Despite recent progress in the field, there is a need for improved materials, in particular porous materials for use in guard beds for removing of impurities such as P, in particular also for feedstocks comprising a significant portion of renewables including a feedstock with 100% renewables, i.e. a 100% renewable feed.

SUMMARY

In an aspect of the present disclosure, there is provided a process for removing one or more impurities from a feedstock, said process comprising the step of contacting said feedstock with a guard bed comprising a porous material, thereby providing a purified feedstock; in which said feedstock is: a renewable source obtained from a raw material of renewable origin; or a feedstock originating from combining said renewable source and a feedstock originating from a fossil fuel;
said porous material comprising alumina,
- said alumina comprising alpha-alumina,
- said porous material comprising one or more metals selected from Co, Mo, Ni, W, and combinations thereof,
- said porous material having a BET-surface area of 1-110 m^2/g,
wherein
- the porous material has a total pore volume of 0.50-0.80 ml/g, such as 0.50-0.75 ml/g, or 0.55-0.70 ml/g, or 0.60-0.70 ml/g, as measured by mercury intrusion porosimetry, and
- the porous material has a pore size distribution (PSD) with at least 30 vol% of the total pore volume, such as at least 40 vol%, at least 50 vol%, or at least 60 vol% being in pores with a radius ≥ 400 Å suitably in pores with a radius ≥ 500 Å, such as pores with a radius up to 5000 Å.

In a further aspect of the present disclosure, there is provided a guard bed for a hydrotreatment system, said guard bed comprising a porous material;

said porous material comprising alumina,
- said alumina comprising alpha-alumina,
- said porous material comprising one or more metals selected from Co, Mo, Ni, W, and combinations thereof,
- said porous material having a BET-surface area of 1-110 m^2/g,
wherein
- the porous material has a total pore volume of 0.50-0.80 ml/g, such as 0.50-0.75 ml/g, or 0.55-0.70 ml/g, or 0.60-0.70 ml/g, as measured by mercury intrusion porosimetry, and
- the porous material has a pore size distribution (PSD) with at least 30 vol% of the total pore volume, such as at least 40 vol%, at least 50 vol%, or at least 60 vol% being in pores with a radius ≥ 400 Å suitably in pores with a radius ≥ 500 Å, such as pores with a radius up to 5000 Å.

In another aspect of the present disclosure, there is provided a hydrotreatment system for hydrotreating a feedstock, said hydrotreatment system comprising:
a guard bed comprising a porous material; and a hydrotreatment section comprising at least one hydrotreatment catalyst, arranged downstream of said guard bed;
said porous material comprising alumina,
- said alumina comprising alpha-alumina,
- said porous material comprising one or more metals selected from Co, Mo, Ni, W, and combinations thereof,
- said porous material having a BET-surface area of 1-110 m^2/g,
wherein
- the porous material has a total pore volume of 0.50-0.80 ml/g, such as 0.50-0.75 ml/g, or 0.55-0.70 ml/g, or 0.60-0.70 ml/g, as measured by mercury intrusion porosimetry, and
- the porous material has a pore size distribution (PSD) with at least 30 vol% of the total pore volume, such as at least 40 vol%, at least 50 vol%, or at least 60 vol% being in pores with a radius ≥ 400 Å suitably in pores with a radius ≥ 500 Å, such as pores with a radius up to 5000 Å.

In a further aspect of the present disclosure, there is provided a use of a porous material as a phosphorus guard in a hydrotreatment process;
said porous material comprising alumina,
- said alumina comprising alpha-alumina,
- said porous material comprising one or more metals selected from Co, Mo, Ni, W, and combinations thereof,
- said porous material having a BET-surface area of 1-110 m^2/g,
wherein
- the porous material has a total pore volume of 0.50-0.80 ml/g, such as 0.50-0.75 ml/g, or 0.55-0.70 ml/g, or 0.60-0.70 ml/g, as measured by mercury intrusion porosimetry, and
- the porous material has a pore size distribution (PSD) with at least 30 vol% of the total pore volume, such as at least 40 vol%, at least 50 vol%, or at least 60 vol% being in pores with a radius ≥ 400 Å suitably in pores with a radius ≥ 500 Å, such as pores with a radius up to 5000 Å.

It is an object of the present disclosure to provide a material comprising one or more metals with hydrotreating activity that is capable of capturing impurities, particularly P, in hydrocarbon feedstocks, and which minimize coking during operation.

It is another object of the present disclosure to provide a material with a higher P penetration and thereby improved P-capture than conventional materials.

It is a further object of the present disclosure to provide a material with high capacity for capturing impurities, particularly P, in a feedstock originating from a renewable source, or a feedstock combining a renewable source and a fossil fuel.

These and other objects are solved by the present disclosure.

Accordingly, in a first example the disclosure is a porous material, in particular a porous material for removing one or more impurities from a feedstock, comprising alumina,
- said alumina comprising alpha-alumina,
- said porous material comprising one or more metals selected from Co, Mo, Ni, W, and combinations thereof,

- said porous material having a BET-surface area of 1-110 m^2/g,

wherein,

- the porous material has a total pore volume of 0.50-0.80 ml/g, such as 0.50-0.750 ml/g, or 0.55-0.70 ml/g, or 0.60-0.7 ml/g (600-700 ml/kg), as measured by mercury intrusion porosimetry,

and

- the porous material has a pore size distribution (PSD) with at least 30 vol% of the total pore volume, such as at least 40 vol%, at least 50 vol%, or at least 60 vol% being

CLAIMS

1. A process for removing one or more impurities from a feedstock, said process comprising the step of contacting said feedstock with a guard bed comprising a porous material, thereby providing a purified feedstock; in which said feedstock is: a renewable source obtained from a raw material of renewable origin; or a feedstock originating from combining said renewable source and a feedstock originating from a fossil fuel; said porous material comprising alumina,
- said alumina comprising alpha-alumina,
- said porous material comprising one or more metals selected from Co, Mo, Ni, W, and combinations thereof,
- said porous material having a BET-surface area of 1-110 m^2/g,
wherein
- the porous material has a total pore volume of 0.50-0.80 ml/g, such as 0.50-0.75 ml/g, or 0.55-0.70 ml/g, or 0.60-0.70 ml/g, as measured by mercury intrusion porosimetry, and
- the porous material has a pore size distribution (PSD) with at least 30 vol% of the total pore volume, such as at least 40 vol%, at least 50 vol%, or at least 60 vol% being in pores with a radius ≥ 400 Å suitably in pores with a radius ≥ 500 Å, such as pores with a radius up to 5000 Å.

2. The process according to claim 1, the porous material with up to 60 vol% of the total pore volume, such as up to 40 vol% of the total pore volume being in pores with a radius below 400 Å, such as pores with a radius down to 40 Å, or down to 80 Å.

3. The process according to any of claims 1-2, wherein the content of alpha-alumina in the porous material is 50-100 wt%.

4. The process according to any of claims 1-3, the alumina in the porous material further comprising theta-alumina and optionally gamma-alumina.

5. The process according to any of claims 1-4, wherein the content of the one or more metals in the porous material is 0.25-20 wt%.

6. The process according to any of claims 1-5, wherein the porous material further comprises a compound selected from Al-borates, calcium aluminates, silicon aluminates, and combinations thereof.

7. The process according to any of claims 1-6, wherein the one or more metals in the porous material comprise Mo and its content is 0.5-15 wt%, such as 0.5-10 wt%, or 0.5-5 wt%, or 0.5-3 wt%, or 0.5-1.5 wt%.

8. The process according to claim 7, wherein the porous material further comprises 0.1-5 wt% of at least one of Ni, Co, and W.

9. The process according to claim 8, wherein the porous material further comprises 0.05-0.5 wt% of Ni, optionally also the porous material not comprising one or more metals selected from Co, W i.e. the porous material is free of Co and/or W.

10. The process according to any of claims 1-9, wherein the BET-surface area of the porous material is 1-70 m^2/g, such as 1-60 m^2/g, or 1-30 m^2/g such as 10-30 m^2/g e.g. 15-25 m^2/g.

11. The process according to any of claims 1-10, wherein the porous material is an extruded or tabletized pellet having a shape selected from trilobal, tetralobal, pentalobal, cylindrical, spherical, hollow such as hollow rings or hollow cylinders, and combinations thereof.

12. The process according to any of claims 1-11, wherein the one or more impurities are selected from a vanadium-containing impurity, silicon-containing impurity, a halide-containing impurity, an iron-containing impurity, a phosphorous-containing impurity, and combinations thereof.

13. The process according to any of claims 1-12, wherein the process is carried out, at high temperature such as 100-400°C, optionally in the presence of a reducing agent such as hydrogen.

14. The process according to any of claims 1-13,

wherein
said renewable source obtained from a raw material of renewable origin is a feedstock originating from plants, algae, animals, fish, vegetable oil refining, domestic waste, waste rich in plastic, industrial organic waste like tall oil or black liquor, or a feedstock derived from one or more oxygenates taken from the group consisting of triglycerides, fatty acids, resin acids, ketones, aldehydes or alcohols where said oxygenates originate from one or more of a biological source, a gasification process, a pyrolysis process, Fischer-Tropsch synthesis, or methanol based synthesis;
or
wherein said feedstock originating from a fossil fuel is diesel, kerosene, naphtha, vacuum gas oil (VGO), spent lube oil, or combinations thereof.

15. The process according to claim 14, wherein the portion of the feedstock originating from a renewable source is 5-60 wt%, such as 10 or 50 wt%.

16. The process according to any of claims 12-15, wherein the one or more impurities is a phosphorous (P)-containing impurity and said feedstock contains 0.5-1000 ppm P.

17. The process according to any of claims 1-16, wherein the purified feedstock is subsequently processed in a hydrotreatment stage in the presence of a hydrotreatment catalyst.

18. A guard bed for a hydrotreatment system, said guard bed comprising a porous material;
said porous material comprising alumina,
- said alumina comprising alpha-alumina,
- said porous material comprising one or more metals selected from Co, Mo, Ni, W, and combinations thereof,
- said porous material having a BET-surface area of 1-110 m^2/g,
wherein
- the porous material has a total pore volume of 0.50-0.80 ml/g, such as 0.50-0.75 ml/g, or 0.55-0.70 ml/g, or 0.60-0.70 ml/g, as measured by mercury intrusion porosimetry, and

- the porous material has a pore size distribution (PSD) with at least 30 vol% of the total pore volume, such as at least 40 vol%, at least 50 vol%, or at least 60 vol% being in pores with a radius ≥ 400 Å suitably in pores with a radius ≥ 500 Å, such as pores with a radius up to 5000 Å.

19. A hydrotreatment system for hydrotreating a feedstock, said hydrotreatment system comprising:
a guard bed comprising a porous material; and
a hydrotreatment section comprising at least one hydrotreatment catalyst, arranged downstream of said guard bed;
said porous material comprising alumina,
- said alumina comprising alpha-alumina,
- said porous material comprising one or more metals selected from Co, Mo, Ni, W, and combinations thereof,
- said porous material having a BET-surface area of 1-110 m^2/g,
wherein
- the porous material has a total pore volume of 0.50-0.80 ml/g, such as 0.50-0.75 ml/g, or 0.55-0.70 ml/g, or 0.60-0.70 ml/g, as measured by mercury intrusion porosimetry, and
- the porous material has a pore size distribution (PSD) with at least 30 vol% of the total pore volume, such as at least 40 vol%, at least 50 vol%, or at least 60 vol% being in pores with a radius ≥ 400 Å suitably in pores with a radius ≥ 500 Å, such as pores with a radius up to 5000 Å.

20. The use of a porous material as a phosphorus guard in a hydrotreatment process;
said porous material comprising alumina,
- said alumina comprising alpha-alumina,
- said porous material comprising one or more metals selected from Co, Mo, Ni, W, and combinations thereof,
- said porous material having a BET-surface area of 1-110 m^2/g,
wherein
- the porous material has a total pore volume of 0.50-0.80 ml/g, such as 0.50-0.75 ml/g, or 0.55-0.70 ml/g, or 0.60-0.70 ml/g, as measured by mercury intrusion porosimetry, and

- the porous material has a pore size distribution (PSD) with at least 30 vol% of the total pore volume, such as at least 40 vol%, at least 50 vol%, or at least 60 vol% being in pores with a radius ≥ 400 Å suitably in pores with a radius ≥ 500 Å, such as pores with a radius up to 5000 Å.