ENERGY RECOVERY IMPROVEMENT USING ORGANIC RANKINE CYCLE AT COVANTA’S HAVERHILL FACILITY

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ABSTRACT

Covanta Energy, in cooperation with United Technologies Corporation (UTC), has evaluated, designed, and is in the process of installing an Organic Rankine Cycle (ORC) system at its Haverhill Energy from Waste (EfW) Facility to improve heat recovery and energy efficiency, and to generate more clean renewable energy. ORC systems have been applied in geothermal applications and some other industrial processes to recover low grade and waste energy to generate electricity. This paper describes the design and integration of the ORC system into the Haverhill EfW steam cycle, and the landfill gas engine system, which also operates at the facility. The anticipated energy efficiency improvements and increased net power output have been analyzed and simulated. The results show that the integration of the ORC system could lead to a potential increase in the net power output by as much as 305 kWe in the summer and by 210 kWe in normal weather. It is also anticipated that with the ORC system the facility has the potential to improve the overall plant energy efficiency, as well as save city water.

1. INTRODUCTION

Covanta Energy owns and operates more than 40 EfW plants in North America. Covanta is committed to improving energy efficiency and generating more renewable energy from its EfW plants. One of the efforts is to effectively recover waste heat from those plants, such as vented and dumped steam, and energy lost with the stack gas. Covanta Energy, in cooperation with United Technologies Corporation, has evaluated, designed, and is in the process of installing an Organic Rankine Cycle (ORC) test system at its Haverhill Energy from Waste (EfW) Facility to improve heat recovery and energy efficiency, and to generate additional renewable energy. The installation will be completed in 2010.

The Haverhill facility operates two 825 TPD mass-burn EfW units that started up in 1989. Each boiler produces 865 psig (5.96 MPag) and 830 °F (443 °C) superheated steam, which is used to generate about 46 MW of gross power through a condensing turbine. The turbine has three bleeds for steam extraction. The 2 psig (13.8 kPag) extraction steam from the third bleed is used to heat the feedwater and is then merged with steam condensate in the air condenser collection tank. Intermediate pressure steam 50 psig (345 kPag) from the second bleed is directed to the deaerator for heating, temperature and pressure control. Energy in the steam turbine exhaust is rejected via an air-cooled condenser. Figure 1 shows a diagram of the main steam cycle system at the Haverhill facility. Due to limitations of the existing air-cooled condenser, some intermediate pressure steam from the 2nd turbine bleed has to be periodically vented to the atmosphere during hot weather (ambient conditions above 80 °F (26.7 °C)), while a given amount of MSW throughout is maintained, resulting in a decrease in both energy efficiency and net power output. This vented steam is a kind of high quality waste energy due to its latent heat, which the facility wants to recover. A secondary value of recovering this stream is the savings of clean, treated water which is lost with the vent.

The Haverhill facility also operates a landfill with a gas recovery system adjacent to the EfW facility. The landfill gas is used to run a 1.6 MW Caterpillar engine. The engine exhaust temperature is 900 - 950 °F (482 – 510 °C). The gas engine exhaust and jacket water coolant loop are sources of recoverable waste heat, which are currently lost to the