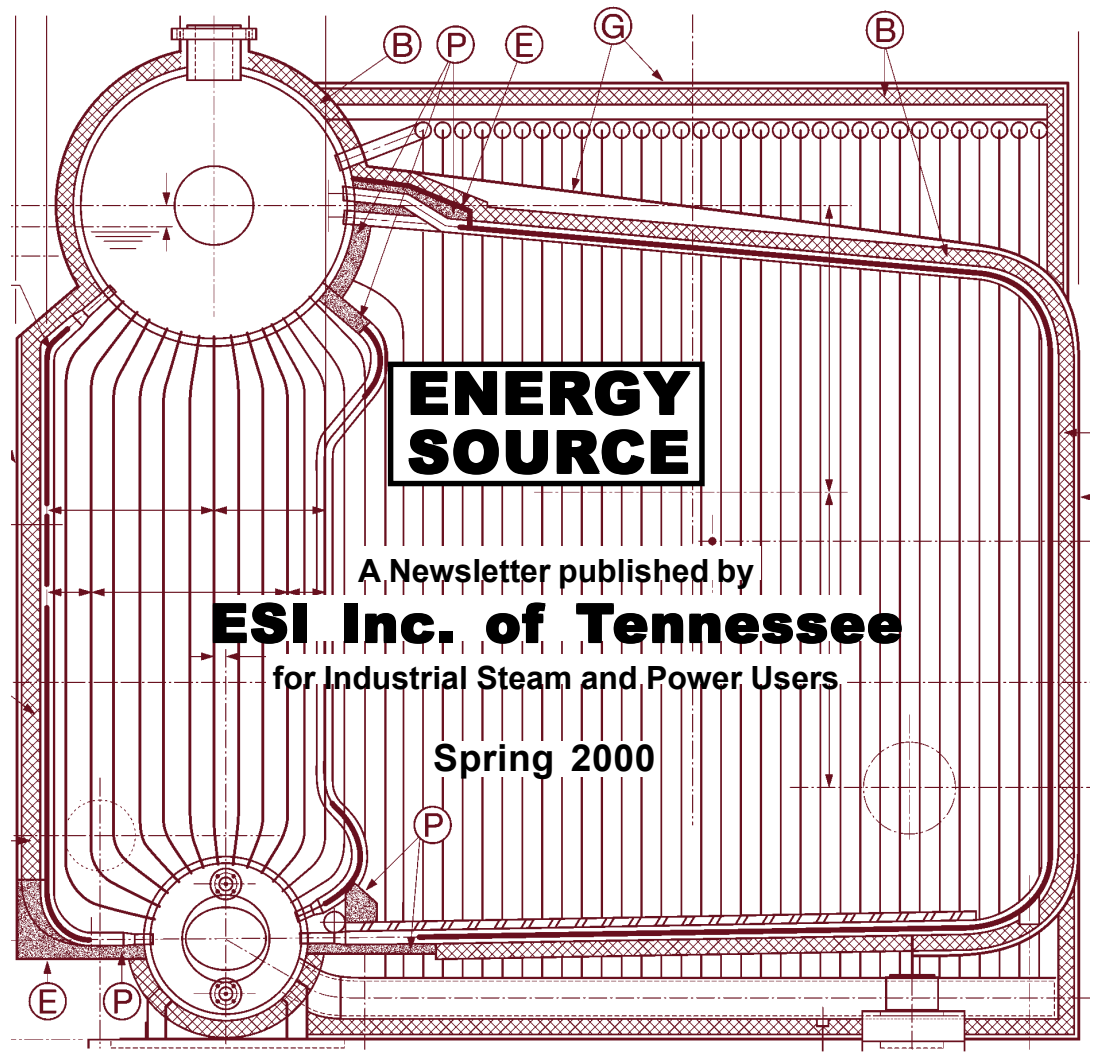

ENERGY SOURCE

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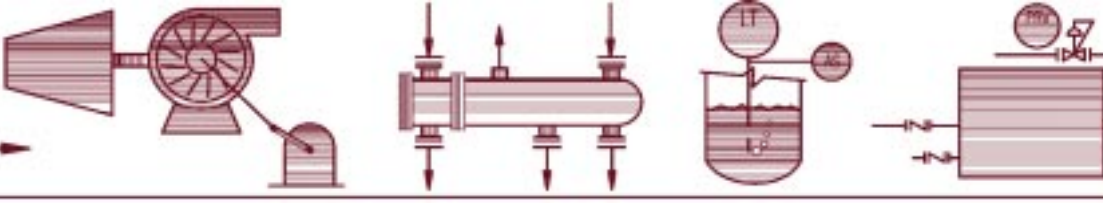
for Industrial Steam and Power Users

Spring 2000



GET THE HEAT OUT!

By: Jackson A. Brown, P.E., Mechanical Engineering Manager, ESI

Did you know that for every 40°F that the boiler flue gas temperature is reduced prior to exiting the system, a 1% increase in boiler efficiency can be gained? Did you know that a 1% increase in boiler efficiency could result in significant savings on your annual fuel costs? If you did not quickly respond yes to these questions, this article is a must read!

Just reclaiming heat from the flue gas is not that difficult to do; however, without knowing the constraints that apply to gas temperature and by not being fully aware of the best way to utilize the heat, what appears to be an improvement may turn out to be an operating nightmare, or certainly not an optimized system.

Heat traps, as they are called, are usually classified as economizers or air heaters. An economizer is a heat exchanger that uses the flue gas to raise the temperature of the feedwater before it is introduced into the boiler. It consists of tubes with feedwater on the inside and flue gas on the outside. An air heater, on the other hand, is a heat exchanger that uses the hot flue gas to preheat the combustion air. In its most common form, it utilizes tubes with flue gas on the inside and combustion air on the outside. The needs of the system must be evaluated to determine which heat exchanger is the best application for that particular plant. Some systems may actually require the use of both an economizer and an air heater.

There are several factors that influence whether an economizer and/or air heater should be chosen. Generally speaking, an economizer is less expensive because it is typically smaller than an air heater serving the same purpose. However, this is far from the only consideration involved in making the appropriate selection.

When a high moisture solid fuel is being burned in the boiler, air heaters are usually included in the design. The hot combustion air aids in the drying of the fuel, thus allowing higher moisture fuel to be burned without supplemental auxiliary fuel (usually gas or oil). This application also has some limitations. First, the grates on which the fuel is being burned rely on the combustion air to help keep the grate temperatures within acceptable limits. Thus there is a maximum combustion air temperature which cannot be exceeded. Second, if an air heater is oversized (too much heat transfer surface area), acidic flue gas condensation can occur. The lowest flue gas temperature which can be utilized without causing potentially corrosive condensation should be chosen.

Continued on Page 5

ENERGY SOURCE

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

ESI is an engineering and construction firm that specializes in steam and power projects for industrial and utility clients.

Complimentary subscriptions to the *ENERGY SOURCE* are available by calling 770-427-6200 or visiting our web site at www.esitenn.com. If you have any suggestions or comments about the newsletter feel free to call us or e-mail us at energysource@esitenn.com.

Deanna Melvin
Managing Editor

Turning Municipal Sewage Sludge Into Construction Products

By: William L. Reeves, P.E., President, ESI
Richard E. O'Conor, P.E., Vice President, Business Development, Minergy

ESI is proud to announce that it has been selected as the EPC Contractor for Minergy Corporation's Clear Horizon Plant to be located in Detroit. This plant will replace the Detroit Water and Sewer Department's wastewater solids incinerators and convert the "waste" stream into a usable product.

The new state-of-the-art treatment facility will recycle all of the City of Detroit's sewage sludge (biosolids), up to 2,700 wet tons per day, into a glass aggregate material that will be sold and used in products such as ceramic floor tiles, roofing shingles, sandblasting grit and other abrasives. The facility's high-temperature technology not only recycles the biosolids into a viable product, but also recovers the process' energy to generate steam and electric power for sale.

The glass aggregate recycling process, presented in Figure 1, begins with receiving the sludge. The sludge is first dried and then it is placed into a cyclone furnace to vitrify it into the glass aggregate material. On a chemical level, the organic content of the sludge is combusted and destroyed which produces energy.

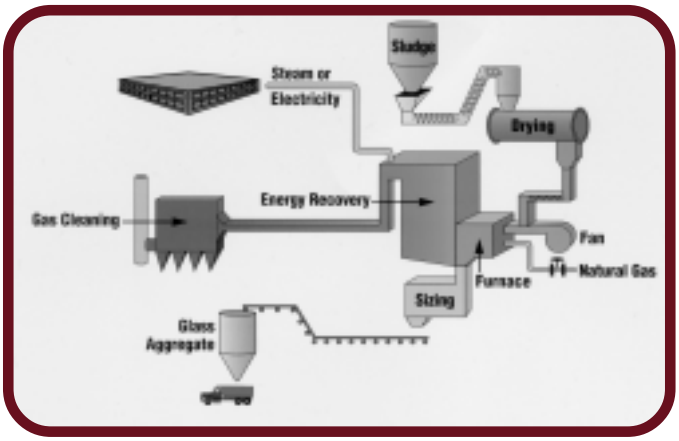


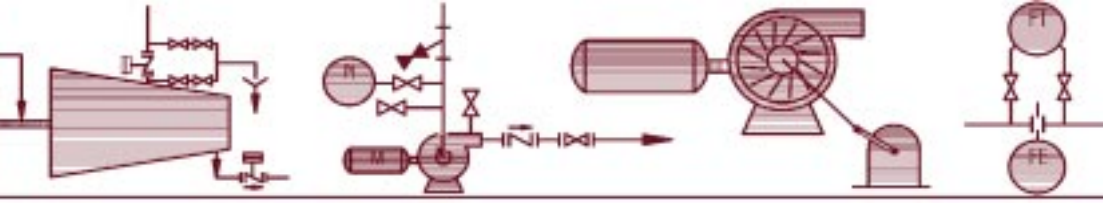
Figure 1. *Schematic of Glass Aggregate Recycling Process.*

This technology has several advantages. First, it is an alternative to landfilling or land application of biosolids that face increasingly more difficult regulations. Second, the biosolids are made into inert material that alleviates any environmental concerns. Also, this technology generates significantly lower air emissions than that of the existing incinerators.

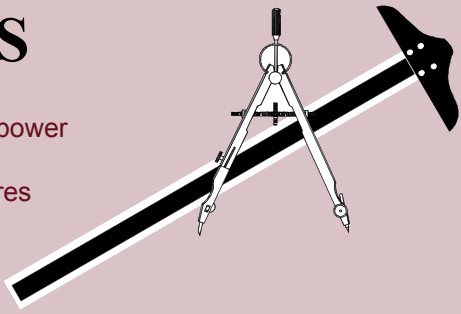
This technology is currently employed at Minergy's Fox Valley Glass Aggregate Plant in Neenah, Wisconsin. This facility, which has been in operation since 1998, receives 1200 wet tons per day of paper mill sludge from eleven different paper companies. This facility, designed and built by ESI, received the 1999 Power Plant Award from *Power* Magazine.

ESI looks forward to working with Minergy to design and build another award-winning facility. Preliminary engineering is underway and plant construction is expected to begin during the first part of 2000, with start-up planned for 2002.

For additional information about this technology, visit Minergy's web site at www.minerals.com/minergy/glass.html, and for more information about ESI, visit us at www.esitenn.com.



DESIGN TIPS



The success of any steam and power installation is the integration of hundreds of subtle design features that ensure everything operates satisfactorily.

Following are a few design tips with respect to controls and instrumentation:

• The setpoints for the O2 control loop and the FGR damper control loop must be based on total fuel flow for all fuels being burned and not based on boiler steam flow. This is due to the fact that steam flow is a lead/lag boiler load indication and not always representative of the actual firing rate. Use of the steam flow in determining the setpoint could result in the improper calculation of the setpoint for either of these control loops.

• Combustion Air Flow measurement can sometimes be a difficult measurement because of the low delta-p generated by most air flow elements. This difficulty has led to the creation of other technologies to measure air flow. One such device is a hot wire anemometer which uses a heated reference RTD and compares it to the actual reading of the RTD inside the element. One design tip associated with a hot wire anemometer is when using them on a boiler with an inlet air duct directly to the outside, make sure that you design the inlet such that no moisture from rain or snow can be drawn into the area with the flow meter. The danger here is that any moisture that contacts the measured RTD will cause the system to think that the air flow is greater than actually present and can lead to a substoichiometric combustion condition. This occurs on control systems that employ a fully metered cross-limited air and fuel relationship.

• Differential pressure measurements of air, flue gas or natural gas should always have the instrument mounted above the process connection(s) with all sensing lines sloping toward the process connection to prevent any condensation from building up in the instrumentation or sensing lines. Conversely, differential pressure measurements or pressure measurements of liquids or steam should always have the instruments mounted below the process connection(s) with all sensing lines sloping toward the instrument to keep the sensing lines consistently full and free from pockets of air. In addition, sensing lines on steam flow or drum level applications should include condensate pots mounted at the process connection(s) to limit the impact of process pressure changes from adversely affecting the measurements.

ESI specializes in the design and construction of steam and power plants for industrial and utility clients. If you have a technical question about your steam or power facility - **ASK US!** Call Deanna Melvin at 770-427-6200 or e-mail us at energysource@esitenn.com.

Too Many Projects . . . Not Enough Capital

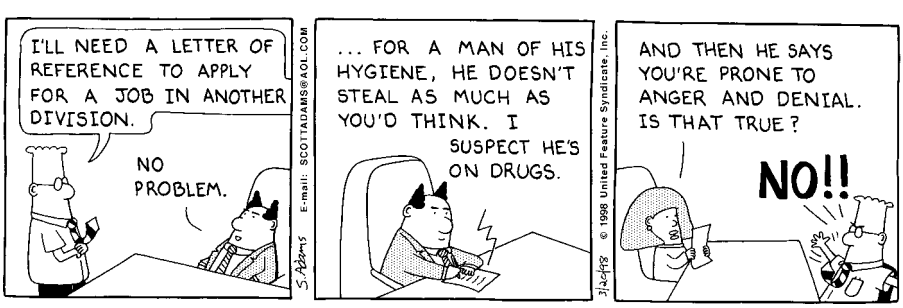
By: William L. Reeves, P.E., President, ESI
Ralph H. Walker, Jr., President, Peregrine Energy Corporation

As global competition squeezes margins, ESI has seen a dramatic change over the past few years in the approval and funding of utility infrastructure projects. Many viable projects are delayed due to a lack of capital, or management reluctance to incur additional balance sheet debt. ESI has made a strategic decision that it must provide a complete and financially attractive solution to the unique challenges facing companies today. Accordingly, ESI, Inc. of Tennessee and Peregrine Energy Corporation have agreed to combine their different, but complementary services to fill this need. This partnership creates a unique and cost-effective opportunity for companies to make energy-related investments to reduce production cost and/or improve productivity.

Together, this new entity will provide needed value in the development and management of industrial utility infrastructure projects. The advantage of our vertically integrated product offering is that we assume the responsibility for the engineering, procurement, and construction of projects and provide the required capital investment. We share ownership of the project with our client. Accordingly, we have a vested interest in the quality of our workmanship and longevity of our equipment. This structure allows us to significantly reduce the project development margins and realize our typical EPC profit and investment returns over the entire contract term. The elimination of numerous middle-man profits further increases the cost-efficiency of our approach. We strive to reduce the project cost by 10% relative to the conventional design and construct approach.

For most companies, the costs and demand for capital improvements and equipment are greater than the available funds. Typically, utility infrastructure investments do not realize the lucrative return(s) that other core business investment opportunities (i.e., process expansions, plant modernizations, etc.) yield. The ESI/Peregrine partnership will invest the capital in your utility infrastructure improvements while simultaneously providing EPC services. Recent contracts with other Fortune 500 companies have proven the cost-effective nature of this project structure. Our contractual structure (executory contract or operating lease) allows the transaction to be considered off-balance sheet by the client and payments are tax deductible. Another key advantage of our contract structure is that additional projects can easily be added and funded over a period of future years if desired.

If you are interested in discussing your particular capital funding and utility infrastructure needs, please call Deanna Melvin at 770-427-6200. For additional information about ESI - visit our web site at www.esitenn.com.



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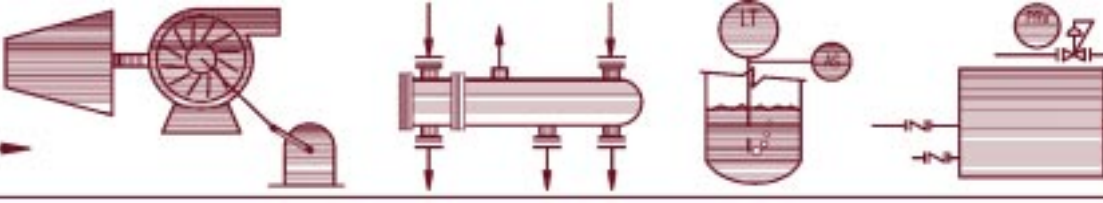

GET THE HEAT OUT... *Continued from Page 1*

However, the possibility of acidic condensate can also occur due to cold combustion air especially under reduced boiler load conditions (i.e., the cold air lowers the flue gas temperature too much). When this possibility exists, the combustion air must be preheated with a steam coil heater prior to entering the air heater.

Systems which have no need for preheated combustion air (i.e., natural gas or oil-fired systems) usually have only an economizer in the flue gas stream. Economizer installations also have limits which must be considered. Occasionally, you will run across a condensing economizer which actually cools the gas below the dew point, resulting in condensation. These type systems are much more expensive from a capital and operating cost standpoint and therefore are seldom used. More commonly, the economizer system is designed to stay above the condensing temperature even under turndown (reduced boiler load) conditions.

It is also very important that both of these heat exchangers be maintained to achieve the design efficiency improvement. A dirty economizer (water or gas side) will not remove the amount of heat for which it was designed. A dirty air heater will experience a similar heat transfer problem and usually is more susceptible to corrosive condensate attack. If air heater tubes develop significant leaks, combustion air will leak into the flue gas stream causing wasted fan horsepower and a loss in boiler efficiency. Proper monitoring of the boiler plant operating data will indicate if these problems are occurring.

In summary, heat traps which are properly designed, installed, operated, and maintained are very important components of an energy-efficient boiler plant. If your boiler plant does not have a heat trap, or if you have reason to believe that the existing heat trap was not properly selected or is not performing properly, please contact ESI for further information.

YOU MAY BE AN ENGINEER IF:

1. Dilbert is your hero.
2. You have ever debated who was a better captain: Kirk or Picard.
3. You have ever owned a calculator with no equals key and know what RPN stands for.
4. You have ever saved the power cord from a broken appliance.
5. You walk around with your hands in your two front pockets 99% of the time.
6. You wear black socks with white tennis shoes (or vice versa).
7. You window shop at Radio Shack.
8. You've ever tried to repair a $5 radio.
9. Your father sat 2 inches in front of your family's first color television set with a magnifying lens to see how they made the colors,
10. and you grew up thinking that was normal.