~~What is claimed is:~~Claims

1. Apparatus for treating acid gas, the apparatus comprising:

an acid gas pre-treatment system; and,

a regulatory system and, in fluid communication with the acid gas pre-treatment system, an ammonia desulfurization system, wherein the acid gas pre-treatment system, the regulatory system and the ammonia desulfurization system are connected successively along a downstream direction;

wherein the pre-treatment system includes a sulfur recovery system plus incineration system, a sulfuric acid production system, and/or a catalytic cracking catalyst regeneration system;

said ammonia desulfurization system being configured to circulate ammonia-containing absorption liquid,

said regulatory system including a temperature regulator configured to regulate a gas temperature in the regulatory system, and/or a humidity regulator configured to regulate a gas humidity in the regulatory system, and

said regulatory system adjusting the enthalpy value of acid tail gas to 60-850 kJ/kg dry gas.

~~2. The apparatus of claim 1 wherein the pre-treatment system includes a sulfur recovery system plus incineration system, a sulfuric acid production system, and/or a catalytic cracking catalyst regeneration system.~~

~~3~~2. The apparatus of ~~any of previous claims 1 to 2~~ claim 1 wherein the sulfur recovery system includes a Claus sulfur recovery system having 1 stage, 2 stages or 3 stages, a liquid-phase catalytic oxidation sulfur recovery system, or a biological sulfur recovery system.

~~4~~3. The apparatus of any one of ~~previous~~ claims 1 ~~to 3~~ or 2 wherein the sulfur recovery system further includes, in fluid communication with the Claus sulfur recovery system, a SuperClaus sulfur recovery system, a EuroClaus sulfur recovery system, a biological sulfur recovery system, or a liquid-phase catalytic oxidation sulfur recovery system.

~~5~~4. The apparatus of any one of ~~previous~~ claims 1 to ~~4~~ 3 further comprising a regulatory system that is in fluid communication with, and upstream from, the ammonia desulfurization system.

~~6. The apparatus of claim 5 wherein the regulatory system includes a temperature regulator configured to regulate a gas temperature in the regulatory system, and/or a humidity regulator configured to regulate a gas humidity in the regulatory system.~~

~~7~~5. The apparatus of any of previous claims 1 to ~~6~~ 4 further comprising in fluid communication with the ammonia desulfurization system, a sulfur removal device, a dust removal apparatus, and/or an impurity removal apparatus.

~~8. The apparatus of any of previous claims 5 to 7 wherein:~~

~~the acid gas pre-treatment system;~~

~~the regulatory system; and~~

~~the ammonia desulfurization system are connected successively along a downstream direction.~~

~~9~~6. The apparatus of ~~any of previous claims~~ claim 5 ~~to 8~~ wherein, in the regulatory system, the temperature regulator, humidity regulator and ~~a~~ the sulfur removal device are connected successively in the downstream direction.

~~10~~7. The apparatus of any one of ~~previous~~ claims 1 to ~~9~~ 6 wherein the ammonia desulfurization system:

is configured to circulate ammonia-containing absorption liquid ; and

includes an absorption liquid treatment system that includes:

a concentration device configured to receive the absorption liquid;

a solid-liquid separation device configured to collect solids suspended in the liquid; and

a drying device configured to dry the collected solids.

~~11~~8. The apparatus of claim ~~10~~ 7 wherein the absorption liquid treatment system further includes a solution purification device in fluid communication with, and disposed in a direction operationally downstream from, the solid-liquid separation device.

~~12~~9. The apparatus of any one of ~~previous~~ claims ~~10~~ 7 to ~~11~~ 8 wherein the absorption liquid treatment system further includes an evaporation crystallization device that is:

in fluid communication with:

the concentration device; and

the solid-liquid separation device; and

disposed, operationally:

downstream from the concentration device; and

upstream from the solid-liquid separation device.

~~13~~10. The apparatus of any one of ~~previous~~ claims ~~11~~ 8 to ~~12~~ 9 wherein the solution purification device includes, in fluid communication with the solid-liquid separation device, an oil removal device, and/or a suspended matter removal device.

~~14~~11. The apparatus of claim ~~13~~ 10 wherein the suspended matter removal device is configured to provide a circulating absorption liquid that has a suspended matter content no greater than 200 mg/L~~, preferably in the range 20-100 mg/L and more preferably in the range 30-50 mg/L~~.

~~15~~12. The apparatus of any one of ~~previous~~ claims ~~13~~ 10 to ~~14~~ 11 wherein the oil removal device includes, in fluid communication with the solid-liquid separation device, an air flotation device, an adsorption device, and/or a precision filtration device.

~~16~~13. The apparatus of any one of ~~previous~~ claims ~~13~~ 10 to ~~15~~ 12 wherein the oil removal device is configured to produce a circulating absorption liquid having an oil content no greater than 100 mg/L~~, preferably in the range 10-80 mg/L and more preferably in the range 20-30 mg/L~~.

~~17~~14. The apparatus of any one of ~~previous~~ claims ~~13~~ 10 to ~~16~~13, wherein the oil removal device is connected to the incineration system.

~~18~~15. The apparatus of claim ~~17~~ 14 wherein the oil removal device is in fluid communication with, and is disposed operationally upstream from, the incineration system.

~~19~~16. A method for treating acid gas, the method comprising:

receiving acid gas; and

deriving from the acid gas:

ammonium sulfate; and

net tail gas that meets a discharge standard;

wherein the enthalpy value of acid tail gas is adjusted to 60-850 kJ/kg dry gas.

~~20~~17. The method of claim ~~19~~ 16 wherein the deriving includes:

recovering sulfur from the acid gas to produce sulfur-recovered tail gas; and, then,

incinerating the sulfur-recovered gas.

~~21~~18. The method of any one of ~~previous~~ claims ~~19~~ 16 to ~~20~~ 17 wherein the deriving includes producing sulfuric acid from the acid gas, and/or incinerating.

~~22~~19. The method of any one of ~~previous~~ claims ~~19~~ 16 to ~~21~~ 18 further comprising channelling the acid gas from a petrochemical chemical reaction, a natural gas chemical reaction and/or a coal chemical reaction.

~~23~~20. The method of any one of ~~previous~~ claims ~~19~~ 16 to ~~22~~ 19 wherein:

the deriving includes generating catalytic cracking regeneration flue gas; and

the acid tail gas includes the regeneration flue gas.

~~24~~21. The method of any one of ~~previous~~ claims ~~19~~ 16 to ~~23~~ 20 wherein the deriving comprises adjusting an enthalpy value of acid tail gas.

~~25~~22. The method of any one of ~~previous~~ claims ~~19~~ 16 to ~~24~~ 21 wherein the deriving includes passing adjusted tail gas through:

a cooling stage,

an absorption stage, and

a water-washing stage,

all in an ammonia circulation desulfurization reactor.

~~26~~23. The method of any one of ~~previous~~ claims ~~24~~ 21 to ~~25~~ 22 wherein the adjusting includes changing a temperature of the acid tail gas and/or a humidity of the acid tail gas, and or further includes removing sulfur, dust and/or impurity from the acid tail gas.

~~27~~24. The method of any one of ~~previous~~ claims ~~24~~ 21 to ~~26~~ 23 wherein the adjusting adjusts the value to 60-850 kJ/kg dry gas~~, preferably 80-680 kJ/kg dry gas and more preferably100-450 kJ/kg dry gas~~.

~~28~~25. The method of any one of ~~previous~~ claims ~~24~~ 21 to ~~27~~ 24 wherein the adjusting produces adjusted tail gas having an organic matter content not greater than 30 ppm~~, preferably not greater than 10 ppm~~.

~~29~~26. The method of any one of ~~previous~~ claims ~~24~~ 21 to ~~28~~ 25 wherein the adjusting produces adjusted tail gas having an elementary sulfur and hydrogen sulfide content not greater than 30 ppm~~, preferably not greater than 10 ppm~~.

~~30~~27. The method of any one of ~~previous~~ claims ~~24~~ 21to ~~29~~ 26 wherein the recovering includes flowing the acid gas through a Claus sulfur recovery system having 1 stage,

2 stages or 3 stages, through a liquid-phase catalytic oxidation sulfur recovery system, through a biological sulfur recovery system, through a SuperClaus sulfur recovery system, and/or through a EuroClaus sulfur recovery system, .

~~31~~28. The method of ~~any of previous claims~~claim 16 wherein the method contains the sulfuric acid production includes wet sulfuric acid production and/or dry sulfuric acid production.

~~32~~29. The method of any one of ~~previous~~ claims ~~20~~ 17 to ~~31~~ 28 wherein the recovering includes producing sulfur-recovered gas having a molar ratio H_2S/SO_2 in the range 1.2-3~~, preferably in the range 1.5-2.5~~.

~~33~~30. The method of any one of ~~previous~~ claims ~~20~~ 17 to ~~32~~ 29 wherein the incinerating:

is performed at a temperature in the range 600 ºC-1,300 ºC~~, preferably in the range 650°C to 950°C~~; and

produces an acid tail gas.

~~34~~31. The method of any one of ~~previous~~ claims ~~20~~ 17 to ~~33~~ 30 wherein, in the incinerating, the sulfur-recovered tail gas has a residence time in the range 1 to 6 s~~, preferably in the range 1.5 to 4 s~~.

~~35~~32. The method of any one of ~~previous~~ claims ~~23~~ 20 to ~~34~~ 31 wherein the acid tail gas has an oxygen content in the range 2%-5%~~, preferably in the range 3%-4%~~.

~~36~~33. The method of any one of ~~previous~~ claims ~~23~~ 20 to ~~35~~ 32 wherein the acid tail gas has a sulfur oxide content in the range 2,000 mg/Nm^3 to 150,000 mg/Nm^3~~, preferably in the range 5,000 mg/Nm^3 to 55,000 mg/Nm^3~~.

~~37~~34. The method of any one of ~~previous~~ claims ~~19~~ 16 to ~~36~~ 33 wherein the deriving includes reducing a suspended matter content of an ammonia desulfurization circulating absorption liquid to no greater than 200 mg/L~~, preferably~~.

~~38~~35. The method of any one of ~~previous~~ claims ~~19~~ 16 to ~~37~~ 34 wherein the deriving further includes reducing an oil content of an ammonia desulfurization circulating absorption liquid to no greater than 100 mg/L.

~~39~~36. The method of any one of ~~previous~~ claims ~~23~~ 20 to ~~38~~35, wherein the acid tail gas comprises the tail gas obtained after treating the petrochemical, natural gas

chemical, and coal chemical acid gas with a process such as sulfur recovery plus incineration, sulfuric acid production, and incineration; or the acid tail gas comprises catalytic cracking regeneration flue gas.

~~40~~37. The method of any one of ~~previous~~ claims ~~23~~ 20 to ~~39~~36, wherein the enthalpy value of the acid tail gas is first adjusted by a regulatory system, and then the acid tail gas is fed into a subsequent ammonia desulfurization process.

~~41~~38. The method of claim ~~19~~16, wherein the specific process steps include:

1) acid gas is treated by sulfur recovery plus incineration or sulfuric acid production or incineration, or directly by catalytic cracking catalyst regeneration process to obtain acid tail gas;

2) the acid tail gas is fed into the regulatory system to adjust the enthalpy value of the tail gas to be within the range of 60-850 kJ/kg dry gas, for example, 80-680 kJ/kg dry gas or 100-450 kJ/kg dry gas;

3) the acid tail gas which meets the enthalpy value requirement is fed into the ammonia desulfurization process for treatment, to achieve the purpose that net tail gas meets the discharge standard through multi-stage circulating absorption.

39. The apparatus of claim 11, wherein the suspended matter removal device is configured to provide a circulating absorption liquid that has a suspended matter content in the range of 20-100 mg/L.

40. The apparatus of claim 11, wherein the suspended matter removal device is configured to provide a circulating absorption liquid that has a suspended matter content in the range 30-50 mg/L.

41. The apparatus of claim 13, wherein the oil removal device is configured to produce a circulating absorption liquid having an oil content in the range 10-80 mg/L.

42. The apparatus of claim 13, wherein the oil removal device is configured to produce a circulating absorption liquid having an oil content in the range 20-30 mg/L.

43. The method of claim 24, wherein the adjusting adjusts the value to 80-680 kJ/kg dry gas.

44. The method of claim 24, wherein the adjusting adjusts the value to 100-450 kJ/kg dry gas.

45. The method of claim 25, wherein the adjusting produces adjusted tail gas having an organic matter content not greater than 10 ppm.

46. The method of claim 26, wherein the adjusting produces adjusted tail gas having an elementary sulfur and hydrogen sulfide content not greater than 10 ppm.

47. The method of claim 29, wherein the recovering includes producing sulfur-recovered gas having a molar ratio H2S/SO2 in the range 1.5-2.5.

48. The method of claim 30, wherein the incinerating is performed at a temperature in the range 650°C to 950°C.

49. The method of claim 31, wherein, in the incinerating, the sulfur-recovered tail gas has a residence time in the range 1.5 to 4 s.

50. The method of claim 32, wherein the acid tail gas has an oxygen content in the range 3%-4%.

51. The method of claim 33, wherein the acid tail gas has a sulfur oxide content in the range 5,000 mg/Nm^3 to 55,000 mg/Nm^3.

52. The method of claim 37, wherein the acid tail gas is fed into the regulatory system to adjust the enthalpy value of the tail gas to be within the range of 80-680 kJ/kg dry gas.

53. The method of claim 37, wherein the acid tail gas is fed into the regulatory system to adjust the enthalpy value of the tail gas to be within the range of 100-450 kJ/kg dry gas.

54. The apparatus of claim 4, wherein, in the regulatory system, the temperature regulator, humidity regulator and a sulfur removal device are connected successively in the downstream direction.