress of coke pieces through the car discharge outlet. The wetting agent may be applied advantageously as an aqueous solution by spraying, or as a dry powder, or by other suitable means. Water contacting the top-treated or dressed surface of the mass will carry a portion of the wetting agent with it as it trickles downwardly into the upper portion of the mass. The bulk mass of coke treated in the car will have a considerable depth or depth of several feet inasmuch as the depth of conventional railroad cars for transporting coke is considerable or of several feet.

Although agglomeration or formation of continuous ice-coke masses may occur to some extent in the top or upper portion of the coke mass of this invention at temperatures below the freezing point of water, such possible agglomeration is not considered to be especially harmful. The reason for this is that workmen normally have relatively easy access to the top of the coke mass in the open-top railway car, and can break up the ice-coke mass thereon. However, when the outlet blocking or obstructing ice-coke mass or masses are buried under several feet of coke and situated in the lower or bottom portion of the mass, workmen do not have access to the ice-coke masses and, hence, can not reduce or break them up until the several feet of free flowing pieces located thereover are removed. Obviously the last-mentioned occurrence is very disadvantageous and is obviated or avoided by the instant invention.

By the term "wetting agent" is meant any compound or material that causes water to penetrate more easily into another material such as into the pores of coke, the effectiveness of the wetting agent being directly related to its capacity for reducing surface or interfacial tension. As disclosed in "Surface Active Agents" (1949), by Schwartz and Perry, page 12, the term "wetting agent" is much less cumbersome than the broader "surface active agent" and the effects of "wetting agent" tend to be high-

ly specific. Any wetting agent capable of causing water to pass into the pores into the interior of coke pieces can be used in the instant invention. Examples of specific wetting agents utilizable herein are "Nacconol NR," an alkyl aryl sodium sulfonate; "Aerosol OT," a di (2-ethylhexyl) sulfosuccinate sodium salt; butylated diphenyl sulfonates and phenylphenol sulfonates such as "Aresket" or monobutyl-diphenyl sodium monosulfonate, "Areskap" or monobutylphenylphenol sodium monosulfonate, and "Aresklene" or dibutylphenylphenol sodium disulfonate; sodium-N-methyl-oleoyl taurate; "Santomerse," an alkyl aryl sulfonate; and "Alkanol S" or sodium tetrahydronaphthalene sulfonate. "Nacconol NR" is preferred.

Comparative tests were run on wetting agent top-treated coke and untreated coke, the coke being taken from regular production and being separately contained in 2 hoppers. Each hopper was 2 ft. square and 9 ft. tall with the bottom sloping at 45°. The bottom was water tight so that any water reaching it could be collected and measured. 5% "Nacconol NR" aqueous solution was applied to the top surface of coke in one hopper in amount of 0.15 pound per ton of coke. Coke in the other hopper was untreated. Moisture determinations made on the coke after it had been exposed to 0.41 inch of natural rainfall showed that the top foot of coke in the "Nacconol NR" top-treated coke hopper contained 7.8% of water, while the top foot of coke in the untreated coke hopper contained 4.3% of water. More important the bottom of the hopper containing "Nacconol NR" treated coke contained no water whereas 1.9 pounds of water collected in the bottom of the hopper containing untreated coke, indicating that frozen or agglomerated coke would have resulted in the untreated coke containing hopper if temperatures below the freezing point of water occurred.

Comparative tests were also made on both a wetting agent top-treated mass of coke pieces, and a uniformly treated (with wetting agent) mass of coke pieces, each piece thereof having been treated or dressed with wetting agent. The top-treated coke mass and uniformly treated coke mass were contained in 2 hoppers identical to the hoppers previously described. After exposure to natural rainfall, further rainfall was simulated by sprinkling the top of the coke in each hopper with water. The maximum rate of application of synthetic rainfall was 0.27 inch per hour. Sprinkling was continued while the bottom 6 ft. of the test hoppers were enclosed by a box filled with Dry Ice to provide freezing conditions. Synthetic rainfall was discontinued after the application of Dry Ice. The 2 test hoppers were then allowed to stand overnight under freezing conditions, and thereafter opened to determine the amount of frozen coke. The treatment and results are recorded in the following table.

Treatment

	Hopper I	Hopper II
Mode of Treatment	Top spray	Uniform coverage.
Lbs. of wetting agent per ton of coke	0.40	4.00.
Solution strength, percent	5	10.
Rainfall, natural and synethetic, inches	1.06	1.06.

Results

Percentage of coke pieces frozen to wall or other pieces in layers starting from bottom of hoppers:

	Hopper I	Hopper II
0 to 16" from bottom	0	38
16 to 24" from bottom	0	52
24 to 32" from bottom	0	65
32 to 40" from bottom	0	100
40 to 48" from bottom	30	100

As shown by the foregoing comparative data, application of wetting agent to the top surface only of the coke mass prevented freeze agglomerating of the coke pieces in every layer except the top or upper layer of the mass. On the contrary, in the uniformly treated mass, every layer including the bottom or lower-most layer contained a considerable amount of frozen or agglomerated coke.

"Nacconol" wetting agents such as "Nacconol NR" are long chain alkyl mononuclear aryl sulfonates such as dodecylbenzene sodium sulfonate and kerylbenzene sodium sulfonate.

What is claimed is:

1. A method for freeze-proofing coke contained in an open-top railroad car having a lower discharge outlet, which comprises applying a wetting agent in amount of from about .05 to 2 pounds per one ton of coke to the top surface only of a bulk mass of considerable depth of normally free-flowing coke pieces in the railroad car whereby water contacting the treated top surface passes into the pores in the interior of coke pieces in the upper portion of the mass to freeze substantially harmlessly therein at a temperature below the freezing point of water, passage of a substantial quantity of water downwardly into the lower portion of the coke mass being thereby avoided, and agglomeration of coke pieces in the lower portion of the mass with resultant blocking of egress of free-flowing coke pieces from the car lower outlet due to water freezing at the below-freezing temperature being thereby avoided.

2. A method of freeze-proofing coke contained in an open-top railroad car having a bottom outlet, which comprises applying a wetting agent in amount of from about 0.1 to 0.5 pound per one ton of coke to the top surface only of a bulk mass of considerable depth of normally free-flowing coke pieces in the railroad car, whereby water contacting the treated top surface passes into the pores in the interior of coke pieces in the upper portion of the mass to freeze substantially harmlessly therein at a temperature below the freezing point of water; passage of a substantial quantity of water downwardly into the lower portion of the coke mass being thereby avoided, and agglomeration of coke pieces in the lower portion of the mass adjacent the car bottom outlet with resultant blocking of egress of free-flowing coke pieces from said outlet due to water freezing at the below-freezing temperature being thereby avoided.

3. The method of claim 2 wherein the wetting agent is an alkyl aryl sodium sulfonate.

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