A Distributed Generation Case Study

Using Microturbines on Waste Gas

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ABSTRACT

Microturbines have been demonstrated to be reasonably well suited to run on waste or bio-gas. The main reason is that waste gas is generally free fuel and therefore the economic value is greatly increased. Microturbines generally operate in the 20% to 25% electric efficiency range. With free fuel the "cost to generate" is zero, excluding the cost for equipment and maintenance. Two (2) Honeywell Power Systems Parallon 75® microturbines* were installed a waste processing facility in Philadelphia, PA. The major benefit to installing the microturbines was the avoided costs in environmental permitting, controls, monitoring and reporting. This article is a summary of the project activities and results of the project.

*EDITOR'S NOTE: Since this article was written, Honeywell has stopped manufacturing the Parallon 75®. However, the novel use of microturbines described here by Mr. Dowiak points out a proven, valuable new application of this versatile power source.

DESIGN

The basic design criteria were the expected composition of the waste gas from the facility. Since the process had only been bench scale tested, it was anticipated that there would be a wide variance in the bench scale test gas and the pilot plant under normal operation. Changing World Technologies (CWT), an E&C firm, working with Kvaerner Process Systems, was contracted to design and construct the facility. From the bench scale testing, Kvaerner provided the expected gas analysis. The expected gas analysis was as follows:

GAS ANALYSIS

Component	Mol %
Methane	81.46
Ethane	10.87
NH_3	6.14
H_2S	1.53

It was determined that the gas constituents that were the limiting were the moisture and sulfur contents. For both of these constituents, the microturbine has operating limits that affect the operation of the unit.

Sulfur content was addressed first. There were two options to control the sulfur content to the unit. First the installation of some form of scrubber could be installed in the line, prior to the microturbine. Kvaerner determined that since the sulfur content could vary a great deal, the gas cleaning equipment would be difficult to size and maintain. Also the cost of the equipment was quite high.

The second way to control the sulfur was to control the waste material that was to be processed. During the development phase of the Changing World Technologies process, CWT decided that waste with minimal sulfur content would be processed. Any wastes with high sulfur content would not be processed.

Having solved the sulfur issue the moisture content of the waste gas was addressed. The main concern was the possibility that the waste gas would either meet the standard moisture requirements or a large amount of free water could be in the gas stream. Kvaerner designed and later installed a large water knockout in the gas stream just prior to the

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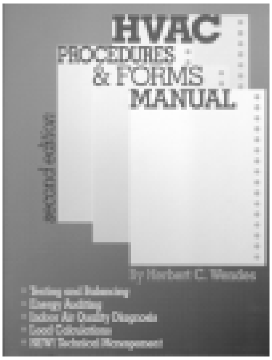

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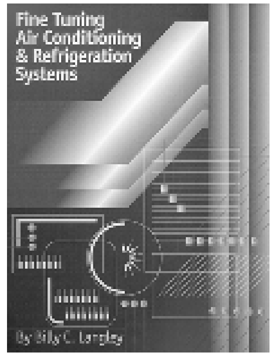

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microturbine. This was to be one of the first times a microturbine was going to be used on some form of waste gas.

The final design criterion was the electric output. Based on the size of the pilot plant and the amount of waste gas that was going to be generated, two microturbines were included in the design. During the full capacity operation of the facility, approximately 2000 cubic feet of waste gas would be generated. A single microturbine has a capacity of approximately 1000 cubic feet per hour.

In addition, the 150 kWe to be generated represented about 50% of the total power requirements of the plant at full capacity. The system was also to operate on "street" gas. Gas regulators were installed in the system to allow for the microturbines to be started on "street" gas and automatically switch over to waste gas when sufficient quantity and pressure was achieved to support operation of the microturbines. Having completed the design, we were ready to move onto the installation evaluation.

UTILITY INTERCONNECTION

The local utility, PECO, was very interested in the overall project, especially the interconnection of the microturbines to their electric distribution system. An application was submitted to PECO for interconnection to the electric distribution system. The application contained plant electrical system design drawings and microturbine operation and design specifications.

INSTALLATION

The installation design was the easiest parts of the project, since the facility was being designed from scratch; the placement of the microturbine was quite simple. Changing World Technologies provided installation information, unit dimensions, fuel, electric and communications connections. Kvaerner placed the microturbines on a larger compressor skid, adjacent to the moisture knockout, output transformers, communications and fuel lines.

Actual installation of the two microturbines took about three days. This included the lifting of the units on the skid, spot welding the unit frame to the skid, installing the output transformers, wiring the units to the transformers and attaching the fuel lines to each of the units.

START-UP

The start-up of the microturbines was very easy with the ability to use "street" gas. Once the installation was complete, Honeywell technicians commissioned the unit to verify that the installation was completed according to specifications. Once verification was complete, the gas was turned on to the unit and the unit was started. The units were allowed to operate to ensure everything was operating properly. The installation was completed and the units were placed on an operating schedule in early October 1999, to ensure that the units would be ready to operate when the pilot plant was complete and waste gas was available to be used as fuel.

The pilot plant was started and tested in mid-December 1999; the two microturbines began combusting waste gas at that time. During the testing and early operation of the pilot plant, the microturbines were exposed to dramatic variations in the composition of the waste gas. The largest fluctuations were in the Btu content. Gas analyses indicated that the Btu content of the gas ranged from 700 to 950 Btu per cubic foot. The only other operational problem was that the in-line moisture knockout was filled and the microturbines tripped off line due to the moisture getting into the onboard gas compressor.

OPERATION

Regular operation of the pilot plant began in early 2000. During the periods between test runs the microturbines were placed on a regular operating schedule that had each unit operating 4 hours per day 5 days per week. Daring waste processing runs plant personnel operated the units manually. The justification for manual operation was since the waste gas never had a consistent composition, it was easier to have the units running and ready to accept waste gas. Most of the test runs were of limited duration and only one microturbine was needed to combust the waste gas. Plant personnel alternated the microturbines in an attempt to balance the operating hours.

The main purpose for installing the microturbines was to beneficially combust the waste gas, thus eliminating the environmental permitting requirements of a plant flare. During each of the process test runs, at least one microturbine was available to combust the waste gas. Emissions testing were conducted during several of the test runs. Gas analysis indicated little or no sulfur compounds, thus the only pollutant of concern was nitrous oxides (NO_x). All of the test results indicated that the NO_x emissions were less that 50 ppm, which is the current certified NO_x emissions level of microturbines.

Electrical efficiency was very difficult to determine during the test runs, since there was no way to determine if any "street" gas was being introduced into the system. The only indication was the outlet pressure from the process and reading that particular gauge was difficult. From the data that were collected, Changing World Technologies estimated that the electrical efficiency was in the 24% range.

CONCLUSIONS

This microturbine system provided numerous challenges throughout the project. The physical installation was the easiest part of the project. The units operated on a regular schedule and manual operation went forward without any major difficulties. Design of the system was the most challenging part of the project since the pilot plant design was being scaled up from bench scale testing. In addition, the actual wastes that were going to be tested changed numerous times. In fact, the microturbines provided some limitations in the types of wastes to be processed in that there was a decision to limit the sulfur content in the waste gas.

The operation of the microturbines was generally acceptable. There were some issues with changes to the unit at times and the availability of some parts, but in any case, at least one unit was available for all of the test runs. The ability to combust the waste gas in the microturbines provided a substantial benefit in not having to deal with local environmental issues, and using the generated electric power for the system operation has enhanced the perception of the process.

From an economic perspective, the free fuel was helpful in the overall economics of the project. The largest economic benefit to the project was the avoided costs for environmental permitting, controls,

monitoring and reporting. As of this writing, the units are still operating as the waste processing system continues to be modified and tested.

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