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ABSTRACT

In line with the then emerging air pollution control regulations Union Electric installed a limestone injection wet scrubber sulfur dioxide removal system on an intermediate size coal-fired utility boiler at its Meramec Power Plant on an experimental basis in September, 1968. During approximately 3 years of operation many difficulties were encountered with plugging and scaling of various system components by calcium sulphate. As a result of this experience along with related experiences by other utilities employing similar systems,the experiment was terminated in June,1971.

As a result of the experiences gained, however, second generation experiments in sulfur dioxide removal have been initiated elsewhere with the hope of improved performance. A number of experimental projects are still under tests. Costs in resources, reliability, and disposal of residual by-products are matters of great concern.

The true cost of sulfur dioxide removal systems in dollars and resources is not well known and perhaps a reevaluation of current and future SO_2 removal projects is in order at this time before additional resources are committed.

UNION ELECTRIC EXPERIENCE

As air pollution control regulations were emerging during the mid 1960's Union Electric Company recognized the need for research work to develop some method of removing sulfur dioxide from the stack gases of large power plant boilers. As a result of discussions with potential suppliers of such equipment Union Electric Company decided in 1967 to install a Combustion Engineering limestone boiler injection wet scrubbing sulfur dioxide removal system on an intermediate size coal-fired utility boiler at the Meramec Power Plant. The system was installed and began operation in September, 1968, and operated intermittently until June,1971. The total operating time during that period was 120 days equivalent. During that time many difficulties were encountered with the system including such problems as:

1) Plugging of the boiler economizer, superheater, and air heater with lime and calcium sulphate deposits.

2) Scaling in the wet scrubber and pipes due to supersaturated solutions of sulphates.

3) Demister and stack gas reheater plugging due to liquid carry over from the wet scrubber which contains sulphates and fly ash.

SOME OTHER SYSTEMS

The flurry of regulatory activities prompted others to become interested in the development of other types of scrubber systems. A somewhat similar scrubbing system was installed at the Lawrence Plant of Kansas Power and Light. This system operated intermittently for some period of time with substantial difficulties. However, it was not until a second unit was placed in service at the station that the combined discharge from the scrubber units resulted in saturation of the recycle water. At that time major scaling problems began to occur in both Lawrence scrubbing systems, and the history of the Lawrence problems is much the same as those experienced at Union Electric.

Kansas City Power and Light Company installed two boiler injection limestone scrubbing systems at their Hawthorn Power Station which experienced the same type of problems.

This cumulative experience has led Union Electric to conclude that limestone boiler-injection systems are not practical for removal of SO_2 from the stack gas; however, the experience has been valuable in the design of second generation scrubber systems which utilize lime/limestone slurry injection directly into the flue gas scrubber container itself.

Numerous processes are now under study. To date the Environmental Protection Agency reports that there are some 44 systems in operation or committed in the United States.[1]

The types of systems under study to date are:

1) The lime/limestone wet scrubber throw away systems.
2) The magnesium oxide scrubber regenerative system.
3) The alkali scrubber regenerative system.
4) Catalytic oxidation system.
5) Carbon Absorption System.

The most promising operations to date are those utilizing lime materials as an absorbant.

Data

When Union Electric began its developmental work it envisioned a scrubber design that would operate with a reliability equal to that of the other major components of the power plant equipment and that the cost of such systems would be reasonable. The Union Electric scrubber installation cost approximately \$10 per kW of unit plant capacity and, at the time the subject system was installed, it was estimated by vendors that a similar system could be installed on a new 500 MW unit for about \$5 or less per kW.

In a 1972 document published by the Federal EPA in connection with final promulgation of "Standards of Performance for New Stationery Sources", it was stated that the cost of the lime scrubbing system which is now in operation at the Paddy's Run Plant of Louisville Gas and Electric would be $28.6 per kW of plant capacity.[2] The final cost of that system which went on line in 1973 has been reported to be $57 per kW.[1] In the 1972 document it was reported that the Will County Station limestone scrubber system of Commonwealth Edison would cost $49 per kW.[2] The final cost of that installation was reported to be $108 per kW.[1]

Testimony submitted by an equipment vendor at hearings held by the Federal EPA in October and November 1973 on power plant compliance with sulfur oxide air pollution regulations indicated that their ratio of installed cost to vendor to the selling price to user of such systems was 3.02.[3] (This ratio is usually less than one.) This reflects the difficulty of estimating costs of scrubber equipment for which operating reliability has not yet been demonstrated and raises the question of what one might expect such equipment to cost once all the design problems have been identified and solved.

Operating Experience

Brief statements about operating experiences of three wet scrubber installations follow.

The operating experience of the Will County System as of December 31, 1973 has demonstrated a reliability on ½ of the scrubbing system of 27% and on the other ½ of the system 13%.

Louisville Gas and Electric's 65 MW Paddy's Run No. 6 is a peaking unit utilizing waste carbide sludge for SO_2 removal. Combustion Engineering designed the system to include two scrubber modules each consisting of two marble bed contactors in series. The scrubbers were started up on April 5, 1973, however, various modifications were required before attaining improved reliability during late 1973.

Use of natural gas in the direct fired reheater has avoided the corrosion problems prevalent in reheaters of other SO_2 removal systems. Availability and economics of natural gas for reheat may be of small consequence on a 65 MW peaking unit but become a major factor of consideration for large base loaded installations.

Because of poor turn-down of the scrubber, Louisville Gas and Electric is recycling gas to keep gas flow up to design load. In large multiscrubber SO_2 removal installations gas flows probably will be regulated by dampers. Demonstration of reliability for critical damper operation is not part of the development program at Paddy's Run and hence this aspect of development of reliable hardware requires additional study.

Although the operating results to date have been encouraging, a longer period of trouble-free operation on the Paddy's Run Unit is required to determine system reliability.

On July 9, 1973, two of Duquesne Light's Phillips Station single stage venturi scrubbers were placed in operation for particulate removal only. At that time the lime addition system was not yet complete. Consequently the unintentional SO_2 removal in the particulate scrubber resulted in low pH which could not be corrected. Corrosion problems were numerous and affected pumps, duct expansion joints, concrete stack, I.D. fans, inlet dampers and stiffner bars. As of February, 1974 no sulfur dioxide removal had yet been attempted.

Operational data on many of the systems now being experimented with in the United States and abroad is not readily available.

Environmental Consequences

There are other potential environmental problems created through the operation of sulfur dioxide stack gas removal systems. For example the volume of sludge generated by throw away systems is substantial. If Union Electric were to install a lime wet scrubbing system on its 880 MW Meramec Plant the sludge generated would fill 100 acres of land to a depth of about 3 feet each year. The reader could easily project this data for a thirty year life at Labadie which has a capacity of 2400 MW.

Work has been carried out by Chicago Fly Ash to "fix" the sludge generated at the Commonwealth Edison Will County Plant and preliminary studies have been conducted by Dravco to manage sludge generated at the Duquesne Power and Light Phillips Station. It is reported that sludge preparation costs at Will County are approximately $17 per ton of dry product and the cost to prepare the sludge for landfill at the Duquesne Power and Light Plant is estimated to be $14-$15 per ton of dry disposable product.[1] The cost, therefore to prepare sludge for landfill by these methods would add nearly 5 million dollars per year to the operating budget of a 1000 MW coal-fired plant, which would be about 10-15% of environmental control costs of SO_2 removal.

TVA has done considerable work on SO_2 emissions and the following excerpts are from their news release of February 5, 1974 on this subject.

> "The basic problem with chemical scrubbing as a means of controlling sulfur dioxide is not confined to the technology of using it in power plants.
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> "Scrubbers themselves create new environmental problems of immense proportions which have not been solved. Foremost among these is the problem of solid waste disposal. The waste created by a power plant using the scrubbing process requires four times as much land for disposal as fly ash. For TVA, this would require disposal areas totaling 20,000 acres in the next 20 years. The waste sludge material is watery and unstable. It is therefore not suitable for other uses and poses the danger of water pollution.
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> "In addition, the process would impose large new burdens on the Nation's energy supply. In TVA's case, scrubbers on all its plants would consume 6 percent of the generation of those plants, requiring an extra 2.4 million tons of coal, the equivalent of 10 million barrels of oil. They would require mining 25 percent more minerals--coal and limestone--with all the environmental problems and additional energy required for mining and transportation."[4]

BACKGROUND INFORMATION FOR PROPOSED NEW-SOURCE PERFORMANCE STANDARDS

The U. S. Environmental Protection Agency published a document titled "Background Information for Proposed New-Source Performance Standards" dated August, 1971 which states:

> "At this time only the lime-slurry scrubbing system is considered adequately demonstrated on large

steam generators. Three other processes have been shown capable of continuous operation at smaller installations."

"A lime-slurry scrubbing system, demonstrated for 6 months on two coal-fired units of 125 and 140 MW capacity, approached the SO_2 emission limit of 1.2 pounds per million BTU."[5]

At the time that document was prepared the Union Electric APCS had been permanently shut down, yet EPA went on to use the document to support regulations on "Standard of Performance for New Stationary Sources". In addition, EPA published a supplemental statement in connection with final promulgation of those regulations in the March 21, 1972 edition of the Federal Register where on page 5768, Table-I shows that the Union Electric APCS "Operated at 73% efficiency during EPA tests".[6] To our knowledge, EPA has never run tests on the Meramec Air Pollution Control System.

The tremendous administrative burden placed on the Federal EPA by the Congress in passing the Clean Air Act is certainly recognized. However, EPA went on to promulgate emission standards which cannot be met and, indeed, which are not compatible with the needs for improving air quality in areas where the quality of the air is already below State and Federal ambient standards. Compliance with arbitrary emission standards under such circumstances results in consumption of scarce resources without providing corresponding benefits to the public.

SUMMARY

The atmosphere was not pristine pure before man's existence on this earth and it would not become so if life became extinct. There are many natural forces at work which result in substantial releases of "pollutants" such as: volcanic action, decay of vegetation which releases sulfur compounds, sulfur compounds released into the air in the form of sea spray, etc. Therefore, our efforts must necessarily be directed to maintain air quality at acceptable levels using wisely the resources available to us.

It is obvious that the true cost of sulfur dioxide systems is yet unknown and it would seem that we need to reevaluate the wisdom of requiring installation of such systems under circumstances where ambient air quality is already better than required to protect the health and welfare of the general public. A review of the social costs and benefits of applying control systems indiscriminately should be undertaken which takes into consideration alternative resource application.

The cost to install sulfur dioxide scrubbers on the three major coal-fired plants now in operation in the Union Electric System would be staggering. It is estimated that the investment required for such a program would be on the order of $400,000,000 and would result in an increase in revenue needs of about $100,000,000 per year. This would result in average power cost increases of about 25%.

There are a variety of ways to control air quality, such as the use of tall stacks for good dispersion, intermittant load reductions when necessary to prevent pollutant build-ups under certain adverse meteorological conditions, use of low sulfur fuels, and in the future, application of emission control devices when they are fully developed and when they become the best alternative method of ambient air quality control.

It seems clear that the time has come for a new look at our air quality control programs and the Clean Air Act itself, in order to make essential corrections which will provide acceptable air quality at the least social and economic costs to the general public.

REFERENCES

(1) "Report of the Hearing Panel - National Public Hearings for Power Plant Compliance with Sulfur Oxide Air Pollution Regulations".

(2) "Standards of Performance for New Stationary Sources - Supplemental Statement in Connection with Final Promulgation" CFR, March 21, 1972.

(3) Environmental Protection Agency Public Hearings and Conference on Status of Compliance with Sulfur Oxide Emission Regulations by Power Plants and Application of Sulfur Oxide Control Technology - October 24, 1973, Page 1288 of the hearing record.

(4) TVA News Release of February 5, 1974, TVA 4516 (3-72).

(5) "Background Information for Proposed New-Source Performance Standards", U. S. Environmental Protection Agency, August, 1971.

(6) Federal Register, March 21, 1973, Table I, Page 5768.