OXYGEN ENRICHMENT OF COMBUSTION AIR IN A 360 TPD MASS BURN REFUSE-FIRED WATERWALL FURNACE

WILLIAM S. STRAUSS AND JOHN A. LUKENS
Harrisburg Steam Generating Facility
Harrisburg, Pennsylvania

FLORIO K. YOUNG AND FRANK B. BINGHAM
Air Products and Chemicals, Inc.
Allentown, Pennsylvania

Discussion by

Peter H. Kromayer
STV/Sanders & Thomas
Pottstown, Pennsylvania

Messrs. Strauss, Lukens, Young and Bingham have done an excellent job of describing what can be done with the use of oxygen to improve incinerator operation in a waste-to-energy plant. Their experience exactly duplicates the experience in the steel industry where oxygen enrichment has been used for many years to:

(a) Improve furnace efficiency and save fuel.

(b) Improve furnace throughout by raising the actual flame temperature.

(c) Replace combustion air lost through leakage in the heat recovery equipment or other inadequacies in the combustion air system.

Data published in various journals of the Iron and Steel Industry have always concluded that the test results closely follow the theoretical results predicted before the test. In other words, the laws of thermodynamics and combustion are inviolate.

The demise of quite a number of steel plants presents an opportunity. Many steel plants had bulk oxygen plants constructed nearby, which may now be idle or have excess capacity. The gaseous oxygen available from these plants is far less costly than liquid oxygen, usually by a factor of four. The availability of gaseous oxygen may be the factor that determines whether the use of oxygen is financially feasible or not. One should therefore consider whether some "distressed" or surplus gaseous oxygen is available nearby. This was the case in Harrisburg.

One word of caution. Gaseous bulk oxygen can safely be utilized at very high flow rates. This has been demonstrated at many installations. However, fires can occur. These can readily be avoided if the following rules are followed:

(a) Meet and exceed all of the rules given in the Compressed Gas Association's Standard G 4.4—Industrial Practices for Gaseous Oxygen Transmission and Distribution Piping Systems.

(b) Take extreme care to keep the insides of all oxygen piping "white glove clean" or free of all contaminants and noncompatible materials during all construction and maintenance work. This includes the proper selection of valve materials.

(c) Keep oxygen piping above ground where its condition can be monitored.

As stated above, failure to do so can result in very serious consequences. This has, unfortunately, been amply demonstrated in the steel industry.

Discussion by

W. G. Collins
Westinghouse Electric Corporation
Pittsburgh, Pennsylvania

The authors report an interesting experiment that showed beneficial effects of oxygen enrichment of the combustion air at the Harrisburg, Pennsylvania waste-to-energy plant. They report improvements in waste processing capacity, boiler efficiency and burnout of the material, as well as improved ability to burn wet refuse and sewage sludge mixed with municipal solid waste. This technique deserves further testing, and should be examined for applicability in other plants.

In considering application to other plants, the improvements reported at the Harrisburg plant should be examined for applicability, as follows:

(a) Waste Processing Capacity. The capacity of the Harrisburg plant is limited by fan capacity. Oxygen enrichment diminishes the total volume of gas that must be handled per unit heat release, and therefore enables higher waste combustion rate and throughput. This would be applicable to other plants that are limited by flue gas flow considerations. When a plant is limited by steam flow, however, oxygen enrichment would actually reduce processing capacity. This is because diminishing the mass of flue gas generated per unit heat release increases boiler efficiency, and hence the amount of steam generated per unit heat release, as the authors report, so less heat release and consequently less throughput would generate the limiting steam flow.

(b) Combustion Quality. The Harrisburg plant showed significant decrease in the combustible content of the residue of combustion when using oxygen enrichment. Other plants should also experience improvement in this area, but in plants that already achieve high burnout of the material, the improvement may not be as significant as was reported for Harrisburg.

(c) Cost. The authors had access to a plentiful, low cost supply of oxygen. Other plants generally would not have oxygen available at such low cost. The cost of oxygen supply would need to be evaluated in relation to the benefits of oxygen enrichment.

The authors also report some gaseous emission numbers from the plant. They say that gaseous emissions need further study, and I agree with this statement. Some of the reported emission numbers are highly questionable. The nitrogen oxide emission numbers, with and without oxygen enrichment, are much lower than have been reported at other waste burning plants, and must be viewed with skepticism. Also, the carbon monoxide and VOC emissions without oxygen enrichment seem inconsistent; the reported carbon monoxide emission seems much too low in relation to the VOC emission. More testing needs to be done to reliably measure the gaseous emissions.

Once again, the authors are to be congratulated for performing a very interesting experiment that showed significant beneficial effects of oxygen enrichment at the Harrisburg plant, and that indicates the value of further exploring use of this technique in other plants.