

Claims.

1. A process for steam reforming a hydrocarbon feedstock containing one or more nitrogen compounds, comprising passing a mixture of the hydrocarbon feedstock and steam through a catalyst bed consisting of one or more nickel steam reforming catalysts disposed within a plurality of externally heated tubes in a tubular steam reformer, wherein each tube has an inlet to which the mixture of hydrocarbon and steam is fed, an outlet from which a reformed gas containing hydrogen, carbon monoxide, carbon dioxide, steam, ammonia and methane is recovered, and the steam reforming catalyst at least at the outlet of the tubes is a structured steam reforming catalyst comprising nickel dispersed over the surface of a porous metal oxide present as a coating on a non-porous metal or ceramic structure, wherein the nickel content of the metal oxide coating is in the range of 5 to 50% by weight and the thickness of the coating is in the range of 5 to 150 micrometres.
2. A process according to claim 1, wherein the thickness of the porous metal oxide coating containing the nickel on the non-porous structure is in the range of 10 to 100 micrometres, preferably 10 to 80 micrometres, more preferably in the range 10 to 50 micrometres.
3. A process according to claim 1 or claim 2, wherein the nickel content of the metal oxide coating is in the range of 10 to 30% by weight, preferably 10 to 20% by weight.
4. A process according to any one of claims 1 to 3, wherein a platinum group metal promoter selected from platinum, palladium, rhodium or ruthenium, or a mixture thereof, is included in the coating.
5. A process according to claim 4, wherein the platinum group metal promoter is present in the coating in amounts in the range of 0.05 to 1% by weight.
6. A process according to any one of claims 1 to 5, wherein the porous metal oxide over which the nickel is dispersed is a refractory oxide, comprising alumina, titania, zirconia, zinc oxide, magnesia, ceria, praseodymium oxide, yttria, and lanthana, preferably alumina, zirconia, ceria, lanthana and mixtures of two or more thereof.
7. A process according to any one of claims 1 to 6 wherein the amount of coating on the non-porous support structure is in the range of 10 to 150 g/m<sup>2</sup>, preferably 10 to 80 g/m<sup>2</sup>, more preferably 30 to 60 g/m<sup>2</sup>.
8. A process according to any one of claims 1 to 7 wherein the structured catalyst comprises metal or ceramic structures having a plurality of passages through which a process fluid may pass in ordered, non-random directions.

9. A process according to claim 8, wherein the structured catalyst comprises cylindrical units with a diameter complimentary to the tubes in which they are placed, comprising a plurality of passages through which a process fluid may pass in ordered, non-random directions.
10. A process according to any one of claims 1 to 9 wherein the hydrocarbon feedstock comprises methane and is preferably a pre-reformed gas, an associated gas or natural gas, more preferably natural gas.
11. A process according any one of claims 1 to 10, wherein the feedstock is compressed to a pressure in the range 10-100 bar abs, preferably 15-80 bar abs, more preferably 20-50 bar abs.
12. A process according to any one of claims 1 to 11, wherein the one or more nitrogen compounds comprises nitrogen gas, N<sub>2</sub>.
13. A process according to claim 12, wherein the nitrogen gas content of the hydrocarbon feedstock is in the range of 0.1 to 25% by volume or 0.5-25% by volume, preferably 1-10% by volume, more preferably 1-5% by volume.
14. A process according to any one of claims 1 to 13, wherein the mixture of hydrocarbon feedstock and steam has a steam to carbon ratio in the range 1.8:1 to 5:1, preferably 2.5:1 to 3.5:1, more preferably 2.8:1 to 3.2:1.
15. A process according to any one of claims 1 to 14 wherein the mixture of hydrocarbon feedstock is fed to the inlets of the tubes at an inlet temperature in the range 300-650°C, preferably 450-650°C.
16. A process according to any one of claims 1 to 15, wherein the tubular steam reformer contains a plurality of tubes through which the mixture of the hydrocarbon feedstock and steam is passed, and to which heat is transferred by means of a hot gas comprising a combustion gas or a synthesis gas, flowing around the tubes.
17. A process according to any one of claims 1 to 16, wherein the catalyst bed consists of one, two, three or more layers of steam reforming catalyst wherein in each case the layer of steam reforming catalyst adjacent the outlets of the tubes is the structured catalyst.
18. A process according to claim 17, wherein there are two or more layers of steam reforming catalyst within the tubes and the structured catalyst layer comprises 95% to 5% of the volume of the bed, preferably 80% to 20% of the volume of the bed, more preferably 75% to 25% of the volume of the bed.

19. A process according to any one of claims 1 to 18, wherein the methane content of the reformed gas is less than 15% by volume on a dry gas basis, preferably less than 10% by volume on a dry gas basis, more preferably less than 5% by volume on a dry gas basis.
20. A process according to any one of claims 1 to 19, wherein the ammonia content of the reformed gas is below 200ppmv on a dry gas basis, preferably below 100ppmv, more preferably below 50ppmv, most preferably below 10ppmv on a dry gas basis.
21. A process according to any one of claims 1 to 20, wherein the process further comprises cooling the reformed gas to below the dew point to condense steam and separating the liquid condensate to form a synthesis gas from the reformed gas.
22. A process according to claim 21, wherein the ammonia content of the liquid condensate is below 400 mg/Litre, preferably below 200 mg/Litre, more preferably below 100 mg/Litre, most preferably below 50 mg/Litre, most preferably below 20mg/Litre.
23. A process according to claim 21 or claim 22, wherein at least a portion of the condensate is recycled and used to generate steam used in the steam reforming process.
24. The use of a structured steam reforming catalyst comprising nickel dispersed over the surface of a porous metal oxide, present as a coating on a non-porous metal or ceramic structure, wherein the nickel content of the metal oxide coating is in the range of 5 to 50% by weight and the thickness of the coating is in the range of 5 to 150 micrometres, for suppression of ammonia formation during catalytic steam reforming of a nitrogen containing hydrocarbon feedstock.