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Project Summary

Municipal Waste Combustion Assessment: Fossil Fuel Co-Firing

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Fossil fuel co-firing, defined as the combustion of refuse derived fuel (RDF) with another fuel (usually coal) in a device designed primarily to burn the other fuel, is generally confined to commercial and utility boilers. This report identifies RDF processing operations and various RDF types; describes such fossil fuel co-firing technologies as coal fired spreader stockers,pulverized coal tangentially fired boilers, and cyclone fired boilers; and describes the population of coal fired boilers that currently co-fire RDF, have previously co-fired RDF but have ceased to do so, and have been used in RDF co-firing demonstration projects. Model plants are developed and good combustion practices are recommended.

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Fossil co-firing is defined as the combustion of RDF with another fuel (usually coal) in a device designed primarily to burn the other fuel.This report provides an overview of fossil fuel co-firing technology and identifies the extent to which fossil fuel co-firing is practiced.

Currently Co-Firing

Four facilities currently co-fire RDF. The Madison Gas and Electric's Blount Street Power Plant includes two 50 MWe front wall fired pulverized coal boilers modified to co-fire RDF by installing RDF injectors between the bottom two burner levels. A drop grate was added to the boilers to ensure complete burnout of the ash generated by the RDF. RDF supplied about 15% by weight of the fuel used by the boilers (12% of total heat input). No major problems have been reported. Minor problems occurred with the formation of clinkers on the grate. Despite the lack of firing problems, the additional operating costs associated with co-firing RDF make it uneconomical without special price concessions and subsidies from the City.

The Ames, Iowa, City Power Plant includes a 35 MWe tangentially fired pulverized coal boiler modified to burn RDF and a 65 MWe front wall fired pulverized coal unit originally designed to burn RDF Air transport RDF injectors on both units are located just above the primary combustion zone. In addition, both units are equipped with drop grates. The 35 MWe unit fires 18% by weight RDF (12% of total heat input). The 65 MWe unit fires 20% by weight RDF (10% of total heat input). Problems reported are related to handling the RDF feed and the resulting ash. The variable nature of RDF makes it difficult to maintain continuous feed with a relatively constant heat content. Wires and non-ferrous metals create significant ash handling problems. The RDF feeding system frequently jams, damaging the machinery. Originally, tube wastage was observed around the drop grate due to the reducing atmosphere produced by ash burning on the grate. This problem was remedied by installing refractory around the grate. The plant operators report that RDF co-firing in their boilers is not financially advantageous because of high maintenance costs.

Baltimore Gas and Electric Company operates two 200 MWe cyclone fired boilers modified to co-fire RDF by installation of RDF injection equipment in the cyclone. Initially, erosion was observed on the cyclone wall opposite the RDF injection port. The installation of a deflection plate eliminated the problem. The RDF is an average of 5 to 10% by weight (3 to 5% total heat input) of the total fuel fed to the boiler. No major problems have been reported operating with RDF. The utility has not yet identified the impact of firing RDF on operating and maintenance costs; however, it reports that, from a fuel cost standpoint, RDF co-firing is financially attractive. The RDF purchase contract requires the utility to pay only 80% of the price they would pay for an equivalent amount of coal (on a heating value basis), resulting in a fuel cost savings of 20%.

The City of Lakeland, Florida's McIntosh Power Plant includes a 364 MWe opposed burner, pulverized coal fired boiler designed to co-fire RDF and coal. The coal burners are located at four elevations on the front and rear walls. Two air transport RDF injectors are located on each side wall at the same elevation as the upper coal burners. The boiler is also equipped with drop grates. Only 1% of the mass fired in the boiler is made up of RDF. Lakeland reports no operating problems, no excess tube wastage, slagging or fouling. They report that firing RDF appears to be financially viable when operating costs alone are considered. However, when debt retirement on the processing plant is also considered, the unit does not quite break even.

Dicontinued Co-Firing

Six facilities have previously co-fired RDF but have discontinued this practice. The Oscar Mayer Steam Generating Plant in Madison, Wisconsin, consists of a spreader stoker traveling grate system modified to burn RDF. The facility had a capacity to burn up to 60 tons (54 tonnes) of RDF per day. Oscar Mayer reports that there was little economic incentive to continue co-firing RDF. They found overhead and maintenance costs to be prohibitive. In addition, the quality of the RDF varied excessively for convenient use. However, the facility still has the capacity to co-fire RDF if the economic situation changes.

The Union Electric, St. Louis Meramec Plant has two 125 MWe tangentially fired pulverized coal boilers modified to co-fire RDF. There are four vertically arranged, tilting coal burners in each corner. RDF injectors were installed, one in each corner between the second and third coal burners. Dump grates were not added. The RDF supplied an average of 10% of the total heat input. Problems experienced included plugging and jamming of the RDF feed system and excessive abrasion from the RDF feed particles due to the high glass and grit content of the RDF. The excessive abrasion caused frequent leaks in the feed lines which had to be continually repaired resulting in extremely high maintenance costs. Boiler efficiency was decreased due to the higher moisture and ash content of RDF compared to coal and increased unburned combustibles in the bottom ash.

The Wisconsin Electric's Oak Creek Station has two 310 MWe tangentially fired pulverized coal boilers modified to co-fire RDF. There are five tilting coal burners in each corner. Four RDF injectors were installed, one in each corner, above the top coal burners. No dump grates were added. The RDF supplied an average of 15% of the total heat input. The facility experienced excessive abrasion of the RDF feed lines because of the glass and grit in the RDF as well as increased slagging. Solidified slag collected at the bottom of the furnace and choked off bottom ash flow. Deslagging involved the use of shotguns and dynamite to blast loose slag deposits and required 4-5 hours. Deslagging was required 12-15 times per month during co-firing as opposed to 7-10 times per month during operation with coal alone.

Four Rochester, New York, Gas and Electric units are tangentially fired, pulverized coal boilers with capacities of 42, 62, 62, and 75 MWe. Two RDF injectors were installed in each unit in opposite corners above the coal burners. Two units received dump grates and two did not. The RDF supplied an average of 15% of the total heat input. Problems experienced included pluggage of RDF feed lines and large clinker formation on dump grates. Boiler efficiency decreased because of the higher moisture and ash content of RDF compared to coal, increased excess air levels, and increased amounts of unburned combustibles in bottom ash.

The Commonwealth Edison, Chicago Crawford Station includes one 200 MWe and one 325 MWe tangentially fired, pulverized coal boilers modified to co-fire RDF. The modifications included installation of two RDF injectors in two opposite corners of each furnace (four per unit). Dump grates were not installed. The average heat input provided by the RDF was 10%. Problems included plugging and excessive abrasion of the RDF feed lines, increased volume and particle size of bottom ash, and increased slag accumulation.

The United Illuminating Harbor Station in Bridgeport, Connecticut, includes an 80 MWe cyclone boiler previously used to co-fire RDF. The RDF was a dry powder with a heat content of 7800 Btu/lb (1.81×10^7 J/kg). The RDF provided an average heat input of 30%. No major problems were associated with co-firing RDF. The facility ceased co-firing because the RDF processing plant closed.

Co-Firing Demonstrations

Two facilities were involved in RDF co firing demonstration projects. The B.L England Station includes one 129 MW cyclone fired unit which was used to co fire RDF as part of an 18 day feasibility demonstration study. The RDF wa injected through the secondary air duct in the cyclone. The facility was able t burn 2550 tons (2313 tonnes) of RD during the 18-day test. Stable operatio was maintained only when RDF was les than 15% of the total heat input to th boiler. Severe fouling and slaggin problems were experienced and the a heater plugged rapidly, forcing shutdown of the unit. In addition, a har tenacious ash that could only be remove with jackhammers fouled the reheat surfaces. Unit efficiency was significantl affected by RDF co-firing. The un gradually derated from 129 to 100 MW Emissions increased significantly whe co-firing RDF. Particulate emissions ar precipitator power levels increased by factor of 3. Because of these problem Atlantic Electric concluded that RDF c firing was unacceptable.

The Milwaukee County Institution Power Plant includes one spreader stok boiler rated at 110,000 lb/hr (49,8 kg/hr) of steam that was used to co-fi RDF during a 9 day test with 3 days performance testing. The RDF consist of about 21% by weight of the coal/RD mixture and about 11% by heating valu No significant feeding problems we encountered. The coal/RDF mixtu clinkered more frequently than co alone. Also, some RDF fell into the a pit unburned. The boiler was unable achieve steam generation rates that h been easily attained when firing co alone, reportedly due to the volumet limitations of the spreader feed equipment when firing the less dense coal/RDF mixture. Erratic steam rates were also experienced, reportedly due to non-uniform mixing of the coal and RDF. Particulate carryover did not increase significantly, reportedly due to using densified RDF rather than fluff RDF.

Conclusions

RDF co-firing affects many aspects of boiler operation and performance, including boiler efficiency, flue gas flow rates, stack emissions, bottom ash production, slagging and fouling. Boiler efficiency decreases with RDF co-firing because of increased flue gas production, increased unburned carbon, and fuel moisture losses. Flue gas flow rates increase as the amount of RDF co-fired increases primarily due to the requirement for increased excess air to account for variability in RDF feeding. Compared to coal, RDF typically has low sulfur concentrations, high chlorine concentrations, and a high ash content. Thus, co-firing RDF typically increases HCl emissions and decreases SO_x emissions. In general, particulate emissions increase with RDF co-firing. CO emissions from RDF co-firing with coal are not significantly changed from coal-fired boiler CO levels. NO_x emissions from RDF co-fired systems are not expected to be significantly different than those from coal-fired systems. The only dioxin data available on co-fired units were from a study co-firing about 20% RDF by weight. No dioxins or furans were detected in the emissions. In addition, emissions tests have been performed at seven coal fired boilers. No CDD or CDF emissions were detected from any of these facilities. The available emissions data from boilers burning 100% RDF indicate that highly variable CDD/CDF emissions may occur under normal operating conditions. However, the conditions under which substantial CDD/CDF emissions occur are not expected to be encountered under normal operation in an RDF co-fired system.

Bottom ash production increases by a factor of 2 or 3 when 10-20% RDF is co-fired on a heat input basis because RDF has a higher specific ash content (lb/Btu) than coal. RDF co-firing may increase the potential for slagging and fouling and result in increased maintenance costs, and decreased boiler efficiency and availability.

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The complete report, entitled "Municipal Waste Combustion Assessment: Fossil Fuel Co-Firing," (Order No. PB90 159 831/AS Cost: $17.00 (subject to change) will be available only from:
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