# C L A I M S

1. A process for upgrading refinery residue feedstock, said process comprising the steps of:

a) introducing the refinery residue feedstock into a fluidized bed reactor as a solid, the refinery residue feedstock selected from asphalt, vacuum residue, coke from a gasifier, residue from an ethylene cracker, and petroleum coke obtained from a delayed coker unit;

b) heating the refinery residue feedstock to a devolatilizing and thermal cracking temperature in the fluidized bed reactor to produce a product stream comprising gaseous hydrocarbons and solid coke;

c) subjecting the gaseous hydrocarbons to catalytic hydroprocessing in the presence of molecular hydrogen in the fluidized bed to increase the hydrogen to carbon ratio and lower the average molecular weight of the gaseous hydrocarbons;

d) separating the gaseous hydrocarbons from step c) from the solid coke from step b) to produce a gaseous product stream and a solid coke product stream; and

e) subjecting the gaseous hydrocarbons from step d) to further processing to produce at least one of: C1-C3 hydrocarbons, liquefied petroleum gas, naphtha range hydrocarbons, and middle distillate range hydrocarbons, wherein the further processing consists of at least one of: condensation of gaseous hydrocarbon and distillation, hydroprocessing of condensed hydrocarbons in a hydroprocessing unit, and fluid catalytic cracking of condensed hydrocarbons in a fluid cracking unit.

2. The process of Claim 1, wherein the fluidized bed reactor in step b) is a bubbling fluidized bed reactor

and wherein at least a portion of the catalytic hydroprocessing in step c) is carried out in the bubbling fluidized bed reactor.

3. The process of claim 2, wherein at least a portion of the catalytic hydroprocessing in step c) is carried out in a fixed bed reactor following step d).

4. The process of Claim 1, wherein the fluidized bed reactor in step b) is a bubbling fluidized bed reactor comprising a catalytically inert heat transfer material and wherein catalytic hydroprocessing in step c) is carried out in a fixed bed reactor following step d).

5.3. The process of Claim 1, wherein the fluidized bed reactor in step b) is an entrained fluidized bed reactor comprising the solid refinery residue feedstock and the solid coke entrained in a stream of gas containing molecular hydrogen.

6.4. The process of Claim 1, wherein the fluidized bed reactor of step a) operates at a total pressure of from 2 barg to 100 barg and the devolatilizing temperature in step b) is from 300°C to 600°C.

7.5. The process of claim 2, wherein the weight-hourly space velocity of the refinery residue feedstock is from 0.05 to 25 kilograms of feedstock per kilogram of catalyst per hour in the bubbling fluidized bed.

8. The process of Claim 3, wherein step c) is carried out in a the fixed bed reactor at a temperature of from 150°C to 600°C, a total pressure of from 2 barg to 100 barg, and a weight-hourly space velocity of from 0.05 to 25 kilograms of refinery residue feedstock per kilogram of fixed bed catalyst per hour.

9.6. The process of claim 2, wherein the fluidized bed reactor comprises at least one catalyst comprising at least one active metal selected from the group consisting

of: group VB, group VIB and group VIII of the periodic table supported on metal oxide selected from: alumina, silica, titania, silica-alumina, ceria, zirconia, crystalline aluminosilicates and combinations thereof.

10. The process of Claim 3, wherein the fixed bed reactor comprises at least one catalyst comprising at least one active metal selected from the group consisting of: group VB, group VIB and group VIII of the periodic table supported on metal oxide selected from: alumina, silica, titania, silica-alumina, ceria, zirconia, crystalline aluminosilicates and combinations thereof.

11. The process of Claim 4, wherein the catalytically inert heat transfer solid is a metal oxide material without any active metal, having a total surface area of 20 $m^2/g$ or less.

12. The process of Claim 1, wherein the further processing of step c) consists of at least one of: condensation of gaseous hydrocarbon and distillation, hydroprocessing of condensed hydrocarbons in a hydroprocessing unit, and fluid catalytic cracking of condensed hydrocarbons in a fluid cracking unit.

13. A process for upgrading solid refinery residue feedstock, said process comprising the steps of:

a) introducing the refinery residue feedstock into a fluidized bed reactor as a solid;

b) heating the refinery residue feedstock to a devolatilizing and thermal cracking temperature in the fluidized bed reactor to produce a product stream comprising gaseous hydrocarbons and solid coke;

c) separating the gaseous hydrocarbons from the solid coke in step b) to produce a gaseous product stream and a solid coke product stream; and

d) combusting at least part of the gaseous hydrocarbons

from step c) to generate energy.

14. The process of Claim 13, wherein the fluidized bed reactor in step b) is a bubbling fluidized bed reactor comprising a catalytically inert heat transfer material fluidized in a stream of gas having an oxygen concentration below the minimum oxygen concentration needed to sustain combustion of the gaseous hydrocarbons or the solid coke in step b).

15. The process of Claim 13, wherein the fluidized bed reactor in step b) is an entrained fluidized bed reactor comprising the solid refinery residue feedstock and the solid coke entrained in a stream of gas having an oxygen concentration below the minimum oxygen concentration needed to sustain combustion of the gaseous hydrocarbon or the solid coke in the fluidized bed reactor in step b).

16. The process of Claim 14, wherein the catalytically inert heat transfer solid is a metal oxide material without any active metal, having a total surface area of 20 $m^2/g$ or less.