

## AIR PROTECTION FROM POWER INDUSTRY EMISSIONS

## 1.3. Sulfur oxide emission reduction

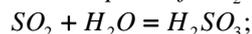
## 1.3.2. Technologies of sulfur oxide emission reduction

## 1.3.2.13. Ammonium-sulphate technology (AST)

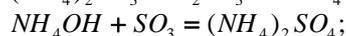
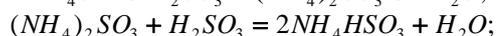
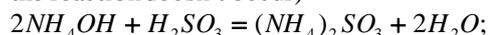
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AST technology is based on binding of sulfur dioxide and trioxide with water solution of ammonia followed by oxidation of the formed products of substance interacting with production of the stable ammonium sulfate. The main chemical reactions in the AST are the following:

at absorption of  $SO_2$  and  $SO_3$



$NH_3 + H_2O = NH_4OH$  (using water solution of ammonia the reaction doesn't occur)



at oxidizing absorption products:

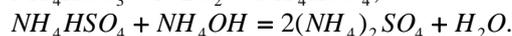
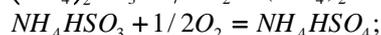
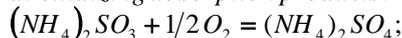
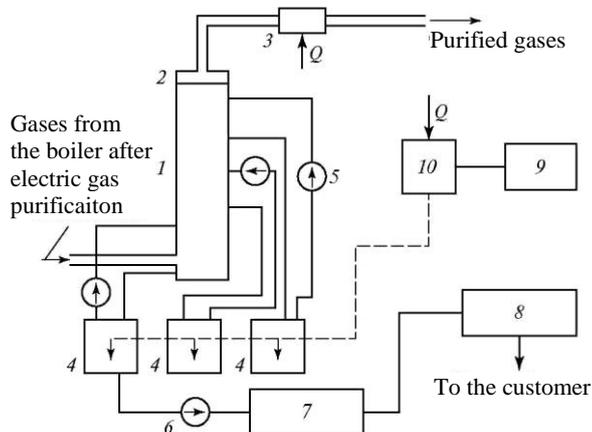


Diagram of sulfate-ammonium installation of desulphurization is shown in Fig. 1.48. It consists of: absorber 1 with three or four circuits of flue gas washing and mist extractor 2; purified gas heating unit 3; collecting reservoirs 4 of irrigation contours; circulating pumps 5 of the absorbing solution; pump 6 of the saturated solution evacuation; unit 7 of dry desulfurization waste production; unit 8 of packing and boxing of dry desulfurization wastes; liquid ammonia storage 9; evaporator 10.



**Fig. 1.48. Principle diagram of the ammonium-sulphate technology**

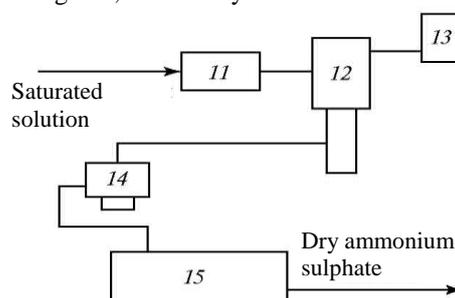
Installation operates as follows. Flue gases, dedusted up to  $50\div 300\text{ mg/m}^3$ , enter the bottom circuit of the absorber, where, along with  $SO_2$  collection, working solution is boiled down by heat of flue gases up to saturation of liquid with ammonium sulfate. The main absorption occurs in the upper contours, irrigated by ammonium-sulfite solution. Lean solution of ammonium salts is fed in the last contour along the gas flow. Solution from each upper contour is discharged by gravity into the subjacent contour. Ammonia is typically injected into the collecting reservoir of each contour. Gaseous ammonia is produced in the steam evaporator, where liquid ammonia from the storage is fed. To increase  $SO_2$  collection efficiency and prevent from formation of

sulfate-ammonium aerosols, emitted with the purified gases, sulfite-bisulfite salts are forcibly oxidized up to sulfate salts in the lower contour.

That provides achievement of a high efficiency of desulfurization - up to 98-99%. Purified gases pass through the mist extractor, where drop moisture, being a source of ammonia losses, is removed. After that the purified gases are heated by  $20\text{-}25^\circ\text{C}$  and emitted into atmosphere. There are two ways of using the saturated solution of ammonium sulfate:

- pouring it in the reservoirs or other containers and dispatching to the consumer in a liquid form; in this case, the installation is the most simple and cheap, but it requires constant shipment of the solution to the consumer;
- additional solution evaporation, separation and drying of crystals of ammonium sulfate with its subsequent packing; in this case waste is minimal and it can be collected in the storage for its shipment to the consumer in large lot.

One of the possible options of treatment of the saturated solution, formed by ammonium-sulfate technology of desulfurization (Fig. 1.48), is shown in Fig. 1.49. The diagram includes: a filter 11, an evaporator 12, an ejector 13, a centrifuge 14, a drum dryer 15.



**Fig. 1.49. Diagram of dry ammonium sulfate production**

In case in the purified gases a lot of ash is contained, the saturated solution is filtered, and then evaporated. The precipitated crystals of ammonium sulfate, are separated from the solution in a centrifuge, and the solution is returned to the lower contour of the absorber. The formed ammonium sulfate is commonly used as fertilizer; by that it differs from the usual industrial one due to availability of trace elements in ash, which essentially increases the commodity properties of desulfurization wastes.

Technical and economic indicators of ammonium-sulphate technology are presented in Tab. 1.27.

In the process of granulated ammonium sulfate production with higher commodity properties and obtaining of ammonium at the world prices, income from the sale of desulfurization wastes allows completely to cover operating costs for desulfurization, and in some cases, to cover the price of the whole installation. But for this the TPP should be located close enough to the source of ammonia to avoid many-fold increase in the reagent cost due to raising the transportation costs.