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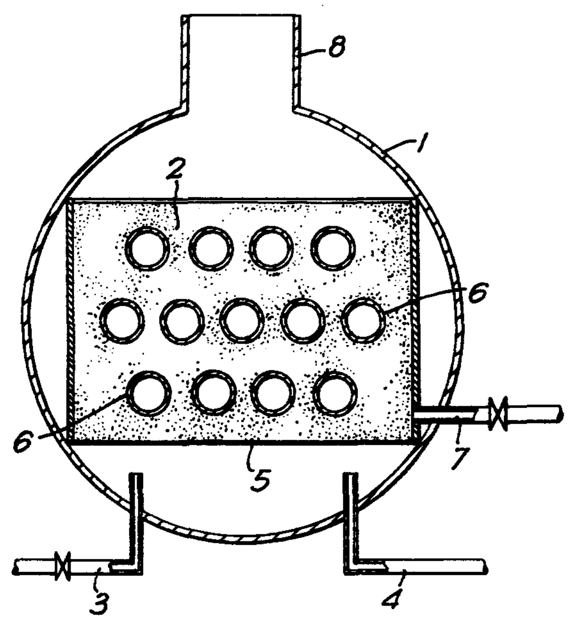
(54) Hydrocarbon processing.

(57) Pyrolysis of a hydrocarbon feedstock, for example naphtha, is carried out by subjecting the feedstock to elevated temperature during passage through a reaction chamber, which is for example one or more tubes arranged horizontally or vertically such as a cracking coil. The reaction chamber is disposed within a fluidised bed of hot inert particles which are heated by firing a solid, liquid or gaseous fuel. A heavy fuel oil, for example pyrolysis fuel oil, is the preferred fuel.



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Hydrocarbon Processing

THE PRESENT INVENTION relates to the conversion of hydrocarbon feedstocks.

Processes involving the conversion of hydrocarbon feedstocks are now operated on a large scale in many parts of the world. Examples of such processes are naphtha reforming in which aromatic hydrocarbons are formed and thermal cracking of feedstocks such as naphtha, gas oil and crude oil to form olefinic hydrocarbons. For ease of description, the invention is hereinafter described with reference to thermal cracking but it is to be understood that this reaction is only one of several reactions to which the invention is applicable.

A large proportion of thermal cracking is directed to the production of ethylene as the primary pyrolysis product and many plants, the largest of which produce about 750,000 tons per year of ethylene, are now in operation.

Processes at present in operation for thermal cracking of hydrocarbon feedstocks almost invariably effect cracking in radiantly heated elongated pyrolysis coils through which a process stream comprising the hydrocarbon feedstock and steam diluent is passed. The radiant heat flux to the pyrolysis coils is derived from numerous burners that supply heat to the furnace boxes containing the pyrolysis coils.

These processes work well and their main limitations tend to be a restriction on the rate of heat input to the processes and coking of the reactors used. Coupled with these is a restriction on the range of feedstock which they can handle and little flexibility in the production of different product spectra. Thus, a given design cannot be easily adapted to a change, say, from naphtha to gas oil as feedstock and the freedom to vary the product spectrum for a given feed is markedly limited.

The usual design for a conventional thermal cracking furnace employs a large number of burners which are distributed uniformly over the walls of the furnace and which produce small flames for heating the suspended pyrolysis coils. Such an arrangement produces a reasonably uniform heat flux around the periphery of the tubes, provided they are in a sufficiently sparse array to limit any radiant shielding effect. These small burners work well with gas as a fuel but oil firing is not so successful. Oil firing requires a large flame for stability and this tends to make the heat flux on the coils less uniform and to reduce the coil life. In addition, small oil burners tend to become blocked with coke and require frequent removal from the furnace for cleaning. A compromise solution is to operate a combination fired system in which large oil burners, called hearth burners, are placed in the base of the furnace and fire upwards and in which the heat flux around the coils is "trimmed" with the usual small gas burners on the furnace wall. Typically about 40% of the furnace fired duty is provided by oil fired hearth burners and 60% by gas fired wall burners.

The literature on thermal cracking contains various proposals for improvement of the process, some of which have been directed to problems concerned with heat transfer in the reactor. For example, it has been proposed to use steam as the heat transfer agent in the reactor, the steam having previously been heated to very high temperatures. We have now found that a fluidised bed can be used advantageously as the medium for heat transfer in a hydrocarbon conversion process.

According to the present invention a process for pyrolysis of a hydrocarbon feedstock comprises subjecting the feedstock to elevated temperature during passage through a reaction chamber, the reaction chamber being disposed within a fluidised bed of hot inert particles which are heated by firing a solid, liquid or gaseous fuel, with the proviso that the bed is maintained at a pressure greater than atmospheric if a gas is used exclusively as the fuel.

Preferred forms of the reaction chamber for the process of this invention include the following three arrangements. In the first arrangement, the reaction chamber comprises one or more tubes arranged horizontally, the fluidised bed being operated at substantially atmospheric pressure. The second arrangement also comprises one or more tubes arranged horizontally, but with the fluidised bed operated at a pressure which is above atmospheric. The third arrangement comprises one or more tubes arranged vertically with the fluidised bed being operated at relatively higher pressures than those used for the horizontal arrangements. It is preferred to operate the process with the fluidised bed at or near to atmospheric pressure but the process is also operable at fluidised bed pressures above atmospheric. No upper limit of pressure has been determined but practical considerations suggest that operations above a pressure of the order of 50 atmospheres are unlikely to be attractive.

When the fluidised bed is operated at above atmospheric pressure, it is preferred to pass at least a portion, and usually all, of the off-gas from the fluidised bed to a gas turbine.

A preferred form of the reaction chamber comprises the well-known so-called "cracking coil" which is in widespread use in existing thermal crackers and which comprises a long tube arranged in the form of a coil.

The fluidised bed is conveniently formed within a chamber which is large enough to house the whole of the reaction chamber and to enable the reaction tubes, in the preferred form of the invention, to be immersed in the fluidised bed. Heat transfer from the particles of the fluidised bed through the walls of the reaction chamber enables the hydrocarbon stream within the reaction chamber to be heated to and maintained at the desired reaction temperature. The fluidised bed particles, therefore, must themselves be capable of withstanding the temperature involved without any adverse effects. With this proviso, any inert particles will be suitable for use in the fluidised bed but particularly preferred are sand particles. The particle size of the sand is preferably in the range 0.01 to 3 mm diameter, more preferably in the range 0.1 to 1.5 mm diameter.

It is preferred to heat the inert particles of the fluidised bed by firing of a liquid fuel comprising a heavy fuel oil. Particularly preferred fuels comprise pyrolysis fuel oil and fractions thereof obtained as a by-product from hydrocarbon conversion processes, for example thermal cracking. The fuel may also comprise a blend of liquid fuels. The use of pyrolysis fuel oil has particular advantages where the process according to this invention comprises cracking of a hydrocarbon feedstock. Cracking processes produce quantities of pyrolysis fuel oil which is regarded as a fuel oil of relatively low quality. Disposal of it has therefore hitherto posed some problem to the operators of plants producing it. Although attempts have been made to use it as a fuel for certain types of conventional furnace, they have not been wholly successful. The process of this invention provides a ready and suitable outlet for pyrolysis fuel oil whether produced in the process itself or in another adjacent plant.

Although oil fuels such as pyrolysis fuel oil have particular applicability, the Applicants believe that there is considerable flexibility in the choice of fuels for the process of this invention and that a wide range of combinations of fuels may be used. Thus, the bed may be fired exclusively with liquid fuel in which the bed of inert particles is fluidised by an upward flowing stream of air. The liquid fuel is injected into the bed through a series of nozzles, preferably uniformly distributed, in the base of the bed. Thereby, the bed is effectively one large "flame" with combustion taking place uniformly throughout the whole bed. The bed may be fired exclusively with gas, the bed being fluidised by separate feeds of gas and air or by premixed gas and air in the appropriate proportions. Combination firing may be achieved, for example, by fluidising with gas and air and thereafter injecting liquid fuel. The use of solid fuel, for example coal, is also possible provided that the ash fusion temperature is greater than the bed temperature and provided that the proportion of sulphur in the fuel is not too great. Although the use of air along with the fuel is most convenient in fluidising the bed, there may be circumstances in which it is advantageous to use a feed of oxygen instead of, or as well as, air.

The temperature used for carrying out the process of this invention will depend on the particular hydrocarbon process and also on the feedstock being converted. For example, in thermal cracking of naphtha at severities and residence times which are typical of operations in conventional plants, it is likely that the temperature of the fluidised bed will lie in the range 1050 to 1200°C. The exact temperature used will depend on the geometry of the thermal cracking coil but the Applicants believe that a fluidised bed temperature of about 1130°C would be typical. In the cracking of heavier feedstocks, for example gas oil, the temperature is likely to be somewhat lower since such feedstocks are generally cracked at lower severities than naphtha.

The reaction conditions used in the reaction chamber will be broadly similar to those used in conventional reactors and the conditions for any particular reaction will be well-known to those skilled in this art.

Compared with a conventional thermal cracking plant, we have found that by using the process of this invention it is possible to reduce the size of plant (and hence also the capital) needed for an olefines plant of given output. Moreover, there is the possibility of a somewhat higher yield of ethylene and of a reduction in the amount of coking resulting, we believe, from the more uniform heating of the reaction chamber which can be achieved with a fluidised bed.

One embodiment of the process of the invention will now be described with reference to the accompanying drawing which shows in cross-section part of the interior layout of a cracking furnace. The furnace shell 1 houses a fluidised bed 2 of sand particles, fluidisation being achieved using fuel gas and air which are fed to the furnace through inlets 3 and 4 respectively and through distributor 5. The furnace houses a horizontal cracking coil 6. Process feedstock comprising naphtha is fed to coil 6 and reaction products leave the coil through an inlet and outlet (not shown). Pyrolysis fuel oil is fed through line 7 and fired to heat the inert particles to a sufficiently high temperature so that the cracking reaction can be maintained in coil 6. An outlet 8 is provided for the exit of hot gases from the fluidised bed and this outlet can lead, for example, to a cyclone and gas turbine (not shown).

Claims

1. A process for pyrolysis of a hydrocarbon feedstock characterised in that the feedstock is subjected to elevated temperature during passage through a reaction chamber, the reaction chamber being disposed within a fluidised bed of hot inert particles which are heated by firing a solid, liquid or gaseous fuel, with the proviso that the bed is maintained at a pressure greater than atmospheric if a gas is used exclusively as the fuel.

2. A process as claimed in claim 1 characterised in that a liquid fuel comprising a heavy fuel oil, preferably pyrolysis fuel oil, is used to heat the inert particles.

3. A process as claimed in claim 1 or 2 characterised in that a solid fuel comprising coal is used to heat the inert particles.

4. A process as claimed in any one of the preceding claims characterised in that the inert particles comprise sand particles.

5. A process as claimed in claim 4 characterised in that the particle size of the sand particles is in the range 0.01 to 3mm in diameter.

6. A process as claimed in any one of the preceding claims characterised in that the reaction chamber comprises one or more tubes arranged horizontally, the fluidised bed being operated either at or above atmospheric pressure.

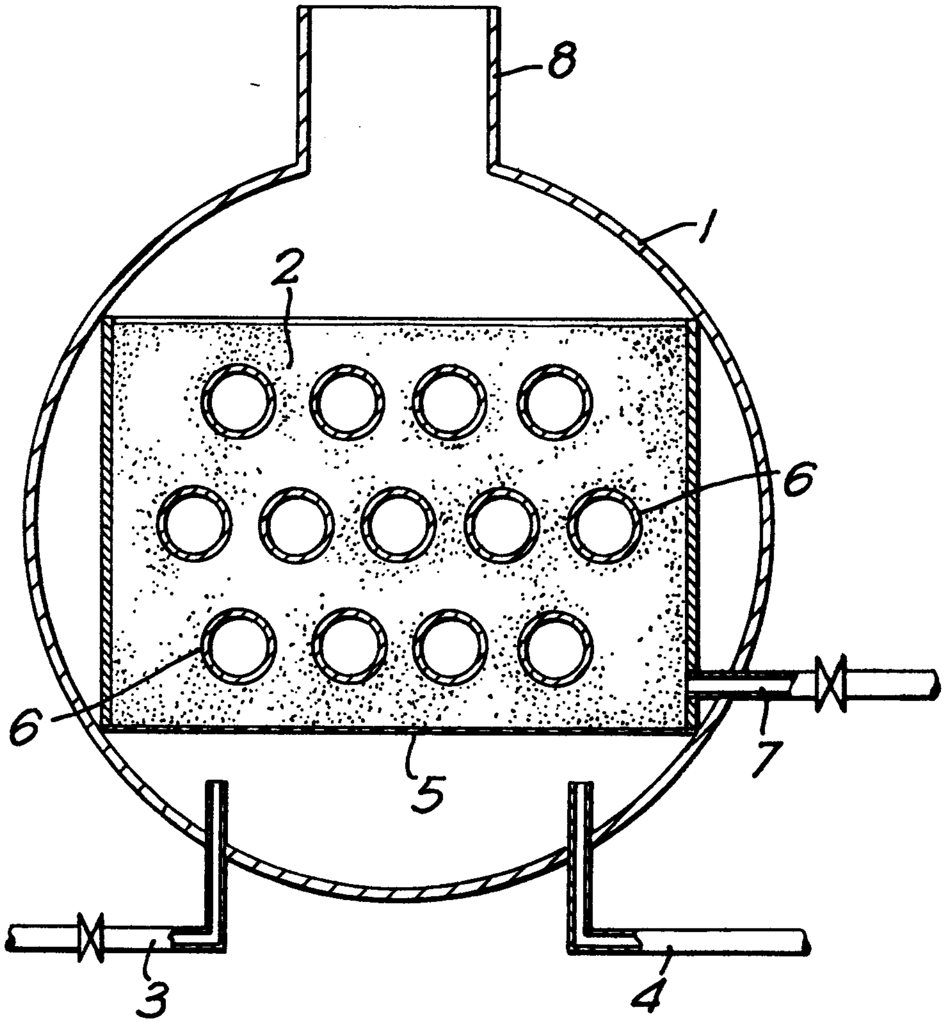
7. A process as claimed in any one of claims 1 to 5 characterised in that the reaction chamber comprises one or more tubes arranged vertically with the fluidised bed being operated at relatively high pressures.

8. A process as claimed in any one of the preceding claims characterised in that the process comprises thermal cracking of a hydrocarbon feedstock.

9. A process as claimed in claim 8 characterised in that the feedstock comprises naphtha and the

temperature of the fluidised bed is in the range 1050 to 1200°C.

10. A process claimed in any one of claims 1 to 7 characterised in that the process comprises reforming of a naphtha feedstock to produce aromatic hydrocarbons.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EUROPEAN SEARCH REPORT

0008169

Application number
EP 79 30 1405

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
X	BE - A - 674 656 (BASF) * Figure 1; claim; page 4, lines 15-19; page 5, line 20 - page 6, line 5; page 7, lines 1-4 * --	1-6,8, 9
E,P	DE - A - 2 815 985 (ROBINSON) * Figure 2; claims 1-6,10,13; page 12, lines 17-22 * ----	1,4,5, 7,10

CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)

C 10 G 9/14
C 10 G 35/00

TECHNICAL FIELDS SEARCHED (Int.Cl. 3)

C 10 G 9/00
9/14
9/18
9/20
B 01 J 8/06
C 10 G 35/00
35/04

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	31-10-1979	MICHIELS