ABSTRACT: An improved system for the removal of naphthalene from coke oven gas which comprises cooling coke oven gas in a primary cooler to a temperature of about 100°F to condense a light oil fraction (primary cooler tar) from the gas; collecting and withdrawing the condensed tar from the primary cooler, stripping naphthalene from the tar, and thereafter scrubbing naphthalene from the cooled gas with the stripped primary cooler tar.
NAPHTHALENE SCRUBBER 18

AMMONIA LIQUOR

PRIMARY COOLER 16

COKE OVEN GAS 12

NAPHTHALENE STRIPPER 34

DECANTER TANK 26

TAR STORAGE 30

STEAM 36

INVENTOR
HERBERT A. GROSIK

Tinnegan, Henderson & Farabow
ATTORNEYS
This invention relates to an improved system for the removal of naphthalene from coke oven gas. More particularly, the invention relates to an improved method and apparatus for scrubbing naphthalene from coke oven gas with naphthalene-stripped, primary cooler tar.

In the process of coking coal and other bituminous materials in the absence of air, large volumes of gas, generally about 20 to 30 percent by weight of the initial charge of the material is driven off, leaving a carbonaceous residue. This gas, or coke oven gas, is commonly called, contains valuable byproducts, such as ammonia, naphthalene, tar, and light oils, which are recovered in byproduct recovery systems commonly associated with coke oven plants.

Conventionally, coke oven gas leaves coking furnaces at temperatures of 1,100 to 1,300°F and is initially shock cooled in a collecting main to a temperature of about 200°F to condense a heavy tar fraction. The heavy tar is collected and withdrawn and further processed for the recovery of valuable byproducts. The gas is then passed through a primary cooler where it is spray cooled with water or ammonia liquor to a temperature of about 100°F to condense a lighter tar or light oil fraction, more commonly known as "primary cooler tar".

While a major portion of naphthalene in the coke oven gas condenses and is separated out with the heavy tar and light tar fractions during cooling of the gas, small portions of naphthalene vapor remain in the coke oven gas following primary cooling. It is desirable, however, at this point in a byproduct recovery system to have all the naphthalene removed from the gas. Naphthalene is a low melting solid and as the gas cools below about 90°F during further processing in the system, naphthalene vapor precipitates as crystals and clogs the gas transmission lines.

In the past, residual naphthalene following primary cooling has generally been removed during final cooling of the coke oven gas. During final cooling, the temperature of the gas is reduced to about 75°F to 85°F. With a cold water quench, the naphthalene precipitating as crystals and being removed with the final cooler water. Subsequently, the naphthalene must be scrubbed from the final cooler water to provide a marketable naphthalene product. It has been found, however, that the removal of naphthalene from the gas by precipitation can cause clogging in the final cooler, and further that the gas leaving the final cooler still contains appreciable quantities of naphthalene vapor.

To improve the recovery of naphthalene from coke oven gas, systems have been provided for scrubbing naphthalene from the gas following primary cooling by bubbling the gas through a wash or absorbent oil, such as creosote oil. While such a system is generally effective for removing substantial quantities of naphthalene from the coke oven gas, a separate scrubber and a separate source of oil must be provided to remove naphthalene from the gas. Additional equipment must also be provided to recover naphthalene from the wash oil and to regenerate the oil for reuse in the naphthalene scrubber. Such a system, therefore, has not proven entirely satisfactory for use in a coke oven gas byproduct recovery system.

In accordance with the present invention, it has been found that an improved process for the removal of naphthalene from coke oven gas can be provided by contacting the gas, after it has passed through the primary cooler, with naphthalene-stripped, primary cooler tar in a scrubbing zone to scrub naphthalene from the gas by absorption into the tar. Preferably, a portion of the naphthalene-enriched, primary cooler tar from the scrubbing zone is recycled back to the scrubbing zone and a portion is passed to the primary cooler where it mixes with the condensing primary cooler tar so that it can be stripped of naphthalene before it is returned to the scrubbing zone.

The invention further provides gas-liquid contact apparatus for the primary cooling of coke oven gas and the removal of naphthalene therefrom comprising: a primary cooling chamber having a coke oven gas inlet, means for introducing primary cooling liquid into the chamber above the gas inlet to condense primary cooler tar from the gas, and means for collecting and withdrawing condensed primary cooler tar from the cooling chamber; and a scrubbing chamber interconnected with the cooling chamber so that the cooled coke oven gas from the cooling chamber ascends directly into the scrubbing chamber, said scrubbing chamber having a gas outlet, spray means for introducing substantially naphthalene-free primary cooler tar to the top of the scrubbing chamber to absorb naphthalene from the ascending gas, and means for collecting and discharging naphthalene-enriched, primary cooler tar from the scrubbing chamber.

Further, means are provided for stripping naphthalene from the primary cooler tar withdrawn from the primary cooling chamber and for conducting the naphthalene-stripped tar to the spray means of the scrubbing chamber.

Preferably, the scrubbing chamber is vertically contiguous with the top of the primary cooling chamber and is separated therefrom by a gas-liquid contact plate that permits the descending scrubbing tar to form a pool at the bottom of the scrubbing chamber and the ascending gas to bubble through the pool before it passes into the scrubbing chamber. Alternately, the flow of descending scrubbing tar can be controlled such that it does not form a pool at the bottom of the scrubbing chamber. Such control can be achieved, for example, by the use of a distributing tray which may be a perforated plate or other such means; the only requirement being that the distribution tray permits adequate passage of descending scrubbing tar so that no pools of tar are formed.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory but are not restrictive of the invention.

The accompanying drawings which is incorporated in and constitutes a part of this specification illustrates a preferred embodiment of the invention and together with the description serves to explain the principles of the invention.

The drawing is a schematic diagram of the improved system of this invention for the removal of naphthalene from coke oven gas.

A counter current gas-liquid contact tower 10 is shown in the drawing having a coke oven gas inlet line 12 and a gas outlet line 14. Tower 10 is divided into two vertically interconnected contact chambers 16 and 18 for the sequential treatment of coke oven gas in accordance with the process of this invention.

Chamber 16 is a conventional primary cooler commonly used in a coke oven gas byproduct recovery system. Initially, coke oven gas is shocked cooled in a collecting main (not shown) from around 1,100°F to 1,300°F, to around 200°F, to condense a heavy tar fraction from the gas. The heavy tar fraction is removed and the gas is then passed to primary cooling chamber 16, where it is sprayed cooled to about 95°F to condense a lighter tar or light oil fraction, commonly called primary cooler tar, from the gas. Conventional primary cooling liquids include water or, more preferably, an ammonia liquor containing about 1.0 percent ammonia.

With reference to the drawing, primary cooling chamber 16, therefore, includes means, such as spray heads 20, above gas inlet 12 for spraying primary cooling liquid, preferably ammonia liquor, into the chamber to condense primary cooler tar from the gas. The condensed primary cooler tar and ammonia liquor are collected in the bottom of chamber 16 and withdrawn through line 24 to a decanter tank 26. In decanter 26, the ammonia liquor overflows through line 28 and is either disposed of or treated and recycled for further use in primary cooling chamber 16.

The separated primary cooler tar is withdrawn from decanter 26 and passed through line 30 to a storage tank 32 for further use in the system of this invention.

In accordance with the invention, primary cooler tar is pumped from tank 32 as needed and passed through a pre-
heater 34, where it is heated to about 320° F. and then introduced into the top of a naphthalene stripper 36. In stripper 36, the gas at 320° F. is stripped with live steam to flash off naphthalene. The naphthalene vapors from stripper 36 can be recovered but they contain small quantities of tar and other byproducts from the coke oven gas and thus would require further purification to provide a marketable naphthalene product. Preferably, therefore, the naphthalene vapors from stripper 36 are recycled back to primary cooling chamber 16 with directly or, as shown in the drawing, by adding them to coke oven gas inlet line 12 through line 37.

The primary cooler tar exiting stripper 36 and now free of naphthalene, passes through a cooler 38 where it is cooled to about 100° F. and is then fed to the top of chamber 18 through line 40. Chamber 18 serves as naphthalene scrubber for the coke oven gas and includes means, such as spray heads 42, for spraying the primary cooler tar into chamber 18 to scrub naphthalene from the gas by absorption into the tar.

As shown in the drawing, primary cooling chamber 16 and scrubbing chamber 18 are separated by a gas-liquid contact plate, such as a bubble cap plate 44, that permits a pool of descending scrubbing tar to form in the bottom of chamber 18 and the ascending gas to bubble through the pool as it passes in chamber 18. The coke oven gas then ascends through chamber 18 countercurrent to the descending spray of primary cooler tar to achieve substantially complete absorption of naphthalene from the gas. Coke oven gas now essentially free of naphthalene passes out through gas outlet line 14 to further processing equipment in a conventional byproduct recovery system.

The naphthalene-enriched primary cooler tar that collects on bubble cap plate 44 still has the ability to absorb more naphthalene. In accordance with the invention, therefore, a portion of the tar is withdrawn from plate 44 through line 45 and recirculated by pump 46 back to the top of scrubbing chamber 18. As described above, however, and to avoid complete saturation of the tar, fresh naphthalene-free, primary cooler tar from stripper 36 is continuously added to the recirculating system. Hence, an equivalent volume of naphthalene-enriched primary cooler tar spills over plate 44 and passes into chamber 16 where it mixes with the primary cooler tar condensing out in that chamber. The condensed tar and naphthalene-enriched tar are then processed as described above for further use in scrubbing chamber 18.

Because tar and naphthalene-enriched tar are continuously being added to the recirculating system, excess primary cooler tar can be bled through line 48 and disposed of or otherwise treated to recover valuable byproducts.

By utilizing primary cooler tar as a naphthalene-scrubbing solvent for coke oven gas in accordance with the present invention, it has been found that the naphthalene content of the gas can be reduced to such a level that the naphthalene no longer causes clogging problems in a coke oven gas byproduct recovery system. Further, the present system for removing naphthalene operates in a more simple, effective, and economical manner than prior art systems, because it utilizes a material as a scrubbing solvent that is abundantly available in any byproduct recovery system.

In operation, and as an illustrative embodiment of this invention, coke oven gas at a temperature of about 200° F. is cooled in primary cooler 16 by an ammonia liquor quench to a temperature of about 95° F. to condense primary cooler tar having a molecular weight around 175 from the gas. The gas exits the cooler with a naphthalene content of about 116 grams per 100 s.c.f. of gas.

The primary cooler tar is withdrawn from the cooler, separated at 26 from the ammonia liquor and passed to tar storage tank 32. The tar is withdrawn from tank 32 at a rate of about 5 gallons per ton of carbonized coal, and preheated to 320° F. before it is introduced to the top tray of a six-tray naphthalene stripper. In the stripper, the tar is stripped of its naphthalene content with about 28 pounds of steam per ton of carbonized coal. The tar leaves the stripper at a rate of about 4 gallons per ton of carbonized coal with a naphthalene content of about 10 percent, is cooled to about 100° F. and is then fed to the recirculating system of the naphthalene scrubber.

The coke oven gas exhaust 16 passes directly into naphthalene-scrubbing chamber 18, where it is stripped with the primary cooler tar to absorb naphthalene from the gas. The gas exits chamber 18 with a naphthalene content of about 2 grains per 100 s.c.f. of gas.

The temperature of the tar is naphthalene scrubber 16 is about 100° F. and the rate of circulation of the tar through the scrubber is about 500 gallons per ton of carbonized coal. Because naphthalene-free tar is being continuously added to the scrubber's recirculating system at a rate of 4 gallons per ton of carbonized coal, an equivalent volume of tar flows over bubble cap plate 44 and into primary cooler 16. In the primary cooler, the overflowing tar mixes with the primary cooler tar condensed by the ammonia liquor quench and passes through the separation and stripping steps as previously described.

The invention in its broader aspects is not limited to the specific details shown and described, and departures may be made from such details without departing from the principles of the invention and without sacrificing its chief advantages.

What I claim is:

1. A method of removing naphthalene from coke oven gas which comprises cooling the gas in a primary cooling zone to condense primary cooler tar from the gas, withdrawing condensed primary cooler tar from the cooling zone, stripping naphthalene from at least a portion of the tar, and thereafter contacting the gas with the naphthalene-stripped, primary cooler tar in a scrubbing zone to scrub naphthalene from the gas by absorption into the tar and including the steps of collecting and withdrawing the naphthalene-enriched primary cooler tar from the scrubbing zone and recirculating at least a portion of said naphthalene-enriched tar directly back to the scrubbing zone for further scrubbing of the gas.

2. The process of claim 1, which includes passing at least a portion of the naphthalene-enriched primary cooler tar from the scrubbing zone to the primary cooling zone for mixture with the condensing primary cooler tar, withdrawing the mixture of primary cooler tars from the cooling zone, stripping naphthalene from at least a portion of the mixture, and recycling the naphthalene-stripped, primary cooler tar back to the scrubbing zone.

3. The process of claim 2, in which the remaining portion of the naphthalene-enriched primary cooler tar in the scrubbing zone is withdrawn from the scrubbing zone and recirculated directly back to the scrubbing zone for further scrubbing of the gas and in which the recycling and naphthalene-stripped primary cooler tar is continuously added to the recirculating naphthalene-enriched primary cooler tar in an amount equivalent to that portion being passed to the primary cooling zone.

4. The process of claim 3, in which the tar is sprayed into the scrubbing zone countercurrent to the flow of gas through the zone and pools in the bottom of the scrubbing zone, so that the gas entering the scrubbing zone first bubbles through the pool of tar before it contacts the spray of tar.

5. The process of claim 3, in which the naphthalene that is stripped from the primary cooler tar is recycled back to the primary cooling zone.

6. The process of claim 1, in which the gas is cooled in the primary cooling zone with ammonia liquor.

7. Apparatus for the primary cooling of coke oven gas and the removal of naphthalene therefrom comprising a primary cooling chamber having a coke oven gas inlet; spray means for introducing a primary cooling liquor into the chamber above the gas inlet to condense primary cooler tar from the gas; means for collecting and withdrawing condensed primary cooler tar from the cooling chamber; means for stripping naphthalene from said condensed primary cooler tar; a scrubbing chamber interconnected with the cooling chamber so that the cooler-stripped primary cooling chamber passes directly into the scrubbing chamber, said scrubbing chamber having a gas outlet; spray means for introducing substantially
naphthalene-free primary cooler tar to the top of the scrubbing chamber to absorb naphthalene from the gas in the scrubbing chamber; means for delivering substantially naphthalene-free primary cooler tar from the stripping means to the spray means of the scrubbing chamber; and means for collecting and discharging the naphthalene-enriched primary cooler tar from said scrubbing chamber.

8. The apparatus of claim 7, including means for recirculating at least a portion of the naphthalene-enriched primary cooler tar to the spray means of the scrubbing chamber.

9. The apparatus of claim 7, wherein the scrubbing chamber is located on top of the cooling chamber and is separated therefrom by a gas liquid contact plate.

10. The apparatus of claim 9, wherein the gas-liquid contact plate is a bubble cap plate permitting the naphthalene-enriched primary cooler tar to pool at the bottom of the scrubbing chamber and to overflow into the cooling chamber, and permitting the cooled coke oven gas to bubble through the pool of tar as it passes into the scrubbing chamber.