ENERGY SOURCE

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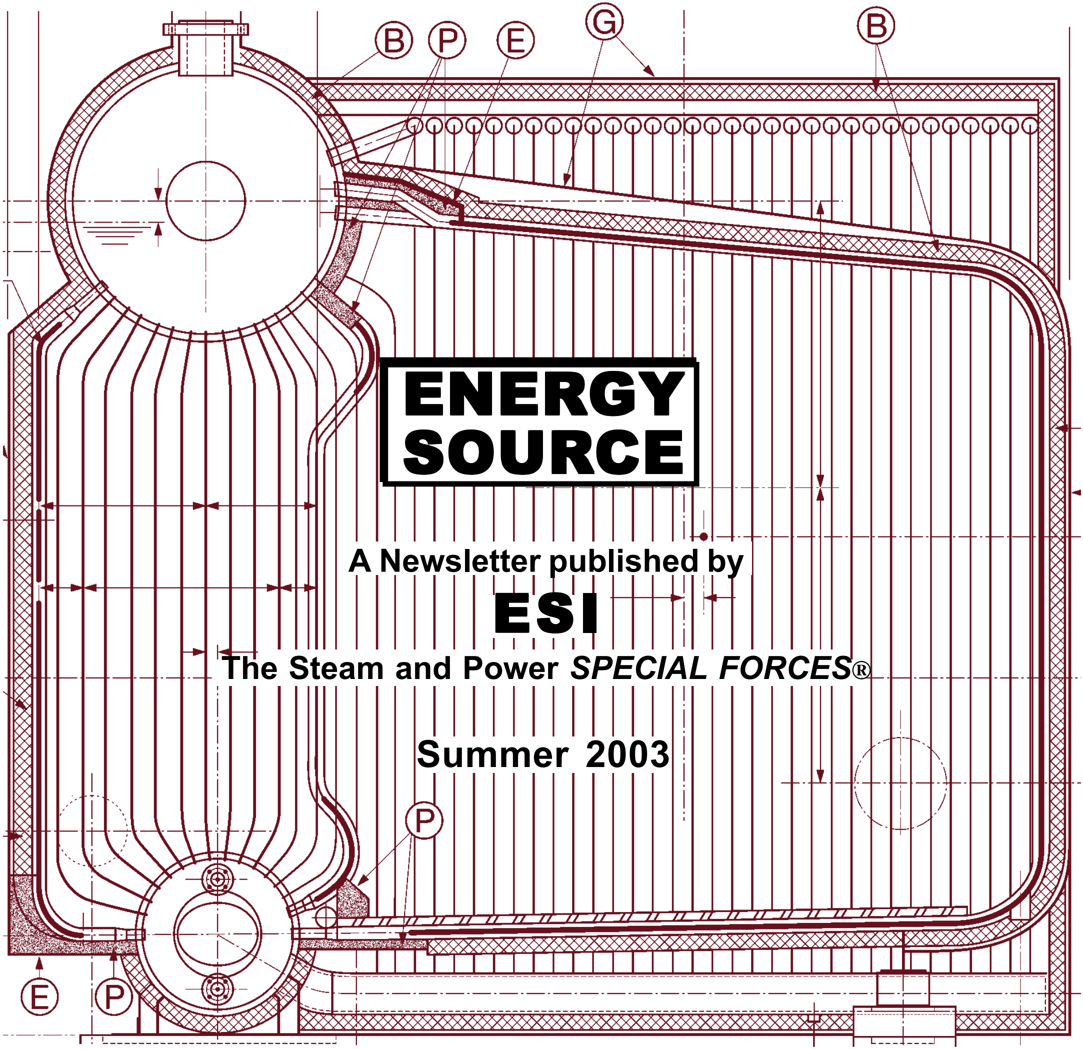

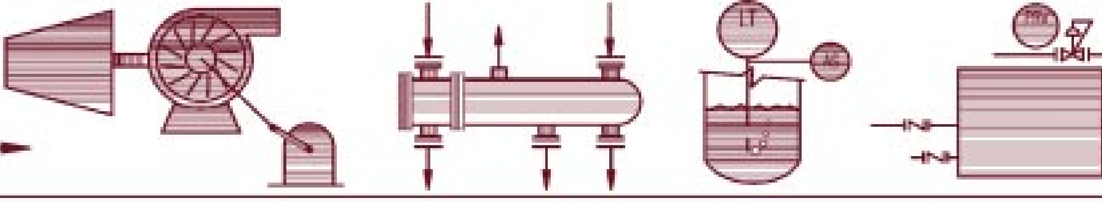

THE BUYER'S GUIDE TO PACKAGE BOILER DESIGN

By: William L. Reeves, P.E., President, ESI

Editor's Note: This article is the second in the series on package boiler design. The first article, presented in the Spring 2003 ENERGY SOURCE, discussed the types of water tube package boiler designs and how shipping restraints can affect certain design parameters. The following article discusses the critical boiler design parameters that should be considered when purchasing a new package boiler.

It is not uncommon for a typical package boiler specification to specify only the steam capacity, steam temperature, steam pressure, steam quality, fuels to be fired, and the required efficiency. Although all of these items are important and critical, they do not give a complete definition of the boiler to be purchased. Imagine buying an automobile and only specifying the number of passengers you would like for it to hold and the gas mileage you would like to achieve. In this article, ESI will share our knowledge on the critical items one should consider when purchasing a new package boiler.

The most important thing to remember is the more design requirements that are included in the specification, the easier it will be to compare the proposal offerings of the different manufacturers. If the specifications are properly prepared, the bid offerings from the different manufacturers will converge and the analysis will ultimately come down to who can provide the same basic boiler as specified for the least expensive cost due to lower production cost or lower mark-up. This will result in purchasing real value.

So what are the critical design features in a package boiler and why are they critical? The specification of critical design features will dramatically affect the emissions, boiler reliability, maintenance, and overall availability. Some of the more common features to consider are as follows:

- Furnace volume and geometry
- Furnace construction
- Adequate steam release area
- Superheat temperature
- Unusual operating conditions
- Volumetric heat release rate
- Design tube metal thickness
- Steam quality
- Skin temperatures and radiation losses

Furnace volume and geometry have become increasingly important with the development of low NO_x burner technology. The furnace geometry is important because the furnace must have the adequate height, width, and length so that the burner combustion can be staged to control NO_x without flame impingement on the furnace tube walls. A conservative larger furnace volume translates into a low volumetric furnace heat release rate that reduces the heat gradient through the furnace tube walls and the furnace temperatures. A conservative furnace volumetric heat release rate is between 70,000-80,000 btu/cu-ft-hr. This conservative furnace heat release rate makes it relatively easy to meet low NO_x emission

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ESI is the Steam and Power *SPECIAL FORCES®* providing clients with innovative, cost-effective, and environmentally-friendly solutions.

If you have any suggestions or comments about the newsletter feel free to call us at 770-427-6200 or e-mail us at energysource@esitenn.com.

Deanna White
Managing Editor

Natural Gas
The Congressional Flip-Flop

By: James W. Garrett, Business Development Manager, ESI

Editor's Note: The following article is based upon excerpts from Energy Central and the July issue of Time Magazine. It paints a dark picture regarding the near term future of natural gas prices for consumers and industry and explains our recent substantial activity in clients looking seriously at coal again.

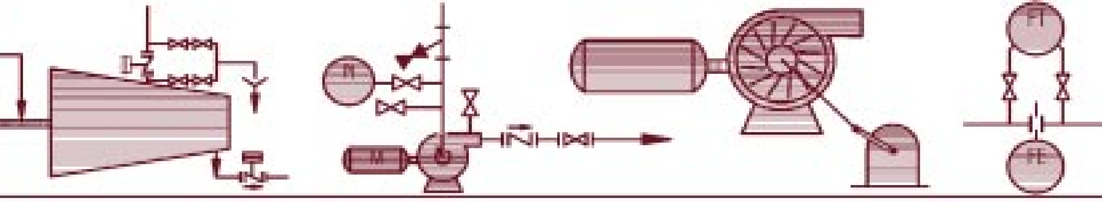
A quarter-century ago, Congress enacted the Powerplant and Industrial Fuel Use Act, which banned the burning of natural gas by power plants to generate electricity after 1990. With the oil embargos of the 1970s still fresh in the minds of the Congressmen, the reasoning was that natural gas was in short supply and was most widely used to heat homes. At that time, natural gas was used to heat half of all residences and therefore, should be preserved for that purpose. Congress recognized that using the vast coal reserves of the U.S. to generate the electrical power needs would be the key to energy independence.

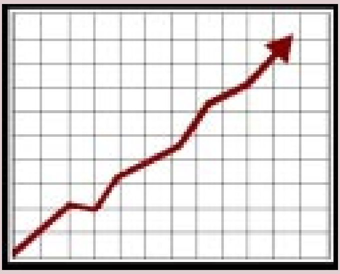
As the years slipped by, Congress reversed course. The lawmakers repealed the ban in 1987 and opened the door to construction of natural gas guzzling power plants. Making matters even worse, three years later, they amended the environmental rules to discourage the burning of coal, America's most plentiful fuel to produce electricity. Predictably, the generation of electricity with natural gas, which had fallen 17% from 1979 to 1987, has shot up 151% since then, reaching a record 686 billion kW-h last year. Nearly 20% of all U.S. electricity is now generated with natural gas, and 88% of all new generating plants built in the past decade use natural gas as the fuel. Meanwhile, U.S. production of natural gas has remained stagnant at 19 trillion cu-ft a year, about the same as a decade ago. But the U.S. consumed 22 trillion cu-ft, up 8% during that time. Because natural gas moves more efficiently by pipeline than tanker (for which it needs to be liquefied), the difference comes mostly from Canada. Now the Canadians are running low, and exports to the U.S. are expected to be flat, or possibly even decline.

Over the years, Congress has debated without positive results the increase of U.S. natural gas production through exploration and drilling of vast reserves in Alaska and the Arctic regions. There is little doubt that over the long run, the U.S. must harvest and bring to market these oil and gas reserves. In the short run, high temperatures this summer could produce spikes in prices and regional brownouts. In June, natural gas sold for an average of $5.83 per million BTUs, up 169% from the same week in 1998.

Higher natural gas prices are taking their toll on energy-dependent industries. Increased utility operating costs are eroding profit margins and driving down earnings. The potentially chronic natural gas shortage and its impact on the economy and employment have even Alan Greenspan worried. Talking about the many industries dependent on natural gas, the Federal Reserve chairman recently told the Senate Energy Committee "we do see the obvious loss of jobs ... because it has made us largely uncompetitive in a number of industries in which gas is a critical input." He also saw little hope that prices would fall. "We are not apt to return to earlier periods of relative abundance and low prices anytime soon," he said.

It appears that our hopes at least for the immediate future to control and reduce energy costs are pinned to solid fuels like wood waste and coal, along with alternate energy supplies such as plant waste. If these alternatives are not practical, then one must concentrate on optimizing existing boiler efficiency to mitigate the effects of increased gas prices.





New Technology Can Help You Fight the War Against Higher Utility Costs

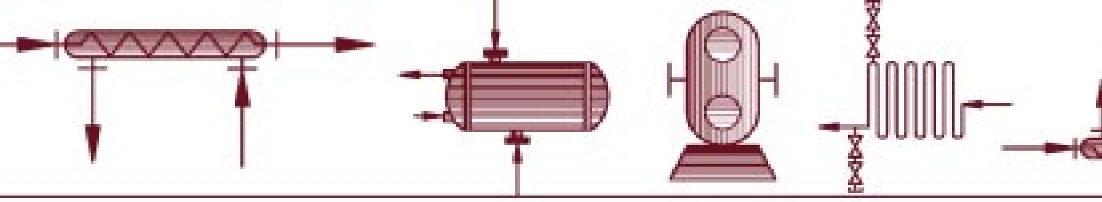
By: William L. Reeves, P.E., President, ESI

ESI has recently identified and researched a new technology that may revolutionize the combustion and operating control of gas/oil-fired package boilers. This new technology has been implemented in several industrial installations with remarkable gains in boiler fuel efficiency. One installation documented a reduction of 28.5% in natural gas use for the same steam production, saving the user nearly three hundred thousand dollars per year in fuel costs. With the controls industry constantly marketing new products to improve boiler efficiency, this dramatic breakthrough in efficiency gain begs the question, how?

This system combines state-of-the-technology in boiler controls computerization and proprietary software with the independent control of virtually every parameter that can affect the combustion and boiler operating efficiency. It goes beyond the traditional control of fuel/air ratio by improving boiler heat transfer and absorption at reduced firing rates. The measurement and micromanagement of every single boiler operating parameter at every firing rate is the secret to these dramatic results.

Despite the phenomenal results this technology has experienced reducing boiler fuel costs, the application of the technology is surprising simple and affordable. The hardware consists of conventional personal computers (PC) combined with industry standard field instrumentation devices. Retrofits have yielded documented cash paybacks of less than 1-2 years with return on investment of several hundred percent. With the recent proliferation of utilities installing peak power capacity with combustion turbine installations, the demand for natural gas has far outstripped increases in supply and transmission. North America is facing the harsh reality of dramatic escalation of natural gas prices over the next couple of years. (Please see the Article on Page 2.) The already dramatic financial results will get even better for those who take advantage of this technology through retrofit of existing boilers.

A typical gas/oil-fired package boiler can be retrofitted in approximately one week after roughly 12 weeks of preparation. For those clients who simply cannot raise the cash for a system purchase, ESI and the technology supplier will be happy to enter into a shared savings option with no upfront cost to the client. This alternative will allow you to immediately begin reaping the rewards of reduced utility operating costs without a capital investment. If you are interested in learning more about this technology and a free analysis of what it can do for your company, please contact Bill Reeves at 770-427-6200. We are truly excited about the savings opportunity this independent technology could create for our clients.



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regulations, which are typically 0.05 and 0.10 lbs per mmbtu input firing natural gas and #2 fuel oil, respectively. Ultra low NO_x burners can meet much lower emission levels than this through special burner design and higher levels of flue gas recirculation. Naturally, as shop-assembled package boilers increase in size, it becomes more difficult to constrain the furnace heat release rate to less than 80,000 btu/cu-ft-hr due to shipping restraints.

Furnace construction is critical not only for minimizing NO_x emissions, but also to reduce maintenance and increase unit reliability and availability. Boiler furnace and convection section enclosures should be all welded wall membrane construction. The use of membrane welded wall construction for the furnace front and rear walls is more expensive; however, the reduction in refractory maintenance and forced outages make it a worthwhile investment. The reduction of furnace refractory results in lower furnace temperatures and lower NO_x emissions. It is also critical that the furnace division wall be of membrane welded wall construction to eliminate the possibility of gas bypassing through the division wall resulting in high CO emissions in the boiler outlet gas. This is a definite problem with low NO_x burners operating with furnace division walls of tangent tube construction.

ASME code and good engineering practice sets the design tube metal thickness for boilers. Most manufacturers use thicker tubes in the furnace than in the boiler generating section due to the harsher environment. It is not widely known that additional tube wall thickness can be purchased for a nominal cost, resulting in a much more conservative design unit with higher reliability and availability. For example, ESI usually specifies package boilers with boiler generating tubes of 0.120", when the manufacturer standard for the required design pressure is 0.105". For an 80,000 pph package boiler operating at 150 psig saturated, the additional capital cost for 0.120" thick generating tubes is approximately $2,000.

In boilers operating at low pressure saturated steam conditions (i.e., 125-250 psig), the standard boiler design steam quality is often 0.5% moisture which translates into approximately 17 ppm. For high pressure units (450-1500 psig) with superheaters, the standard design steam quality leaving the steam drum is typically 1 ppm. A steam quality at or below 1 ppm is critical to prevent the formation of deposits in the superheater tubes as well as protecting any downstream steam turbine equipment. Steam quality can be affected by the size of the steam drum. A more conservative boiler has a larger diameter steam drum to provide more steam release area and lower steam velocities, reducing water particle loading on the steam separation equipment. Although ESI generally does not specify the steam drum diameter in a boiler specification, we always compare the different manufacturer offerings to ensure that they are consistent, and will naturally lean to the unit with a larger steam drum. Not only will this feature improve steam quality, it will also dramatically enhance drum water level stability.

When operating a package boiler with higher pressures and superheated steam for steam turbine drives, a boiler specification generally has a specific superheat temperature which corresponds to the required steam temperature at full rated boiler capacity. At reduced loads, the steam temperature will fall dramatically due to lower furnace exit gas temperatures and reduced flue gas flow. If maintaining superheat temperature at reduced loads is critical, it is necessary that the boiler specifications include a percent of full capacity at which superheat steam temperature must be maintained. For example, it is not unusual to require steam temperature control down to 60%-70% of full boiler capacity. In order to achieve the desired steam temperature at reduced loads, the boiler manufacturer must include sufficient tube surface to achieve the desired steam temperature at the lower load. This will result in

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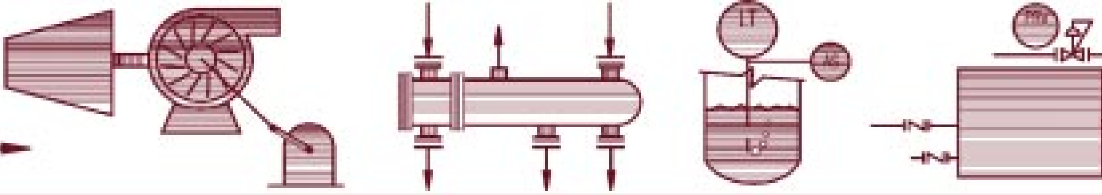

Just A Reminder

ESI has expertise in all aspects of steam and power-related systems including: Complete Steam and Power Generating Systems, Material Handling Systems, Water Treatment Systems, Instrumentation and Controls, Environmental Compliance, Biomass Dryers, Carbon Burnout Systems, and several first-of-a-kind technologies.

ESI has experience combusting a wide range of fuels including: Natural Gas/Fuel Oil, Coal, Paper Mill Sludge, Biomass, and several other "Plant Opportunity Fuels".

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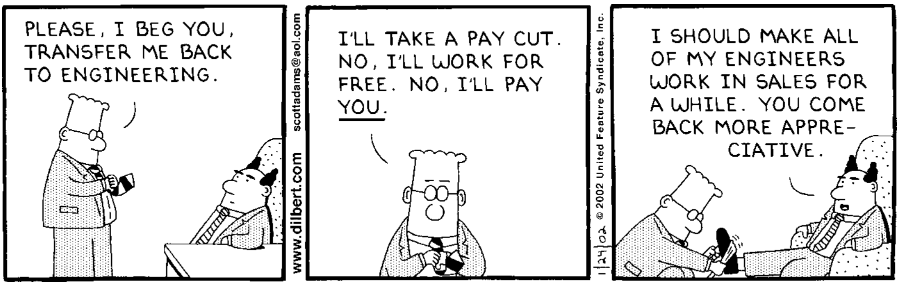
too high a steam temperature at full boiler capacity. A steam attemperator is used to spray water into the steam to control steam temperature throughout the range of steam temperature control. Naturally, it is imperative that the facility have demineralized water or clean condensate as the source of spray water for the steam attemperator.

The boiler design specification should also include a maximum boiler skin temperature for operator safety and reduced radiation losses resulting in higher boiler operating efficiency. A good typical skin temperature specification for indoor installations is not to exceed 140ºF with an ambient air temperature of 80ºF and a velocity of 0 ft/min across the face of the skin.

Whenever a package boiler is specified, it is important to make sure the manufacturer understands any unusual operating requirements such as severe instantaneous load swings, rapid heat up from cold start, hot standby, etc. These types of unusual demands on a package boiler may require special design features in the steam drum internals to maintain proper water level control, or special expansion capabilities to accommodate severe transient differential expansion. For example, the best way to maintain a package boiler in hot standby condition so that it can be put into service immediately is to utilize a steam coil in the mud drum.

As you can see, buying a boiler to meet your specific requirements is much like buying an automobile. One has to evaluate the desired features versus the price to end up with the boiler that best meets the criteria. Many of the design features discussed will affect the overall life cycle cost as well as the service life of the unit. Stay tuned for the Fall 2003 issue of the *ENERGY SOURCE* where we will discuss the keys to understanding boiler operating efficiency. Please remember, if your steam or power facility needs additional capacity, contact the Steam & Power *SPECIAL FORCES®* today at 770-427-6200 or info@esitenn.com.



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