EPI

Energy Products of Idaho

Flexible Fuel Boiler Cures "The Natural Gas Blues"

By Kent Pope
Energy Products of Idaho

ENERGY PRODUCTS OF IDAHO
4006 Industrial Avenue
Coeur d'Alene, Idaho 83815-8928
Ph: 208/765-1611 Fax: 208/765-0503
E-mail epi2@energyproducts.com - http://www.energyproducts.com

Executive Summary

Historically, ethanol plants and other industrial steam users have produced steam with natural gas-fired boilers. These gas boilers are relatively inexpensive to construct but leave their owners completely dependent upon the volatile natural gas market. Price fluctuations, supply disruptions and curtailment in the natural gas market have had, and will continue to have, a substantial impact on the profitability of these plants. The bottom line profit impact caused by wild increases in natural gas prices is the basis of “The Natural Gas Blues.” Many companies have cured “The Natural Gas Blues,” increasing their profitability and limiting their energy cost fluctuations by adding a flexible fuel boiler system.

Flexible Fuel Boiler

An EPI flexible fuel fluidized bed energy system provides an alternative to natural gas with significant decreases in energy costs. So significant, in fact, that the capital costs incurred can be repaid, in fuel savings alone, within one to three years depending on the alternative fuel available. Escaping the natural gas trap is important, but it is equally important to not get stuck with the next high cost fuel. Installing a boiler that can handle a variety of fuels in the same boiler system provides long-term energy security at predictable costs. Most of the flexible fuel fluidized bed systems installed by EPI are operating on a different fuel mix than what they were originally designed to handle. The ability to change fuels as fuel prices and availability change is a critical component in keeping a plant profitable in an ever-changing energy market.

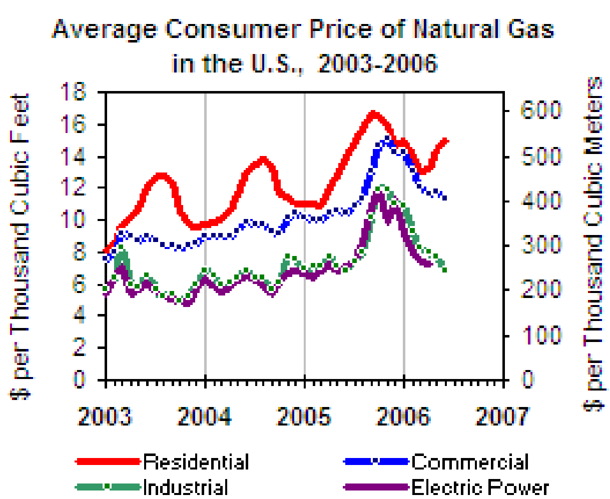
Recently, natural gas has been the high cost fuel, so comparisons can be made between gas and other available fuels. Installing and operating a flexible fuel fired energy system today results in significant cost savings over natural gas only systems. With natural gas at $9.70 per million BTU delivered, and agricultural wastes at $0.81 per million BTU delivered, the fuel cost savings alone for a 150,000 lb/hr boiler operated for one year would more than offset the equipment costs of an EPI flexible fuel energy system. According to figure 1 below, this size of boiler can realize fuel cost savings of $12 million per year. Other potential fuels could include waste products that ordinarily command a tipping fee for disposal. Tipping fee fuels provide for even higher energy savings and associated profit boosts for the owner as other industrial or municipal entities pay for the privilege of providing fuel for plant operations. Refuse derived fuel, (RDF), and tires are shown as a sample of tipping fee fuels but others may be available in the local area.

Many times a plant has significant waste streams that are being land filled at a considerable cost. Substantial savings are realized by using in-plant waste streams as fuel. Paper mills produce a paper sludge waste that is typically land filled but can be utilized as a fuel to produce steam for the paper making operations. Other industries may have plastics, paper, cardboard, oat hulls, rice hulls, distiller's grains, syrup, glycerin or other byproducts that could be converted into usable energy utilizing EPI's flexible fuel fluidized bed system. EPI's fluidized bed systems convert hundreds of otherwise waste byproducts into usable energy at nearly 100 different locations worldwide. Figure 1 below provides a comparison of fuel costs for various boiler sizes and fuels.

Fuel Costs $/MMBtu	Natural Gas 9.7	Coal 2.6	Wood 2.5	Ag Waste 0.81	Tires/C&D -0.5	RDF -2.2
Boiler Size					Tipping Fee	Fuels $$$
75,000	$6,595,952	$1,767,987	$1,699,988	$550,796	-$339,998	-$1,495,989
100,000	$8,794,602	$2,357,316	$2,266,650	$734,395	-$453,330	-$1,994,652
125,000	$10,993,253	$2,946,645	$2,833,313	$917,993	-$566,663	-$2,493,315
150,000	$13,191,903	$3,535,974	$3,399,975	$1,101,592	-$679,995	-$2,991,978
175,000	$15,390,554	$4,125,303	$3,966,638	$1,285,191	-$793,328	-$3,490,641
200,000	$17,589,204	$4,714,632	$4,533,300	$1,468,789	-$906,660	-$3,989,304
225,000	$19,787,855	$5,303,961	$5,099,963	$1,652,388	-$1,019,993	-$4,487,967
250,000	$21,986,505	$5,893,290	$5,666,625	$1,835,987	-$1,133,325	-$4,986,630
275,000	$24,185,156	$6,482,619	$6,233,288	$2,019,585	-$1,246,658	-$5,485,293
300,000	$26,383,806	$7,071,948	$6,799,950	$2,203,184	-$1,359,990	-$5,983,956
325,000	$28,582,457	$7,661,277	$7,366,613	$2,386,782	-$1,473,323	-$6,482,619
350,000	$30,781,107	$8,250,606	$7,933,275	$2,570,381	-$1,586,655	-$6,981,282

Figure 1, Estimated Fuel Cost Comparison

While figure 1 shows a fixed natural gas price of $9.70 per MMBtu, it is important to note the price volatility in natural gas over the past few years as the chart below depicts.



Long-term trends in the energy markets are impossible to predict, but the substantial and persistent price volatility of natural gas is expected to continue. It does not take many months of gas prices approaching $16 per MMBtu to justify a flexible fuel boiler. Having a variety of options to burning natural gas provides companies a more stable basis for predicting energy costs.

The success of many power plant projects is dependent on fuel flexibility of the energy system. A plant designed for a single fuel may run profitably for many years and then suddenly find that fuel costs have increased to the point where the plant is no longer profitable. Fuel flexibility is the key to long-term financial viability of a project.

Why Fluidized Bed Technology?

Fluidized bed technology provides more fuel flexibility than any other combustion technology available. Fluidized bed thermal oxidation and gasification systems are located throughout the world. Municipalities and a number of industries, including fossil fuel, wood products, paper, power generation, agriculture, and food processing, are recovering energy from wastes such as municipal garbage and sludge, paper, paper sludge, coal, plastic, manure, biomass, wood, and numerous other materials. The fluidized bed is suitable for converting a wide range of materials containing varying moisture contents into usable energy while generating the lowest possible emissions.

Fluidized Bed Combustion Process Description

Fluidization is a term used to describe a phenomenon that passing an air stream vertically upward through a mass of solid particles creates. The upward velocity creates a lifting effect on the particles and results in the suspension of those particles within the air. As the air velocities are increased above a minimum fluidization velocity, the particles are no longer held to normal solid-to-solid contact and they begin to float and travel within the air stream. The fluidized media exhibits the physical characteristics of a fluid and resembles a pot of water in a rolling boil. These fluid properties provide a constant temperature environment with continuous scrubbing action and plenty of oxygen to consume the fuel particles. The bed also acts like a thermal flywheel helping to maintain a constant temperature when the heating content of the fuel fluctuates.

Due to the fluidized bed's inherent benefits, the technology has been utilized in the combustion of solid fuels over the past twenty-five years. The fluidization effect of the bed media results in a constant surface cleaning of the burning fuel particle. Any ash and char created from the combustion of that fuel, as it is slowly being burned, will be scraped off by the etching effect of the sand. This allows a new surface to be exposed to the combustion air and results in much faster and very complete thermal conversion of the fuel particle.

In the fluidized bed process, the bed media serves three major purposes:

- It acts as a thermal storage medium to hold the heat within the system
- It provides the ignition source for fuel fed into the unit
- It cleans the surface of the fuel particle exposing it to combustion air.

These properties allow the fluidized bed to consume much higher moisture content fuels (65% moisture and even higher with air pre-heat) because the bed media retains sufficient heat storage capacity to evaporate the moisture from the fuel particles prior to combustion. This in itself is a substantial advantage over many conventional combustion systems that are limited in their ability to handle wet fuels because of the tendency of the high moisture content to extinguish the fire.

Fluidized bed technology is well suited for burning coal, biomass, municipal wastes, tires, DDGS, agricultural wastes, wood and paper byproducts, and nearly any other organic or combustible material. Depending on the fuel, it can be fed into the system through over-bed or in-bed feeders. Once fuel is in the system, the thermal oxidation process begins. The fine portions of the combined fuel stream begin burning as they are projected across the active bed. The lighter particles may completely burn in the vapor space while the larger particles fall onto the fluidized bed. The larger fuel particles are thermally oxidized in the active fluidized bed region. Coal and large wood particles take longer to ignite than the fine particles. These heavier fuel particles overcome the updraft from the fluidizing air and become part of the active bed. The bed is maintained at a temperature of about 1500ºF. At this temperature, ignition of the fuel is relatively quick. As the fuel burns, the ash is liberated as small particles that get carried out of the bed. This process limits the formation of clinkers normally formed at higher combustion temperatures. Sorbents such as limestone can be added to the bed to capture sulfur contained in the fuels before it becomes SO2, an acid gas emission.

Efficiency and Emissions

Due to the continued cleaning action of the bed, and extended residence time, which is the exposure of fuel particles to oxygen at elevated temperatures for many seconds, the overall combustion efficiency is inherently high in fluidized bed systems. In fact, in many cases the carbon burnout percentages within the systems are in excess of 99%. Enhanced combustion efficiency of the fluidized bed allows it to operate at lower temperatures than other technologies. Lower temperatures produce less NO_x and have less potential to form slag from the ash on the combustor and boiler surfaces.

The extended residence time and low operating temperatures of the fluidized bed minimizes the production of most emissions and allows for the application of various abatement techniques to further reduce various pollutants. The products of incomplete combustion (PIC) such as; carbon monoxide (CO), volatile organic compounds (VOC), total hydrocarbons (THC), dioxins and furans (PCDD and PCDF), are minimized due to the high combustion efficiency of the fluidized bed.

Fluidized beds continue to be considered the best available control technology due to their ability to control acid gas CO and VOC emissions. Inexpensive calcium-based sorbent material such as limestone can be introduced to the fluid bed to capture sulfur. A chemical reaction occurs under normal combustion operating temperatures whereby the calcium oxide, generated on calcination of the limestone, reacts with oxidized sulfur from the fuel to form a stable calcium sulfate (gypsum) product. This material becomes part of the ash particulate stream and is removed from the system with the normal particulate gas cleanup devices. Consequently, sulfuric acid gas is minimized in a manner that is very cost competitive to both wet and dry acid gas scrubbers. The calcium oxide (CaO) that is carried out of the combustor as particulate also assists in the abatement of hydrochloric (HCl) acid gases in the cooler zones downstream of the heat transfer equipment.

Production of nitrogen oxides (NO_x) is inherently low in fluidized bed systems due to the reduced operating temperatures of the combustor. Typically the vapor space temperatures are maintained at levels well below the temperature where air borne nitrogen converts to NO_x. At these reduced temperatures, the fuel bound nitrogen is the source of most of the NO_x produced. Given the wide range of fuels that these systems handle, many times the most cost effective fuel contains the highest amounts of nitrogen. To control the NO_x produced by the fuel-bound nitrogen, selective non-catalytic reduction (SNCR) for NO_x abatement is an ideal solution. The low operating temperature profile, coupled with the efficiencies of combustion associated with the fluidized bed, provide optimum conditions for use of SNCR to reduce emissions of NO_x. These systems utilize ammonia (aqueous, anhydrous or urea) as a reacting agent to abate NO_x. Due to the simplicity of the design, these systems are relatively inexpensive, yet have a dramatic impact on NO_x abatement. Fluidized bed combustion systems typically achieve NO_x reductions in excess of 80%.

Fluidized bed technology has continually met the world's most stringent emissions requirements. It has also been considered LAER (lowest achievable emission rate) for CO and VOCs, and BACT (best available control technology) for NO_x especially when coupled with SNCR.

Conclusion

The decision to install an EPI flexible fuel energy system is a long-term solution to the single fuel source problem. While there are differences in capital and operation costs between a flexible fuel system and a gas-fired boiler, the fuel cost differential between the two is so great that the decision becomes quite easy when all factors are considered. EPI's flexible fuel energy systems utilize a variety of fuels, enabling the owner to adapt to ever-changing fuel markets and to avoid the pinch of fluctuating natural gas prices. Fuel savings alone generally return the entire initial capital investment in an EPI fluidized bed burner system within a short period of time. Burning plant waste materials adds dramatic additional savings, and burning tipping-fee fuels may even offer additional profits. For many industrial companies, energy costs are second only to raw material costs in the major expense column. Raw material costs in like industries are fixed, so energy savings offer the biggest opportunity for cost reduction, profit enhancement and a competitive advantage. EPI's fuel-flexible energy systems dramatically lower energy costs and ultimately provide the greatest chance to cure "The Natural Gas Blues."