Proceedings of the 17th Annual North American Waste-to-Energy Conference
NAWTEC17
May 18-20, 2009, Chantilly, Virginia, USA

NAWTEC17-2373

ELEMENTS OF A SUCCESSFUL WASTE-TO-ENERGY BOILER UPGRADE

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ABSTRACT

Great River Energy operates a waste-to-energy plant in Elk River, Minnesota. The plant burns 850 tons per day of refuse derived fuel (RDF) in three boilers, and its three steam turbines can produce 32 MW of electricity. In the largest of the three units, the No. 3 Boiler, steam generation was restricted by carbon monoxide (CO) and nitrogen oxides (NO_x) emission limits. The plant had an interest in improving the combustion performance of the unit, thereby allowing higher average RDF firing rates while staying within emissions compliance.

The project was initiated by an engineering site visit and evaluation. The boiler had a history of unstable burning on the stoker grate, which required periodic natural gas co-firing to reduce CO levels. As an outcome to the evaluation, it was decided to install a new overfire air (OFA) system to improve burnout of combustible gases above the grate.

Current and new OFA arrangements were evaluated via Computational Fluid Dynamics (CFD) modeling. The results illustrated the limitations of the original OFA system (comprised of multiple rows of small OFA ports on the front and rear furnace walls), which generated inadequate mixing of air and combustible gases in the middle of the boiler. The modeling illustrated the advantages of large and fewer OFA nozzles placed on the side walls in an interlaced pattern, a configuration that has given excellent performance on over 45 biomass-fired boilers of similar design upgraded by Jansen Combustion and Boiler Technologies, Inc. (JANSEN).

Installation of the new OFA system was completed in April of 2008. Subsequent testing of the No. 3 Boiler showed that it could reliably meet the state emission levels for CO and NO_x (200 ppm and 250 ppm, respectively, corrected to 7% dry flue gas oxygen) while generating 24% more steam than a representative five month period prior to the upgrade.

This paper describes the elements that led to a successful project, including: data collection, engineering analyses, CFD modeling, system design, equipment supply, installation, operator training, and startup assistance.

1. INTRODUCTION

Great River Energy operates a late 1950s vintage Riley Stoker Boiler called the No. 3 Boiler at its waste-to-energy plant in Elk River, Minnesota. The boiler was designed to produce 215,000 lb/hr of steam at a temperature of 905°F and a pressure of 875 psig while firing pulverized coal. In 1989, the unit was converted to fire RDF on a traveling grate generating up to 173,600 lb/hr of steam at 750°F and 615 psig. A sectional side view of the boiler is shown in Figure 1.

The OFA system installed in 1989 was typical for OFA systems installed on stoker fired boilers during that time period. It consisted of several small circular ports (made from 4" and 2.5" pipe) arranged in three levels on the rear wall and two levels on the front wall. In this configuration, a booster OFA fan supplied hot combustion air to the OFA ports and to the fuel distributor spouts.