CLAIMS

1. A process for in-situ oxygen production and sour gas combustion using chemical looping combustion while producing a product stream comprising the steps of:

reducing a bed of metal oxide oxygen carriers that is disposed on a perforated substrate in a lower portion of a fuel reactor to provide gas-phase oxygen which flows to a riser that is in fluid communication with the fuel reactor;

delivering sour gas into the riser at a location that is downstream of the metal oxide oxygen carriers such that the sour gas is free of direct contact with the metal oxide oxygen carriers;

combusting the sour gas under oxy-combustion conditions within the riser to produce the product stream which includes SO_2;

removing the SO_2 from the product stream;

oxidizing the reduced metal oxides with air in an air reactor to produce the metal oxide oxygen carriers; and

delivering the oxidized metal oxide oxygen carriers back to the fuel reactor.

2. The process of claim 1, wherein the bed is fluidized by a stream of CO_2, steam, or a combination thereof.

3. The process of claim 1, wherein the metal oxide oxygen carriers are copper-based, cobalt-based, manganese-based, or a mixture thereof.

4. The process of claim 1, wherein the metal oxide oxygen carriers are manganese-based oxygen carriers.

5. The process of claim 1, wherein the sour gas is a liquid feed that flows into an inlet formed in the riser at a location downstream of the fuel reactor.

6. The process of claim 1, wherein the product stream includes CO_2 and H_2O.

7. The process of claim 6, wherein the product stream further includes amounts of unburnt CO and H_2.

8. The process of claim 1, wherein the SO_2 is removed from the product stream by reacting the SO_2 with a calcium-based sorbent that is introduced into the riser to form $CaSO_4$.

9. The process of claim 8, further including the step of separating the $CaSO_4$ from the product stream using a gas-solid separation device.

10. The process of claim 8, wherein the gas-solid separation device is a cyclone.

11. The process of claim 8, wherein at least a portion of the $CaSO_4$ is delivered back to the riser to act as a nonmetal oxygen carrier which provides additional oxygen as a result of reacting with the sour gas and other gases within the riser.

12. The process of claim 11, wherein the $CaSO_4$ reacts with CO and H_2 in the riser to produce a stream comprising CO_2 and steam.

13. The process of claim 11, further including the steps of reducing the $CaSO_4$ nonmetal oxygen carrier to CaS and separating the CaS from the product stream.

14. The process of claim 13, further including the step of oxidizing the separated CaS to form the $CaSO_4$ nonmetal oxygen carrier which is then delivered back to the riser.

15. The process of claim 14, wherein the step of oxidizing the separated CaS comprises the step of delivering the separated CaS to a hopper and injecting air into the hopper to oxidize the CaS to form the $CaSO_4$ nonmetal oxygen carrier which is delivered to the riser.

16. The process of claim 8, wherein the calcium-based sorbent is limestone.

17. The process of claim 8, wherein a ratio of Ca/S is between about 2 and 2.5.

18. The process of claim 1, wherein heat and steam are generated as by-products.

19. A process for in-situ oxygen production and in-situ reduction of the emission of sulfur compounds that are produced during sour gas combustion using chemical looping combustion while producing a product stream comprising the steps of:

reducing a metal oxide oxygen carrier that is disposed within a fuel reactor to provide gas-phase oxygen which flows to a riser that is in fluid communication with the fuel reactor;

delivering sour gas into the riser at a location that is downstream of the metal oxide oxygen carrier such that the sour gas is free of direct contact with the metal oxide oxygen carrier;

combusting the sour gas under oxy-combustion conditions within the riser to produce the product stream which includes SO_2;

removing the SO_2 from the product stream in-situ within the riser by reacting the SO_2 with a calcium-based sorbent that is introduced into the riser and reacts with the SO_2 to form $CaSO_4$ which is separated from the product stream;

oxidizing the reduced metal oxide with air in an air reactor to produce the metal oxide oxygen carrier; and

delivering the oxidized metal oxide oxygen carrier back to the fuel reactor.

20. The process of claim 19, further including the step of using the $CaSO_4$ which is separated from the product stream as a nonmetal oxygen carrier in the riser to increase sour gas conversion as a result of the $CaSO_4$ reacting with CO and H_2 in the riser to produce CO_2 and steam.