Oct. 30, 1956 H. Z. MARTIN 2,768,938

METHOD OF COKING AND GRINDING COKE

Filed May 24, 1954 2 Sheets-Sheet 1

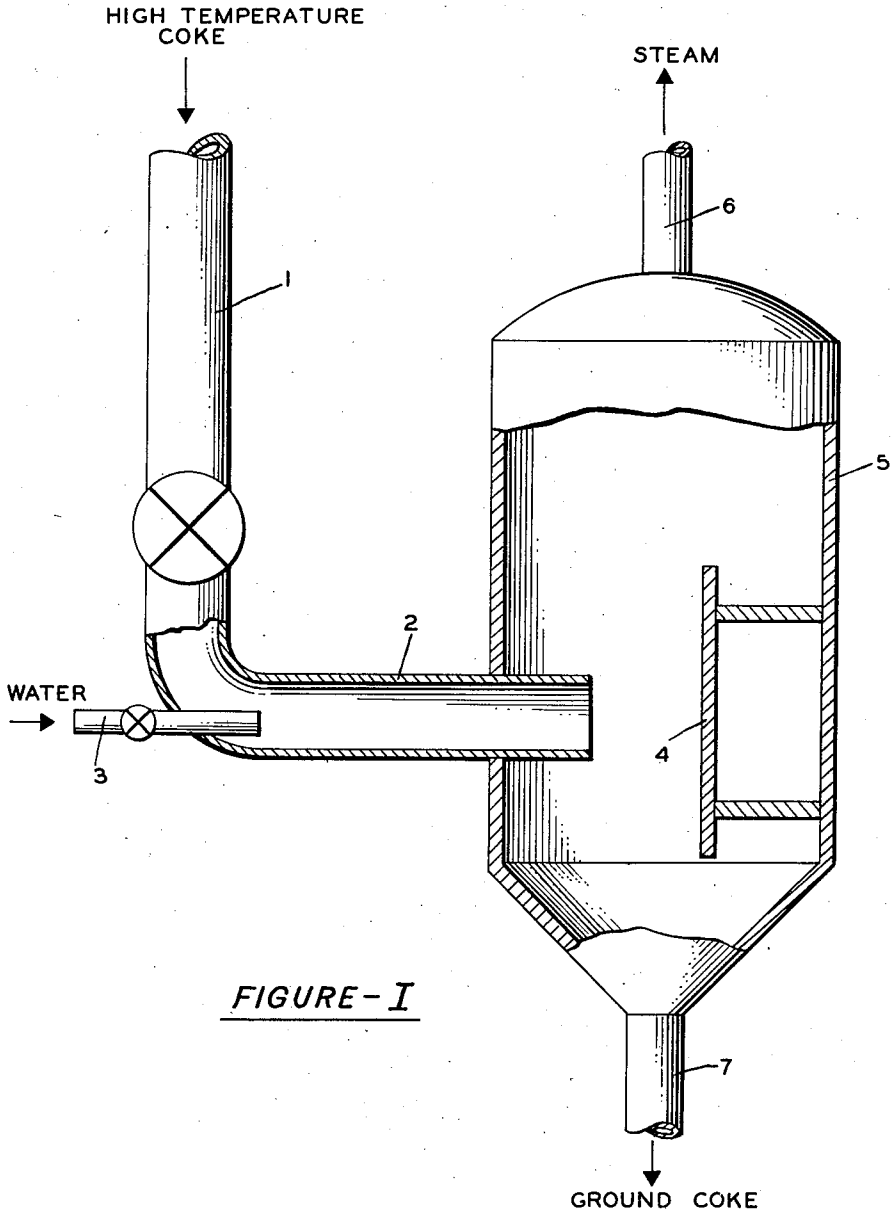


FIGURE - I

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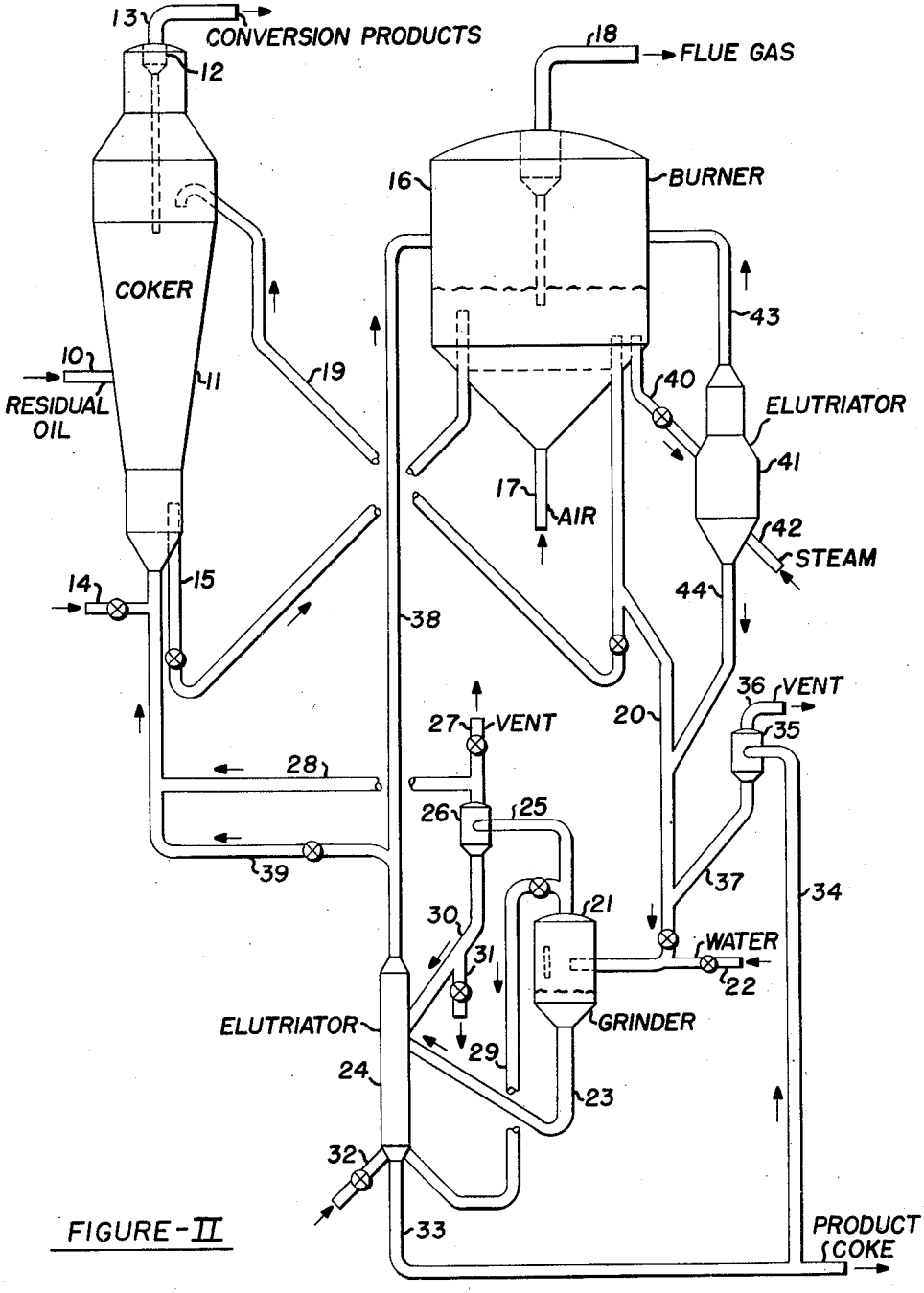


FIGURE - II

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METHOD OF COKING AND GRINDING COKE

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Application May 24, 1954, Serial No. 431,689

5 Claims. (Cl. 202—14)

This invention relates to an apparatus and a process for the size reduction of solids. More particularly, the invention pertains to both an apparatus and a process for providing seed coke for a heavy petroleum oil fluid coking system and also provides for withdrawing adequately cooled net coke product from such a system.

There recently has been developed a fluidized solids process for the pyrolytic conversion of hydrocarbon oils wherein an oil, such as vacuum residua, is upgraded by injecting it into a coking vessel containing a bed of fluidized, high temperature particulate solids, usually coke produced in the process. The oil upon contacting the solids thermally decomposes, depositing carbonaceous residue on the coke and evolving substantial proportions of lighter hydrocarbon vapors. Usually a portion of the coke is circulated to an external combustion zone and back to supply heat to the coking process.

Coke is withdrawn as product to remove the excess that is produced by the process and a portion of the withdrawn coke is reduced in size and returned to the coking system as seed coke, i. e. to furnish nuclei for further carbon deposition. A sufficient number of new particles must be supplied to the coking system to maintain the number of particles in the system substantially constant.

Jet-impact grinding has been a recently proposed method of producing these seed particles. In this grinding scheme, large size coke particles are accelerated to velocities in excess of about 200 ft./ sec. and then are impacted against a target or other coke particles. By this means, the particles are broken up into a size suitable for seed coke.

This method of grinding and its integration into a fluid coking system is more fully presented in co-pending application, entitled "Apparatus and Process for Preparation of Seed Coke for Fluid Bed Coking of Hydrocarbons," Serial No. 403,218, filed January 11, 1954, by Boisture et al.

An object of the present invention is to present to the art an improved method of jet impact grinding of coke produced by a hydrocarbon oil fluid coking system. Another object of this invention is to produce seed coke for a fluid coking system and concurrently cool coke removed from the process as product to a temperature sufficiently low to prevent the product coke from igniting upon contact with air. Further objects will become apparent as this description proceeds and the attached drawings, forming a part of this specification, are discussed in detail.

Figure I of the drawings illustrates in a somewhat simplified manner jet impact grinding apparatus to which this invention may be applied. Figure II depicts this invention used in a hydrocarbon oil fluid coking process.

Referring to Fig. I, the coke to be ground is conveyed to an acceleration tube 2 by line 1. The coke may originate from any place within the coking system, but it is preferred to withdraw coke from the coker heating unit,

e. g. usually a fluid bed combustion zone used to supply the necessary heat for the pyrolysis, or from the reactor vessel, particularly from the stripping zone of the reactor vessel. These coke particles have a temperature of 900–1600° F., or more, depending upon the particular process. In some applications, it is advantageous to elutriate or otherwise segregate the coke withdrawn prior to its grinding so that only selected relatively coarse fractions are subjected to grinding and finer coke particles are selectively retained in the system.

The particles travel at a controlled rate through line 1 at a relatively low velocity so that practically no erosion occurs. As is known by the art, a pressure in line 1 sufficient to prevent back-flow may be created by various means, i. e. by a standpipe, a series of standpipes, lock hoppers, screw conveyers, etc.

A readily vaporizable liquid, e. g. water, is injected into the hot coke particles by line 3 and is vaporized, thereby cooling the coke by 400–500° F. or more, and producing quantities of steam. The steam produced accelerates the coke particles in tube 2 to a velocity in the range of 200 to 1000 feet per second, preferably 200 to 350 feet per second. From the tube the particles are expelled with considerable force against a target plate 4. The impact disintegrates a substantial proportion of the particles into the desired particle size range.

The acceleration tube may be suitably shaped to achieve the maximum efficiency. Thus a venturi design or orifice design may also be used to achieve the maximum acceleration of the particles and to obtain some explosive disintegration of the coke.

The impact area is enclosed in an expanded vessel 5 or settling zone such that there is a separation of the disintegrated solids from the steam. In other designs of this invention, the vessel 5 can be utilized as a dense or dilute phase classification or elutriation zone. The steam is removed overhead by line 6 and may be transferred to a cyclone system, not shown, to remove further amounts of coke fines from the gas which can then be returned to the coking process.

A preferred embodiment of this invention is to transfer the steam generated in the acceleration tube to the base of the coking vessel whereby the fluidization and/or stripping steam normally used in the coking operation is augmented or supplanted. In other applications of this invention, it is advantageous to have this steam serve as elutriating gas in an elutriation zone so that the coke fines or seeds produced can be selectively segregated from the remaining or unbroken relatively coarse coke. Even then, the steam, after having served as an elutriating gas, can be transferred to the coking vessel along with, if it be desired, elutriated seed coke. In still other applications of this invention, the steam or vapors generated in acceleration tube, after having the coke particles substantially removed, can profitably be utilized in other processes. Thus, it may serve as stripping steam in fractionation towers, it may be used to generate power, it may be used in heat exchange systems, etc.

The solids, after striking the impact plate, collect at the base of the vessel and are removed by line 7. The solids may be classified by any suitable means, such as by elutriation, to obtain the desired particle size and amount of seed coke. The coarse coke may be directly removed as product since it has conveniently been cooled to a temperature at which it will not spontaneously ignite upon contact with air. Alternatively, portions of this coke may be recycled to the grinder for further size reduction. It is advantageous to so recycle coarse fractions as it has been found that less energy has to be expended to reduce the size of the recycled particles.

Still another variation of this invention is to operate the jet grinder at higher velocities. By operating at steam

velocities in the range of 400–1500 feet/sec., preferably 800–1200 feet/sec., there will be produced a much finer product, in amounts beyond that required for seed nuclei, suitable for combustion in boilers or furnaces. The coarse part of the impacted particles can be used as a seed coke and the finer part as fuel.

It is to be understood that jet impact mechanism is capable of use in multiple arrangements. Two or more acceleration tubes may be arranged to eject the particles into a common target area which may or may not be equipped with a target plate. In such an arrangement without a target plate, the particles can be made to disintegrate by collision between particles.

The jet grinder is operable with coke having a particle size up to about ¼ inch or larger, but it is contemplated that it will be applied to particles in the size range of up to about 100 microns.

The solids loading for the coke in the acceleration tube after injection of the water can vary from 250,000 to 2 million lbs./hr.-ft.^{2} depending upon the requirements of the process.

The water requirements will vary with the temperature of the high temperature feed coke. 0.1 to 0.5 lbs. of water per pound of coke can be used. In some instances, the water may be suitably preheated, or steam may be injected along with the water to reduce the solids loading in the mixture passing to the nozzle.

It will be apparent to those skilled in the art that other readily vaporizable media, other than water, can be used to cool the coke and generate the volume of gas necessary to accelerate the coke. Thus, a light oil fraction, such as a naphtha, may be used. Or a slurry of oil and coke particles obtained from the separation of the coker products may advantageously be used. This would supplement the benefits of this invention as the slurry would be conveniently dissipated.

As an example, with a 1.9" I. D. acceleration tube, 72" long from the point of injection of the water and with a flat target plate spaced 4" from the end of the tube, 4120 lbs./hr. of water at 80° F. would be used with a coke feed rate of 20,800 lbs./hr. at 1125° F. to produce 1900 lbs./hr. of seed coke between 74 and 150 microns in diameter, and, in addition, 1040 lbs./hr. of fines smaller than 74 microns, from coke feed having particles no larger than 800 microns, with 275 microns being the median. The maximum velocity in the acceleration tube would be 600 ft./sec. and the product coke would have a temperature of 300° F. Operating conditions at the outlet of this nozzle would be 30 p. s. i. g. and 300° F. This pressure is such that the attriter products can be returned directly to the coking reactor, preferably after removing the coarse fraction by means of a cyclone, elutriator, or other classifier. Thus the steam used for attrition can be reused for stripping and aeration in the reactor. The pressure at the bottom of the stripper of the coking vessel will normally be 20–29 p. s. i. g.

The fine coke, smaller than about 74 microns, does not satisfactorily serve, in most fluid coking processes, as seed coke as the extremely fine particles quickly agglomerate or are otherwise lost from the system and needlessly wasted. If desired, the very fine fraction of the ground coke can be removed selectively and combined with the product coke, used as fuel, etc., although it can be returned to the coking system without detrimental effects.

It can be seen, then, that there is charged to the jet impact grinder of this invention only coke from a fluid coking system which it is desired to withdraw as product plus the seed coke requirement of the system. An advantage of the present process is that cooling of the product coke is carried out in the same apparatus in which the grinding is done. Another advantage is that the power for the grinding comes from the heat of the coke which is desirably dissipated before the coke is exposed to the atmosphere. It is to be understood, however, that the apparatus may also be used in cases, such as to produce boiler fuel, where the extent of grinding is greater than that required to meet seed coke requirements. It is still advantageous to use this invention in such applications as the heat for steam to be used for grinding would have to come from some source and this source can well be the heat contained in the particulate coke in the coking system.

Figure II illustrates the invention as used in a hydrocarbon oil fluid coking system to supply seed coke thereto. A heavy, low value oil is injected by line **10** into a reactor or coker **11**. Charging stocks customarily used in fluid coking operations include petroleum tars, asphalts, vacuum and atmospheric residua and similar high boiling, low value heavy oils. Coker **11** contains a fluid bed of particulate solids, preferably coke particles produced by the process, having a size in the range of 20 to 1000 microns, maintained at a coking temperature in the range of about 850° F. to 1500° F. The oil, upon contact with the high temperature solids, undergoes pyrolysis evolving substantial proportions of relatively lighter hydrocarbon vapors and depositing coke on the fluidized solids. The vapors, along with the fluidizing gas, after having entrained solids removed in cyclone **12**, are taken off overhead via line **13**. The high boiling ends of these vapors may be condensed and recycled to the coker and the remainder may be processed by conventional means to recover the various product fractions desired.

Steam or other substantially inert gas is admitted to the base of the coker by line **14** as fluidizing gas. The rate of fluidizing gas addition is controlled such that superficial vapor velocity in the coker is in the range of about 0.2 to 5 ft./sec., sufficient to cause the particles to form a dense ebullient mass having a well defined upper level. This fluidizing gas first serves to strip the solids in the lower portion of the coker and then flows upwardly fluidizing the main bed.

Stripped solids are continuously removed from the coker by line **15** and transferred to a combustion vessel or fluid bed burner **16**. Air or other oxidizing gas is injected into the burner by line **17** and serves to fluidize and partially burn the solids therein, thereby reheating the solids to a temperature 100° to 400° F. above the coking temperature. Gaseous combustion products, after having entrained solids removed, are taken off overhead by line **18** and vented to the atmosphere. Reheated coke is circulated to the coker by line **19**. Other means of heating the coke such as transfer line burners may, of course, be used.

In accordance with this invention, a portion of the circulating coke is withdrawn from the system and passed through a jet attrition grinding apparatus. A standpipe **20** withdraws coke from line **19** at the temperature of the process and passes it to a grinding vessel **21**. Water is admitted to line **20** by line **22**. The steam formed thereby accelerates the solids and they are ejected against a target plate in the grinder. A major portion of the attrited solids settle in the lower portion of the grinder and are removed therefrom by line **23** and transferred to an elutriation vessel **24**. The attrited solids may, in some cases, be returned directly to the process. The spent steam is taken overhead by line **25** and passed to cyclone **26** wherein entrained solids are removed. The steam may then be vented to the atmosphere by line **27** but is preferably passed by lines **28** and **37** to the coker to serve as fluidizing gas. As an alternative, the steam, along with entrained solids may be passed directly from the grinder by line **29** to the base of elutriator **24** to serve as an elutriation gas therein, or may be passed directly to the coker. Solids separated in cyclone **26** are preferably transferred to the elutriator **24** by line **30** but may be withdrawn as fine product by line **31**.

Steam is admitted to the base of elutriator **24** by line

32 in controlled amounts to classify the solids therein by disperse phase elutriation. The superficial velocity of the steam passing through the elutriator is adjusted in the range of about 4 to 20 ft./sec., such that coarse solids deentrain while coke particles of seed size are entrained and removed overhead with the steam. The coarser solids so separated are removed by line 33 as product but may be recycled to the grinder for further size reduction. Thus, the coarse solids may be conveyed by lines 33 and 34 to a cyclone 35 at an elevation above the grinder wherein the conveying gas is removed and vented by line 36 while the solids are reintroduced into line 20 by line 37.

Returning to elutriator 24, the finer material entrained in the steam is returned to the process as by being passed by line 38 to burner 16 or to the base of the coker by line 39 as previously mentioned. Also as previously indicated, a portion of these finer solids may be recovered as in a cyclone system to be removed as product of the process.

In some applications, it is preferred to classify the material transferred to the grinder such that only a coarse solid is subjected to jet attrition. This avoids needlessly comminuting particles already in the desired range. Accordingly, solids may be withdrawn from the burner by line 40 and transferred to a means of classification, e. g., elutriator 41. Steam is admitted to the base of the elutriator by line 42 and serves to entrain and remove finer solids overhead from the elutriator through line 43. These finer solids are then returned to the system, e. g., to the burner as shown. The coarser solids are transferred from the elutriator via lines 44 and 20 to the grinder. In some applications a single elutriation vessel may be used in place of elutriators 24 and 41, as will be apparent to those skilled in the art.

Having described this invention, what is sought to be protected by Letters Patent is succinctly set forth in the following claims.

What is claimed is:

1. In a process for coking heavy hydrocarbon oils by contacting said oils with a fluidized mass of coke particles maintained at a coking temperature in a coking zone, wherein said coke particles accrete in size by deposition of coke thereon; a method for producing the requisite seed coke for said process which comprises withdrawing a portion of said coke particles from said process, introducing said portion without cooling into a narrowly confined elongated passageway under a pressure sufficient to prevent back-flow, injecting liquid water into said conduit to produce steam and to cool the coke particles more than 400° F., said steam serving to accelerate the coke particles to a high velocity, co-currently flowing said steam and coke particles through said passageway, ejecting the high velocity coke particles against a target plate thereby reducing the average particle size of the ejected particles by impact, classifying the particles so impacted to recover fine coke particles of seed size therefrom, leaving relatively coarse particles, and returning the fine coke particles so recovered to said coking zone.

2. The process of claim 1 wherein said coarse coke

particles separated from said fine coke particles are removed as by-product of the process.

3. The process of claim 1 wherein said steam, after serving to accelerate said coke particles, is used to separate said fine coke particles by elutriation from said impacted particles.

4. A process for producing finely divided particulate coke to serve as nuclei for coke deposition in a hydrocarbon oil fluid coking process containing high temperature coke particles substantially under 1000 microns in size, which comprises introducing a portion of said high temperature coke particles into a narrowly confined elongated passageway at a solids loading in the range of 250,000 to 2 million lbs./hr./sq. ft., and under a pressure sufficient to prevent back-flow, also introducing into said passageway a readily vaporizable liquid medium which upon contact with said high temperature coke particles produces quantities of vapors, said vapors serving to accelerate the coke particles to a high velocity, co-currently flowing said vapors and coke particles through said passageway, directing the high velocity particles so obtained against an impact target to produce fine coke particles, and classifying the particles so impacted to recover fine coke particles therefrom, leaving relatively coarse coke particles.

5. A fluid coke comminuting process which comprises introducing fluid coke particles from a hydrocarbon oil fluid coking process at a temperature in the range of 900° to 1600° F. into a narrowly confined elongated passageway at a solids loading in the range of 250,000 to 2 million lbs./hr./sq. ft. and under a pressure sufficient to prevent back-flow, also introducing into said passageway 0.1 to 0.5 lbs. of water per lb. of said fluid coke particles, said water upon contact with the high temperature particles producing quantities of steam and cooling said fluid coke particles at least 400° F., said steam serving to accelerate said fluid coke particles to a high velocity in the range of 200 to 1000 ft./sec., co-currently flowing said steam and fluid coke particles through said passageway, ejecting the high velocity coke particles so obtained against an impact target to produce fine coke particles, and classifying the particles so impacted to recover fine coke particles therefrom, leaving relatively coarse coke particles.

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