1.3. Sulfur oxide emission reduction

1.3.2. Technologies of sulfur oxide emission reduction

1.3.2.4. Simplified wet-dry technology (E-SO_x technology)

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E-SO_x technology is based on binding of sulfur oxides with the finely dispersed aqueous slurry of lime, followed by evaporation of drops in the purified flue gases. The main chemical reactions of E-SO_x technology are:

$$SO_2+Ca(OH)_2=CaSO_3\cdot 1/2H_2O;$$
$$SO_2+Ca(OH)_2+1/2O_2+H_2O=CaSO_4\cdot 2H_2O;$$
$$CO_2+Ca(OH)_2=CaCO_3+H_2O$$

A layout of desulfurization plant under E-SO_x technology is shown in the Fig. 1.41. It consists of a system of injectors *1* for the finely dispersed spraying of suspension, installed in the prechamber *2* of electrostatic precipitator *3* or in the supplied gas flue, suspension storage tank *5*, suspension feed pump *4*, lime storage silo *7*, lime slaking installation *6*.

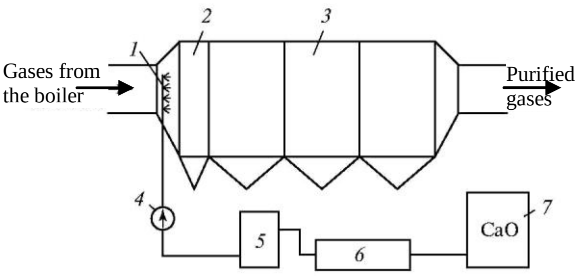

Fig. 1.41. A principle layout of the simplified wet-dry lime desulfurization

The plant operates as follows. The finely dispersed lime slurry with a large contact surface is injected into flue gases exhausted from the boiler. It ensures a quick absorption of sulfur oxides from the gases and evaporation of drops of suspension before intake of gas into the first field of electrostatic precipitator. Dry desulfurization wastes together with fly ash are collected in the electrostatic precipitator. Application of E-SO_x technology also increases the working efficiency of electrostatic precipitator. Flue gas volume is reduced by 15 ... 18 %, and its moisture content increases due to cooling by evaporation of suspension drops. It entails prolongation of gas residence time in the active part of the unit, electrode voltage increase and balancing of operation of ESP fields.

Finely dispersed spraying of suspension is provided by pneumomechanical injectors, where the operating environment is the compressed air or superheated steam. For preparation of lime slurry, calk CaO or lime hydrate $Ca(OH)_2$ is used. Crushed hydrate lime from the silo is fed to the reservoir with a blender. When reaching the required concentration, suspension is supplied to the absorber. Lump calk or crushed lime is fed to a lime-slaking apparatus, from which the concentrated slurry is poured into the reagent preparation reservoir, where it is mixed with water and brought to the required indicators.

Technical and economic parameters of the principle wet-dry technology are presented in Tab.1.19.

Table 1.19. **Indicators of the principle wet-dry desulfurization technology**

Achievable desulfurization efficiency, %	50 … 60
Reduced sulfur content of fuel depending on the heat capacity of the boiler, % kg/MJ	According to GOST R 50831—95: up to 199 MW — 0,063…0,075; 200…249 MW — 0,05…0,056; 250…299 MW — 0,038; ≥ 300 MW — 0,038 According to requirements of the II Protocol to SO_2 ICTM (for solid fuel): 50…100 MW — 0,11; 100…500 MW — 0,11…0,022; ≥ 500 MW — 0,022
Used reagent	Lump lime, hydrate or air slaked lime containing calcite hydroxide $Ca(OH)_2$ of 92 ... 98%
Reagent toxicity	Toxic
Reagent excess factor	1,3...1,5
Resulting waste	Mixture of fly ash with semiaquatic calcium sulfite, two-aqueous calcium sulfate and calcium hydroxide
Waste toxicity	Non-toxic
Technologies and industries of waste utilisation	Road construction, land planning, fillers at manufacture of building products
Working environment (name, parameters)	Voltage of 380 V, industrial water, air with pressure of 0,5 ... 0,6 MPa
Ash collection efficiency specifications	No
Effect of desulphurization on ESP operation	Improvement of ESP operation due to cooling and moisturizing of flue gases, 5 ... 7 times reduction of fly ash emissions
Specific area for equipment installation, m^2/kW	Less than 0,0005
Specific energy consumption, % of equivalent unit (boiler) capacity	0,027 for n '= 0,6 ... 1,0 g/MJ and N_e = 300 ... 500 MW
	0,025 for n '= 0,6 ... 1,0 g/MJ and N_e = 80 ... 200 MW
Specific capital costs, U.S. $/kW of the installed capacity	3,8 ... 4,3 for n '= 0,6 ... 1,0 g/MJ and N_e = 300 ... 500 MW 1,8 ... 5,7 for n '= 0,6 ... 1,0 g/MJ and N_e = 80 ... 200 MW
Specific operating costs, U.S. cents/(kW·h)	1…5 for n' = 0,6…1,0 g/MJ and N_e = 300…500 MW 1,1…5,4 for n' = 0,6…1,0 g/MJ and N_e = 80…200 MW

SO_2 collecting costs, U.S. $/t	210…315 for n' = 0,6…1,0 g/MJ and N_e = 300…500 MW 140…880 for n' = 0,6…1,0 g/MJ and N_e = 80…200 MMW