In an aspect, there is provided a hybrid iron nanoparticle catalyst consisting of:

i) 30 to 70 wt. % of nanoparticles in oxide form comprising iron, at least one metal M selected from the group consisting of alkali metals, alkaline earth metals, transition metals of groups 3 to 7 or 9 to 11 of the Periodic Table of Elements, lanthanides, and combinations of M thereof, and a halogen; and

ii) 70 to 30 wt. % of an aluminosilicate or silicoaluminophosphate zeolite, based on the total weight of the catalyst,

wherein said nanoparticle has a diameter of 2 to 50 nm, and the total wt.% of the nanoparticles and zeolite is 100 wt.%.

Advantageously, the presently described hybrid iron nanoparticle catalyst may demonstrate improved activity over the Fischer Tropsch iron catalysts known in the art. High selectivity and

Claims

1. A hybrid iron nanoparticle catalyst consisting of:
   i) 30 to 70 wt. % of nanoparticles in oxide form comprising iron, at least one metal M selected from the group consisting of alkali metals, alkaline earth metals, transition metals of groups 3 to 7 or 9 to 11 of the Periodic Table of Elements, lanthanides, and combinations of M thereof, and a halogen; and

   ii) 70 to 30 wt. % of an aluminosilicate or silicoaluminophosphate zeolite, based on the total weight of the catalyst,

   wherein said nanoparticle has a diameter of 2 to 50 nm, and the total wt.% of the nanoparticles and zeolite is 100 wt.%.

2. The catalyst of claim 1, wherein said metal M is the alkali metal.

3. The catalyst of claim 1, wherein said metal M comprises 10 to 50 wt. % based on the weight of the iron nanoparticle.

4. The catalyst of any of the preceding claims, wherein the nanoparticles adopt a spinel crystalline phase, or a spinel crystalline phase having the formula FeM_2O_4.

5. The catalyst of any of the preceding claims, wherein the zeolite is an aluminosilicate zeolite, a pentasil zeolite or faujasite zeolite, or the zeolite is selected from the group consisting of zeolite X, ZSM-5, zeolite Y, ZSM-12, ZSM-22, and HY zeolite.

6. The catalyst of any of the preceding claims, wherein the mole ratio of alumina to silica in the zeolite is 1:2 to 1:90.

7. The catalyst of any of the preceding claims, wherein the zeolite is a silicoaluminophosphate zeolite, SAPO 11 or SAPO 34.

8. The catalyst of any of the preceding claims, wherein the weight ratio of the zeolite to the iron nanoparticle is 1:0.5 to 1:2.

9. The catalyst of claim 1, wherein the oxide of the halogen is present in an amount of 0.1 to 50 wt. %, based on the weight of the nanoparticles.

10. The catalyst of any of the preceding claims, wherein the iron nanoparticles further comprise a transition metal of groups 3 to 7 and 9 to 11 of the Periodic Table of Elements.

11. The catalyst of claim 10, wherein the molar ratio of iron to the transition metal is 1:1 to 50:1.

12. The catalyst of any of the preceding claims, wherein the iron nanoparticles further comprises a SiO_2 matrix.

13. A method of preparing a hybrid iron nanoparticle catalyst, the method comprising

    i) mixing an iron salt with an aqueous surfactant to form a mixture;

ii) adding a basic salt solution comprising a salt of alkali metals to the mixture of step (i) to form a precipitate;

iii) heating the precipitate of step (ii) in the presence of air and oxygen at a temperature of 300°C to 600°C; and

iv) mixing the precipitate of step (iii) with an aluminosilicate or a silicoaluminophosphate zeolite to yield a hybrid iron nanoparticle catalyst.

14. The method of claim 13, wherein said salt of the element comprises hydroxide, carbonate or bicarbonate anions.

15. The method of claim 13 or 14, wherein the molar ratio of the iron to the element of the basic salt is 1:2 to 1:25.

16. The method of any of claims 13-15, wherein the heating step is carried out for 1 to 10 hours.

17. The method of any of claims 13-16, wherein the iron salt is an iron (II) or iron (III) salt or the iron salt comprises an anion selected from the group consisting of nitrate, chloride, fluoride, bromide, iodide, phosphate, pyrophosphate and perchlorate.

18. The method of any of claims 13-17, wherein the surfactant is an ionic surfactant, or the surfactant comprises an anion selected from the group consisting of: halides, sulfonates, sulfates, phosphates and carboxylates.

19. The method of claim 17, wherein the surfactant comprises the halide anion.

20. The method of any of claims 13-19, wherein the molar ratio of iron to the surfactant is 1:0.5 to 1:15.

21. The method of any of claims 13-20, further comprising, prior to step (iii), the steps of:

collecting the precipitate; and

drying said precipitate in air.

22. The method of claim 21, wherein the collection of the precipitate is by centrifugation and/ or filtration.

23. The method of any of claims 13-22, further comprising, prior to step (ii), adding a solution of a salt of a transition metal to the mixture of step (i).

24. The method of any of the claims 13-22, further comprising:

prior to step ii), introducing a solution of a silicate to the mixture of step (i).

25. The method of claim 24, wherein the silicate comprises alkoxy groups of 2 to 15 carbon atoms.

26. The method of claim 24 or 25, wherein the molar ratio of iron to said silicate is 1:1 to 1:50.

27. The catalyst of claim 2, prepared according to the method of claim 19, or the catalyst of any of claims 10-11, prepared according to the method of claim 23, or the catalyst of claim 12, prepared according to the method of any of claims 24-26.

28. A process for the production of light olefins, the process comprising the step of:

    i) heating the catalyst of any of claims 1-12 or 27 in the presence of a gas comprising one or more oxides of carbon and hydrogen to activate said catalyst; and

    ii) contacting said activated catalyst of step (i) with a gas stream comprising one or more oxides of carbon and hydrogen to partially or fully convert said one or more oxides of carbon to said light olefins, said light olefins comprising between 2 to 4 carbon atoms,

    wherein methane is substantially absent from said light olefins, or constitutes less than 20% of said light olefins.

29. The process of claim 28, wherein the step (i) is carried out at a temperature of 200ºC–350ºC, or wherein step (ii) is carried out at a temperature of 200ºC-450ºC, or wherein step (i) is carried out at a pressure of 5-30 bar, or wherein step (ii) is carried out at a pressure of 5 to 50 bar.

30. The process of claim 28 or 29, wherein the space velocity of the gas stream in step (ii) is 1500 ml/g.h to 5000 ml/g.h.

31. The process of any of claims 28-30, wherein the molar ratio of hydrogen to the one or more oxides of carbon in the gas is 4:1 to 1:3.

32. The process of any of claims 28-31, further comprising, prior to step (i), reducing the catalyst of any of claims 1-12 or 27 by contacting said catalyst with a stream of hydrogen gas.

33. The process of any of claims 28-32, wherein the oxide of carbon in the gas stream of step (ii) is substantially carbon dioxide.