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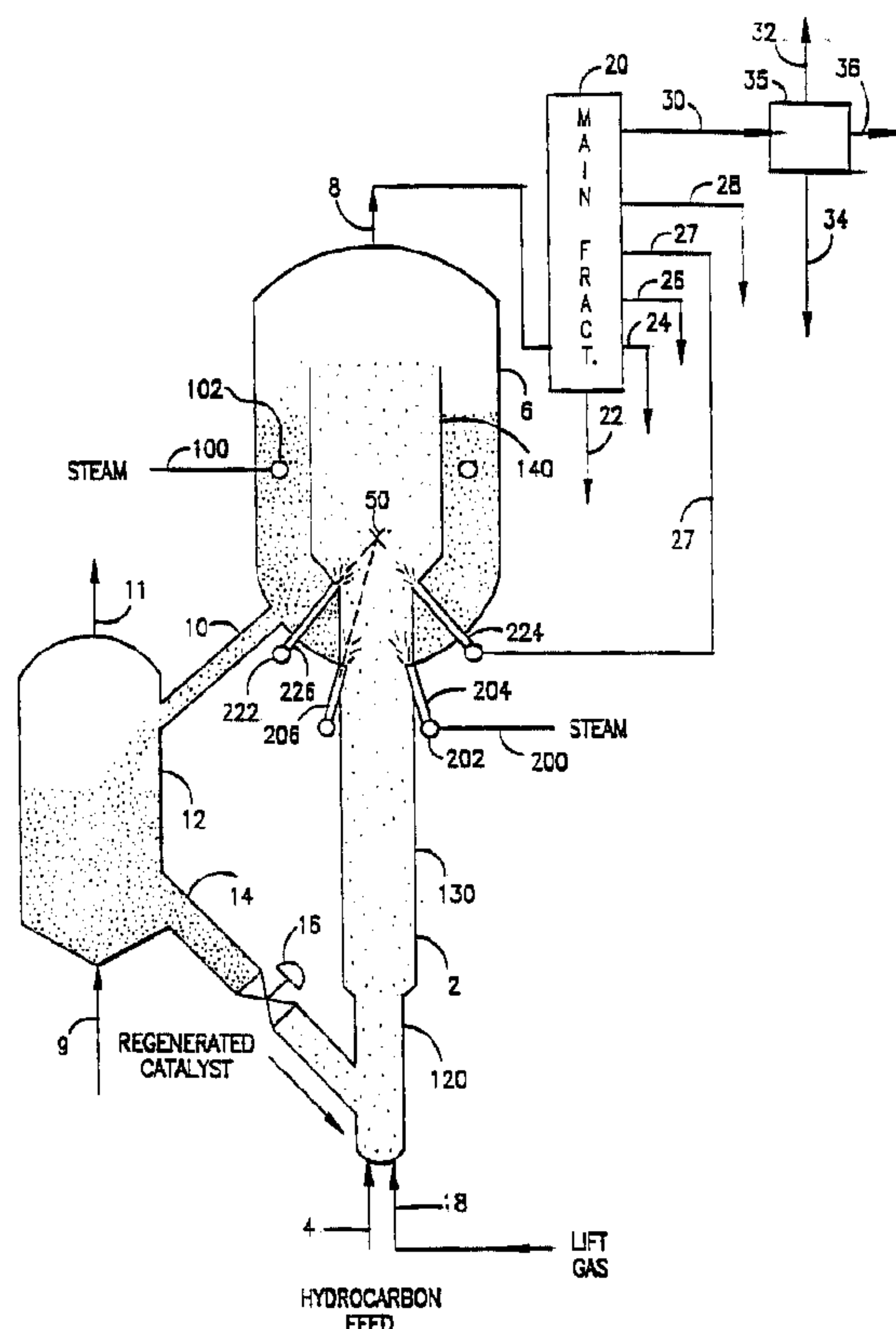
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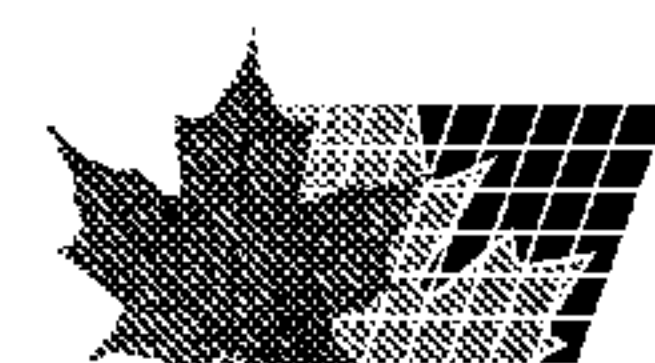
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(54) Title: CATALYTIC CRACKING PROCESS



(57) Abrégé/Abstract:

In a process for catalytically cracking a heavy hydrocarbon feedstock in a vertical riser reactor (120), the feedstock is mixed with hot regenerated cracking catalyst adjacent the base (12) of the reactor and, as the mixture flows up the riser (130), is thermally and catalytically cracked by the catalyst for at least 1 second and for at least the first 50 % of the length of the riser reactor (130) from the base (120). The mixture is then quenched in a quench zone (50) located within the first 90 % of the length of the riser reactor (130) from the base (120) by injection of a quench fluid in an amount sufficient to lower the temperature in the riser by at least 3 °C (5 °F).





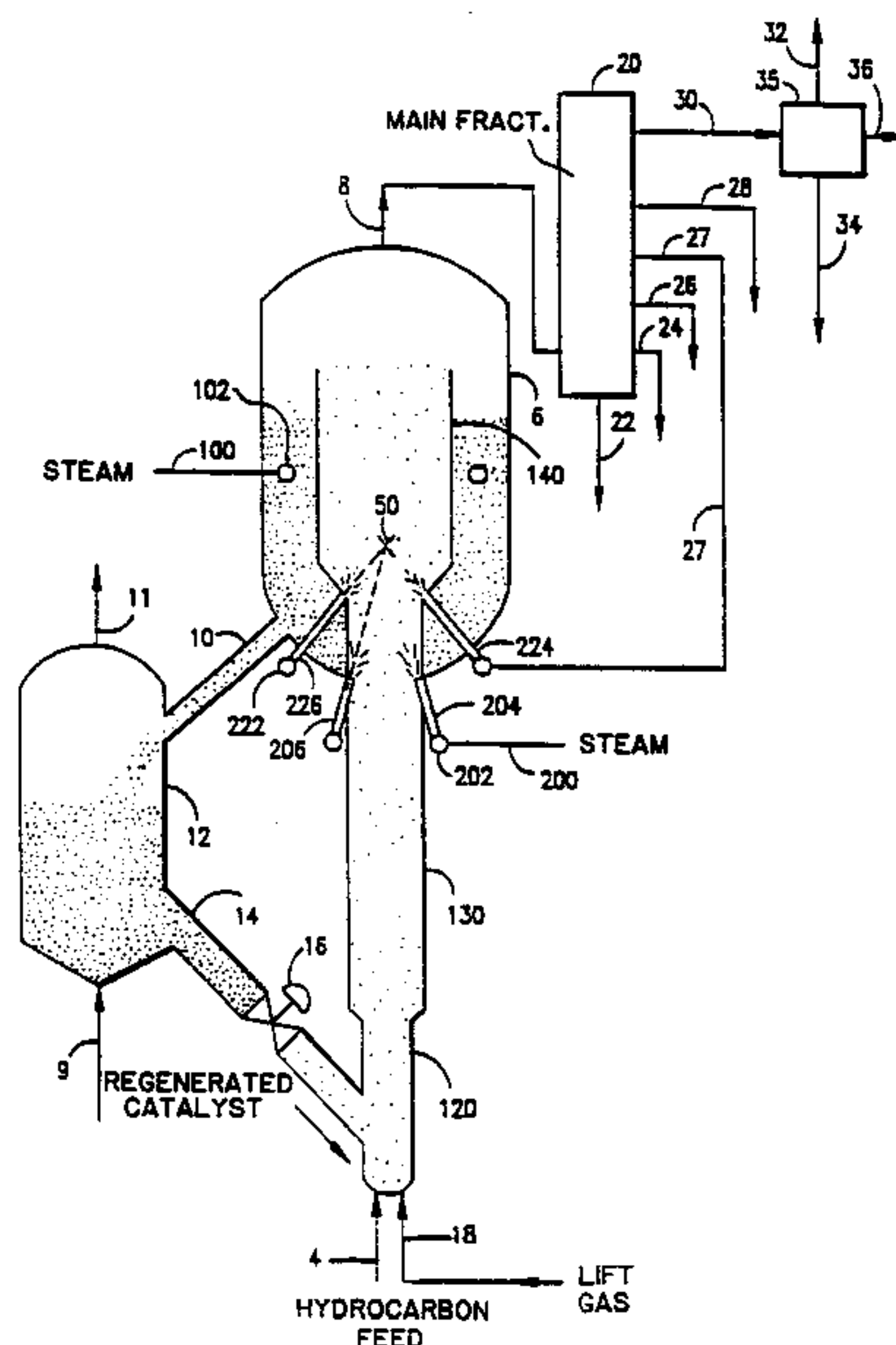
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(21) International Application Number: PCT/US93/04084 (22) International Filing Date: 30 April 1993 (30.04.93) (30) Priority data: 877,913 4 May 1992 (04.05.92) US (71) Applicant: MOBIL OIL CORPORATION [US/US]; 3225 Gallowes Road, Fairfax, VA 22037 (US). (72) Inventors: ADORNATO, Peter, Martin ; 10 Embassy Drive, Cherry Hill, NJ 08002 (US). AVIDAN, Amos, Andrew ; 2120 Stackhouse Drive, Yardley, PA 19067 (US). JOHNSON, David, Lee ; 181 Concord Meeting Road, Glen Mills, PA 19342 (US).		(74) Agents: ROBERTS, Peter, W. et al.; Mobil Oil Corporation, 3225 Gallowes Road, Fairfax, VA 22037 (US). (81) Designated States: AU, CA, JP, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published With international search report.

(54) Title: CATALYTIC CRACKING PROCESS

(57) Abstract

In a process for catalytically cracking a heavy hydrocarbon feedstock in a vertical riser reactor (120), the feedstock is mixed with hot regenerated cracking catalyst adjacent the base (12) of the reactor and, as the mixture flows up the riser (130), is thermally and catalytically cracked by the catalyst for at least 1 second and for at least the first 50 % of the length of the riser reactor (130) from the base (120). The mixture is then quenched in a quench zone (50) located within the first 90 % of the length of the riser reactor (130) from the base (120) by injection of a quench fluid in an amount sufficient to lower the temperature in the riser by at least 3 °C (5 °F).



CATALYTIC CRACKING PROCESS

This invention relates to a process for catalytically cracking hydrocarbon feedstocks.

Processes for cracking hydrocarbon feeds with hot regenerated fluidized catalytic particles are known generically as "fluid catalytic cracking" (FCC).

Distilled feeds such as gas oils are preferred feeds for FCC. Such feeds contain few metal contaminants and make less coke during cracking than heavier feeds. However, the higher cost of distilled feeds provides great incentive to use heavier feeds, e.g., residual oils, in FCC. Resids generally contain more metals, which poison the catalyst and an abundance of coke precursors, asphaltenes and polynuclear aromatics, which end up as coke on the catalyst rather than as cracked product. Resids are also hard to vaporize in FCC units. FCC operators are well aware of the great difficulty of cracking resids and of the profit potential, because these heavy feeds are much cheaper than distilled feeds.

Most FCC operators that crack resid simply blend in a small amount of resid, on the order of 5 or 10 wt %, with the distilled feed and add the blended feed to the base of the riser. However, it is also known to crack different kinds of feed at different elevations in an FCC riser. For example, U.S. Patent 4,422,925 discloses an FCC process with a light feed fed to the base of a riser, and a heavier feed, having a higher tendency to form coke, charged higher up the riser. Similarly, U.S. Patent No. 4,218,306 teaches cracking gas oils in a lower part of a riser then cracking a more difficult feed, such as a coker gas oil, in an upper section of the riser.

Blending feeds or splitting feeds, with a heavier feed added higher up in the riser, are not completely satisfactory when the feeds contain large amounts of

resid or asphaltenes which are difficult to vaporize quickly in the base of a riser reactor.

Most units cracking resids adopt the blended feed approach and try to improve the process by using relatively large amounts of atomizing steam. Thus while conventional FCC units, cracking wholly distillable feeds, might add 1 or 2 wt % steam with the heavy feed to improve atomization, those units cracking heavier, more viscous feeds add significantly more steam, 3, 4, or 5 wt % steam, or even more. While increased atomization steam usually improves cracking efficiency, it also substantially increases the load on the main column, and limits primary feed throughput. Steam reduces hydrocarbon partial pressure, which is beneficial, but increases overall pressure, which increases operating costs. The increased steam usage associated with cracking resids also produces large amounts of sour water which is a disposal problem.

Another proposal for dealing with residual feeds is to charge the resid-containing feed to the base of the riser, cracking it momentarily at an unusually high temperature, then quenching with a heat sink such as water or a lower boiling cycle oil higher up in the riser. According to this proposal, the higher temperatures are sufficient to thermally shock asphaltenes into smaller molecules which could then be cracked catalytically. One example of such a proposal is U.S. 4,818,372, which teaches quenching with an auxiliary fluid within one second of the resid-containing feed being charged to the base of the riser. However, this process suffers from a number of problems since the rapid quenching limits the amount of high temperature conversion and requires large amounts of quench fluid, either large amounts of water

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or even larger amounts of a recycled fluid such as a cycle oil. Water quench increases plant pressure and sour water production, much as does increased use of atomizing steam. LCO or HCO quench does not create as
5 severe a pressure problem as water, because of smaller molar volume, but there is some loss of riser cracking capacity and a significantly increased load on the main column.

10 An object of the present invention is to provide an improved process for catalytically cracking a heavy hydrocarbon feedstock.

Accordingly, the invention resides in a process for catalytically cracking a heavy hydrocarbon feedstock by contacting the feedstock in a vertical
15 riser reactor with a source of hot, regenerated cracking catalyst to produce catalytically cracked vapors and spent cracking catalyst, the cracked vapors being withdrawn and the spent cracking catalyst being regenerated to produce hot regenerated cracking
20 catalyst which is recycled to contact said heavy feed, wherein the heavy hydrocarbon feedstock is mixed with the hot regenerated cracking catalyst adjacent the base of the reactor and, as the mixture flows up the riser, is thermally and catalytically cracked by the
25 catalyst for a vapor residence time of at least 1.5 seconds and for at least the first 50 % of the length of the riser reactor from the base, and wherein the mixture is then quenched in a quench zone located within the first 50-80 % of the length of the riser
30 reactor from the base by injection of a quench fluid in an amount sufficient to lower the temperature in the riser at least 3°C.

The invention will now be more particularly described with reference to the accompanying drawings, in which:

Figure 1 is a simplified schematic view of a preferred embodiment, with upper riser quench points and aspirating quench nozzles.

5 Figure 2 shows a plot of yields versus quench points and quench amounts.

Referring to Figure 1, which is not drawn to scale, a heavy feed is charged to the bottom of a riser reactor 2 via inlet 4. Hot regenerated catalyst is added via conduit 14 equipped with a flow control
10 valve 16. A preferred but optional lift gas is introduced below the regenerated catalyst inlet via conduit 18. The riser reactor 2 is an elongated, cylindrical, smooth-walled tube which periodically gets wider to accommodate volumetric expansion in the
15 riser. The narrowest portion of the riser is the base region 120, with the middle region 130 being wider, and the top region 140, extending into a catalyst stripper 6, being the widest. Such a riser configuration is conventional.

20 The preferred but optional lift gas, from an external source, or a recycled light end from the main fractionator added via line 18, helps condition the catalyst and smooths out the flow patterns of catalyst before catalyst meets injected feed. The feed is
25 usually injected via 4 - 10 atomizing feed nozzles to contact hot regenerated catalyst, which vaporizes the feed and forms a dilute phase suspension, which passes up the riser.

30 Roughly 2/3 way up the riser, quenching fluid is injected via several layers of radially distributed quench nozzles. In the embodiment shown, steam from line 200 is supplied via steam distribution ring 202 to a plurality of nozzles 204, 206. These nozzles have a relatively narrow spray pattern and are aimed at a

converging point 50, roughly 1.25 riser diameters downstream of the first ring of nozzles.

5 A second set of nozzles quench with a recycled heavy naphtha fraction, which is added via line 27 and distribution ring 222 to a plurality of nozzles 224, 226. The naphtha quench nozzles can be identical to those used to inject steam. Additional energy will usually be added to light liquid hydrocarbon quench streams by pumps not shown or by addition of steam, 10 preferably moderate or high pressure steam. Preferably the converging point of the nozzles 224, 226 is also the point 50.

Alternatively, a single set of nozzles could be used, injecting a mixture of steam and hydrocarbon.

15 The design shown makes effective use of much of the conventional hardware associated with riser reactors and uses it to approximate a venturi shape. Most risers have enlarged sections, but no beneficial use is made of them, and the enlargement may 20 exacerbate undesired catalyst reflux by creating a more stagnant region just downstream of each point where the riser diameter increases. This promotes growth of an annular ring of refluxing catalyst, which is trapped in the riser for a long time, cycling back 25 and forth in the riser, serving no useful function and building up coke levels.

After quenching, and a limited amount of additional cracking in the upper portion of the riser 140, cracked products and coked catalyst pass into a 30 solid-vapor separation means, such as a conventional cyclone separator, not shown. The separated coked catalyst then passes into the catalyst stripper 6, to which stripping steam is added via line 100 and steam distributor ring 102 to strip entrained hydrocarbons 35 from the coked catalyst. Cracked products are

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5 withdrawn from the reactor by conduit 8 and the stripped coked catalyst is withdrawn via conduit 10 and charged to regenerator 12. The catalyst is then regenerated by contact with an oxygen-containing gas, usually air added via line 9. Flue gas is withdrawn from the regenerator by line 11.

10 Usually the feed temperature is 150°C to 375°C (300 to 700°F), whereas the regenerator operates at 650°C to 760°C (1200 to 1400°F). Some regenerators run even hotter, such as two stage regenerators, and these may be used as well in the process of the invention. The catalyst to feed weight ratio is usually at least 4:1, preferably 4:1 to 10:1, adjusted as necessary to hold a reactor outlet temperature of
15 500° to 550°C (932° to 1020°F).

Most FCC riser reactors operate with regenerated catalyst addition set by reactor top temperature control. Addition of quench fluid reduces the riser top temperature, causing more catalyst addition to the
20 base of the riser. The net effect of quenching will be higher temperatures at the base of the riser, and more or less conventional temperatures at the top of the riser. Other control schemes may also be used, e.g., constant addition of regenerated catalyst, with
25 variable feed preheat to keep riser top temperature constant.

Cracked product from the FCC unit passes via line 8 to main fractionator 20, where product is separated into a heavy, slurry oil stream 22, heavy distillate
30 24, light distillate 26, heavy naphtha 27, light naphtha 28, and a light overhead stream 30, rich in C2-C4 olefins, C1-C4 saturates, and other light cracked gas components. Conveniently, some of the heavy naphtha fraction is withdrawn as product by

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means not shown, with the remainder recycled for use as quench.

The light cracked gas stream is usually treated in an unsaturated gas plant 35 to recover various light gas streams, including C3-C4 LPG stream in line 36, and an optionally C₂ fuel gas or the like recovered via line 32. A light, H₂ rich gas stream may be recycled from the gas plant via line 34 and lines not shown for use as all, or part, of a lift gas used to contact catalyst in the base of the riser.

Riser Cracking Conditions - Pre Quench

The conditions in the base of the riser can be more or less conventional, although the riser base temperature is preferably 6 to 30°C (10 to 50°F) higher than that conventionally used in FCC riser cracking. Typically, the riser base temperature is 510 to 620°C (950 - 1150°F), preferably 540 to 590°C (1000 - 1100°F).

The use of a high riser base temperature, which is typically achieved by using a high catalyst/oil ratio of at least 4:1, promotes both thermal and catalytic cracking of the feed. The high riser base temperature also reduces the tendency for acid sites of the cracking catalyst to be neutralized by basic nitrogen compounds. The higher temperatures of the cracking catalyst are sufficient to desorb, or prevent adsorption of, at least a portion of the basic nitrogen compounds in the feed.

Quench

It is important that quenching does not occur too quickly after mixing of the regenerated catalyst and the feedstock. Quenching preferably occurs only after the catalyst loses most of its initial activity due to coke formation. Catalytic cracking predominates in the base of the riser, due to the extremely active

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5 catalyst and high temperature. The catalyst deactivates rapidly and, after quenching, all reactions, both thermal and catalytic, are reduced in the upper portions of the riser. The activation energy for coking reactions is lower than that for catalytic cracking reactions. Therefore, the rate of catalytic cracking reactions is enhanced relative to coking reactions in the lower portion of the riser.

10 Thus delaying quenching leads to an improvement in selectivity as well as an increase in severity. This is apparent from Figure 2, which shows that the gasoline yield is increased if the quench is arranged to occur after at least a second of vapor residence time in the base of the riser, and preferably after 15 1.5 seconds of residence time, and most preferably after 2.0 seconds of residence time.

It is, however, also important that quench occurs well before the riser outlet so that the initial thermal and catalytic cracking at severe conditions is 20 followed by additional cracking at or below conventional riser cracking conditions. Quenching at or too near the outlet of the riser, say within 1/2 second of the riser outlet, will not achieve the desired result; essentially all of the cracking in the 25 reactor will be at the overly severe conditions. This will overcrack the gasoline, and reduce gasoline yield.

30 Rather than refer to vapor residence time, which varies greatly from unit to unit and is difficult to calculate, quenching at the following fractional riser locations may be considered. In general for riser operating with a vapor residence time of 4 seconds or more, quenching should occur more than 1/4 way up the riser, preferably more than 1/3 up the riser, and even 35 more preferably 1/2 way up the riser. In many units,

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quenching about 50 - 80% of the way up the riser, or even later, will be optimum.

Any conventional quench fluid, such as cold solids, water, steam, or inert vaporizable liquids, such as cycle oils and slurry oils, or other aromatic rich streams, may be used. Preferably liquids are used so that more heat can be removed from a given weight of fluid added. Use of a reactive quench liquid, which promotes endothermic reactions, may be preferred in some circumstances. The preferred quench fluids are water, steam, recycled heavy naphtha or light cycle oil (LCO) and mixtures thereof.

The amount of quench, assuming perfect mixing of quench with material in the riser, at the point of quench injection, should be sufficient to reduce riser temperature by at least 3°C (5°F), and preferably by 5 to 55°C (9 to 100°F), and most preferably by 10 to 50°F (6 to 30°C). The optimum amount of quench will vary with the quench point in the riser.

The present invention can be used especially well in refineries where bottlenecks in downstream processing equipment limit the amount of quench. One examples of such a bottleneck is the main column, where flooding can occur from too much heavy naphtha recycle. Another type of bottleneck occurs if the plant cannot tolerate large amounts of steam or sour water from use of water quench. For these units use of 20 to 80% of the "conventional" amount of quench, added much later in the riser, will give gasoline yields similar to those achieved with large amounts of quench near the base of the riser.

For FCC units with no restrictions on quench amount, it will be possible to significantly increase gasoline yields by using conventional amounts of quench and adding it later to the riser.

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Quench Fluid Ejectors

5 Quench adds extra fluid to the riser, but the resultant increase in riser pressure can be limited by using aspirating nozzles, which function as steam-jet ejectors or eductors near the top of the riser.

Steam-jet ejectors are a simplified type of vacuum pump or compressor with no moving parts. They are commonly used in refineries and extensively discussed in Perry's Chemical Engineer's Handbook,
10 Sixth Edition, Sections 6-31 to 6-35.

Quench nozzles, especially when injecting steam or a steam/water mixture, can lift or drive the riser contents toward the outlet much as steam jet ejectors. For maximum effect, it is preferable to use a design
15 similar to that of Fig. 6-71, Booster Ejector with multiple steam nozzles, and a venturi throat.

By using multiple quench nozzles, at least 6 or 8 radially distributed nozzles having outlets near the vertical walls of the riser reactor, it is possible to
20 remove significant amounts of spent catalyst, which tends to collect as an annular ring near the walls of the riser and reduce the effective internal diameter of the riser.

A venturi throat can be formed by pointing the
25 nozzles, or each layer of nozzles if 2 or more rings of nozzles are used, at a converging point 0.5 to 2.5 riser diameters downstream of the nozzles.

A mechanical approximation of a venturi section can be achieved by placing the nozzles at, or just
30 below or even slightly above, a location in the riser where the riser diameter increases. This uses the conventional riser configuration, with an increased diameter to allow for molar expansion, to approximate a venturi or at least the expansion section of the
35 venturi.

For a vertical riser reactor, the quench nozzles should be aimed at a point on a centerline of the vertical riser reactor, at an angle ranging from 30 to approaching 90° from horizontal, and preferably at an angle ranging from 45 to 80° from horizontal.

Alternatively, one or preferably a plurality of quench nozzles pointing downstream to the riser outlet may be used to quench and simultaneously achieve some eduction effect.

Preferably the quench fluid is steam or a vaporizable liquid added via atomizing feed nozzles added in a way so that the maximum eductor effect is achieved. The simplest way to implement this is to point the nozzles in a downstream direction relative to fluid flow in said riser. This will usually not be the quickest way to quench the fluid in the riser, perpendicular or countercurrent injection of quench fluid would probably be most effective from an instantaneous quench standpoint. However, cross-flow, or countercurrent, quench injection, will also increase riser pressure which tends to lower gasoline yields.

Aspirating or educting quench works especially well when relatively high nozzle exit velocities are used, preferably in excess of 30m/sec (100 fps), and most preferably in excess of 61 m/sec (200 fps). This allows some useful work to be performed by the quench fluid, in reducing overall riser pressure, riser pressure drop, and catalyst residence time.

Riser Top Temperature

Although conditions at the base of the riser are more severe than those associated with conventional FCC operations, the FCC unit at the top of the riser, and downstream of the riser, can and preferably does operate conventionally. When processing large amounts

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of resids, especially those which contain large amounts of reactive material which readily forms coke in process vessels and transfer lines, it may be preferable to operate with conventional or even
5 somewhat lower than normal riser top temperatures. Riser top temperatures of 510 to 565°C (950 - 1050°F) will be satisfactory in many instances.

Catalyst

10 Conventional FCC catalyst, i.e., the sort of equilibrium catalyst that is present in most FCC units, can be used herein. Highly active catalysts, with high zeolite contents, are preferred.

15 In many instances it will be beneficial to use one or more additive catalysts, which may either be incorporated into the conventional FCC catalyst, added to the circulating inventory in the form of separate particles of additive, or added so that the additive does not circulate with the FCC catalyst.

20 ZSM-5 is a preferred additive, whether used as part of the conventional FCC catalyst or as a separate additive.

SOx capture additives, available commercially, may be used to reduce the level of SOx in the regenerator flue gas. CO combustion additives,
25 usually Pt on a support, are used by most refiners to promote CO combustion in the FCC regenerator.

Feed Composition

30 The present invention is applicable for use with all FCC feeds. The process can be used with distilled feeds, such as gas oils or vacuum gas oils, or heavier feeds such as resids or vacuum resids. Preferred feeds contain at least 10 wt % material boiling above 500°C, and preferably contain 20, 25, 30% or more of such high boiling material.

5 A mixture of resid, and conventional FCC recycle streams, such as light cycle oil, heavy cycle oil, or slurry oil, can also be used. In this instance, the FCC recycle stream acts primarily as a diluent or cutter stock whose primary purpose is to thin the resid feed to make it easier to pump and to disperse into the base of the riser reactor.

EXAMPLE

10 Several computer simulations were run to test the effect in riser cracking of a sour gas oil of adding varying amounts of naphtha quench liquid at various points in the riser.

15 Such computer models are frequently used to predict FCC operation in commercial refineries and are believed to be a reliable predictor of plant performance. The model is also more flexible and more consistent than a single test.

20 The basis for the simulations was a commercial scale FCC riser reactor having a throughput of $12700\text{m}^3/\text{day}$ (80,000 BPD) and having an initial diameter of 1.1m (3.5 feet), expanding to 2.3m (7.5 feet) at the riser outlet, and an overall length of 47m (155 feet). The total vapor residence time in the riser reactor was 4 seconds.

25 Feed properties of the sour gas oil and heavy naphtha were:

	<u>Fresh Feed</u>	<u>Heavy Naphtha Quench</u>
API	22.5	19.4
Basic N wt ppm	425	50
Total N, wt ppm	1275	150
5 UOP K	11.6	
Analine Pt	165°F(74°C)	
Sulfur, wt %	2.04	
D1160 DISTILLATION		
10%	590°F(310°C)	400°F(204°C)
10 50%	760°F(404°C)	450°F(232°C)
90%	965°F (518°C)	495°F(257°C)

The results are shown in the following table and are plotted in Figure 2.

	<u>Quench Time</u>	<u>wt % Heavy</u>	<u>Quench</u>	<u>Gasoline</u>	<u>Yields:</u>
15	<u>(seconds)</u>	<u>Naphtha</u>	<u>delta T</u>	<u>WT %</u>	<u>LV %</u>
	NONE	-	°F(°C)	45.8	55.5
	0.2 s	15	17°(9°)	47.1	57.0
	0.5 s	15	17°(9°)	47.2	57.1
	2.2 s	15	17°(9°)	47.6	57.7
20	2.2 s	12	14°(8°)	47.3	57.3
	2.2 s	10	12°(7°)	47.1	57.0
	2.2 s	8	10°(6°)	46.9	56.8
	2.2 s	5	6°(3°)	46.5	56.3

The model calculations show that for relatively large amounts of quench, 15.0 wt % heavy naphtha, the optimum quench location was at 2.2 seconds of residence time in the riser.

The model calculations also show that use of 10.0 wt % heavy naphtha quench, at 2.2 seconds of residence

time, was equivalent to use of 50% more quench within 0.2 seconds of residence time. Clearly this would put less load on the air blower and main column.

Use of only modest amounts of quench, e.g., just 5 wt %, past the mid point of the riser, significantly improves gasoline yields over the base case but adds much less heavy naphtha, to much less of the riser, as compared to the prior art practice of adding quench near the base of the riser.

Accordingly, the process of the present invention gives refiners great flexibility in improving the operation of their FCC units. Units able to tolerate large amounts of quench fluid can significantly increase conversion and improve yield of gasoline. Units which are constrained by their ability to tolerate quench may, by delayed quenching, achieve the higher conversions characteristic of quenching with larger amounts of quench within one second of riser vapor residence time.

Addition of large amounts of a vaporizable quench fluid, more than halfway through the riser, will also improve the cracking process by providing a substantial increase in superficial vapor velocity at the point of injection. The increased vapor velocity will reduce catalyst slip, and promote rapid removal of both spent catalyst and cracked products from the riser. Near the end of the riser, e.g., about 3/4 of the way through the cracking reactor, the catalyst has little activity, and functions more as a coke sink than as catalyst.

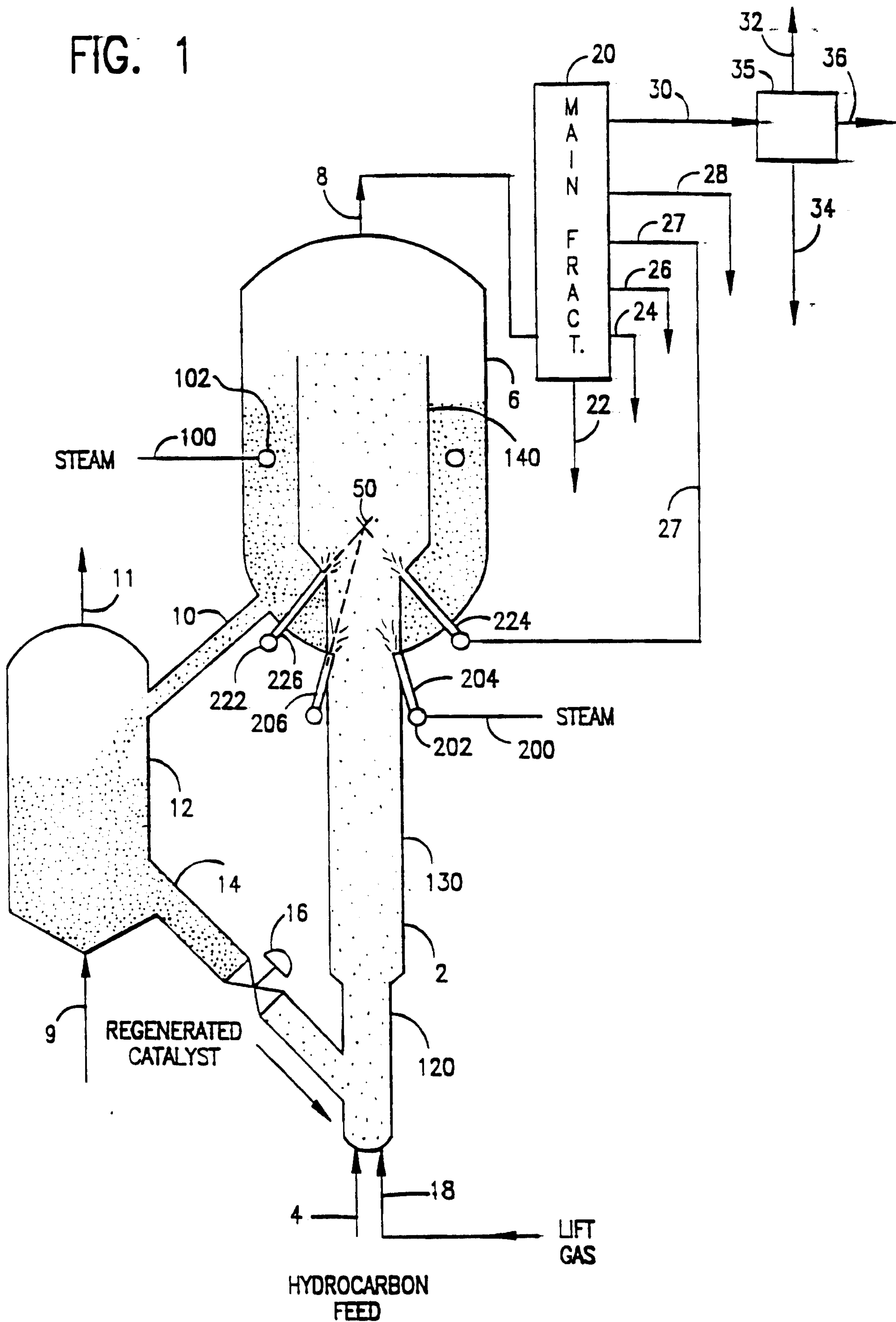
CLAIMS:

1. A process for catalytically cracking a heavy hydrocarbon feedstock by contacting the feedstock in a vertical riser reactor with a source of hot, regenerated cracking catalyst to produce catalytically cracked vapors and spent cracking catalyst, the cracked vapors being withdrawn and the spent cracking catalyst being regenerated to produce hot regenerated cracking catalyst which is recycled to contact said heavy feed, wherein the heavy hydrocarbon feedstock is mixed with the hot regenerated cracking catalyst adjacent the base of the reactor and, as the mixture flows up the riser, is thermally and catalytically cracked by the catalyst for a vapor residence time of at least 1.5 seconds and for at least the first 50 % of the length of the riser reactor from the base, and wherein the mixture is then quenched in a quench zone located within the first 50-80 % of the length of the riser reactor from the base by injection of a quench fluid in an amount sufficient to lower the temperature in the riser at least 3°C.
2. The process of claim 1 wherein the heavy hydrocarbon feedstock contains at least 10 wt% hydrocarbons boiling above 500°C.
3. The process of claim 1 wherein the heavy hydrocarbon feedstock is mixed with the hot regenerated cracking catalyst at a catalyst:feed weight ratio of a least 4:1.

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4. The process of claim 1 wherein the quench fluid is selected from water, steam, recycled catalytically cracked products, and mixtures thereof.
- 5 5. The process of claim 1 wherein the quench fluid is added in an amount sufficient to quench the mixture in the riser by 4 to 56°C.
6. The process of claim 1 wherein the quench fluid is added after at least 2.0 seconds of vapor residence time.
10
7. The process of claim 1 wherein the quench fluid is added 50 - 80% along the length of the riser from the base.
8. The process of claim 1 wherein the inert quench fluid is water or steam added in an amount equal to 5 to 15 wt % of the hydrocarbon feed.
15
9. The process of claim 1 wherein said quench fluid is steam or a vaporizable liquid added under pressure via atomizing quench nozzles pointing toward the centerline of said riser and in a downstream direction relative to fluid flow in said riser, and said nozzles have a nozzle discharge velocity of at least 30 m/sec.
20
10. The process of claim 1 wherein the temperature at the base of the riser is 540 to 590°C.
25

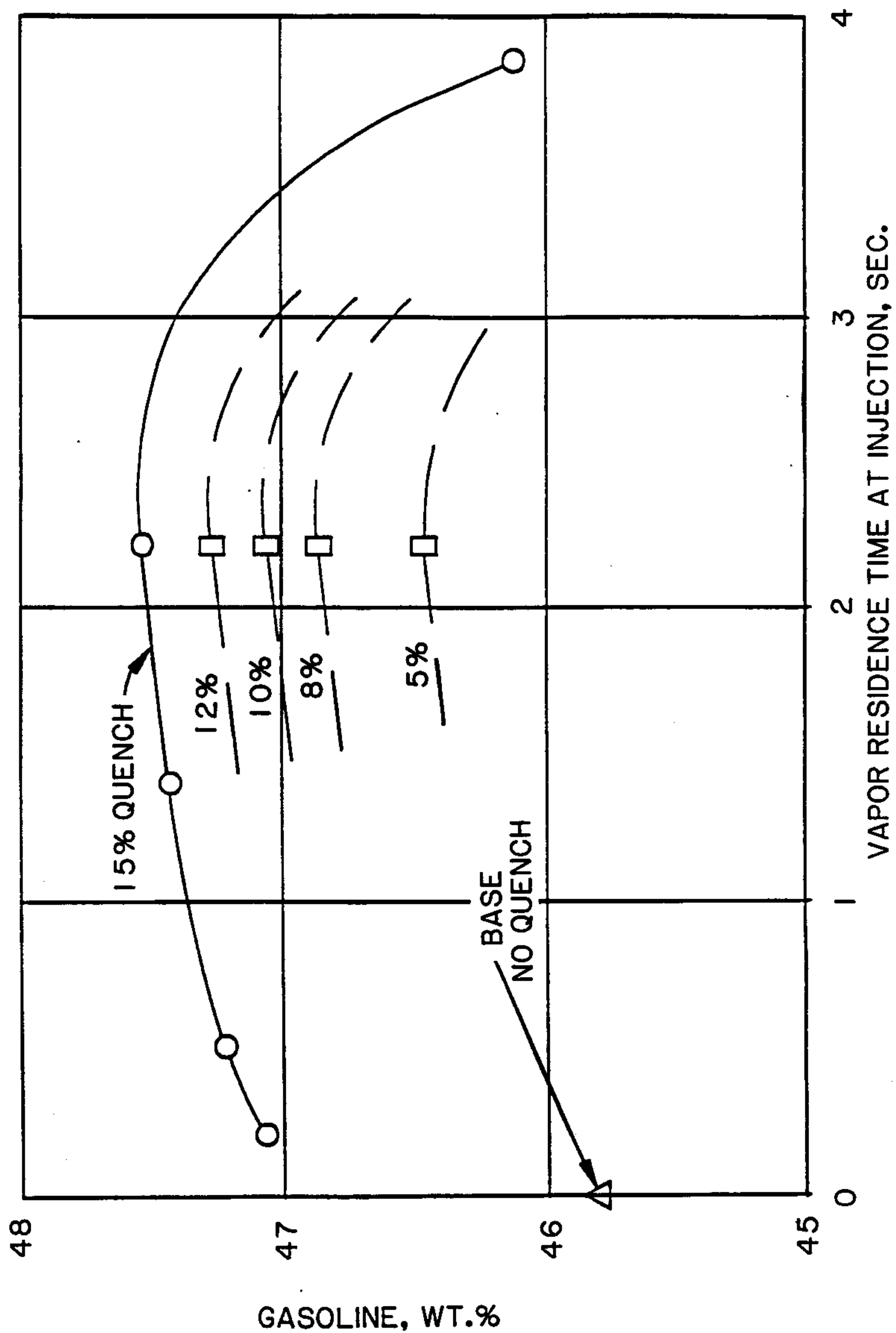
FIG. 1



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FIG. 2



GASOLINE, WT.%

VAPOR RESIDENCE TIME AT INJECTION, SEC.

SUBSTITUTE SHEET

