Claims

1. A method for the catalytic oxidation of a C1-C5 alkane using an oxidation catalyst comprising a photoactive material, said method comprising the steps of:
    a) activating the photoactive material by irradiating the catalyst with UV light; and
    b) contacting the activated catalyst with a gaseous feedstream comprising an amount of C1-C5 alkane at a temperature of from 150 °C to 600 °C.

2. A method according to Claim 1, wherein the photoactive material is activated in step a) in the absence of the gaseous feedstream comprising an amount of C1-C5 alkane, for example wherein activation is performed in the presence of air or under at least a partial vacuum.

3. A method according to Claim 1, wherein the photoactive material is activated in step a) in the presence of the gaseous feedstream comprising an amount of C1-C5 alkane, and preferably at a temperature of from 150 °C to 600 °C.

4. A method according to any one of Claims 1 to 3, wherein the photoactive material is irradiated intermittently or continuously with UV light during contact with the gaseous feedstream comprising an amount of C1-C5 alkane in step b).

5. A method according to any one of the preceding claims, wherein the gaseous feedstream comprises from 0.01 to 20% by volume of C1-C5 alkane, preferably from 0.1 to 10.0% by volume, more preferably from 0.5 to 5.0% by volume of C1-C5 alkane.

6. A method according to any one of the preceding claims, wherein the C1-C5 alkane is selected from C1-C3 alkanes and combinations thereof, more preferably the C1-C5 alkane is selected from methane, propane or a combination thereof, even more preferably the C1-C5 alkane is methane.

7. A method according to any one of the preceding claims, wherein the feedstream comprises from 4.0% to 20.0% by volume of water vapour, preferably from 5.0 to

15.0% by volume of water vapour, more preferably from 5.0% to 10.0% by volume of water vapour.

8. A method according to any one of the preceding claims, wherein contacting step b) is conducted at a temperature of at least 175 °C, preferably at least 200 °C, more preferably at least 225 °C, even more preferably at least 250 °C.

9. A method according to any one of the preceding claims, wherein irradiation in step a) is with UV radiation having a wavelength of from 280 to 450 nm, preferably UV radiation having a wavelength of from 375 to 395 nm.

10. A method according to any one of the preceding claims, wherein the photoactive material comprises a photoactive material selected from TiO_2, WO_3 and CoO and combinations thereof, preferably wherein the photoactive material is TiO_2.

11. A method according to any one of the preceding claims, wherein the oxidation catalyst comprises one or more metals selected from ruthenium, palladium, platinum, gold, silver, rhodium, iridium, rhenium, manganese, chromium, nickel, iron, molybdenum, tungsten, zirconium, gallium, thorium, lanthanum, cerium and mixtures thereof.

12. A method according to Claim 11, wherein the oxidation catalyst comprises at least two different metals, preferably selected from palladium, platinum, gold, silver, rhodium, iridium and rhenium, more preferably wherein the at least two different metals include palladium and platinum.

13. A method according to any one of the preceding claims, wherein the oxidation catalyst is supported with a support material, wherein the support material is in the form of a powder, granulate, pellet, extrudate, or combinations thereof.

14. A method according to Claim 13, wherein the catalyst is supported with a support material and the supported catalyst comprises from 10 to 40 % of the photoactive material by weight of the supported photocatalyst, preferably from 15 to 35 %, more preferably 20 to 30 % of the photoactive material by weight of the supported catalyst.

15. A method according to Claim 13 or Claim 14, wherein the support material is selected from silica, alumina, aluminosilicate such as zeolite, silica-alumina, ceria, titania, gallia, zirconia, magnesia, zinc oxide, activated carbon, silicon carbide, titanium carbide, fluoropolymer resins and mixtures thereof, preferably where the support material is alumina or zeolite such as ZSM-5.

16. A method according to any one of the preceding claims wherein the gaseous feedstream is an exhaust gas stream, preferably wherein the exhaust gas stream is derived from: i) an engine, such as an engine powered by natural gas and/or propane; or ii) an electric power generator or combined heat and power (CHP) generator.

17. A method according to Claim 16, wherein the engine is an internal combustion engine for an automotive vehicle, locomotive vehicle or marine vessel and steps a) and b) of the method are conducted adjacent to, or inside, the exhaust gas system of the automotive vehicle, locomotive vehicle or marine vessel.

18. A method according to any one of claims 1 to 15, wherein the gaseous feedstream is an exhaust stream from a hydrocarbon combustion process using a methane-based fuel.

19. An apparatus for use in catalytic oxidation of C1-C5 alkane present in an exhaust gas, said apparatus comprising:
    a) an oxidation catalyst configured for catalytic oxidation of C1-C5 alkane present in a exhaust gas at temperatures of up to 600 °C, wherein the catalyst comprises a photoactive material, where the apparatus is arranged to contact the exhaust gas with the oxidation catalyst at a temperature of from 150 °C to 600 °C;
    b) a UV light generating means configured for irradiation of the photoactive material; and
    c) a housing within which the oxidation catalyst is disposed and within which UV light from the UV light generating means may be transmitted, which housing is configured to receive a supply of the exhaust gas comprising C1-C5 alkane, wherein the housing is configured for fluidic attachment to a means for conveying the exhaust gas from an exhaust gas supply.

20. An apparatus according to Claim 19, wherein the means for conveying the exhaust gas is configured to connect to an engine's exhaust system, wherein the engine powers an automotive vehicle, locomotive vehicle or marine vessel and the apparatus is configured for integration adjacent to, or inside, the exhaust system of the automotive vehicle, locomotive vehicle or marine vessel.

21. An apparatus according to Claim 19 or Claim 20, wherein the housing comprises a UV light reflective interior surface, such as a metal foil or ceramic.

22. An apparatus according to any one of Claims 19 to 21, wherein the oxidation catalyst is as defined in any one of Claims 10 to 15.

23. An apparatus according to Claim 22, wherein the oxidation catalyst is applied on a monolithic structure disposed within the housing.

24. An apparatus according to any one of Claims 19 to 23, wherein the UV light generating means is configured to provide pulsed and/or continuous UV light having a wavelength of from 280 to 450 nm, preferably having a wavelength of from 375 to 395 nm.

25. An exhaust system for an internal combustion engine for powering an automotive vehicle, locomotive vehicle or marine vessel comprising an apparatus as defined in any one of Claims 19 to 24.