CLAIMS

1. A sulfur recovery system, comprising:

a primary feed stream comprising elemental sulfur;

a separation device in fluid communication with the primary feed stream for separating the primary feed stream into a first liquid stream comprising elemental sulfur and a vapor stream comprising a sulfur vapor;

a first heater fluidly connected to the separation device by the vapor stream for producing a heated vapor stream;

a primary reactor fluidly connected to the first heater by the heated vapor stream, the primary reactor comprising a catalyst for adsorbing elemental sulfur from the heated vapor stream and producing a treated vapor stream comprising a sulfur vapor;

a first condenser fluidly connected to the primary reactor by the treated vapor stream for converting the treated vapor stream to a second liquid stream comprising elemental sulfur and a first cooled vapor stream;

a second heater fluidly connected to the first condenser by the first cooled vapor stream for producing another heated vapor stream;

a secondary reactor fluidly connected to the second heater by the another heated vapor stream, the secondary reactor including a catalyst for adsorbing elemental sulfur from the another heated vapor stream and producing a product vapor stream comprising a sulfur vapor;

a regeneration reactor in fluid communication with the primary feed stream for regenerating a catalyst comprising adsorbed elemental sulfur and producing a flashed-gas vapor stream comprising elemental sulfur; and

a second condenser fluidly connected to the regeneration reactor by the flashed-gas vapor stream for converting the flashed-gas vapor stream to a third liquid stream comprising elemental sulfur and a second cooled vapor stream.

2. The sulfur recovery system of claim 1, further comprising an oxidizer in fluid communication with the first liquid stream, the second liquid stream and the third liquid stream for converting elemental sulfur in the first liquid stream, the second liquid stream and the third liquid stream into a secondary feed stream comprising at least one of thiosulfate, sulfur dioxide, sulfur trioxide, sulfuric acid and sulfurous acid.

3. The sulfur recovery system of claim 2, further comprising another secondary feed stream comprising hydrogen sulfide, wherein the secondary feed stream and the another secondary feed stream are fluidly connected to the primary feed stream for converting at least one of thiosulfate, sulfur dioxide, sulfur trioxide, sulfuric acid and sulfurous acid in the secondary feed stream and hydrogen sulfide in the another secondary feed stream to elemental sulfur in the primary feed stream.

4. The sulfur recovery system of any one of claims 1 to 3, wherein each catalyst comprises at least one of alumina, activated alumina and gamma activated alumina; and/or wherein the sulfur vapor in the product vapor stream comprises less than 20 ppmv sulfur.

5. The sulfur recovery system of any one of claims 1 to 4, wherein the heated vapor stream is 240ºF to 400ºF; and/or wherein the another heated vapor stream is 240ºF to 325ºF.

6. A sulfur recovery method, comprising:

separating a primary feed stream into a first liquid stream comprising elemental sulfur and a vapor stream comprising a sulfur vapor;

heating the vapor stream to produce a heated vapor stream;

adsorbing elemental sulfur from the heated vapor stream onto a catalyst;

producing a treated vapor stream comprising a sulfur vapor;

converting the treated vapor stream to a second liquid stream comprising elemental sulfur and a first cooled vapor stream;

heating the first cooled vapor stream to produce another heated vapor stream;

adsorbing elemental sulfur from the another heated vapor stream onto a catalyst;

producing a product vapor stream comprising a sulfur vapor;

regenerating a catalyst comprising adsorbed elemental sulfur;

producing a flashed-gas vapor stream comprising elemental sulfur; and

converting the flashed-gas vapor stream to a third liquid stream and a second cooled vapor stream.

7. The sulfur recovery method of claim 6, further comprising converting the elemental sulfur in the first liquid stream, the second liquid stream and the third liquid stream into a secondary feed stream comprising at least one of thiosulfate, sulfur dioxide, sulfur trioxide, sulfuric acid and sulfurous acid.

8. The sulfur recovery method of clam 7, further comprising converting at least one of thiosulfate, sulfur dioxide, sulfur trioxide, sulfuric acid and sulfurous acid in the secondary feed stream and hydrogen sulfide in another secondary feed stream into elemental sulfur in the primary feed stream.

9. The sulfur recovery method of any one of claims 6 to 8, wherein each catalyst comprises at least one of alumina, activated alumina and gamma activated alumina; and/or wherein the sulfur vapor in the product vapor stream comprises less than 20 ppmv sulfur.

10. The sulfur recovery method of claim 8, wherein the heated vapor stream is 240ºF to 400ºF; and/or wherein the another heated vapor stream is 240ºF to 325ºF.

11. A sulfur recovery system, comprising:

a primary reactor with a catalyst for adsorbing elemental sulfur from a primary feed stream and producing a treated vapor stream comprising a sulfur vapor;

a first condenser fluidly connected to the primary reactor by the treated vapor stream for converting the treated vapor stream to a first liquid stream comprising elemental sulfur and a first cooled vapor stream;

a heater fluidly connected to the first condenser by the first cooled vapor stream for producing a heated vapor stream;

a secondary reactor fluidly connected to the heater by the heated vapor stream, the secondary reactor including a catalyst for adsorbing elemental sulfur from the heated vapor stream and producing a product vapor stream comprising a sulfur vapor;

a regeneration reactor in fluid communication with the primary feed stream for regenerating a catalyst comprising adsorbed elemental sulfur and producing a flashed-gas vapor stream comprising elemental sulfur; and

a second condenser fluidly connected to the regeneration reactor by the flashed-gas vapor stream for converting the flashed-gas vapor stream to a second liquid stream comprising elemental sulfur and a second cooled vapor stream.

12. The sulfur recovery system of claim 11, further comprising an oxidizer in fluid communication with the first liquid stream and the second liquid stream for converting elemental sulfur in the first liquid stream and the second liquid stream into a secondary feed stream

comprising at least one of thiosulfate, sulfur dioxide, sulfur trioxide, sulfuric acid and sulfurous acid.

13. The sulfur recovery system of claim 12, further comprising another secondary feed stream comprising hydrogen sulfide, wherein the secondary feed stream and the another secondary feed stream are fluidly connected to the primary feed stream for converting at least one of thiosulfate, sulfur dioxide, sulfur trioxide, sulfuric acid and sulfurous acid in the secondary feed stream and hydrogen sulfide in the another secondary feed stream to elemental sulfur in the primary feed stream.

14. A sulfur recovery method, comprising:

adsorbing elemental sulfur from a primary feed stream onto a catalyst;

producing a treated vapor stream comprising a sulfur vapor;

converting the treated vapor stream to a first liquid stream comprising elemental sulfur and a first cooled vapor stream;

heating the first cooled vapor stream to produce a heated vapor stream;

adsorbing elemental sulfur from the heated vapor stream onto a catalyst;

producing a product vapor stream comprising a sulfur vapor;

regenerating a catalyst comprising adsorbed elemental sulfur;

producing a flashed-gas vapor stream comprising elemental sulfur; and

converting the flashed-gas vapor stream to a second liquid stream and a second cooled vapor stream.

15. The sulfur recovery method of claim 14, further comprising converting the elemental sulfur in the first liquid stream and the second liquid stream into a secondary feed stream comprising at least one of thiosulfate, sulfur dioxide, sulfur trioxide, sulfuric acid and sulfurous acid.

16. The sulfur recovery method of claim 15, further comprising converting at least one of thiosulfate, sulfur dioxide, sulfur trioxide, sulfuric acid and sulfurous acid in the secondary feed stream and hydrogen sulfide in another secondary feed stream into elemental sulfur in the primary feed stream.

17. A sulfur recovery system, comprising:

a primary reactor with a catalyst for adsorbing elemental sulfur from a primary feed stream and producing a treated vapor stream comprising a sulfur vapor;

a first condenser fluidly connected to the primary reactor by the treated vapor stream for converting the treated vapor stream to a first liquid stream comprising elemental sulfur and a first cooled vapor stream;

a regeneration reactor in fluid communication with the primary feed stream for regenerating a catalyst comprising adsorbed elemental sulfur and producing a flashed-gas vapor stream comprising elemental sulfur;

a second condenser fluidly connected to the regeneration reactor by the flashed-gas vapor stream for converting the flashed-gas vapor stream to a second liquid stream comprising elemental sulfur and a second cooled vapor stream;

an oxidizer in fluid communication with the first liquid stream and the second liquid stream for converting elemental sulfur in the first liquid stream and the second liquid stream into a

secondary feed stream comprising at least one of thiosulfate, sulfur dioxide, sulfur trioxide, sulfuric acid and sulfurous acid; and

another secondary feed stream comprising hydrogen sulfide, wherein the secondary feed stream and the another secondary feed stream are fluidly connected to the primary feed stream for converting at least one of thiosulfate, sulfur dioxide, sulfur trioxide, sulfuric acid and sulfurous acid in the secondary feed stream and hydrogen sulfide in the another secondary feed stream to elemental sulfur in the primary feed stream.

18. The sulfur recovery system of claim 17, wherein the oxidizer comprises an oxidant comprising at least one of atmospheric oxygen, purified oxygen, ozone, permanganate, hypochlorite, and peroxide; and/or wherein the oxidizer comprises an oxidant comprising at least one of sulfuric acid, sulfurous acid, and sulfur trioxide.

19. A sulfur recovery method, comprising:

adsorbing elemental sulfur from a primary feed stream onto a catalyst;

producing a treated vapor stream comprising a sulfur vapor;

converting the treated vapor stream to a first liquid stream comprising elemental sulfur and a first cooled vapor stream;

regenerating a catalyst comprising adsorbed elemental sulfur;

producing a flashed-gas vapor stream comprising elemental sulfur;

converting the flashed-gas vapor stream to a second liquid stream and a second cooled vapor stream;

converting the elemental sulfur in the first liquid stream and the second liquid stream into a secondary feed stream comprising at least one of thiosulfate, sulfur dioxide, sulfur trioxide, sulfuric acid and sulfurous acid; and

converting at least one of thiosulfate, sulfur dioxide, sulfur trioxide, sulfuric acid and sulfurous acid in the secondary feed stream and hydrogen sulfide in another secondary feed stream into elemental sulfur in the primary feed stream.

20. The sulfur recovery method of claim 19, wherein an oxidant comprising at least one of atmospheric oxygen, purified oxygen, ozone, permanganate, hypochlorite, and peroxide is used for converting the elemental sulfur in the first liquid stream and the second liquid stream into the secondary feed stream; or

wherein an oxidant comprising at least one of sulfuric acid, sulfurous acid, and sulfur trioxide is used for converting the elemental sulfur in the first liquid stream and the second liquid stream into the secondary feed stream.