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### RETROFIT INJECTION OF HUMID GAS FROM SLUDGE DRYER AND SECONDARY AIR IN WTE FURNACES OF QUÉBEC CITY

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#### ABSTRACT

This paper discusses the retrofit injection of humid gas from sludge dryer with secondary air in the WTE furnaces in Québec City. In 1992, a municipal sludge treatment plant was added in the WTE building. Three sludge dryers, each connected to a furnace, were added. Direct contact with hot furnace gas was used to dry sludge in a rotary drum. Humid gas from the dryer was returned to the rear wall of the furnace just above the finishing grate. CFD modeling showed cold flow of humid gas on the rear furnace wall, restriction of the combustion area on the principal grate, and stratification of the flow inside the boiler. A retrofit of the first chamber of the boiler was designed using injection of humid gas from the sludge dryer with secondary air on the front and rear walls. The main purpose of the retrofit was to maintain CO levels of under  $57 \text{ mg/m}^3$  on a 4 hour mobile average. The first boiler was retrofitted in winter 2008 and results have been very encouraging.

#### 1. INTRODUCTION

The Québec City waste-to-energy plant serves a population of 540,000. In addition to receiving residential waste, it also processes waste from the institutional, commercial, and industrial sectors. Built in 1974, it is made up of four furnaces with three grate sections designed by the supplier Von Roll. Each furnace has a capacity of 10 metric tons per hour. In 1992, three municipal sludge dryers designed by Swiss Combi were connected to three of the four furnaces. The hot gases from the furnaces are diverted as they emerge from the first pass just before the boiler and used for direct contact sludge drying in a rotational drum dryer. The wet or humid gas is returned to the combustion chamber and the dried sludge granules are returned

separately by pneumatic conveying. The evaporating capacity of each dryer is 3,500 kg of water per hour and the weight capacity is 1.15 metric tons per hour of sludge in dry base. In 2008, 290,000 metric tons of waste and 19,600 metric tons of sludge in dry base were treated.

The furnaces have seen various upgrades over the years. Nonetheless, the injection of secondary air into the combustion chamber is one aspect that has changed little over time. During the review of the process, the proportion of secondary air to total air was only 12%, while best practices recommend a proportion in the range of 33%. The orientation of the airflow nozzles and level of airflow penetration were also problematic. The concept of injecting wet gases from the dryer and locating the furnace entry in the back above the third grate section has also been called into question.

#### 2. CONCERNS

During the operational review of the WTE facility's furnaces in early 2005, it was noted that the furnaces were not delivering complete combustion. Bad homogeneity was being provided by the secondary air injectors. Computational fluid dynamic (CFD) gas flow simulations have demonstrated gas flow to be extremely stratified over the secondary air injectors. This bad homogeneity was caused by poor distribution due to the proportion of combustion and secondary air below the grates, as well as to poor distribution of air between secondary air injectors of the front and back walls. CFD simulations also showed that, despite better distribution and better air mixing, the temperature at the top of the combustion chamber remained relatively low. Furthermore, analysis of gas residence time over the secondary air injectors showed that gases had a transit time of less than one second before entering the boiler.