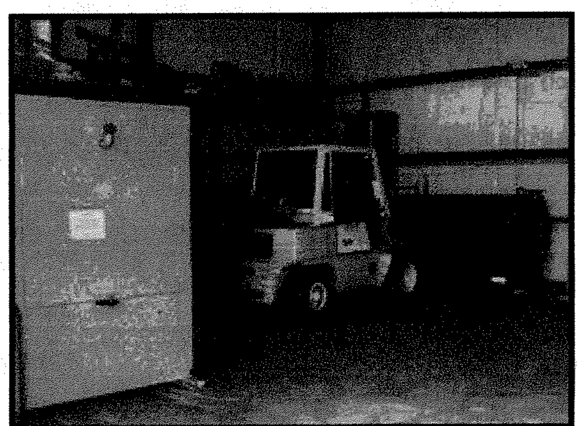
NTSB D058

BOILER SERVICES

The concept of a boiler is simple heat transfer: A boiler provides the interaction between the heat source (combustion gases) and the heat medium (water, the predominate fluid). Boilers are designed to serve this function for a whole variety of applications. Boiler systems still provide the most cost-effective source of efficient heat transfer in manufacturing industries. In many corporations, the efficiency of its steam systems will significantly influence not only the rate of production, but also the per-unit cost of production. Although the concept of a boiler is simple, the variables that affect its overall efficiency are not. Design, maintenance, deterioration, and operation determine system efficiency.

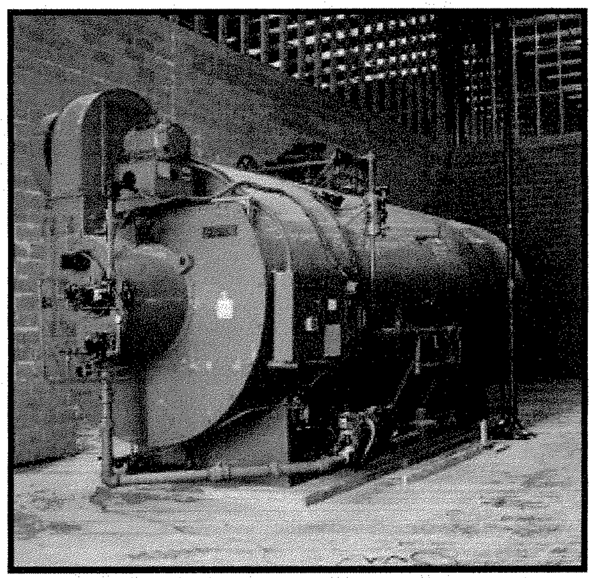


DESIGN: Principles of combustion, heat-transfer design, and water chemistry have a direct impact on efficiency, reliability, consistency, and cost-effectiveness of the end product. Steam system design and equipment selection are dictated by good engineering practices, applicable codes, utility and insurance requirements, operating requirements, fuel requirements, and electrical requirements. The design of an economical system is affected by the complex relationship between design water temperature, design water pressure, flow rate, piping layout, pump selection, terminal unit selection and control method. The size and complexity of the system determines the importance of these relationships, affecting the total system's success.

MAINTENANCE: Any system is only valuable when it is operating efficiently. To operate efficiently, the boiler must combine chemical elements with the exact temperature, time and turbulence to produce the highest level of reaction and achieve the maximum amount of transferable heat using the least amount of fuel. Heat loss is the primary characteristic of inefficiency and can be caused by numerous reasons.

DETERIORATION: All components of a boiler (generating tubes, water wall tubes, water screen tubes, downcomers, economizers, etc.) are subject to corrosion and erosion. Fireside tubes are usually subject to direct flames. Build-up is due to the exhaust of the burner, which contains sulfur, "soot." Soot will collect on the exterior of the furnace tubes and may not allow for the designed heat transfer. More often this is caused from a burner operating inefficiently. If a burner is suffocating due to lack of oxygen, the exhaust will contain heavier compounds of carbon monoxide and noncombusted fuel. This weight will accelerate soot build-up. If this is not corrected the burner will be fired at an excessive rate to achieve the necessary temperature. This action, not only compounds the initial problem, but will cause thermal fatigue, "scaling." Unlike corrosion fatigue, scaling occurs in a high-temperature oxygen atmosphere. The corrosion product is iron oxide, which will deteriorate the metal and thin the thickness of the tube, eventually causing rupture. Many times this is due to a lack of maintenance, but more often it is the mechanical failure of the soot blower, a device that aids in the removal of soot from the surface of the boiler tubes.

Blistering will occur due to sediment build-up on the waterside of the tubes, prohibiting heat transfer. This insulating barrier promotes a focus of heightened fireside, tube metal temperature. This stress will eventually cause deterioration in a blistering manner, usually resulting in a tube failure.



Dissolved solid deposition of the interior tubes, waterside deposits (carry-over), is directly related to the chemical composition of the water within a system. What we commonly refer to as water is a composition of the chemical compound H_2O and many other varying elements, such as silica and carbonate. These additional elements are detrimental to a boiler. Solid particles entrained in the circulating water will deposit on heat transfer surfaces, where boiling is most vigorous in the highest heat-release regions of the furnace. These compounds will deposit on the boiler tubes and impede heat transfer by forming an insulating layer. In addition to the lack of heat transfer and related tube-metal temperature increase, under-deposit corrosion, tube wastage, and hydrogen damage may occur. Chemical treatment of the feedwater neutralizes such elements, allowing their removal from the system and therefore eliminating their detriment. Specific tests indicate the contents of the system's water. The resulting data dictates the necessary, proper treatment for the feedwater tests, such as:

Chloride content - a measure of the salt content of the water. Salt promotes "carry-over," solids transported by steam through the system.

Phosphate content - measures the hardness of the water. If the water is hard, it will necessitate more heat to create steam, thus consuming more fuel.

Alkalinity (pH) - measures the acidic/caustic characteristic of the water. Ferric steels will be more rapidly attacked in strongly acidic and strongly caustic water solutions. The proper pH balance must be maintained to prevent corrosion of this type. If water has a high pH, it is known to be caustic. Hydroxide reacts with steel (iron) to form the ferrite ion, which results in localized wastage or "caustic gouging." When the pH is low, the water is acidic. When acidic conditions occur within a boiler, atomic hydrogen is trapped between the deposit and the steel. Hydrogen, due to its minuscule size is able to diffuse easily into steel, where it reacts with iron carbide to form methane and ferrite. Methane is unable to diffuse and thus collects at the ferrite grain boundaries. As the pressure builds, cracks will develop and weaken the steel. Typically trisodium phosphate, disodium phosphate (ammonia), or sodium hydroxide are implemented into the feed system to achieve alkaline balance.

Electrical conductivity - measures the total dissolved or suspended solids within the boiler system. Due to gravity, this matter will attach itself to the interior wall of the tube. This sediment will compact and increase, eventually blocking the tube.

Dissolved oxygen - by nature the compound for water is comprised with oxygen. The presence of dissolved oxygen, which forms anodes (positive) and cathodes (negative) that are constantly changing locations within the metal of the tubes, will lead to rapid corrosion or pitting of ferric steels (oxidization). Oxidization causes the tube wall to exfoliate. Exfoliation creates a protective barrier, called a scab, under which virgin metal is continuously oxidized, also known as black oxidization. Chemicals, typically nitrogen compounds (hydrazine), are added to react with the oxygen and form innocuous compounds.

OPERATION: Material failure and operator error are the two primary causes of system inefficiency. More commonly, operator error causes material failure. If a boiler is not running at capacity, the characteristics of a system will demonstrate what is causing the inefficiency. An experienced operator should be able to determine the maintenance, repair or inspection that the situation requires. Systems that have not been religiously maintained, will eventually fail. Typically this failure will require extensive repairs and possibly replacement. The cost of preventative maintenance is an insignificant expense relative to the cost of halting production, not to mention the cost of purchasing and installing a new system.

The expense of systematic cleaning of interior and exterior surfaces of a system through applications such as: waterblasting, chemical and mechanical cleaning; inspection of refractory linings, safety valves, operating instruments and controls, faultless water treatment; and necessary replacement and repair; will be far less expensive.

Poor operating practices can also result in thermal shock. Since an operating boiler uses the medium of heat transfer, it is constantly under stress. Often when water is added to the system, it has a cooler temperature than the existing water. If this addition is done improperly, you could shock the system, thermally. The best way to prevent thermal shock damage to a boiler is to prevent rapid changes in water temperature within the boiler. Thermal shock is more often preventable. To minimize the potential for this problem, a boiler should have slow acting valves that bleed the system's water into the boiler during cooling/heating mode changeover; and implement an accumulator tank and/or blend pump arrangement to the system.

B&D has the expertise to repair, inspect, maintain, refurbish, sell, install and even manufacture any type of boiler, however, the most important component of these tasks needs to be focused on before the first physical work is done. We must know how the steam that the client's equipment will provide works as a part of the overall process. This data will greatly affect the determination of a system design that will competently serve the client's demands at the lowest cost. Considerations, such as the cost of the systems energy requirements (fuel and electricity), the installation cost and the projected maintenance costs must all be studied to achieve a cost-effective system that satisfies the need for the system. Although B&D is not an engineering corporation, we often work hand-in-hand with engineers to develop planning for satisfying such demands.

B&D Boilers

- Boiler Services
- Industrial Services
- Affiliated Sales
- News & Views
- Search PCP's
- Fabricating Services
- Marine Services
- Boiler Rental/Refurbishing
- Contact & Query
- Career Opportunities
- Boiler Sales

B&D Marine and Industrial Boilers, Inc.

Charleston Plant

3567 Meeting Street
PO Box 71687
Charleston, SC 29415-1687
Phone: (843) 747-0951
Fax: (843) 747-0659
Email: service@bdboilers.com

Greenville Plant

14 Oakville Road, Suite B
PO Box 14186
Greenville, SC 29610
Phone: (800) 845-5877
Email: gvl@bdboilers.com

B&D Marine and Industrial Boilers, Inc.
is a drug free workplace and EOE.

Contact webmaster