CLAIMS

1. Process for producing fuel oil having a sulfur content of less than or equal to 0.5% by weight, a sediment content of less than or equal to 0.1% by weight, and a viscosity between 1 cSt and 700 cSt at 50°C, by treating a hydrocarbon feedstock having a sulfur content of at least 0.5% by weight, an initial boiling point of at least 340°C and a final boiling point of at least 440°C, which makes it possible to obtain at least one liquid hydrocarbon fraction with a sulfur content of less than or equal to 0.5% by weight, comprising the following successive steps:

a) a step of fixed-bed hydrotreatment, wherein the hydrocarbon feedstock and hydrogen are placed in contact over at least one hydrotreatment catalyst,

b) a step of separation of the effluent obtained from the hydrotreatment step (a) into at least one light fraction and at least one heavy fraction,

c) a step of hydroconversion of at least part of the heavy fraction of the effluent derived from step (b) in at least one ebullated-bed reactor containing a supported catalyst, and

d) a step of separation of the effluent derived from step (c) to obtain at least one gaseous fraction and at least the said liquid hydrocarbon fraction.

2. Process according to Claim 1, wherein the hydrotreatment step (a) comprises a first step (a1) of hydrodemetallation (HDM) performed in one or more fixed-bed hydrodemetallation zones and a subsequent second step (a2) of hydrodesulfurization (HDS) performed in one or more fixed-bed hydrodesulfurization zones.

3. Process according to either of Claims 1 and 2, wherein the hydrotreatment step (a) is performed at a temperature of between 300°C and 500°C, at an absolute pressure of between 2 MPa and 35 MPa, with an hourly space velocity of the hydrocarbon feedstock which is within a range from 0.1 h^{-1} to 5 h^{-1}, and the amount of hydrogen mixed with the feedstock is between 100 Nm^3/m^3 and 5000 Nm^3/m^3.

4. Process according to any one of Claims 1 to 3, wherein the hydroconversion step (c) is performed at an absolute pressure of between 2.5 MPa and 35 MPa, at a temperature of between 330°C and 550°C, with an hourly space velocity which is in a range from

0.1 h^{-1} to 10 h^{-1}, and the amount of hydrogen mixed with the feedstock is from 50 Nm^3/m^3 to 5000 Nm^3/m^3.

5. Process according to any one of Claims 1 to 4, wherein the hydrotreatment step (a) is performed in one or more fixed-bed hydrotreatment zones preceded by at least two hydrotreatment guard zones which are also in fixed beds, arranged in series so as to be used in a cyclic manner consisting of the successive repetition of steps a'') and a''') defined below:

a') a step wherein the guard zones are all used together for a duration that is at most equal to the deactivation and/or clogging time for one of them,

a'') a step wherein the deactivated and/or clogged guard zone is short-circuited and the catalyst it contains is regenerated and/or replaced with fresh catalyst, and during which the other guard zone(s) are used, and

a''') a step wherein the guard zones are all used together, the guard zone whose catalyst has been regenerated and/or replaced during the preceding step being reconnected and the said step being continued for a duration at most equal to the deactivation and/or clogging time of one of the guard zones.

6. Process according to any one of Claims 1 to 5, wherein the hydrocarbon feedstock is chosen from atmospheric residues, vacuum residues obtained from direct distillation, crude petroleums, de-headed crude petroleums, deasphalted oils, deasphalting resins, deasphalting pitches or asphalts, residues obtained from conversion processes, aromatic extracts obtained from lubricant base production lines, bituminous sands or derivatives thereof, bituminous shales or derivatives thereof, parent-rock oils or derivatives thereof, taken alone or as a mixture.

7. Process according to any one of Claims 1 to 6, wherein the effluent obtained from the hydrotreatment step (a) undergoes a step (b) of separation with decompression, comprising the following steps:

- the said effluent from step (a) is sent to a fractionation section with a cutoff point of between 200°C and 400°C making it possible to obtain a light fraction and a heavy fraction,

- the said heavy fraction is fractionated by atmospheric distillation into at least one atmospheric distillate fraction, preferably containing at least one light fraction of hydrocarbons of naphtha, kerosene and/or diesel type, and an atmospheric residue fraction,

- at least part of the atmospheric residue fraction is fractionated by vacuum distillation into a vacuum distillate fraction, preferably containing vacuum gas oil, and a vacuum residue fraction, and

- at least part of the vacuum residue fraction and/or of the atmospheric residue fraction is advantageously sent to the hydroconversion step (c).

8. Process according to one of Claims 1 to 6, wherein the effluent from the hydrotreatment step (a) undergoes a step (b) of separation without decompression, comprising the following steps:

- the effluent from the hydrotreatment step (a) is sent to a fractionation section having a cutoff point of between 200 and 400°C making it possible to obtain at least one light fraction and at least one heavy fraction,

- the heavy fraction is directly sent to the hydroconversion step (c);

- the light fraction is subjected to an atmospheric distillation making it possible to obtain a gaseous fraction, at least one light fraction of liquid hydrocarbons of naphtha, kerosene and/or diesel type, and a vacuum distillate fraction, and

- the said vacuum distillate fraction is at least partly sent to the hydroconversion step (c).

9. Process according to any one of Claims 1 to 8, wherein the separation step (d) also comprises at least one atmospheric distillation, wherein the liquid hydrocarbon fraction(s) obtained after separation are fractionated by atmospheric distillation into at least one atmospheric distillate fraction and at least one atmospheric residue fraction.

10. Process according to any one of Claims 1 to 9, wherein the separation step (d) also comprises at least one vacuum distillation in which the liquid hydrocarbon fraction(s) obtained after separation and/or the atmospheric residue fraction obtained after atmospheric distillation are fractionated by vacuum distillation into at least one vacuum distillate fraction and at least one vacuum residue fraction.

11. Process according to Claim 10, wherein part of the vacuum residue fraction is recycled into the hydroconversion step (c).

12. Process according to any one of Claims 9 to 11, also comprising a step (e) of separating out sediments and fines, wherein at least part of the atmospheric residue fraction and/or vacuum distillate fraction and/or vacuum residue fraction is subjected to a separation of the catalyst fines and sediments, using at least one filter, a centrifugation system or on-line decantation.

13. Process according to any one of Claims 10 to 12, also comprising a catalytic cracking step (f), wherein at least part of the vacuum distillate fraction and/or of the vacuum residue fraction, which has optionally been subjected beforehand to the step for separating out the sediments and fines (e), is sent to a catalytic cracking section in which it is treated under conditions enabling the production of a gaseous fraction, a petroleum fraction, a diesel fraction and a residual fraction.

14. Process according to any one of Claims 9 to 13, wherein the atmospheric residue and/or the vacuum distillate and/or the vacuum residue obtained after the separation step (d), which has optionally been subjected beforehand to the step (e) for separating out the sediments and fines, are mixed with one or more flux bases chosen from the group consisting of light cycle oils from a catalytic cracking, heavy cycle oils from a catalytic cracking, the residue of a catalytic cracking, a kerosene, a gas oil, a vacuum distillate and/or a decanted oil.

15. Process according to Claim 14, wherein the said flux base is chosen from part of the light hydrocarbon fraction of kerosene or gas oil type obtained from the separation step (b), part of the heavy hydrocarbon fraction of vacuum distillate type obtained from the separation step (b), and part of the petroleum fraction, of the diesel fraction and/or of the residual fraction obtained from the catalytic cracking step (f).

16. Process according to any one of claims 1 to 15 wherein the fuel oil produced has a sulfur content of less than or equal to 0.5% by weight, preferentially less than or equal to 0.3% by weight, more preferentially less than or equal to 0.1% by weight and even more preferentially less than or equal to 0.08% by weight.

17. Process according to any one of claims 1 to 15 wherein the fuel oil produced meets the specification of standard ISO 8217:2012.