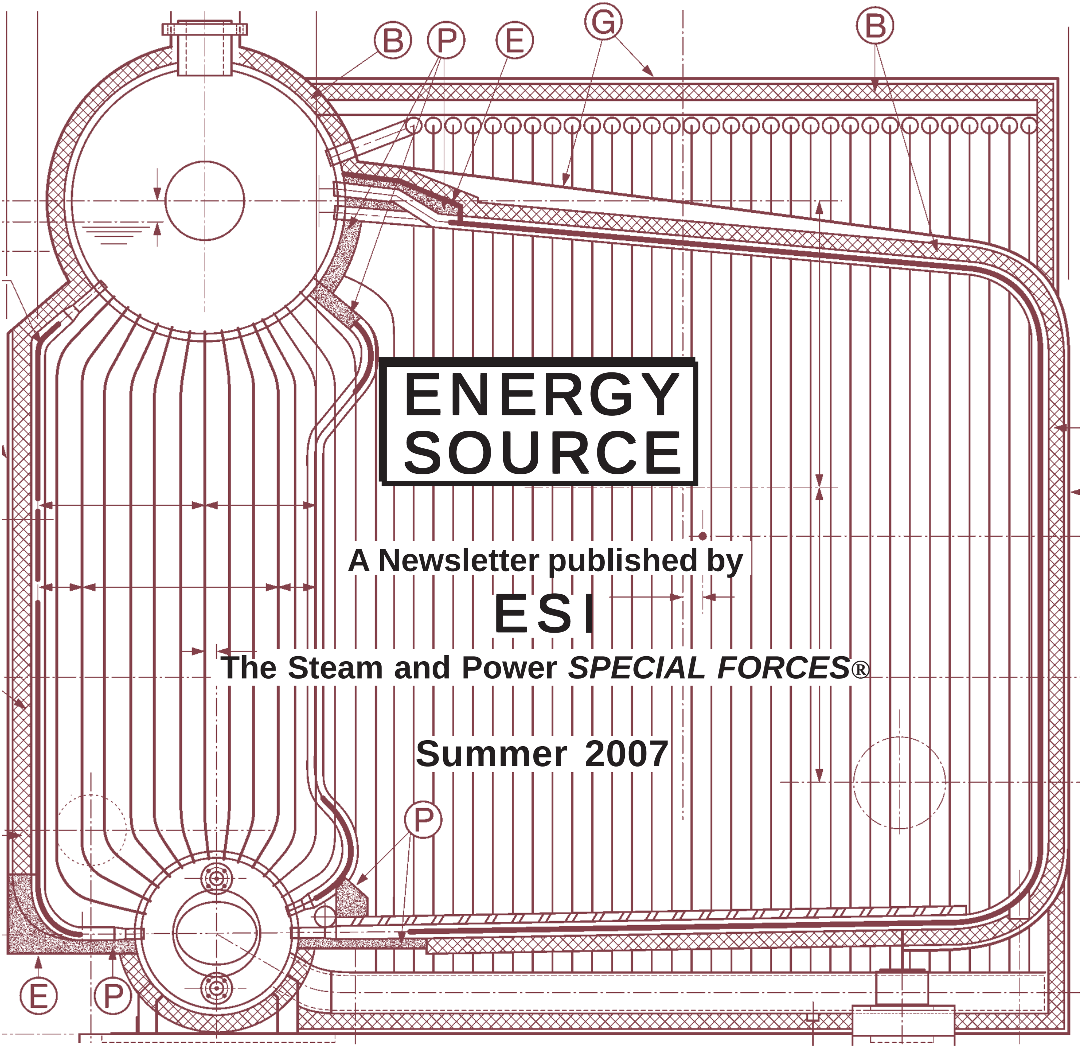


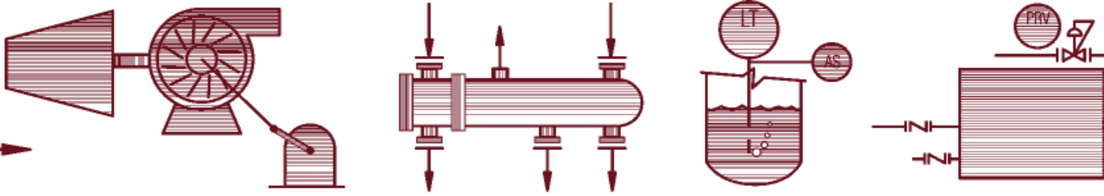
ENERGY SOURCE

A Newsletter published by

ESI

The Steam and Power *SPECIAL FORCES*®

Summer 2007



What Are My Fuel & Technology Choices?

By: Jeffrey H. White, P.E., Vice President – Engineering, ESI

Editor's note: This article is the third in the series "What Are My Fuel & Technology Choices?". The previous article, presented in the Spring 2007 ENERGY SOURCE, discussed the differences between the four primary commercially available technologies for firing solid fuels including pulverized coal, stoker-fired, bubbling fluid bed, and circulating fluid bed. The following article discusses the key factors that must be evaluated to select the best technology for a specific fuel.

What Technology Is Best For A Specific Fuel? When determining the best technology for a specific fuel, there are several key factors associated with the fuel that will impact the decision:

- Availability
- Price
- Operating Costs
- Capital Cost
- Analysis and Properties
- Moisture Content
- Variability

Availability

The availability of a fuel to meet the long-term demands of a facility is one of the key items to be considered when trying to select a combustion technology for a fuel source. Availability in this sense is in terms of the fuel's long-term viability at a price which will make it economically attractive to the end user. For example, a user could make a determination to design and build a facility to burn used motor oil. Without knowing the availability of the oil, the user would be in danger of consuming the entire supply quickly and then be forced to seek another source at a much higher cost. The factors associated with availability are market driven and can be very complex. For example, ESI is aware of a facility that was designed to combust 100% paper mill sludge. Prior to the facility coming on-line, all sludge was sent to a local landfill. One of the economic drivers for the facility was the reduction of tipping fees for local paper mills. Because the facility dramatically reduced the sludge quantity going to the landfill, tipping fees immediately dropped by half of the previous rate after the unit had operated for a couple of months. When determining the availability of a fuel, proper and thorough research is necessary. ESI recommends a multi-faceted approach including: employing experts in the area where a project is being considered, interviewing other users of the fuel to determine their experience with market volatility, meeting with multiple fuel suppliers, and looking at potential market factors like source stability.

Price

The price of a given fuel is also paramount in selecting the appropriate technology. Like availability, price is also market driven. This factor is definitely the most important and the most difficult to analyze. By price we mean the long term, through the life of the project, costs of the fuel relative to other fuels which may be higher, but have a lower overall plant operating cost. There are several organizations that provide indexes which attempt to

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ENERGY SOURCE

The *ENERGY SOURCE* is published quarterly for customers, employees, and friends of ESI Inc. of Tennessee.

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

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predict the future potential price of fuel. These can be an aid in trying to determine a long-term price. However, the end user should do his research and consider outside market drivers as well. For example, very few of these indexes were predicting the $15/ mmbtu natural gas pricing which some customers saw a couple of years ago. Yet had the researchers been able to understand the number of utility plants which were being developed firing only natural gas and the leveling of natural gas production which has occurred over the past five years, they might have been able to weigh that additional usage into its effect on the supply of natural gas. Even the purchase of long-term contracts can offer limited security to the end user, since the supplier's ability to honor these contracts can be very limited under the drastically changing markets that can occur today. In the end, one of the best indicators of a fuel's price will be the long-term availability and possible competition for the fuel.

Operating Costs

The effect of long-term operating costs on a facility due to the fuel is one that can define a project's success or failure. Operating costs associated with the fuel include:

- The disposal cost associated with the ash generated from the fuel.
- The emissions clean-up chemicals, horsepower, and maintenance costs associated with bringing the system under emissions compliance when firing the chosen fuel.
- The operating personnel cost, maintenance cost, and additional horsepower requirements associated with the handling and combustion of the fuel.

To analyze these costs, the end user should obtain the advice of experts in the industry. These experts should have experience in the design and operation of similar facilities. Technology suppliers can also be a good source for references of similar installations. Ultimately, thorough research is the best way to avoid surprises associated with higher than predicted operating costs.

Capital Cost

The effect that the fuel has on a project's capital cost will vary based primarily on the fuel's properties. For example, the capital cost of a solid fuel-fired system is much more expensive than for natural gas or liquid fuels due to the significant costs of material handling. If the fuel has a high percentage of sulfur, some type of SO_x removal equipment will be required. If the material needs to be sized or dried from its as-received state prior to combustion, sizing and screening or drying equipment will be required. To determine the capital cost associated with a fuel, a thorough understanding of the fuel, its properties, and variability is necessary.

Analysis and Properties

In addition to the economic factors mentioned above, the analysis and properties of the fuel are the most critical elements in selecting a technology. The analysis is defined as the chemical composition of the fuel. This can be determined by performing or obtaining an ultimate analysis of the fuel which includes higher heating value, a chemical analysis, and an ash analysis to determine ash characteristics and the constituents of the trace minerals. For certain fuels, additional information might be necessary. For example, if firing a certain coal is being considered, the ash softening initial deformation temperature is necessary information. The properties associated with the fuel include such items as material density, handling properties, sizing, etc. Each of these will have an effect on the storage, conveying, and combustion technology chosen. Since this topic is so broad, ESI will expand on what fuel properties are critical in the selection of fuels for each of the major combustion technologies in the Fall 2007 issue of the newsletter. Suffice it to say that the fuel analysis and properties must be known to properly select an appropriate technology.

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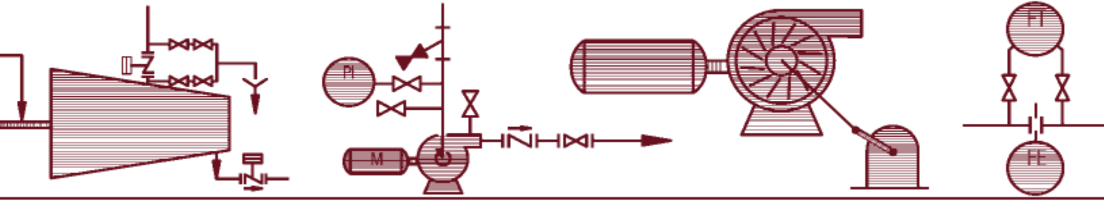

POWER PLANT DESIGN TIPS

The success of any steam and power installation depends on the integration of hundreds of subtle design features that ensure that the installation goes smoothly and the system operates satisfactorily.

The following are design tips which should enhance a project effort:

- **Field Investigation** – Historically, site investigations of existing equipment and pipe installations have required weeks of field time and expense to create enough notes, sketches, and photos for generating orthographic drawings. In addition, final verification of the new design usually requires additional site visits. The latest technology of 3D scanning at the site has now reduced the field time to days, while resulting in more accurate details and a greater depth of the field review documented. The scans are developed into orthographic drawings and/or 3D model downloads to assist the new design. Many items and issues missed during the site investigation are now revealed in the scan with an accuracy that eliminates a final site visit.

- **Pipe Specifications** - Pipe and hand valve specifications are often not specifically addressed at the start of a capital project. While many companies have established corporate, plant, or mill specifications, constant company restructuring seen in recent years has resulted in these specifications not being updated. Although the basic requirements of B31.1 (power) and B31.3 (chemical) have remained the same, many specific items within a company's specifications have become out of date and are incorrect for today's designs. The pipe specifications used for a project should not be over two years old, or if so, project time should be included to bring the specifications up to date.

- **Smart P&ID's** – The idea and ability to generate "Smart" P&IDs has been around for years. A number of engineering firms have explored the utilization of this technology, but to date, most have not progressed beyond generating the line list, hand valve list, or motor list. Shared ownership of the P&IDs between the design groups of controls, electrical, and mechanical often inhibits this development due to a lack of primary ownership. Years spent creating specialized databases for indexes and specification forms can be eliminated with the final selected "Smart" software. With customers demanding shorter engineering schedules, automated deliverables, and increased design efficiency, engineering managers must identify in-house "Champions" for developing and using this technology.

- **Hanger Selection** – Pipe hanger design requires specific consideration for pipes that "grow" at elevated temperatures or "pulsate" during surge operation. Clevis style support components, while inexpensive, are often improperly applied in these support design systems. When used in a pulsating or surging system, the pipe can sway during operation. A complete pipe system design should give consideration to "grabbing" the pipe with U-bolt or single/double pipe clamp supports specifically at direction and elevation turning points.

- **Pipe Support Spans** - Pipe support span charts originating from the B31.1 Power Pipe Code were established for continuous straight runs of pipe (such as on pipe bridges or pipe alleyways) without any concentrated loads between supports. Unless specifically designated, the sole use of support spacing charts should not be depended upon for horizontal pipe, nor used at all for vertical runs of pipe.

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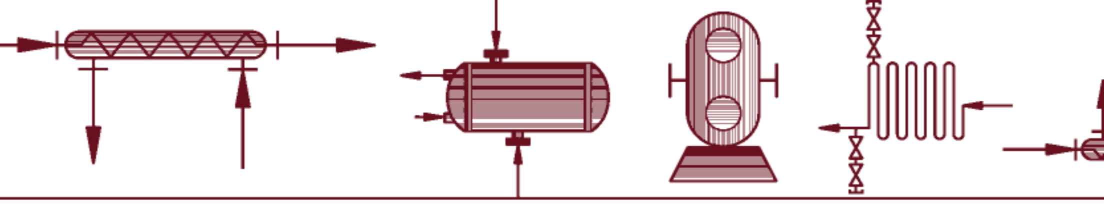


Drawings and Specifications
ESI is Your Engineering Partner

For LARGE UTILITY AREA PROJECTS…*and small ones, too!*

By: Jay Garrett, Business Development Manager, ESI

For over 25 years, ESI has provided cost-effective solutions to the needs of industrial and utility clients. In every region of the U.S. and all across Canada, in Central and South America and most recently in Asia, ESI has performed the engineering for projects such as a 1.1 million pph coal-fired CFB installation and a 40 MW wood-fired power generating plant. We are solid fuel firing experts and can handle every aspect of design and construction from material handling through the boiler, all environmental compliance requirements, controls, system start-up, and commissioning.

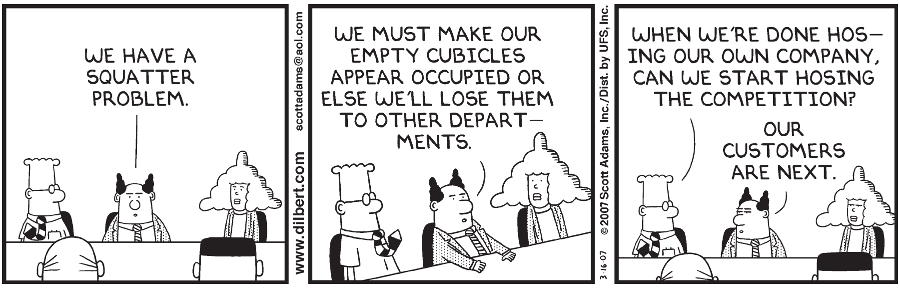
The overwhelming majority of our time is dedicated to helping clients who are in the very early stages of project evaluation. It is during this phase of technical and economic “modeling” that ESI can drastically save our clients time and money. Because we are an EPC (Engineer, Procure, Construct) company, we have an intimate knowledge of how much things really cost, making it simple to evaluate project options after only a phone call. Sometimes, a simple phone discussion results in our recommendation that the client abandon a project due to poor economics. However, often after this detailed question/answer discussion, ESI will provide budget pricing for a preferred solution in a matter of days.

…And this phone consultation

and rough budget pricing is “FREE”.

Very often, our clients will take this rough budget pricing and determine that this is, in fact, a project worth pursuing for further development and analysis. At that point, ESI can provide “feasibility study” services or, as has been the case with most of our recent work, clients can choose to contract with ESI to perform “preliminary engineering” services. This more detailed engineering work provides the client with drawings and specifications necessary to derive very close budget price projections and firm price proposals from vendors and contractors. This preliminary engineering work is accretive to the final engineering requirements of a project. Therefore, if the preliminary budgetary economics dictate that the project is potentially viable, the money spent on doing preliminary engineering to further define the scope and an accurate capital cost estimate is a good investment.

In this age of ever-shrinking corporate engineering staffs coupled with the volatility of both the emerging technology market and the price of new technology, ESI is available to act as your “engineering partner” for all phases of projects, large and small.



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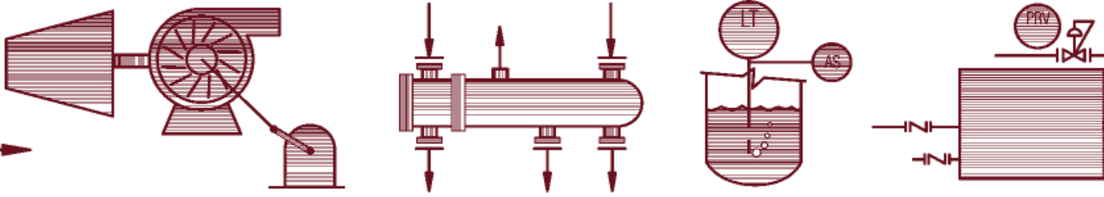

What Are My Fuel & Technology Choices?... *Continued from Page 2*

Moisture Content

Although moisture content is a part of the fuel analysis, it is critical enough that it deserves its own discussion. Moisture content can be the primary determining factor that defines the appropriate firing technology. High fuel moisture has a quenching effect in the combustion process. Essentially, additional energy is required to drive the moisture in the fuel to a vapor form so that the volatiles in the fuel can be combusted. As described in the Spring 2007 issue of the newsletter, fuels with moisture contents above 55% can only be comfortably fired using CFB or BFB technology and even then may require the addition of a supplementary fuel to add the necessary energy to drive off the fuel's moisture. However, even if a fuel has relatively high moisture, there are options available to dry the fuel and bring the fuel back into a range that can be fired by a different technology.

Variability

The variability of a fuel can be a critical component in determining which technology should be used for combustion. Although there is much less variation in some fuels such as coal when compared to most biomass fuels, it is still very important to understand what variations the combustion technology will see in order to make a proper selection. Variations can occur as a result of different fuel suppliers, different fuel sources, seasonal impacts, or processing changes. The best indicator of the variability of the fuel is historical data. The more historical data that is available over as long a duration as possible makes for a better decision. ESI recommends obtaining at least one year's worth of data if possible to truly understand the possible variations in the fuel. Once the range of variations is known, then it will be possible to determine how much flexibility needs to be incorporated into the material handling system and combustion technology process. For example, if the data states that the fuel moisture varies seasonally from 45% moisture to 65% moisture, then a BFB might be a better choice for the project than a stoker.

Conclusion

The bottom line in determining which technology is appropriate for a specific fuel is a thorough understanding of the fuel itself. Once the above factors are defined, the technology selection can be quickly determined by a technical and economic analysis. The last article in this series, which will be presented in the Fall 2007 issue of the *ENERGY SOURCE*, will discuss the differences between firing wood, coal, and other solid fuels along with a discussion regarding the critical parameters in a fuel analysis that affect technology selection and plant design. If you are currently evaluating your options for solid fuel firing, give the experts at ESI a call to discuss your options. Contact Jay Garrett with ESI today at 770-427-6200 or info@esitenn.com.

POWER PLANT DESIGN TIPS... *continued from Page 3*

- **Control Valve Interference** – Preliminary pipe design practice identifies a control valve as one size smaller than the pipe line size. Pipe run allowances for the reducers, flanges, and flanged control valve (globe, ball, plug) do not require major redesign if the purchased control valve becomes two sizes smaller than the pipe line size. If, however, the purchased control valve is flangeless or a butterfly type and two pipe line sizes smaller; at least one side of the pipe flange connecting to the control valve will require an additional length of straight pipe to allow for the connecting studs and/or cap screws to be installed or removed so as to avoid hitting the two-size pipe reducer. Also, it is considered good practice to install a control valve station bypass above the control valve. Valve actuator orientation or space between the two pipe runs should be such that the valve actuator can be removed without removing the control valve.