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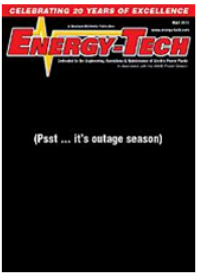

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Alternative fuel applications ensure economic and environmental gains

BY NORMAND BUJOLD

<< Prev 1 of 2 Next >>

Companies are increasingly exploring alternatives to fossil fuels, due to their high prices and stricter government regulations. Simply venting or flaring process by-products to the atmosphere no longer meets industries' environmental and energy trends, and there are a number of innovative solutions that companies have successfully implemented to improve their energy and environmental performance. Among these solutions is the combustion of alternative fuels, such as biogas refinery fuels, hydrogen and flammable liquids, to produce usable power.

Motivation to make a change

Behind each alternative fuels project is an incentive that justifies the additional investment and development costs. In most cases, the motivation involves two factors: environmental regulations and/or energy cost savings.

The disposal of process by-products can be problematic when considering the cost of transport or post-treatment. In some cases, there are no alternatives available due to strict emission regulations preventing the venting or removal of certain gases from the process to the atmosphere. Combustion or thermal oxidation, therefore, can be both a cost-effective and efficient way to dispose of these waste streams.

How can combustion be a solution to emissions concerns when it is also a source of pollutant emissions? Today, modern combustion systems can be designed to be clean burning and extremely efficient. With the latest burner designs and combustion control technologies, emissions of NOx, CO, VOCs and particulate matter can be maintained below the local regulation limits. Typically, when firing low-BTU alternative fuels, NOx emissions are not an issue since they inherently burn "cooler" than conventional fossil fuels. CO and VOCs emissions, on the other hand, must be carefully controlled by designing the system so that furnace temperatures are kept at adequate levels for proper oxidation.

The combustion process also will oxidize the combustible chemical compounds that are contained in the waste stream and are potentially harmful to the environment. This category includes VOCs, THC and aromatics such as benzene. Proper design of the combustion system will provide the necessary conditions for the complete oxidation of those compounds into CO2 and water.

In addition, waste streams can contain inert matter or elements that the combustion cannot oxidize into harmless gases. These include sulphur (responsible for SOx emissions), fuel bound nitrogen (that will increase NOx emissions) and other elements (like metals of minerals that will be responsible for particulates emissions). Special attention must be given to the solids contained in the fuel that can degrade the combustion chamber or boiler tubes. Chemical analysis of process fuels is necessary to determine the concentration of such elements and compounds. A case-by-case evaluation is necessary to predict performance of waste stream combustion. Some examples of waste streams are: digester gas, landfill gas, off-gas, tail gas, dryer exhaust gas, fatty acids and tars.

Comparison between the cost of the combustion alternative and the other disposal solutions will determine which remedy will be the most profitable. The evaluation must analyze the potential energy value that can be present in some waste streams. With respect to the capitalization cost, it is possible to modify an existing combustion unit. Other times it is necessary to install a new system.

Alternative fuels yield cost savings

The cost of energy typically has a significant impact on a company's bottom line due to an upward price trend in conventional fossils fuels. Most long-term forecasts predict this trend will continue with the growing global demand and limited supply of resources. Therefore, process flow charts are being scrutinized to determine if any by-product might contain sufficient energy that can be used as an alternate source.

The economics of fuel savings are easily calculated using the $MMBTU, or dollars per millions of BTU. The present market price for natural gas is $5.68 MMBTU1. This means that every MMBTU worth of energy found in the by-products could save $5.68 in natural gas purchasing cost. For example, a plant venting an average of 2,000 SCFM of H_2 (305 BTU/SCF) during the year could reduce its annual energy cost by $1.8 million if it burned hydrogen to offset the natural gas cost. Given the huge savings potential, it is evident that an investment into a combustion and steam generating system is attractive. Simply flaring or venting high BTU process gas is no longer the way to go.

The firing of high BTU fuel often equates to higher NOx emissions. But with the current technology it is relatively easy to control NOx emissions to meet regulation limits.

Examples of process by-products that have a significant energy value include: hydrogen, refinery gas, syngas, CO, produced gas and methanol, among others.

Integration is instrumental to success
During preliminary engineering discussions of an alternate fuel combustion or thermal oxidation project, there are special considerations that must be taken into account. These liquids or gaseous fuels are by-products of processes that are independently controlled to produce something else – the main production of the plant. This will confer a variable characteristic to most of the process fuels. Variations in available flow, pressure, composition and temperature are common.

When one looks at how a combustion system works, one can see that the basic function is to control the air and fuel flow to obtain a precise mixture ratio and produce the desired amount of energy. To achieve this task, a typical combustion system relies on a stable, constant and reliable fuel source, like natural gas, for instance. When fed with a fuel source that is not stable, the combustion system will have to react and automatically adjust itself in some way to remain efficient and safe. This is a serious design challenge.

The success of the system depends greatly on the understanding of the process and the necessary knowledge to predetermine the normal operating conditions and the potential upset conditions. Once this is understood, the required intelligence will be designed into the combustion system so it will be able to automatically adjust itself to the changes, and reciprocally for the process. The combustion system and the process are now dependent on each other. They are linked through their respective operating conditions. This integration starts right at the beginning of the project and is completed during the commissioning of the combustion system. Collaboration between the process people and the combustion people is of paramount importance.

Here are some typical points that should be considered when embarking on a process fuels firing project:

- Header pressure and its control strategy
- Condensation in gaseous fuels – verify particulate content, potential condensation and corrosion
- Composition variations and related characteristics, such as density, heating value, etc.
- Fuel available flow and its variation through time
- Sustaining fuels, simultaneous firing and other firing strategies
- Steam demand scenarios
- Furnace configurations, temperature and residence time, among other things

Without a doubt, process fuel firing projects are more complex than standard natural gas jobs. Nevertheless, numerous projects have been successfully commissioned to date. The innovative approach, experience and collaboration between the combustion equipment supplier and the process company all contribute to push the limits of what can be achieved.

A thorough understanding of a plant's process and fuel characteristics is recommended to ensure the success of an alternative fuels project. Several companies, such as Cleaver-Brooks Engineered Systems Group (featuring Nebraska Boilers, Natcom Burners and Energy Recovery products), regularly custom design combustion and steam generator systems for various gaseous and liquid fuels.

Notes:

1. *Source: oilnergy.com, NYMEX Henry-hub gas price Jan. 25, 2010, 5.678 USD/MMBTU*

Normand Bujold has 25 years of experience in mechanical design and has spent the past 15 years in the industrial combustion business. As vice president of design engineering for Cleaver-Brooks Engineered Systems Group, Bujold is responsible for the design and development of the Natcom product line. Under his supervision, 9 ppm natural gas burners, thermal oxidizers, gas heaters and process fuel burners have been sold in more than 15