ENVIRONMENTAL PROTECTION

REDUCTION OF SULFUR OXIDE EMISSIONS IN COMBUSTION OF HIGH-SULFUR BOILER FUELS

F. Kh. Valitov, V. P. Skorin,
V. M. Sharafutdinov, and Yu. D. Morozov

UDC 665.637:662.96:546.244-31

High-sulfur residual oils and coals that are used as fuel are sources of pollution of the environment by sulfur oxides, with adverse effects on the ecology of the particular region, as well as adverse effects in terms of equipment corrosion [1]. Various methods have been proposed for reducing the amounts of SO_2 and SO_3 discharges. Of particular interest is the cleanup of stack gas by means of alkaline additives that are introduced directly into the process of fuel combustion [2-5]. The main disadvantages of these methods are the large consumption of alkaline agent (up to 120% relative to the amount of fuel oil) and the comparatively low degree of cleanup (50-80%).

We have investigated the emission of SO_2 and SO_3 in the combustion of high-sulfur boiler fuels in the presence of alkaline and alkali-earth metals. In these studies we used boiler fuels produced by the Industrial Association "Salavatnefteorgsintez," with a sulfur content of 3.5-4% by weight. As additives we used sodium carbonate, calcium carbonate, barium carbonate, calcium oxide, and sodium hydroxide.

The components were mixed in a rotary-pulse apparatus (RPA). The working volume of the apparatus was $6 \cdot 10^{-6}$ m^3, rotor speed 50 sec^{-1}. The combustion of the fuel oil and the determination of sulfur oxide emissions were performed by procedures given in [6], with a furnace temperature of 1223 ± 20°K. The dry additives were introduced into the fuel oil as powders (particle size 1-30 μm). The water and the aqueous solutions were emulsified in the RPA down to a disperse-phase drop size of 0.5-2 μm.

From these studies of the different additives, we obtained the following data on the percentage removal of sulfur oxides from the stack gas (additive concentrations are given in parts by weight per 100 parts of fuel oil):

Na_2CO_3	
100 parts without water	62
100 parts with 10 parts water	90
10 parts with 10 parts water	71
$CaCO_3$	
100 parts without water	56
100 parts with 5 parts water	76
100 parts with 10 parts water	85
10 parts with 10 parts water	69
100 parts with 10 parts Fe_2O_3 without water	87
100 parts with 1 part Fe_2O_3 and 10 parts water	94
$BaCO_3$	
100 parts without water	54
100 parts with 10 parts Fe_2O_3 without water	86
NaOH	
10 parts without water	37
10 parts with 30 parts water	81
10 parts with 1 part Fe_2O_3 and 20 parts water	83
10 parts with 2 parts Fe_2O_3 and 20 parts water	92
CaO (10 parts) with 10 parts water	76

These data indicate a substantial reduction of sulfur oxide emission when the additives are introduced into the fuel oil in the form of aqueous emulsions and slurries. Thus, in the

---

Industrial Association "Kaustik," Sterlitamak. Translated from Khimiya i Tekhnologiya Topliv i Masel, No. 8, p. 39, August, 1988.

combustion of the fuel oil with the aqueous emulsion of sodium hydroxide solution, the degree of removal of sulfur oxides from the stack gas increases to 81-92%. A high degree of cleanup (>90%) is also achieved when the catalyst Fe_2O_3 is introduced into the fuel oil. Water and iron(III) oxide make it easier for the alkaline additives to interact with sulfur compounds under relatively milder conditions in the fuel combustion process, with a consequent reduction of sulfur oxide emissions. The use of aqueous solutions favors uniform distribution of the additives throughout the fuel, and this also improves the additive efficiency in binding sulfur.

Analyses of the vanadium content in the ash residues from combustion of fuel oil with additives [7] have shown that the amount of V_2O_5 is increased by a factor of 1.5-2 in comparison with the content in the ash from the original fuel oil. When a procedure given in [8] is used to recover V_2O_5 from the ash residue after combustion of fuel oil in the presence of $BaCO_3$ and Fe_2O_3, the degree of recovery is 96%. The binding of toxic oxides of vanadium in the combustion of boiler fuels on a commercial scale will undoubtedly have a favorable effect on air cleanliness. Moreover, the vanadium oxides can serve as a source of raw material for the recovery of pure vanadium from the ash [9].

Thus, when alkali and alkaline-earth metal compounds in the form of solutions or slurries are introduced into high-sulfur boiler fuels before burning, the degree of removal of SO_2 and SO_3 from the stack gas can be brought up to 90-94%.

LITERATURE CITED

1. B. S. Belosel'skii and V. N. Pokrovskii, Sour Fuel Oils in Power Generation [in Russian], Énergiya, Moscow (1969).
2. Jpn. Pat. 56-98287.
3. West Ger. Pat. 30157109.*
4. Br. Pat. 1,601,364.
5. G. Schu, Brauwelt, 124, No. 39, 1690-1692 (1984).
6. Petroleum Products — Test Methods [in Russian], Part 1, Izd. Standartov, Moscow (1967).
7. A. K. Ergalieva, A. V. Kotova, and S. F. Bakirova, Khim. Tekhnol. Topl. Masel, No. 12, 33-34 (1984).
8. A. K. Ergalieva, A. V. Kotova, S. M. Ospanova, et al., Zh. Prikl. Khim., 59, No. 6, 1396-1397 (1986).
9. N. K. Nadirov, Neftekhimiya, 24, No. 4, 435-441 (1984).

---

*As in Russian original — Translator.