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ADVANCEMENTS IN GRATE COOLING TECHNOLOGY

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ABSTRACT

Over the last few years an increase in the calorific value of the waste has been observed at our waste-to-energy facilities. Wheelabrator Technologies, Inc. in conjunction with Von Roll/Inova decided to install a zone of water-cooled grate blocks at the Millbury Massachusetts waste-to-energy facility as a pilot program. Common in Europe these water-cooled grate blocks address the issue of higher BTU waste and increase the overall life expectancy of the blocks compared to regular air-cooled grate blocks. This technical paper provides an overview on the installation, operation, and maintenance of a zone of water-cooled grate blocks. Discussed are the procedures for evaluating the overall project and some of the challenges we resolved.

INTRODUCTION

As a company Wheelabrator Technologies, Inc. (Wheelabrator) spends roughly 9% of its overall maintenance budget on combustion grates. Always on the lookout for ways to reduce expenditures and improve performance Wheelabrator paired with Von Roll/Inova, the original manufacturer of Wheelabrator's grates, to install and perform tests on a zone of water-cooled grate blocks in our Millbury, Massachusetts facility. Common in Europe, water-cooled grate blocks have been installed at 25 plants in 39 boilers.

Chosen for its excellent operating statistics and motivated personnel, Millbury proved to be the right location for such an endeavor. The Millbury Waste-to-Energy (WTE) Facility (Millbury) consists of two 750 ton per day (tpd) mass burn boilers. In February of 2007 Wheelabrator personnel with assistance from Von Roll installed water-cooled grate blocks in zone #3 of one boiler.

VON ROLL WATER-COOLED GRATE BLOCK DESIGN

Von Roll first began offering their water-cooled Aquaroll® in 1994. Water-cooled grate blocks address the issue of an increase in the calorific value of the waste over the years and the subsequent increase in wear and resultant maintenance costs. Wheelabrator and Von Roll believe this increase in calorific value is due to in part to recycling trends which preferentially remove high density, low calorific materials from the waste stream versus high calorific materials. When comparing life expectancy of air-cooled grate blocks versus water-cooled, Von Roll's experience has shown that after 16,000 operating hours, 25% of air-cooled grate blocks will have to be replaced versus none of the water-cooled. An added benefit of the water-cooled grate blocks is that the under-grate air can be redistributed within the furnace to improve combustion. Whereas, air-cooled grate blocks this redistribution is not possible since air controls combustion and acts as the cooling medium for the grate blocks.

Von Roll currently offers several types of water-cooled grate blocks in Europe which are successfully operating in numerous facilities. The Type IIa water-cooled grate block is a casting with cooling water channels cast into it with welded block cooling water connections. The Type IIIa water-cooled grate block is a solid casting, made of a similar alloy as the air-cooled grate blocks, with embedded tubing in the interior of the casting. Wheelabrator decided to install the Type IIIa water-cooled grate blocks at Millbury because they could be run without water should a leak develop, and the modified piping connections seemed more reliable.

Water-cooled grate blocks are recommended by Von Roll for waste with an average higher heating value greater than 4,350 BTU/lb and strongly suggested for waste exceeding 5,300 BTU/lb, as indicated in the figure 1 below.

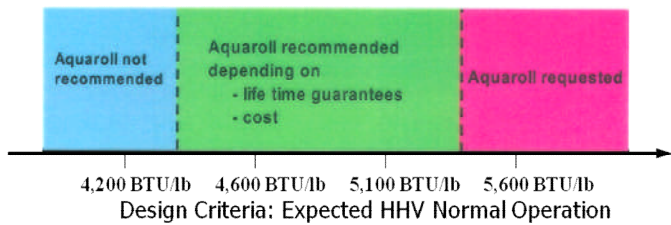


FIGURE 1 RECOMMENDED HEATING VALUES FOR WATER-COOLED GRATE BLOCKS

EXTERNAL PIPING SYSTEM

Typically in Europe when water-cooled grate blocks are installed the system is a closed loop, with water flowing through the blocks and out to a heat exchanger. The heat recovered from the heat exchanger is then utilized for some application in the plant. Typically, if water-cooled grate blocks are installed in a new plant the heat recovered is used to heat the primary air upstream of the steam coil air heater. If water-cooled grate blocks are retrofitted into an existing plant the heat is usually returned to the condensate system to improve overall plant efficiency.

Since the water-cooled grate block installation at Millbury was done on a trial basis, the heated cooling water from the grate blocks is not beneficially used, but simply added as make-up water to the cooling tower. The facility is currently examining more efficient ways to utilize the heat.

INSTALLATION, OPERATION, AND MAINTENANCE

When Wheelabrator first considered installing the water-cooled grate blocks there were concerns about how to handle 240 lb blocks without injuring anyone, how the blocks would affect daily operations, how reliable and durable the blocks really were, how to replace the press plates and roof elements around the blocks, the durability of the piping connections, and the differences between European waste and U.S. waste. Through the results of this pilot program the above concerns have been successfully alleviated.

Given the task of coming up with a method for safely handle the blocks, Millbury personnel designed a conveyor system that pulled the blocks up a roller-conveyor with rungs made of roller bearings and tube material. The blocks could be effortlessly winched up the ladder and lowered with an overhead winch into a module, as seen in the figures 2 and 3. This resolved the concern about safely handling the heavy blocks leaving Wheelabrator to focus on the other concerns that

would be resolved with long-term operating and maintenance experience.



FIGURE 2 CONVEYOR USED TO TRANSPORT THE BLOCKS INTO THE BOILER



FIGURE 3 WINCH USED TO LOWER THE BLOCKS INTO PLACE

The addition of water-cooled grate blocks had no adverse effects on operations, as observed by Millbury operators. Concerns about water-cooled grate blocks reducing the effectiveness of preheated primary air were never observed.

Since installation in February of 2007 the water-cooled grate blocks operated with little to no wear. The blocks were removed in January of 2010 this year due to cracks caused by a low external cooling water temperature and phase transformations at the grain boundary. During the outage in January modifications were made to the external system to raise

the water temperature to within a normal operating range typically seen in Europe. Regardless of the cracks, the faces and tops of the water-cooled grate blocks were in excellent condition after three years of operation. The last 6 months the water-cooled grate blocks operated without cooling water demonstrating that there was no sudden or rapid increase in wear.

Along with new water-cooled grate blocks Wheelabrator decided to install new lower profile roof elements. Installed in zone #3 through zone #5 are these shorter less exposed roof elements that should last longer than regular profile roof elements. The goal of this new design is to prevent having to replace the roof elements during outages, extend their life to at least three years further reducing maintenance costs.

An initial concern Wheelabrator had regarding all the welded connections and piping in the riddling hoppers proved to not be an issue. After three years there were no leaks caused by failed welded connections or cracked piping. However, there were leaks from the flexible hoses that connected a moving rows to the external piping system. These leaks were the result of grate siftings working its way into the braided hoses causing the metal to become brittle. Every six months we replaced the hoses in all modules until Wheelabrator personnel began resolving this problem by applying a large amount of high temperature silicon sealant to the braided hoses. All new braided hoses in the riddling hoppers are supplied with silicon fire sleeves.

The last concern Wheelabrator had regarding the water-cooled grate blocks was the difference in European trash versus U.S. trash. In the United States our trash is mass burn with limited presorting and recycling. In Europe most of the glass and metal is removed from the waste prior to delivery to the WTE facility. Wheelabrator anticipated more thermites, molten metal that cools and adheres to all grate blocks, than what is experienced in Europe. As a precaution, the automatic feature that increases the hydraulic pressure on a module that fails to reach the limit switch was turned off for the entire zone. This precaution resulted in operators manually correcting any stopped grate module during normal operation limiting any potential damage to the water-cooled grate blocks or the carriage assembly.

Another added benefit is a noticeable difference in the amount of material collected in the riddling hoppers. Since the water-cooled grate blocks are 6 times wider than the air-cooled grate blocks, there are fewer spaces for the siftings to fall through or for molten liquids to seep through. Through their routine inspections, the laborers continue to be impressed with how clean the hoppers are under the water-cooled sections as compared to the air-cooled zones.

Although most of Wheelabrator's initial concerns regarding the installation of these water-cooled grate blocks have been resolved, the addition of lower profile roof elements and future observations of thermite formations will continue to be evaluated. For now, Wheelabrator and Von Roll look forward to installing permanent systems of water-cooled grate blocks at three or four facilities.