Claims

What is claimed is:

1. A fuel cell system, comprising:

a fuel cell;

a catalytic reactor having a sulfur oxidation catalyst including at least one Group VIII noble metal and iron; wherein the catalytic reactor is configured to contact a sulfur-containing hydrocarbon fuel and an oxidant with the sulfur oxidation catalyst; wherein the sulfur oxidation catalyst is configured to oxidize sulfur-containing compounds to form sulfur oxides; and wherein the iron concentration in the catalyst is in the range of 0.5% to 40% by weight; and

an adsorbent fluidly disposed between the catalytic reactor and the fuel cell, wherein the adsorbent is configured to adsorb the sulfur oxides,

wherein the catalytic reactor and the adsorbent are operative to remove sulfur-containing compounds from the sulfur-containing hydrocarbon fuel prior to supplying the hydrocarbon fuel to the fuel cell.

2. The fuel cell system of claim 1, wherein the iron concentration in the sulfur oxidation catalyst is in the range of 1% to 30% by weight.

3. The fuel cell system of claim 2, wherein the iron concentration in the sulfur oxidation catalyst is in the range of 2% to 10% by weight.

4. The fuel cell system of claim 3, wherein the iron concentration in the sulfur oxidation catalyst is in the range of 3% to 7% by weight.

5. The fuel cell system of claim 4, wherein the iron concentration in the sulfur oxidation catalyst is in the range of 4% to 6% by weight.

6. The fuel cell system of claim 1, wherein the at least one Group VIII noble metal concentration in the sulfur oxidation catalyst is in the range of 0.01% to 20% by weight.

7. The fuel cell system of claim 1, wherein the at least one Group VIII noble metal is platinum.

8. The fuel cell system of claim 1, further comprising a reformer, wherein the adsorbent is fluidly disposed between the catalytic reactor and the reformer.

9. A desulfurization system, comprising:

a catalytic reactor operative to oxidize sulfur-containing compounds in a feed stream having a sulfur-containing hydrocarbon fuel and an oxidant, wherein the catalytic reactor includes a sulfur oxidation catalyst having platinum as a first active metal and iron as a second active metal; wherein the iron concentration in the sulfur oxidation catalyst is in the range of 0.5% to 40% by weight; and wherein the sulfur oxidation catalyst is configured to oxidize sulfur-containing compounds to form sulfur oxides; and

a sulfur oxide trap in fluid communication with and disposed downstream of the catalytic reactor, wherein the sulfur oxide trap is configured to capture sulfur oxides from the feed stream.

10. The desulfurization system of claim 9, wherein the desulfurization system is configured to desulfurize a feed stream having an O_2/C ratio of about 0.001 to 0.3.

11. The desulfurization system of claim 10, wherein the desulfurization system is configured to desulfurize a feed stream having an O_2/C ratio of about 0.001 to 0.05.

12. The desulfurization system of claim 9, wherein the desulfurization system is configured to desulfurize a feed stream having an O_2/S ratio of at least 10.

13. The desulfurization system of claim 9, wherein the catalyst further includes promoter elements configured to promote sulfur oxidation.

14. The desulfurization system of claim 13, wherein the promoter elements include at least one element selected from Groups IIa-VIIa, Groups Ib-Vb, Lanthanide Series and Actinide Series.

15. A desulfurization system, comprising:

a catalytic reactor operative to oxidize sulfur-containing compounds in a feed stream having a sulfur-containing hydrocarbon fuel and an oxidant, wherein the catalytic

reactor includes a sulfur oxidation catalyst including platinum as a first active metal and iron as a second active metal; and wherein the sulfur oxidation catalyst is configured to oxidize sulfur-containing compounds to form sulfur oxides; and

a sulfur oxide trap in fluid communication with and disposed downstream of the catalytic reactor, wherein the sulfur oxide trap is configured to capture sulfur oxides from the feed stream,

wherein an iron concentration in the sulfur oxidation catalyst is selected to provide greater desulfurization of the sulfur-containing hydrocarbon fuel than that provided by catalysts having platinum as the only active metal and that provided by catalysts having platinum and other base metals as the active metals.

16. The desulfurization system of claim 15, wherein the iron concentration is selected to yield at least fifty percent less sulfur breakthrough downstream of the sulfur oxide trap than catalysts having platinum as the only active metal and than catalysts having platinum and other base metals as the active metals.

17. A method of operating a fuel cell system, comprising:

providing a catalytic reactor having a sulfur oxidation catalyst including at least one Group VIII noble metal and iron; wherein the catalytic reactor is configured to contact a sulfur-containing hydrocarbon fuel and an oxidant with the sulfur oxidation catalyst; wherein the sulfur oxidation catalyst is configured to oxidize sulfur-containing compounds to form sulfur oxides; and wherein the iron concentration in the catalyst is in the range of 0.5% to 40% by weight; and

providing a sulfur oxide trap configured to capture sulfur oxides;

supplying the sulfur-containing hydrocarbon fuel and the oxidant to the catalytic reactor;

contacting the sulfur-containing hydrocarbon fuel and the oxidant with the sulfur oxidation catalyst;

oxidizing sulfur-containing compounds in the hydrocarbon fuel using the oxidant and the sulfur oxidation catalyst;

capturing sulfur oxides using the sulfur oxide trap; and

providing desulfurized fuel to a component of the fuel cell system.

18. The method of claim 17, further comprising providing an adsorbent configured to adsorb the sulfur oxides.

19. The method of claim 17, wherein the component is a reformer.

20. The method of claim 17, wherein the at least one Group VIII noble metal is platinum.

CLAIMS

1. A fuel cell system, comprising:

a fuel cell;

a catalytic reactor having a high combustion activity (high oxidation activity) sulfur oxidation catalyst having platinum, and having iron configured in concentration to improve the effectiveness and durability of the sulfur oxidation catalyst in comparison to a sulfur oxidation catalyst having platinum but not having iron; wherein the catalytic reactor is configured to contact a sulfur-containing hydrocarbon fuel and an oxidant with the sulfur oxidation catalyst; wherein the sulfur oxidation catalyst is configured to oxidize organic and inorganic sulfur-containing compounds, including mercaptans, sulfides, thiophenes, hydrogen sulfide, carbonyl sulfide and carbonyl disulfide, to form sulfur oxides in the form of sulfur dioxides, sulfur trioxides and mixtures thereof; and wherein the platinum concentration in the sulfur oxidation catalyst is in the range of 0.01% to 20% by weight and the iron concentration in the catalyst is in the range of 0.5% to 40% by weight; and

an adsorbent fluidly disposed between the catalytic reactor and the fuel cell, wherein the adsorbent is configured to adsorb the sulfur oxides SO_2 and SO_3,

wherein the catalytic reactor and the adsorbent are operative to remove sulfur-containing compounds from the sulfur-containing hydrocarbon fuel prior to supplying the hydrocarbon fuel to the fuel cell; and wherein the catalytic reactor and the adsorbent are configured to desulfurize hydrocarbon fuel with an O_2/S ratio of at least 10.

2. The fuel cell system of claim 1, wherein the iron concentration in the sulfur oxidation catalyst is in the range of 1% to 30% by weight.

3. The fuel cell system of claim 2, wherein the iron concentration in the sulfur oxidation catalyst is in the range of 2% to 10% by weight.

4. The fuel cell system of claim 3, wherein the iron concentration in the sulfur oxidation catalyst is in the range of 3% to 7% by weight.

5. The fuel cell system of claim 4, wherein the iron concentration in the sulfur oxidation catalyst is in the range of 4% to 6% by weight.

6. The fuel cell system of claim 1, further comprising a reformer, wherein the adsorbent is fluidly disposed between the catalytic reactor and the reformer.

7. A desulfurization system, comprising:

a catalytic reactor operative to oxidize sulfur-containing compounds in a feed stream having a sulfur-containing hydrocarbon fuel and an oxidant, wherein the catalytic reactor includes a high combustion activity (high oxidation activity) sulfur oxidation catalyst having platinum, and having iron configured in concentration to improve the effectiveness and durability of the sulfur oxidation catalyst in comparison to a sulfur oxidation catalyst having platinum but not having iron; wherein the platinum concentration in the sulfur oxidation catalyst in the range of 0.01% to 20% by weight, and the iron concentration in the sulfur oxidation catalyst is in the range of 0.5% to 40% by weight; and wherein the sulfur oxidation catalyst is configured to oxidize organic and inorganic sulfur-containing compounds, including mercaptans, sulfides, thiophenes, hydrogen sulfide, carbonyl sulfide and carbonyl disulfide, to

form sulfur oxides in the form of sulfur dioxides, sulfur trioxides and mixtures thereof; and

a sulfur oxide trap in fluid communication with and disposed downstream of the catalytic reactor, wherein the sulfur oxide trap is configured to capture sulfur oxides SO_2 and SO_3 from the feed stream; wherein the desulfurization system is configured to desulfurize a feed stream having an O_2/S ratio of at least 10.

8. The desulfurization system of claim 7, wherein the desulfurization system is configured to desulfurize a feed stream having an O_2/C ratio of about 0.001 to 0.3.

9. The desulfurization system of claim 8, wherein the desulfurization system is configured to desulfurize a feed stream having an O_2/C ratio of about 0.001 to 0.05.

10. The desulfurization system of claim 7, wherein the catalyst further includes promoter elements configured to promote sulfur oxidation.

11. The desulfurization system of claim 10, wherein the promoter elements include at least one element selected from Groups IIa-VIIa, Groups Ib-Vb, Lanthanide Series and Actinide Series.

12. A desulfurization system, comprising:

a catalytic reactor operative to oxidize sulfur-containing compounds in a feed stream having a sulfur-containing hydrocarbon fuel and an oxidant, wherein the catalytic reactor includes a sulfur oxidation catalyst having platinum, and having iron configured in concentration to improve the effectiveness and durability of the sulfur

oxidation catalyst in comparison to a sulfur oxidation catalyst having platinum but not having iron; and wherein the sulfur oxidation catalyst is configured to oxidize organic and inorganic sulfur-containing compounds, including mercaptans, sulfides, thiophenes, hydrogen sulfide, carbonyl sulfide and carbonyl disulfide, to form sulfur oxides in the form of sulfur dioxides, sulfur trioxides and mixtures thereof; and

a sulfur oxide trap in fluid communication with and disposed downstream of the catalytic reactor, wherein the sulfur oxide trap is configured to capture the sulfur dioxides and the sulfur trioxides from the feed stream,

wherein the platinum concentration in the sulfur oxidation catalyst is in the range from 0.01% to 20% by weight, and the iron concentration in the sulfur oxidation catalyst is selected to provide greater desulfurization of the sulfur-containing hydrocarbon fuel than that provided by catalysts having platinum as the only active metal and that provided by catalysts having platinum and other base metals as the active metals and is in the range from 0.5% to 40% by weight; and wherein the catalytic reactor and the adsorbent are configured to desulfurize hydrocarbon fuel having an O_2/S ratio of at least 10.

13. The desulfurization system of claim 12, wherein the iron concentration is selected to yield at least fifty percent less sulfur breakthrough downstream of the sulfur oxide trap than catalysts having platinum as the only active metal and than catalysts having platinum and other base metals as the active metals.