Part 1

AIR PROTECTION FROM POWER INDUSTRY EMISSIONS

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1.3.2.7. Ammonia-cyclical technology

A chemical basis for this technology is a balanced reaction between the saluted sulfite and ammonium bisulfite and sulfur dioxide, removed from the furnace gases:

$$(NH_4)_2SO_3 + SO_2 + H_2O = 2NH_4HSO_3.$$

At the temperature of 30 ... 35°C, this reaction proceeds from left to right, and in the process of solution boiling occurs in the opposite direction. Process diagram of such purification is shown in Fig. 1.44.

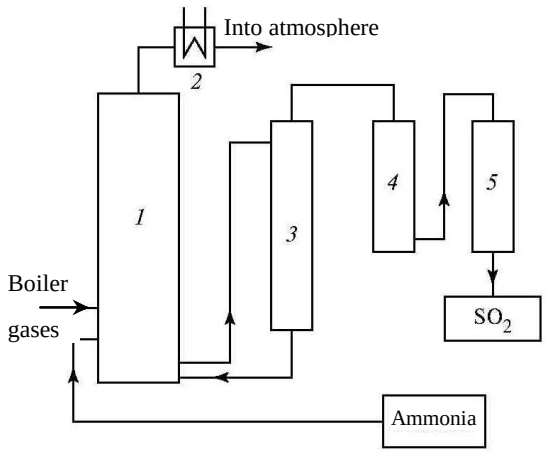

Fig. 1.44. Process diagram of ammonium-cyclical desulfurization

Furnace gases from the boiler with concentration of fly ash of 250 ... 300 mg/m^3 (which is achieved by applying of electrical gas purification) enter the countercurrent absorber *1*, sprayed by the sulfite-bisulfite solution. Absorber (hollow or nozzle) consists of several stages of irrigation, in which ammonia for compensation of losses is fed. Saturated with sulfur dioxide solution enters the desorption column *3*, in which the temperature is 97°C and vacuum is about 36 Mmhg (470 Pa). As a result of decomposition of ammonium bisulfate, sulfite solution, recycled to the absorber, and gaseous SO_2 are formed. From the desorber a mixture of sulfur dioxide and water vapor first pass through a capacitor *4*, in which a main part of moisture is removed, than through the drying tower *5*, irrigated with sulfuric acid. Dried sulfur dioxide is cooled by evaporation of liquid ammonia, resulting in SO_2 reduction. This liquid, boiling at a temperature of -10°C, is poured into the tanks and transported to the consumer. Liquefied sulfur dioxide is used for production of sulfuric acid and also as a preservative of agricultural products.

The purified flue gases after removal of a dropwise moisture pass through a heater *2* and are discharged into atmosphere.

Presence of oxygen in flue gases causes formation of irrecoverable ammonium sulfate, which, incidentally, is used as a fertilizer. In addition, the adverse reactions of oxidation of sulfite salts are elemental sulfur and ammonium thiosulfate, which should be removed from the desulfurization cycle.

Capital expenses of ammonia-cyclical desulphurization are higher than for the wet limestone technology and, as shown by calculations, the first becomes profitable when a content of sulfur dioxide in flue gases is about 0,5%.

1.3.2.8. Magnesite cyclical technology

The essence of magnesite cyclical technology lays in binding of sulfur dioxide by a slurry of magnesium oxide:

$$MgO + SO_2 = MgSO_3.$$

Formed magnesium sulfite sates a spray solution and precipitates in the form of large crystals of hexahydrate sulfite $MgSO_3 \cdot 6H_2O$. Crystals are separated from the liquid, dried and fired, which leads to thermal degradation of sulfite:

$$MgSO_3 \rightarrow MgO + SO_2\uparrow.$$

Magnesium oxides return to desulfurization installation and sulfur dioxide is condensed under the technology specified in it.1.3.2.7.

Magnesite method is simpler than the ammonia-cyclical one, since there is a waste in the form of crystals. In addition, the only side irrecoverable waste is magnesium sulfate. But the scope of application of this technology is the same as for the ammonia-cyclic. Dioxide content in flue gases should be of 0,3 ... 0,4%.

1.3.2.9. Natrium sulfite-bisulphite technology

This method (also called - Wellman-Lord process) is similar to the ammonia-cyclical, but instead of ammonium salts, sulfurous natrium salts are used:

$$SO_2 + Na_2SO_3 + H_2O = 2NaHSO_3.$$

Formed natrium bisulfite enters the stripping column, where at solution heating the reaction proceeds in the opposite direction. Sulfur dioxide is a main waste of such desulfurization, and natrium sulfate, which is produced by oxidation of sulfite by gas oxygen, is a by-product. Instead of sulfate, removed from the cycle, an equivalent amount of carbonate sodium Na_2CO_3 is added into the spray solution.

Natrium salts bind sulfur dioxide more strongly than the ammonium salts, so a great heat flow is needed at regeneration. Natrium salts have practically zero vapor pressure above the surface of solutions, so losses of reagent with the purified gases are absent.

Foreign experience of such technology application has shown that for TPPs it can be attractive when the regeneration is conducted on a special chemical industry, not related with power engineering. Furthermore, this technology, as well as any cyclical, requires a constant flow of flue gases, i.e. a constant load of the power unit (boiler), at which such desulphurization plant is constructed.