June 16, 1959 W. J. METRAILER 2,891,000

PROCESS FOR FEEDING HEAVY OILS INTO CONVERSION SYSTEMS

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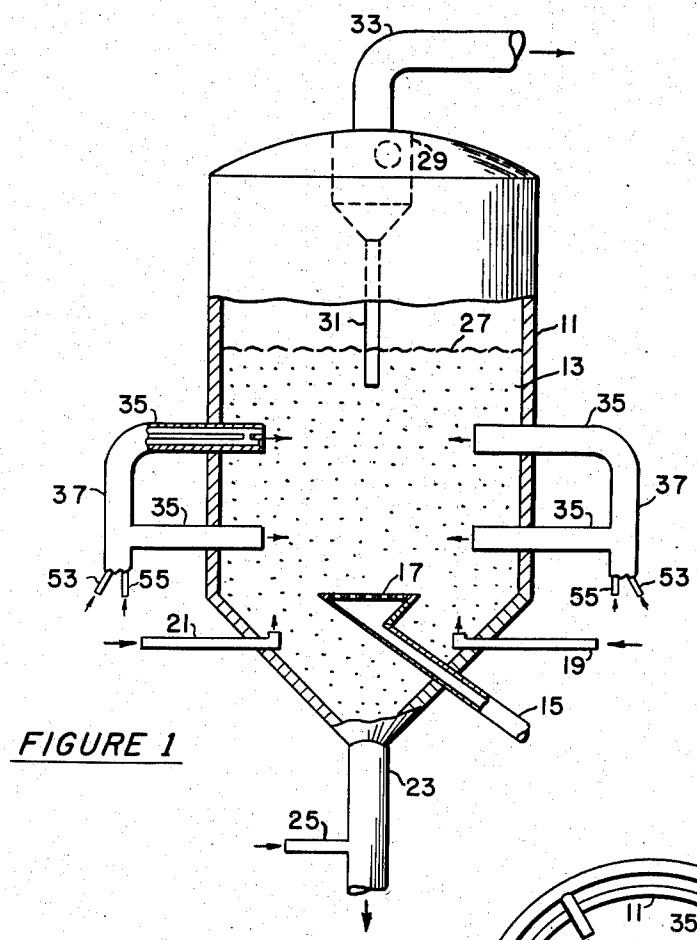

FIGURE 1

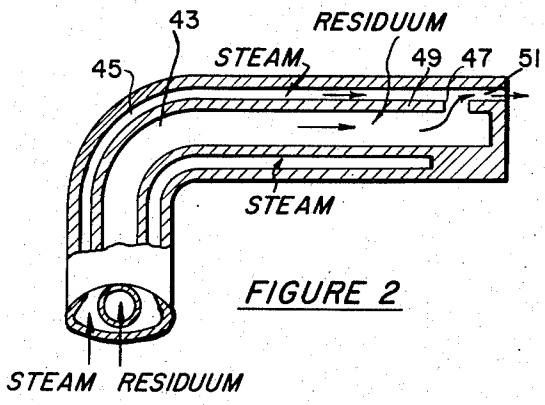

FIGURE 2

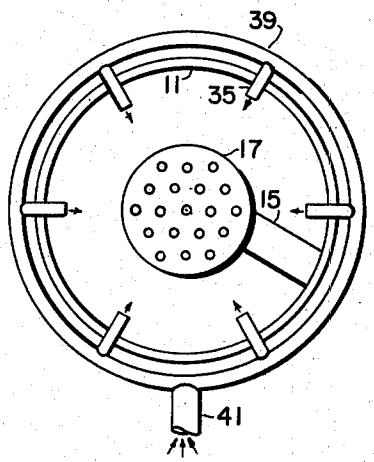

FIGURE 3

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PROCESS FOR FEEDING HEAVY OILS INTO CONVERSION SYSTEMS

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2 Claims. (Cl. 208—157)

The present invention relates to improvements in a process and apparatus for feeding heavy oils into conversion systems. The invention is particularly applicable to systems for converting heavy crude oil residua and the like by coking in a fluidized solids coking zone, although it has other applications also.

In the conversion of heavy residual oils by coking, one of the most useful conversion systems is one which employs a fluidized bed of finely divided solid particles which are substantially catalytically inert. These solids, preheated to a temperature of 1000° to 1300° F. or more, are utilized to supply the necessary heat for the endothermic coking or conversion reaction. In systems of the type mentioned a bed of aerated mobile solids, preferably fluidized by passing gasiform fluids upwardly therethrough, is established in a coking zone. The oil to be converted is introduced into said zone by spraying or otherwise finely subdividing it in various ways. In the prior art some difficulty has been encountered in obtaining uniform dispersion of the feed.

For successful operation of a fluidized coking bed it is highly important to prevent substantial agglomeration of the particles because agglomerated particles tend to grow beyond fluidizable sizes and to settle out of the system. If they become too numerous and/or too large the bed bogs down and loses its mobility or its fluidized condition. Under such circumstances the system must be shut down immediately since introduction of further feed into a settled bed of hot solids simply results in coking up the whole system.

Hence various attempts have been made, without complete success, to introduce the heavy oil feed into the fluid bed in such a manner as to avoid agglomeration and bogging. With the conventional fluid solids bed the heat carrying particles, which may be sand, shot, bead, particles of clay, ceramics and the like, but preferably are small particles of coke, are present in high concentration. A typical fluidized bed had a density of 20 to 50 pounds per cubic foot. Obviously at such densities it is difficult for a jet of oil or vapor to penetrate very far into the fluidized mass. As a result, particles near the outlet receive the bulk of the feed and become quite heavily coated or saturated with it, while particles more remote remain comparatively dry and uncontacted by the feed.

According to the present invention it has been found that improved penetration of the bed by a spray of heavy oil such as residuum may be secured by shearing the feed into fine droplets with an extremely high velocity fluid jet which is relatively easy to obtain. Attempts to feed the heavy oil itself as a continuous liquid jet have indicated, in some cases, that excessive power is required to secure the velocity needed for good bed penetration. According to the present invention, sufficient penetration may be obtained by the use of a jet of steam or the like at extremely high velocities with comparatively very low power or steam requirements.

The invention will be more fully understood by referring to the attached drawing wherein

Fig. 1 shows a system, partly in section, for conversion of hydrocarbons embodying the feeding means of the present invention;

Fig. 2 is an enlarged detailed section of one of the nozzles of Fig. 1;

Fig. 3 is a horizontal cross-section of a coking system showing one preferred arrangement of feed nozzles for good dispersion of the feed.

Referring to Fig. 1, there is shown a reactor vessel **11** of conventional type for holding a fluidized bed of solids **13**. The vessel is shown for purposes of illustration as being generally cylindrical in shape although it may be depressed to provide for higher gas velocities at the bottom than would otherwise be realized, as is sometimes desirable.

Preheated solids of suitable type such as coke particles heated to a temperature of 900 to 1300° F., preferably between about 1000 and 1200° F., are introduced in any suitable fashion, for example, through a line **15** which terminates in a distributing device **17** within the reactor. The preheated particulate solids are fed by an impelling stream of fluids such as steam or hydrocarbon gas and are distributed in a manner that is well known in the art, for example through openings in the distributor **17**. Alternatively, a conventional grid may be used which extends more completely across the reactor vessel.

The fluid which serves to impel the solid particles into the reactor may also serve to fluidize them or partially to fluidize them. Supplementary fluids such as steam may be introduced through additional nozzles **19**, **21**. The latter may also serve to strip hydrocarbon vapors and the like from a descending stream of the hot particles as they are withdrawn from the vessel through outlet line **23**. A stripping and/or fluidizing gas may be introduced into line **23** through inlet **25** as is known in the art.

By virtue of the fluidizing gases mentioned, plus the conversion products of the feed, the fluid bed is established with a more or less regular upper level, as indicated at **27**. The effluent gases and vapors rise from the turbulent bed and pass out through a gas-solids separator such as a cyclone **29**. Separated solids are returned to the bed through a return line or dip leg **31** and the product gases and vapors pass overhead through line **33** to a suitable recovery point or system, not shown. The heavy hydrocarbons fed to coker operations are usually very viscous liquids at ordinary temperatures. As such, they are preheated to a temperature of 300 to 700° F., preferably above 500° F., and may be conveyed to a feed structure, next to be described, in any suitable manner.

The feed structure mentioned consists of one or more, preferably several, feed nozzles **35**. In Fig. 1 four are shown but the number may be much greater in the case of a large coking system. As shown, the nozzles **35** extend from a manifold **37** which may be duplicated on either side or at several points spaced about the periphery of the coker vessel **11**. One suitable arrangement is to form an annular conduit **39** from which the nozzles extend through the coker vessel **11** at a number of points as indicated in Fig. 3. In the latter figure the preheated oil feedstock may be introduced through a central line surrounded by a steam jacket line **41** so as to keep the feed hot until it is injected into the reactor.

Thus the manifolds and the nozzles themselves are preferably equipped with a central conduit **43** (Fig. 2) for the oil and an outer conduit **45** for steam or other hot gasiform fluid which maintains the temperature of the feed.

Referring now in detail to Fig. 2, each of the nozzles

35 preferably is designed so that a perforation 47 is provided in the partition 49 between the channels 43 and 45. It will be understood that two or more perforations 47 may be provided in each nozzle if desired, depending upon its design and capacity. Channel 45 preferably is annular and surrounds the partition 49. The residuum emerging through opening or openings 47 is sheared by the rapidly flowing steam jet which passes out through the nozzle opening 51 at extremely high velocity under moderate pressure. A desirable steam jet velocity may equal or exceed sonic velocity, i.e. up to about 1200 feet per second. A velocity as low as 200 feet per second is quite effective. With this arrangement the feed is well dispersed.

It will be understood that the hot jacketing fluid, such as steam, may be brought in through lines 53 into manifold 37 or through a line 41 in the case of the system of Fig. 3. The preheated residua may be fed through the connecting lines 55 which lead to the conduit 43 inside the nozzles.

Modifications in the number of jets and their arrangement may be made depending upon the size of apparatus and the type of bed formed therein as will be obvious to those skilled in the art.

With the system described above, it is not difficult to secure jet velocities as high as 1000 feet per second with moderate steam pressure. For good atomization it appears that a steam jet velocity of at least 200 feet per second is required. The heavy oil feed is preferably introduced at an angle of 75 to 105° to the steam jet, an angle of about 90° being particularly preferred. The feed rate of the oil should be at least 3 linear feet per second, up to 20 or 30 feet per second, so that the emerging oil is effectively sheared by the high velocity steam. With this arrangement the oil is broken up into very small and relatively uniform particles. These particles are projected into the fluidized bed of solid particles an adequate distance.

Tests in laboratory coking apparatus indicate that jet velocities of 400 to 900 feet per second are about optimum for average residua but it is contemplated that steam jet velocities as low as 200 and as high as 1200 feet per second or more may be used. Steam or power requirements increase very rapidly above the sonic range and this limits the practical maximum steam jet velocity.

In addition to their utility in securing good feed dispersion the high velocity jets serve to cause some attrition and breaking of coke particles so as to make some seed coke. This is particularly true of jet velocities above 400 f.p.s. By the use of this system it is possible to reduce the requirements for seed coke from other sources.

It will be understood that fluids other than steam may be used for atomization and injection of the feed. Gases such as nitrogen, CO_2, etc., may be used, and even hydrocarbon vapors in some cases. The term "jets," therefore, is understood as referring to high velocity jets of any hot fluid having the same general properties as steam for a coking operation.

What is claimed is:

1. A process of converting heavy residual hydrocarbon oil which comprises preheating said oil to a temperature between about 300° F. and 700° F., supplying said preheated oil to a confined passageway surrounded by a separate passageway in annular relationship to said first confined passageway, said confined passageway having an orifice near its end, said separate passageway having an outlet opening beyond said orifice, passing said preheated oil from said confined passageway through said orifice arranged at an angle between about 75° and 105° to the flow of hot gas, to be referred to hereinafter, at a lineal rate of about 3 to 30 feet per second, flowing a jet of hot gas through said separate passageway across said orifice at a velocity of about 200 to 1200 feet per second to shear and atomize said oil leaving said orifice and continuing the jet with entrained atomized oil through said outlet opening directly into a dense turbulent fluidized bed of preheated solid particles in a conversion zone to effect conversion of said oil by contact with said particles.

2. A process according to claim 1 wherein said preheated oil is passed through said orifice at an angle of about 90° to the flow of hot gas.

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