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(54) Title: METHOD FOR TREATMENT OF HEAVY HYDROCARBON FRACTION AND EQUIPMENT THERETO

(57) Abstract: A method and device for treating heavy oil material is disclosed. The raw material is exposed to combined flux of accelerated particles and ionizing radiation of predetermined energy and charge, while in the volume of irradiated feed nonuniformities of density and flow rate are introduced. The device for treating of heavy oil products according to the disclosed comprises the body or irradiator with enclosed radiation sources, feed heating system, feed running system and biological shielding means, the feed running system incorporating means for generation of flow nonuniformity.

Method for treatment of heavy hydrocarbon fraction and equipment thereto

Background of the Invention

A method and device for treatment of heavy oil products is disclosed in US patent 4,188,284. According to said patent the raw material is treated with hydrogen at high temperatures around 600 °C in presence of porous alumina catalysts. The disclosed reactor comprises reactor body, a portion of catalyst, means for heating the feed and means for running the feed. The disclosed method and device is limited by the low yield of white products.

Another method and device for treatment of heavy oil products is disclosed in US patent 4,874,503. The disclosed method is based on operation in fluidized bed in vertical tubes. The process proceeds at high temperatures, a mixed catalyst on porous alumina is used and ethylene introduced. The disclosed reactor comprises reactor body, a portion of catalyst, means for heating the feed and means for running the feed. The use of fluidized bed and enriching of the hydrocarbon feed with ethylene results in increased yield of white products.

Still another method and device for treatment of heavy oil products is disclosed in US patent 4,323,448. The disclosed method employs mechanical treatment. The disclosed device comprises a body of desintegrator, beaters, system for running the feed, actuator means. The feed is passed through the desintegrator, and treated with 3 - 12 impacts in 0.01 - 0.001 seconds interval. The use of mechanical works results in increased yield of white products.

Another method and device for treatment of heavy oil products is disclosed in US patent 4,434,049. The treatment is effected by impact of a stream of preheated to 300 °C raw material on a surface. The disclosed device comprises a body of heater, injecting system, feed preheating system, feed running system. The hydromechanical destruction of the raw material increases the yield of white products.

Still another method and device for treatment of heavy oil products is disclosed in Japanese patent 62-46597. The treatment is brought about by electromagnetic field. The feed is treated by magnetic field of more than 4000 G$. The disclosed device comprises a reactor body which encases mesh, means for producing electromagnetic field in the feed, system for heating the feed, feed running system. The use of electromagnetic field results in higher yield of white products.

Another method and device for treatment of heavy oil products is disclosed in US patent 4,749,470. The treatment is realized in fluidized bed at high temperatures, employing a catalyst on porous alumina with accompanying microwave irradiation. The disclosed device comprises a reactor body, catalyst, system for heating the feed, feed running system and microwave generator. The use of fluidized bed and microwave energy increases the yield of white products.

Still another method and device for treatment of heavy oil products is disclosed in US patent 4,772,379. The process is realized in a reactor at high temperature in presence of solvent with gamma-irradiation. The disclosed device comprises a reactor body, system for heating the feed, feed running system, gamma-radiation source (cobalt-60), solvent feeding system. The use of gamma-irradiation activates the feed and increases the output of white product fractions.

Another method and device for treatment of heavy oil products, used as a closest analogue, is disclosed in Czech patent 281889. The disclosed method teaches irradiation of the volume of feed simultaneously with gamma-radiation from Co60 and Ce137 sources and electron beam with energy of 10 MEV and a proton flux with energy up to 40 KEV. The exposure to ionizing radiation in combination with electron and proton flux significantly increases the output of white product fractions. The disclosed device for treatment of heavy oil products, taken here as a closest analogue, comprises a reactor body, feed heating system, feed running system, radiation sources, biological shielding of irradiator means. The limitation of the disclosed method and device is the relatively low output of white product fractions.

Description of the Invention

The instant invention is aimed at increasing the output of white product fractions by creating in the irradiatrd volume a nonuniformity of density and uneven flow of feed. This aim is attained by treating the heavy oil feed by combined flux of accelerated particles and ionizing radiation with predetermined energies and charges, while creating heterogenous density and uneven flow of feed by local injection of gas, local acceleration of flow, spinning of flow by accoustic frequency vibrations.

By interaction of flux of accelerated particles and accoustic waves, as well as ionizing radiation with macromolecular compounds, a certain part of the flux energy is spent in activation or destruction of said molecules, while another part is dissipated by elastic and non-elastic dissipation. For log-chain molecules of black oil under equal other conditions the destruction consumes 38% of gamma-radiation energy and 46% of electron-irradiation energy. Nevertheless, in practice the output of the destructed material is significantly lower. This is explained by the fact, that the fragments of the disrupted molecules or free radicals, possessing free valencies after the disruption of the molecule, restore the molecule by re-uniting, if the disrupted parts of the molecule are not mutually displaced.

The useful percentage of the destruction energy is increased by creating nonuniformity of density and nonuniformity of feed velocity in the volume of irradiated raw material by, for example, sparging of gases trough the volume of feed, by means of local acceleration of flow, by local spinning of flow, by exposure to acoustic waves, i.e., the creation in the volume of the irradiated raw material nonuniformity of density and nonuniformity of velocity of feed flow, the output of the white product increases 1.5 times in comparison with the yield from the raw material with uniform density and constant flow rate at the equivalent level of irradiation. Such method provides for increased yield of white product with lesser energy consumption. The disclosed method may be realized by a device for treatment of heavy oil hydrocarbons, comprising a body of irradiator with placed therein radiation sources, feed heating system, feed running system, bological shielding means. According to the invention, the feed running system incorporates means for generating fluctuations of flow rate, e.g., ultrasonic generator or pressure pulsator. The disclosed device provides for higher percentage of white product in the resulting product. The experimental investigation of dependance of the yield of white product in the treated heavy oil fractions indicated, that introduction of nonuniformity of density and nonuniformity of flow rate in the irradiated volume of feed results in increased yield of white products.

The disclosed solution of the problem provides for novel techological result, namely, higher output of white product fraction with boiling range of 300-420 °C .

Description of the Figures

Fig. 1 shows the horizontal cross-section of the device for treatment of heavy hydrocarbon raw material.

The device comprises a body 1, external radiation sources 2, an irradiation zone 3, heating means 4, a container for heavy oil 5, a pump 6, fittings for input of heavy oil feed 7, fittings for discharge of treated product 8, biological shielding means 10, internal radiation sources 11, means for local spinning of flow 12, oscillators 13. The container of heavy oil 5, the pump, the body 1 including the heat exchanger 4, the irradiation zone 3, the radiation sources 2, 11, the means for local spinning of flow 12, the oscillators 13 and the container for the treated product 9 are oriented in tandem and connected into a single technological line by fittings for input of the heavy oil feed 7 and fittings for discharge of the treated product 9.

The device operates as follows. The pump 6 feeds heavy oil into the container 5 and through the input fittings 7 into the body 1. Heavy oil is heated in the heat exchanger 4 and delivered into the irradiation zone 3. In the irradiation zone 3 the local spinning means 12 and the oscillators 13 produce nonuniformity of density and velocity of feed. After the targeted radiation dose from the radiation source 11 is delivered, the treated feed is discharged through the output fittings 8 into the treated feed container 9. The biological shielding means 10 take up radiation unabsorbed by the feed.

Examples

The principal type of heavy oil used was black oil with density 0.93 kg/dm^3. A 1 m thick volume of black oil was treated with various doses of radiation from different sources and distilled into separate fractions. The results of the assay are given in Tables.

Table 1 shows the results of rectification of 10 dm^3 of black oil with mass of 9.3 kg, treated by radiation from gamma-source Co60 and electrons from electron beam accelerator, the summary absorbed radiation dose being 103 KJ as compared with the results, obtained from the same volume and mass of unirradiated black oil, subjected to heating by electric coil.

Table 1

Yields in temperature intervals

Temperature interval	Non-irradiated		Irradiated	
	volume dm^3	%	volume dm^3	%
301-320	0.0	0.0	0.3	3.0
321-340	0.1	1.0	0.3	3.0
341-360	0.1	1.0	0.8	8.0
361-380	0.2	2.0	1.8	18.0
381-400	0.4	4.0	2.4	24.0
401-420	0.6	6.0	1.3	13.0
421-440	2.0	20.0	0.7	7.0
441-460	2.0	20.0	0.7	7.0
461-480	1.2	12.0	0.3	3.0
481-500	0.7	7.0	0.2	2.0

Table 2 shows the results of rectification of 10 dm^3 of black oil with mass of 9.3 kg, treated by radiation from gamma-source Co60 and electrons from electron beam accelerator, the summary absorbed radiation dose being 92 KJ, with nitrogen gas sparging, as compared with the results, obtained from the same volume and mass of unirradiated black oil, subjected to heating by electric coil.

Table 2

Yields in temperature intervals

Temperature interval	Non-irradiated		Irradiated	
	volume dm^3	%	volume dm^3	%
301-320	0.0	0.0	0.2	2.0
321-340	0.1	1.0	0.3	3.0
341-360	0.1	1.0	0.6	6.0
361-380	0.2	2.0	1.9	19.0
381-400	0.4	4.0	2.6	26.0
401-420	0.6	6.0	1.4	14.0
421-440	2.0	20.0	0.9	9.0
441-460	2.0	20.0	0.5	5.0
461-480	1.2	12.0	0.2	2.0
481-500	0.7	7.0	0.3	3.0

Table 3 shows the results of rectification of 10 dm^3 of black oil with mass of 9.3 kg, treated by radiation from gamma-source Co60 and electrons from electron beam accelerator, the summary absorbed radiation dose being 81 KJ, with nitrogen gas sparging and local spinning of flow by paddle mixer, as compared with the results, obtained from the same volume and mass of unirradiated black oil, subjected to heating by electric coil.

Table 3
Yields in temperature intervals

Temperature interval	Non-irradiated		Irradiated	
	volume dm^3	%	volume dm^3	%
301-320	0.0	0.0	0.4	4.0
321-340	0.1	1.0	0.4	4.0
341-360	0.1	1.0	0.7	7.0
361-380	0.2	2.0	1.8	18.0
381-400	0.4	4.0	2.2	22.0
401-420	0.6	6.0	1.5	15.0
421-440	2.0	20.0	0.8	8.0
441-460	2.0	20.0	0.6	6.0
461-480	1.2	12.0	0.2	2.0
481-500	0.7	7.0	0.1	1.0

Table 4 shows the results of rectification of 10 dm^3 of black oil with mass of 9.3 kg, treated by radiation from gamma-source Co 60 and electrons from electron beam accelerator, the summary absorbed radiation dose being 81 KJ, with nitrogen gas sparging and local spinning of flow by paddle mixer plus 100 KHz ultrasonic irradiation, as compared with the results, obtained from the same volume and mass of unirradiated black oil, subjected to heating by electric coil.

Table 4
Yields in temperature intervals

Temperature interval	Non-irradiated		Irradiated	
	volume dm^3	%	volume dm^3	%
301-320	0.0	0.0	0.3	3.0
321-340	0.1	1.0	0.4	4.0
341-360	0.1	1.0	0.8	8.0
361-380	0.2	2.0	1.6	16.0
381-400	0.4	4.0	2.3	23.0
401-420	0.6	6.0	1.5	15.0
421-440	2.0	20.0	0.8	8.0
441-460	2.0	20.0	0.5	5.0
461-480	1.2	12.0	0.2	2.0
481-500	0.7	7.0	0.2	2.0

The data in Tables show, that treating the heavy oil hydrocabon raw material with combined radiation flux the energy consumption for destruction decreases, if nonuniformities of density and flow rate are introduced in the volume of irradiated material.

The source of gamma-radiation - Co60, positioned inside the black oil volume in combination with electron source from the electron accelerator, together with spurging, local spinning of flow by paddle mixer and 100 KHz ultrasonic irradiation resulted in 43% increase of white product output at the radiation intensity of 7.2 KJ/kg.

Thus, the creation of nonuniformity of density and feed flow rate along with irradiation by combination of accelerated particles and ionizing radiation can be the basis for industrial technology of heavy oil treatment.

Claims

1. A *method of treating heavy oil material by exposure to combined flux* of accelerated particles and ionizing radiation of predetermined energy and charge, characterized in that nonuniformities of density and flow rate are introduced into the volume of irradiated feed.

2. A device for treating of heavy oil products according to Claim 1, comprising the body or irradiator with enclosed radiation sources, feed heating system, feed running system and biological shielding means, characterized in that the feed running system incorporates means for generation of flow nonuniformity.

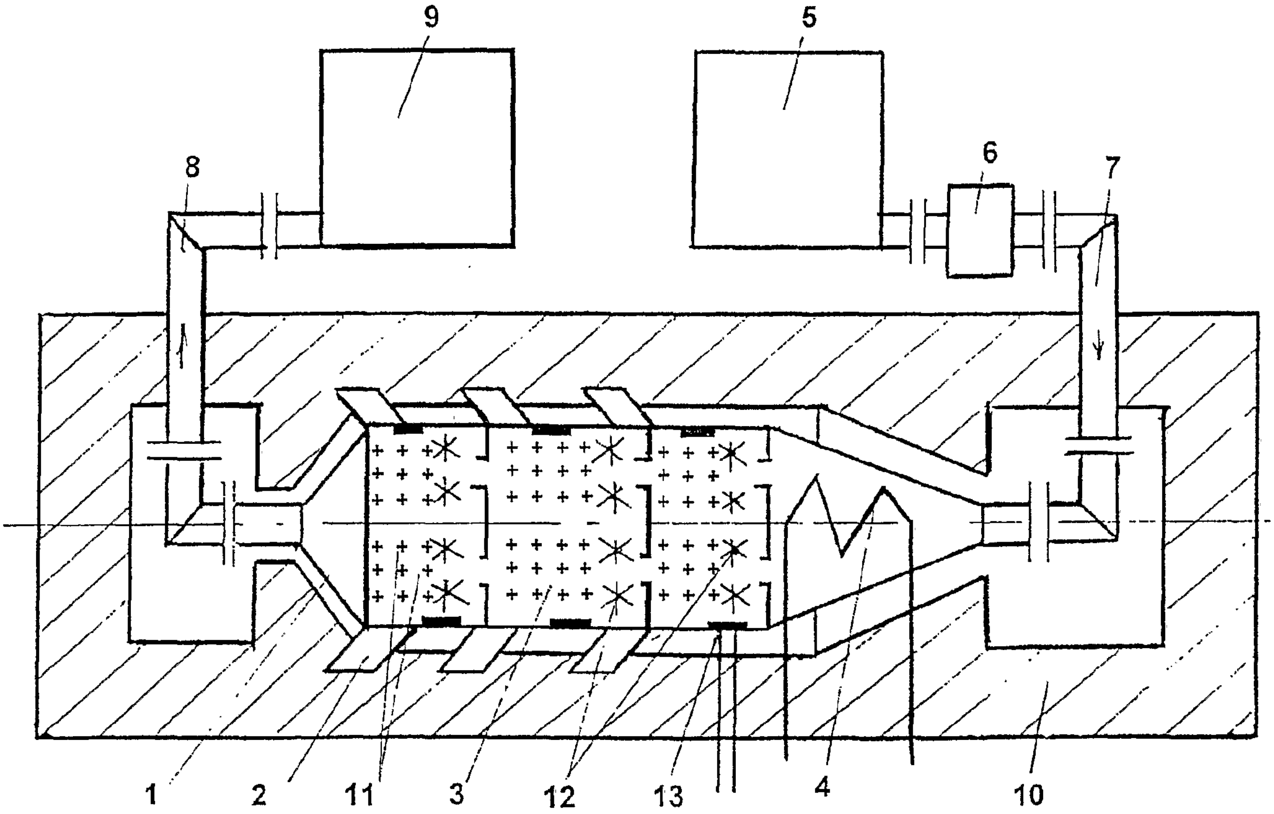

Fig. 1