Environment Protection Engineering

Vol. 11 1985 No. 2

HENRYK MELOCH*, PIOTR KABSCH*

DRY METHODS FOR THE DESULPHURIZATION OF FLUE GASES

Problems dealt with in the design and operation of wet systems for the desulphurization of flue gases are pointed out. The alternative solutions to the problem of interest that have been considered so far make use of a fluidized bed or the ammonia soda process. The latest tendency in environmental engineering practiced in industrialized countries consists in adapting the spray-drying process to the need of sulphur-oxides and nitrogen-oxides removal.

There is also considered the possibility of desulphurizing flue gases by adsorption of sulphur dioxide on dry pulverized sorbents. Novel solutions to the problem of desulphurizing flue gases emitted by lignite-fired, large power plants are suggested.

Poland, like most industrialized countries of the world, is exposed to emission of two primary pollutants – sulphur dioxide and particulates – which enter the atmosphere in a combination with flue gases. Any preventive measures to abate sulphur-dioxide emission have failed not only because adequate technologies are lacking. The main reason is the ever increasing power demand, and power generation involves low-quality fuel, specifically sulphur-containing coal. It should be noted that the environmental impact of airborne sulphur compounds has become an increasingly serious problem in the whole of Europe, the more so as conventional wet methods include high-cost operation and large-scale installations.

In Poland, sulphur dioxide emissions come primarily from coal-fired power plants, thermal-electric power stations, as well as from ferrous and non-ferrous metallurgy. All of these produce large amounts of flue gases which call for large-scale systems when sulphur dioxide is to be removed by wet methods. These limitations have directed the attention of environmental scientists and engineers to simpler and cheaper desulphurization systems making use of dry methods.

* Institute of Environment Protection Engineering, Technical University of Wrocław, pl. Grunwaldzki 9, 50-377 Wrocław, Poland.

Two dry methods, the old ammonia soda process and the more recent direct method involving a fluidized bed (installed in the boiler) and addition of limestone or dolomite [6], [10] may be of significance to the desulphurization problem.

The ammonia method is simple, but has the inherent disadvantage (specifically troublesome in Poland) that it needs large ammounts of ammonia. Taking into account the deficiency of ammonia on the Polish market, it becomes obvious that the industrial management fails to ensure a continuous operation of such desulphurizing systems. Another limitation is the insufficient degree of reaction between ammonia and sulphur dioxide to minimize ammonia emission. Attempts at utilizing reaction products have shown that a two-stage dust separation system is needed. Furthermore, if the product for utilization is to be of appropriate purity and the method itself is to remain dry, each of the separation stages must be highly efficient.

If the reaction products were processed to obtain ammonia for recirculation, there would necessarily be a "wet" stage (to say nothing of the expected ammonia losses). A few years ago, one of our largest lignite-fired power plants developed a full-scale desulphurization system, making use of the ammonia method [3]. The system of interest has not been implemented yet because of the disadvantages mentioned.

The fluidized-bed method (which has been patented lately) involves calcium compounds and fluidized combustion of solid fuel. Although it is still far from being sufficiently recognized, the technology in question seems to be promising (pilot-scale experiments are underway) [10]. But full-scale application requires substitution of units equipped with fluidized furnaces for the existing boilers.

Thus, the question of how to abate environmental impact of sulphur dioxide emission has not been answered yet. A novel approach to the desulphurization of flue gases was presented by the Niro Atomizer staff at the 1983 Know-How and Technology Symposium in Denmark [5]. Niro Atomizer have been a leading company in the manufacture of spray dryers since the 1930ies. The Niro Atomizer concept uses a high-efficiency absorber based on the following principle. The whitewash feed is sprayed by using a disk atomizer. The droplets formed in this manner get in touch with hot flue gases to absorb sulphur dioxide and nitrogen oxides. The absorber creates favourable conditions for a complete evaporation of water from the atomized solution. The solid products of the reaction are passed – together with the flue gas stream – to a dry dust separator. The concept combines the advantages of both dry and wet methods and is much cheaper than wet processes. Considering the data reported in 1984, unit expenditures for the placing of a spray-dryer system amounted to about 115 U.S. dol. per kilowatt of power installed. Niro Atomizer is now oferring twelve or so flue gas desulphurization systems applicable to large power plants (depending on the power produced and the fuel used), as well as ten smaller systems for oil-fired industrial boilers which have to be coal-fired for economy. The Niro Atomizer system (its construction was begun in 1978) has been working since the end of 1982 (at a performance of 3.5 million m^3/h) in the 450 MW Antelope Valley Station, Beulah, North Dakota. In 1979, the 115 MW Riverside Station, Minneapolis, Minesota, decided to install a 1.1 million m^3/h performance Niro Atomizer system which has been oper-

ated since December, 1980. In March, 1984 a 2.3 million m^3/h performance system was installed at the 275 MW Rawhide Unit I, Colorado. By the end of 1986, seven flue gas desulphurization systems (of an overall performance amounting to 18.3 million m^3/h) will have been operated in the United States. By the end of 1988, twelve systems (of a total performance approaching 40 million m^3/h) will have been run in the entire world. Of these, two will have been installed in Europe (in Austria and West Germany, respectively). In 1984, Niro Atomizer ranked fourth among the world manufacturer of flue gas desulphurization systems [8]. And this means that Niro Atomizer methods are safe, reliable and highly efficient as applied to the desulphurization of flue gases from power generation [2], [4]. Nevertheless, the application of Niro Atomizer systems is not as widespread as it seems to be. In 1988, they will have worked for power stations of a global output of 5165 MW. Compared to the electric power generated in Poland, this total approaches the overall output of two Polish lignite-fired power plants after development. But we should keep in mind that spray-dryer systems are operated in high-developed and industrialized countries alone (the United States, West Europe). And this means that the Niro Atomizer concept cannot be thought of as being applicable in Polish power stations in the nearest future.

In Poland, recent investigations focus on desulphurization by injection of a pulverized sorbent to the flue gas stream. Chemical adsorption processes are promising as far as economical success is concerned, but it cannot be expected that high sulphur removal will be achieved. The calculated [1] unit expenditure per one kilowatt of power installed approaches 25 U.S. dol. (i.e., one fifth of the expenditure for Niro Atomizer systems). Tests carried out for a 22 MW system making use of sodium-based sorbents, such as sodium bicarbonate, yielded a degree of desulphurization approaching 70°/o [1], which seems to be of great promise. However, recent results reported by KEENER and DAVIS [7] showed that the reaction of sulphur dioxide with sodium carbonate and sodium bicarbonate was slow. Thus, 60°/o conversion of sodium carbonate to sodium sulphate took approximately 600 s. This implies two alternative approaches – increasing the amount of the sorbent to be injected or extending the time of contact by transportation of the sorbent and flue gas mixture through a long pipeline. But neither of the two procedures eliminates economic considerations. Increased sorbent injections account for the rise in operation costs; they also yield products that are mostly unfit for utilization. Extended contact time calls for the construction of long pipeline systems and for increased energy supply. Despite these inherent disadvantages, the concept involving a dry injection of pulverized sorbents is worth developing provided that attempts are made to accelerate the dry sorption of sulphur dioxide, thus contributing to the abatement of sulphur compound emission from power stations in Poland.

One of the Research Teams affiliated with the Institute of Environment Protection Engineering, Technical University of Wrocław, investigates the problem of desulphurization by the dry injection of pulverized sorbents to the flue gas stream. The objective of the study is to achieve such a time of contact (taking several seconds only) that will yield 50 to 60°/o removal of sulphur and ensure a high degree of sorbent utilization. It has been assumed that the para-

meters of both the flue gas and the sorbent should be modified prior to injection at moderate increase of the installation and operation costs. It is estimated that this method will involve expenditures as low as one fourth of those for the absorption process in a spray-dryer, and that the managers will avail themselves of the existing pipelines and dust separators. Analysis of reported data seems to corroborate these expectations. NIKITIN and co-workers [9] obtained 60% removal of sulphur from the flue gas of an iron ore agglomerating plant (Makeev Metalurgical Works). They made use of natural dust from the agglomeration process. Calcium oxide contained in the dust amounted to 9.8 wt. %. The flue gas had a temperature ranging between 350 and 400 K, and consisted of dust particulates, sulphur dioxide and water vapour amounting to 4–5 g/m^3, 15–20 g/m^3 and 8–10% respectively. After desulphurization, the concentration of sulphur dioxide varied from 6 to 8 g/m^3.

Now, laboratory investigations are underway. The results will be published in domestic and foreign journals (e.g. JAPCA).

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SUCHE METODY ODSIARCZANIA GAZÓW ODLOTOWYCH

Przypomniano trudności związane z budową i eksploatacją mokrych instalacji do odsiarczania gazów odlotowych. Podkreślono, że dotychczas w Polsce nie stosuje się odsiarczania spalin ani w palenisku fluidalnym, ani na bazie metody amoniakalnej. Przedstawiono przyczyny, dla których metody te nie są rozpowszechnione. Zwrócono uwagę, że oczyszczanie gazów odlotowych w przodujących w tej dziedzinie krajach polega os-

tatnio na adaptacji procesu suszenia rozpyłowego do usuwania tlenków siarki i azotu. Omówiono szanse odsiarczania spalin podczas adsorpcji dwutlenku siarki na suchych pylistych sorbentach. Zaprezentowano kierunki prowadzonych w Instytucie Inżynierii Ochrony Środowiska poszukiwań nowych rozwiązań w odsiarczaniu spalin, m.in. w aspekcie oczyszczania spalin pochodzących z elektrowni wielkich mocy korzystających z węgla brunatnego.

GASENTSCHWEFELUNG IM TROCKENVERFAHREN

Es besteht eine dringende Notwendigkeit in Polen, die bisher angewandten Nassreiniger aus vielen Gründen mit Trockenverfahren und mit entsprechender Apparatur zu ersetzen. Das Institut für Umweltschutz und Umwelttechnik der Technischen Universität zu Wrocław hat neue Methoden zur Gasentschwefelung entwickelt und vorgeschlagen.

Der Aufsatz enthält eine ausführende Besprechung des sogenannten Spray-Dryer-Verfahrens, das bereits seit Jahren in den Vereinigten Staaten und in einigen westeuropäischen Ländern mit Erfolg angewandt wird.

СУХИЕ МЕТОДЫ ОБЕССЕРИВАНИЯ ОТХОДЯЩИХ ГАЗОВ

Представлены затруднения, связанные со строительством и эксплуатацией мокрых установок для обессеривания отходящих газов. Подчёркнуто, что до сих пор в Польше не применяется обессеривание отходящих газов ни во флюидной камере сгорания, ни аммиачным методом. Указаны причины, по которым эти методы не распространены в Польше. Обращено внимание на то, что в странах, имеющих самые большие успехи в этой области, очистка отходящих газов, в последнее время, состоит в адаптации процесса распылительной сушки для удаления окислов серы и азота.

Обсуждены шансы обессеривания отходящих газов во время адсорбции двуокиси серы на пылеватых сорбентах. Представлены направления, проводимых в Институте технической охраны среды, поисков новых способов обессеривания отходящих газов, в частности, в аспекте очистки отходящих газов, которые испускают электростанции большой мощности, пользующиеся бурым углем.