

Volume

45

HURST BOILER AND WELDING CO., INC.

SERIES "MH" SOLID FUEL/BIOMASS ENERGY SYSTEMS

Component & System Guide

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Introduction

HBC & our Family

The Two Most Valuable Assets Hurst Boiler and Welding Co., Inc. has to Offer Our Clients are the Skills and Wisdom of our Family Members and the Products we Engineer, Fabricate and Install.

To help you better understand our organization and products, Gene Hurst (our "Capt'n") put together this manual. He hopes this manual will help you save time and enable you to make informed, profitable business decisions. You will find the information in this manual to be a complete, if general, review of the components HBC uses and how they work together to make HBC's Hybrid Solid Fuel/Biomass Energy Systems the best available. Before we get to the technical issues, we would like to use this introduction as an opportunity to provide more detailed information about our company, HBC's team members and how to contact us.

Product

For over forty-three years (founded in 1967), Hurst Boiler and Welding Co., Inc. has been a major supplier of gas, oil and solid fuel boilers to thousands of satisfied customers. Our firm has manufactured over 20,000 pressure vessels for world markets. Hurst currently manufactures boilers ranging in size from 6 to 3,000 boiler horsepower and from 30 PSI hot water up to 900 PSI steam (with superheat) operating pressures. Hurst also manufactures a complete line of boiler room peripherals such as blow down separators, surge tanks, pressurized feed water systems, open vented feed water systems, steam accumulators, super heaters, underfeed stokers, sloped reciprocating stokers, "chain grate" type stokers, pneumatic stokers, combustion chambers, multi-cyclone collectors and exhaust stacks.

Location

All of these high quality products are produced in our facilities located in Coolidge, GA, USA. Our corporate facilities are located on US Highway 319 North in Thomas

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County, Georgia; two miles south of Coolidge, Georgia (population 250) and 11 miles north of Thomasville, Georgia. Hurst Boiler and Welding Co., Inc. is in close proximity to Albany, GA, Valdosta, GA and Tallahassee, FL. Tallahassee Airport accommodates major airlines while Albany and Valdosta are serviced by the major airlines' commuter divisions. Our facilities are located within five minutes of two smaller airports, Thomasville and Moultrie, Georgia, which serve local corporate jet aircraft. This is also the location of two of our plants. HBC also owns and operates another manufacturing facility in Coolidge, GA.



Facilities

Hurst Boiler and Welding Co., Inc.'s corporate facilities are located on over 20 acres of land with 1,000 feet of highway frontage and local rail siding access. Our manufacturing facilities measure over 240,000 square feet with many overhead and mobile cranes in three plants in the USA. We recently completed the construction of an additional 40,000 square foot manufacturing facility at our Coolidge facility with new corporate offices.

Our plant resources include two state-of-the-art CNC Plasma cutting/beveling machine, submerged arc, MIG (argon), GMA welding, automated welders, furnace corrugators, presses, shears, rollers, drills and profiling equipment.

Our stress relieving oven easily accommodates all HBC's heat treatment requirements.

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Our skilled labor and management, around ~400 employees, includes A.S.M.E. Certified welders, certified to Section IX in our own shop.

Site installations and servicing are carried out throughout the United States and the world.

Quality

Quality control activities are organized to achieve the highest product quality and to suit the customer's specific requirements. This policy is carried out in practice to detailed standard procedures in the Company's Quality Control Manual.

Hurst Boiler and Welding Co., Inc. is totally committed to meeting all of the requirements of the A.S.M.E. Boiler and Pressure Vessel Code, as a minimum, and the Quality Control System outlined in Hurst Boiler and Welding Co., Inc.'s Quality Control Manual for shop fabrication and field installation of boilers, pressure vessels and their appurtenances.

Shop or field repairs and/or alteration to boilers and pressure vessels shall be in accordance with the National Board Inspection Code and the jurisdiction in which the repair is being performed.

Hurst Boiler and Welding Co., Inc. routinely certifies our products to CE, EU, Chinese and Canadian standard requirements as well as other countries' standards.

Management

THOMAS E. HURST, VICE PRESIDENT

Tommy Hurst has developed a sales team second to none of a high technical and direct practical caliber. He knows the business well having joined the company as a boilermaker's helper in 1970. He has experience with the technical demands of coordinating the present corporate activities.

HAYWARD HURST, FIELD OPERATIONS

Hayward worked part time with Hurst Boiler and Welding Co., Inc. from 1975 until January 1979 when he became full time Field Manager. He has considerable experience with fabrication, machining, pipe work, installations and general site erection. He is responsible for the development of practical skills and production resources that contribute to the company's high reputation for quality installation and repair services worldwide.

System Sales

GENE ZEBLEY, GASIFICATION-THERMAL SYSTEM SALES

Experience ranging from project development, negotiation and export issues to remote installation supervision, Gene is a member of the United States Department of Commerce's Southeast Regional Export Advisory Council and has experience teaching biomass thermal energy technologies in a class room setting.

CHARLES COFFEE, SOLID FUEL SYSTEM SALES

Employed by Hurst Boiler in October 1979, Charlie has worked from installation crew chief of boiler systems to become the leader of our solid fuel sales staff. His primary areas of expertise are in the areas of solid fuel fired boiler projects, with over 300 systems installed worldwide, and lumber drying technology. Charlie is also responsible for direct marketing of our solid fuel systems in the Southern USA.

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Cliff Hurst, Solid Fuel System Sales (ext. 1061)

Cliff has over ten years experience in boiler manufacturing and system design. He is a prime example of Hurst Boiler Co.'s commitment to passing its corporate knowledge of boiler making on to the enthusiastic third generation of the HBC family.

Technical

BRUCE COFFEE, CHIEF ENGINEER

After beginning as a part time boiler maker's helper while in school Bruce began full time with Hurst Boiler in 1981. Bruce has extensive experience in thermal and stress design and has been involved with the development of the skills, methods and plant improvement which enable Hurst Boiler to initiate programs and control high quality fabrication and welding to satisfy quality control requirements in the production of pressure vessels. Bruce engineered our highly successful Hybrid systems to be THE CHOICE when a solid fuel system is needed by the US lumber industry.

JOHN WINSHIP, LOGISTICS SPECIALIST (extension 1080)

John joined Hurst Boiler and Welding Co., Inc. in April 1994. John is responsible for the scheduling and coordination of all boiler installation and repair personnel as well as the sale of repair and maintenance services. John's special skills are related to the installation, operation and maintenance of the packaged petroleum burner packages provided by Hurst Boiler and Welding Co., Inc.

GARY HUNTER, TRANSPORTATION MANAGER (extension 1027)

Gary joined Hurst Boiler and Welding Co., Inc. in 1984. Gary is responsible for the permitting and scheduling of all the modes of transportation required to move Hurst Boiler's products to market. The daunting array of configurations, which our products possess, presents a challenge that Gary is well equipped to meet successfully.

HIRAM WALKER, PARTS DEPARTMENT MANAGER (extension 1107)

Hiram began working with Hurst Boiler and Welding Co., Inc. in November 1995. He is responsible for the administration of the parts warehouse, the coordination of parts requisition and parts sales. Hiram has over fifteen years experience in material handling, requisition, administration and sales related to the boiler business.

Contact Information

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Coolidge, GA 31738

Corporate Website: www.hurstboiler.com

E-mail Address: info@hurstboiler.com

Family of Products

Hurst Boiler and Welding Co., Inc. manufactures a full range of packaged boiler systems. To obtain additional product information, please contact us with your requirements.

Following is an overview of the HBC Series “MH” Solid Fuel/Biomass Energy System from the fuel storage systems to the exhaust stacks which HBC engineers, fabricates and installs.

RECIPROCATING/WALKING FLOOR SOLID FUEL/BIOMASS STORAGE

Material handling. Of all the things we do, material handling may be the most critical part. If a biomass energy system does not have a reliable source of fuel, it will NOT work to its specifications. There are many ways to store biomass and transport it to a particular location: bins, silos, truck dumps, traversing screw bins, reciprocating floors, etc.

Of all the solid fuel/biomass storage technologies available Hurst has found the reciprocating floor system to be the most adaptable, simple and low maintenance of all technologies for the storage of high moisture content (>30% Moisture Content. Wet



Figure 1 A typical reciprocating floor unit. Notice the main assembly is mounted on a single steel plate rather than to the concrete

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Basis) biomass fuels. HBC offers this system as an option to its clients. Hurst engineers, fabricates and installs these systems worldwide. The reciprocating or more commonly referred to as a “walking” floor is a fuel storage/handling system that allows bulk biomass fuel to transition from a storage area into the fuel feed circuit as called for by the power system it is supplying.

A Hurst reciprocating floor installation may be comprised of two (2) to eighteen (18) approximately twenty-four (24) foot long by three (3) foot wide, hydraulically activated slides moving on a steel base plate. Each slide possesses airfoil-like wedges welded to it at approximately three (3) foot increments, on either side. As the slide moves forward the wedges present a near vertical surface to the fuel and plow/push it. On the return motion the wedges tend to lift the fuel as they pass under it, thus fuel movement occurs mostly in the forward motion. The slides move on UHMW polyethylene glide pads attached to their bottom. These glide pads are designed to prevent fuel from building up under the slides and lifting them. Stationary wedges, welded to the base plate, are positioned between the slide assemblies to prevent fuel from “riding” with the slides on the return stroke. The slides are held down and alignment maintained by a guide roller at the front end and at varying points along its length by UHMW padded, “U-shaped”, welded steel hold-downs. This entire assembly is welded to a steel plate base that acts as the foundation, in lieu of concrete anchoring. This completely eliminates the possibility of concrete anchoring failure due to inconsistent concrete density.



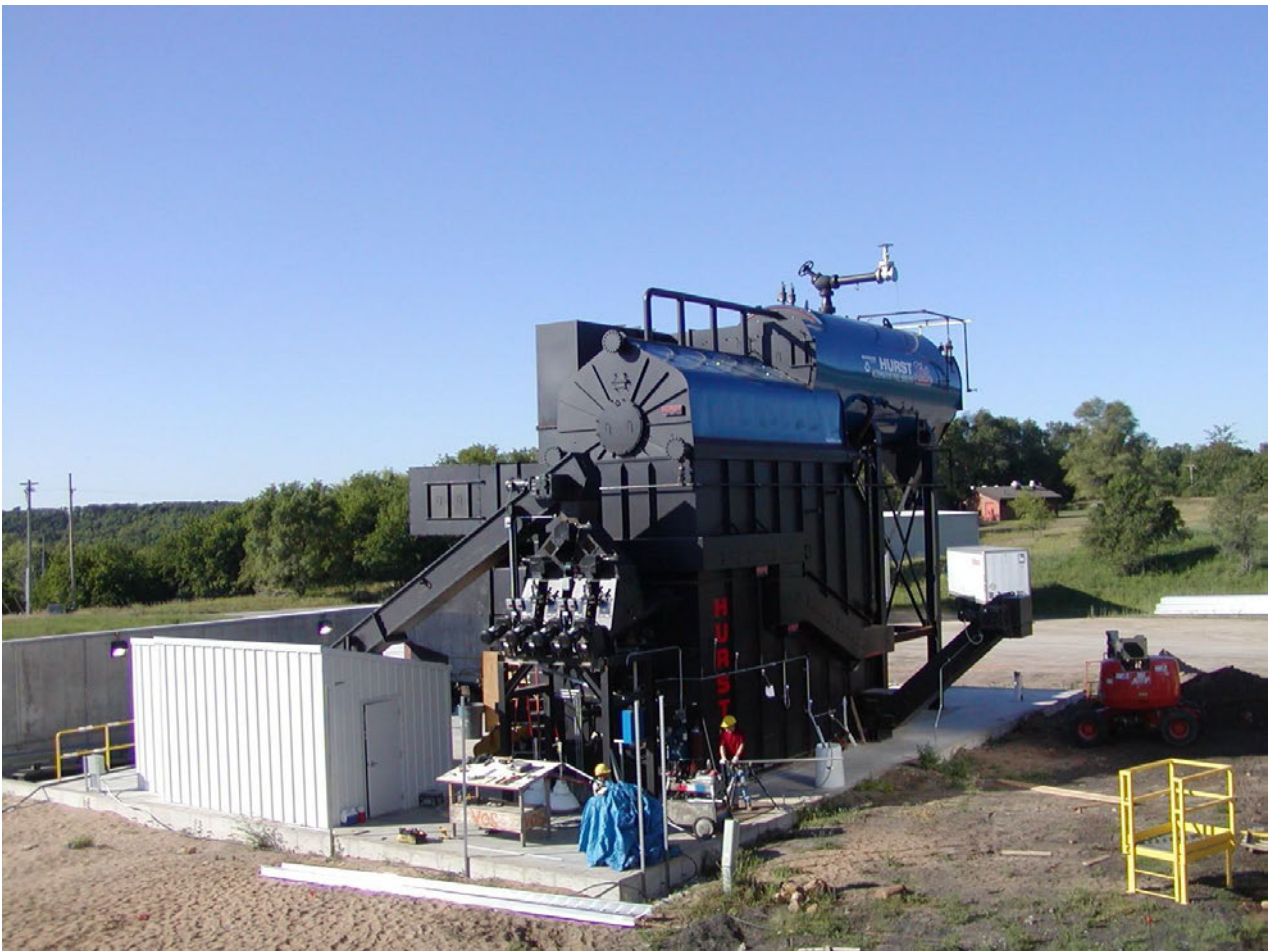
Figure 2 typical hydraulic cylinders and pump arrangement.

The heart of the walking floor system is the Parker Hannifin, high pressure, 2500 to 3000 PSI, hydraulic pump capable of delivering approximately eleven (11) gpm. Larger, higher capacity units may be used for larger boiler installations. The hydraulic

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unit supplies the motive force for the actuating cylinders attached to each slide. The six (6) inch bore, thirty-six-inch stroke cylinders are actuated on demand by the system's PLC. The Parker Hannifin hydraulic unit, while capable of 3000 PSI, is normally adjusted to that pressure at which the walking floor is able to deliver fuel without experiencing a stall condition --- the point at which the resistance to move the fuel is greater than the pressure exerted by the cylinders. At installation, the pressure is set, normally 1500 PSI, to accommodate the fuel at that time, though a change of fuel, i.e. saw dust to bark, may necessitate an increase in pressure. The hydraulic pump also has a volumetric delivery control feature allowing the unit's GPM delivery rate to be adjusted. Programmable Logic Controller (PLC) timers are used to control the selection, actuation and duration of stroke for each of the hydraulic cylinders.

The fuel typically is transitioned to a vibrating (with a 2-1/2" fuel sizing screen) or screw conveyor, commonly referred to as the exit conveyor or cross over conveyor, to a feed/transfer conveyor supplying a metering bin. The metering bin maintains a small fuel reserve just prior to the biomass being delivered to the gasification/combustion chamber.



SOLID FUEL BIOMASS FEED SYSTEM

The fuel feed system is comprised of all those elements necessary to deliver fuel to the point of consumption, in this case the combustion/gasification chamber. This is one of the most critically important tasks performed by HBC's systems. HBC's advanced and reliable systems incorporate fuel feed units that offer the greatest reduction of uncontrolled air being introduced into the system thereby increasing gasification/combustion efficiencies to a nominal level. The following narrative begins at the Metering bin. The typical conveyance from the storage area to a metering bin is accomplished through the use of a reciprocating/walking floor. For a detailed description see "Reciprocating/Walking Floor".

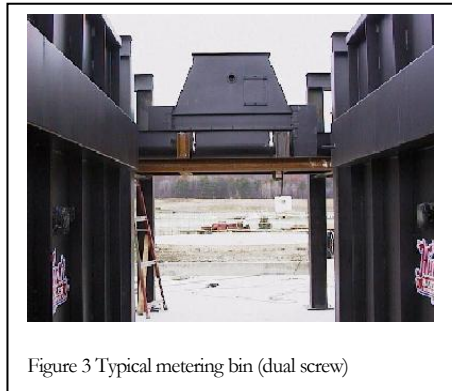


Figure 3 Typical metering bin (dual screw)

The metering bin maintains a minimal reserve of fuel, however its prime function is to provide a positive head of fuel above the variable pitch metering screw to assure a relatively constant delivery rate per revolution.

The metering bin is fitted with a level-indicating device, most typically a Delavan Sonac System. This is a sonar sensor unit that has proven to offer the most trouble free sensing and service to date. As the load on the energy system is increased (i.e. steam pressure or water temperature drops) the demand for fuel correspondingly increases lowering the fuel level in the bin. The Sonac initiates a signal to the main PLC that activates the fuel storage unloading system, cross over conveyor and transfer conveyor. A delay timer, allowing the exit conveyor and feed conveyor to satisfy the demand and/or empty themselves, is also provided with the system.

A metering screw located immediately below the metering bin is used to transport the fuel, at a measured rate, to a rotary air lock device. Typically, the screw is either nine (9) inches in diameter for 400 BHP and less, or twelve (12) inches in diameter for up to 600 BHP. Multiple screw units may be used for larger applications. Hurst utilizes aggressive screw designs that have proven to reduce binding and provide the most trouble free transport of solid fuels. The screw is usually driven by a five (5) HP variable hertz drive. The variable hertz drive allows for delivery of fuel based on demand. The speed of the screw is determined by the load on the unit as represented

by the boiler's working steam header pressure (or water temperature) --- as the header pressure drops the metering screw speeds up and as the pressure increases the speed reduces. While direct speed control of the screw is handled by the variable hertz drive, the drive itself is controlled by a Honeywell Universal Digital Controller (UDC), a microprocessor-based stand alone controller or the PLC, that not only controls the speed of the unit but also the rate of speed increase up to its 100% setting and its rate of descent. As the boiler header pressure drops off, the UDC determines the rate of drop off and activates the variable hertz drive accordingly --- a rapid drop off will cause the variable hertz drive to go to its 100% setting quickly. Conversely, as the pressure approaches the operator specified, boiler pressure set point, the UDC will gradually slow the drive down to avoid over feeding and allow for a more controllable output. This is also known as fully modulating fuel feed, as opposed to the older technologies available that offer only on-off operation. This HBC modulating control allows for feed control with minimum adjustment and provides the operator the opportunity to alter the speed based on changing conditions such as fuel quality. A dryer fuel will meet the systems needs with less poundage. For a more detailed description of the control parameters see "*System Controls*".

A HBC rotary air lock or fuel "plug" (created using advanced screw design) then acts as a "draft barrier", allowing fuel to pass from the metering screw to the stoker screw while limiting the intrusion of air through the fuel system. If applicable, an air lock is provided and driven by a 3 or 5 HP, depending on application, constant speed motor. The air lock motor, through a sprocket and chain connection, also drives the stoker screw. These components may be eliminated with the use of HBC's fuel "plug" technology.

Finally, we've come to the stokers. Stokers are the heart of all biomass systems. They come in every form that man can contemplate. They may be in mechanically round, flat, inclined, reciprocating, fluidized or rotating forms, stationary or moving, or even pneumatic. All these designs have advantages and disadvantages, both economically and mechanically. After exhaustive research and experimentation, Gene Hurst decided that HBC should endeavor to build only those stoker designs that offered the absolute best of all worlds in economy, proven technology and adaptability.

The five stoker designs that Hurst Boiler Co. manufactures, the HBC Stationary Pinhole, the HBC Pneumatic, the HBC Underfeed and the HBC Automatic Biomass and Coal Deashing, are economical, mechanically proven and adaptable for a wide range of fuels. Each stoker system design has specific applications where their best attributes are magnified to your greatest advantage.

The HBC Stationary Pinhole Stoker System is designed for manual feeding of solid fuels. This system is typically applied to the smallest of boiler designs in applications where labor costs are not a factor. The gasification chamber's floor is constructed of an under fire air plenum, support steel and multiple pinhole grates (12" x 6") specifically

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designed with an optimum cooling profile. Safeties are provided on all access doors to protect the operator during the stoking process.

The HBC Pneumatic Stoker System is specifically designed for the combustion of dry (<20% Moisture Content, wet basis) biomass fuels with very low silica content. This type of stoker has developed a dedicated following over many years use. The pneumatic stoker does have a few drawbacks in all its implementations. The fuel distribution usually is inconsistent with heavy fuel particles settling on the nearest grates, lighter particles farther out on the grate and the lightest particles never even reaching the grates (instant particulate that must be collected later). The grates are left exposed to the extremely turbulent, heated atmosphere of the chamber and WILL degrade prematurely. Finally, the use of air to introduce the fuel to the combustion zone negates the possibility of gasification and this excess air is extremely difficult to control while maintaining the optimum emission characteristics. Despite these drawbacks, the market demands that HBC continue to offer this design as an option

The HBC Underfeed Stoker System has evolved from the Frederick underfeed coal stoker developed in the early 1900's. This technology has been adapted to our solid fuel/biomass fired systems. The underfeed stoker has proven over the last 20 years to be the most effective method of introducing low to medium silica/ash content fuels into the gasification zone on the market.

The eight (8) or ten (10) inch diameter, based on application, constant speed stoker screw supplies fuel to the rectangular bathtub-shaped retort located below furnace floor level. The stoker screw tube, sch. 80 pipe, which encloses the screw is fitted with both a temperature sensor, to initiate a water spray should the temperature inside the tube rise above a preset amount --- a fire prevention mechanism --- and, in applications where dry (low moisture content) fuel is anticipated, a water spray nozzle to condition the fuel to the desired moisture content. It has been found that extremely dry fuel can adversely affect the operating conditions of the unit. The conditioning system is tied to a temperature UDC that opens or closes a solenoid in the spray line. Spray quantity is controlled by manually adjusting a needle valve attached to flow meter in the line. The stoker screw is designed to force fuel into the retort. In so doing, an air seal ("fuel plug") is maintained within the stoker screw tube further preventing the intrusion of air through the fuel system.

The retort is the transition piece between the feed system and the grates upon which pyrolysis --- decomposition from heat --- first occurs. The retort is encased in a rectangular wind box, located



Figure 4 Typical stoker retort

in the plenum region below gasification/floor level. The wind box is fitted with slide-type dampers along both of its longitudinal sides to allow plenum air to surround the retort. The flanged edges of the retort are fitted with slotted cast iron grates that extend above floor level. As the fuel is forced into the retort it spills over the lip/ledge formed by the grates. The slots allow air to pass through the grates and it is at this point that the gasification process begins. While in units of 400 BHP and less the retort is located centrally in the combustion/gasification chamber, in larger units the retort is positioned closer to the supply end of the fuel system and employs pin hole grates located ahead of the retort. The pinhole grates are supplied air from the common plenum air supply. This air plenum has been compartmentalized and is equipped with slide-type dampers to regulate the air pressure of the separate zones. More pressure where the fuel is deepest and less where the ash burnout occurs.

The HBC Underfeed Stoker System builds a pile composed of ash from the biomass and silica (dirt) that has been introduced with the biomass fuel. The most common sources of silica are the biomass harvesting process and sometimes the biomass material handling. This silica can make what is commonly known as "glass". "Glassing" will occur when the temperature of the surrounding refractory exceeds $\sim 1,650^{\circ}$ F, the



Figure 5 Latest stationary stoker design

silica becomes "sticky", then liquid or even gaseous and collects or condenses on the nearest, porous and cooler surface. This is usually the adjacent refractory. "Glassing" doesn't damage refractory, but in the process of removing the silica operators may damage the refractory. "Glassing" occurs when the combustion process temperatures are not strictly regulated. HBC's Underfeed Stoker addresses this problem in two ways. The first way is by constantly monitoring the refractory temperature and implementing fuel conditioning to slow the gasification/combustion process. Second, in high pressure applications, HBC employs an extended water wall, from the main boiler water legs, down the sides of the gasifier/combustion casing whenever the fuel will consistently be under 20% Moisture Content. These water legs can eliminate as much as 65% of the refractory from this area of the boiler, greatly reducing the potential for glass production. Other advantages of using these water legs will be discussed later.

HBC can help prevent "glassing" but this doesn't remove the silica from the stoker. This must be done manually by the operators using a rake on a schedule that's

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frequency is dictated by the ACTUAL quantity of silica introduced. The frequency can be as often as every eight (8) hours or as seldom as once per week. This operation will cause a decrease in steam production during raking (this usually takes 30 minutes) and the exposure of the operator to the gasification and combustion process by way of the over fire access doors. Raking is usually scheduled to coincide with shift or production changes so as not to interfere with plant operations.

Hurst Boiler and Welding Co., Inc. has recently introduced the ultimate biomass stoker available on the market today. HBC's Automatic Deashing Biomass Stoker is the product of the combination of over 100 years of experience in the operation of solid fueled boiler systems and HBC's unsurpassed manufacturing abilities. HBC is now able to offer the solution to just about any stoking requirement in the world with this system. The advantages of this system over all other stoker designs are numerous. A lot like Mr. Gene Hurst's "best of all worlds".

The HBC Automatic Deashing Biomass Stoker is fed by the same time-tested, reliable and safe feed system as used by the HBC Underfeed Stoker, but here the similarities end. This stoker incorporates a wide, continuous, sloped grate area consisting of

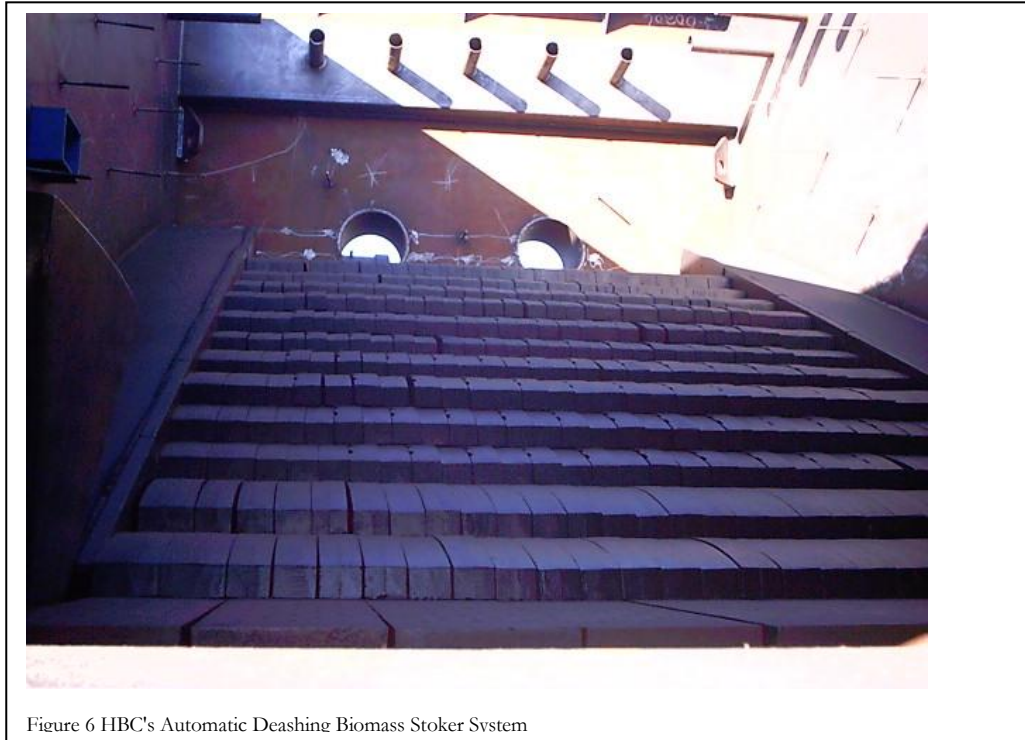


Figure 6 HBC's Automatic Deashing Biomass Stoker System

hundreds of individual grates. The spaces between these grates created by the shape of grates provides thousands of air passages for the gasification air. This greatly reduces the resulting air velocities and creates an extremely "quiet" zone to optimize gasification, reduce particulate creation and increase gas retention times thereby reducing VOC emissions. Distinct under-grate air zones providing air pressure control

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are also created by the stoker's configuration. These zones provide the ultimate in operational flexibility.

The system is driven using a hydraulic pump. The pump actuates alternating rows of grates to push forward with a frequency set by the operators. The ability to infinitely adjust the speed of the stoker using timers allows the operator to regulate the fuel-drying zone, the fuel pile height and the ash discharge rates. In concert with the PLC controls this system gives the operator COMPLETE control of the gasification and combustion process for a very wide variety of biomass quality and/or fuel types.

Then the system automatically deashes the grate to a dry screw or submerged conveyor for removal to an ash bin.

We recently began to manufacture this stoker integrated with direct-fired lumber dry kilns and rotary dryers. Current systems in the field range from 3-100 mmBTU output using high moisture content biomass. The gasification, combustion, refractory lined gas ducting and temperature control systems are designed, manufactured and installed by Hurst Boiler Co.

Finally, HBC's Automatic Deashing Coal Stoker. It is usually fed by a reliable gravity bin feed system. This stoker incorporates a wide, continuous chain constructed of hundreds of main drive links, stabilizers and common links that is supported from both

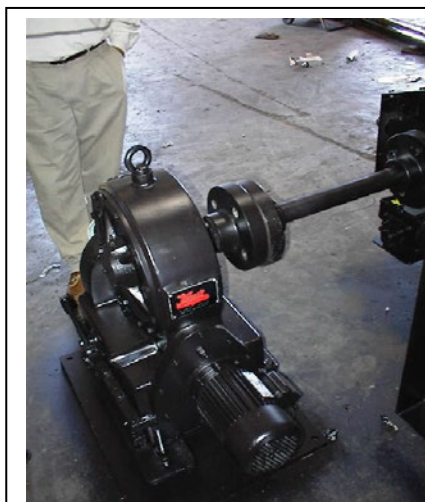


Figure 7 HBC's Stoker Drive with clutch

ends of the combustion chamber by main sprockets. The HBC Automatic Deashing Coal Stoker's chain provides thousands of air passages for the gasification air. This greatly reduces the resulting air velocities and creates an extremely "quiet" zone to optimize gasification, reduce particulate creation and increase gas retention times thereby reducing VOC emissions. Multiple, distinct air zones providing air pressure control are also created by the stoker's configuration. These zones provide the ultimate in operational flexibility.

The system is driven using a variable frequency drive. The ability to infinitely adjust the speed of the stoker allows the operator to regulate the fuel-drying zone, the fuel pile height and the ash discharge rates. In concert with the PLC controls this system gives the operator COMPLETE control of the gasification and combustion process for a very wide variety of bituminous coals.

Then the system automatically deashes the grate to a dry screw or submerged conveyor for removal to an ash bin.

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We still wanted to make maintenance as easy as possible. HBC has designed the stoker system to actually extend outside of the gasification and combustion chamber. This extension allows the operator to implement the same procedure as used for raking grates to access the chain and sprockets and service them externally WITHOUT having to wait for the entire system to cool down to go into the casing. Even if the chain should cease to function, the design of the system allows fuel feed and steam production to continue with interrupted automatic ash removal until the required maintenance can be implemented.



Figure 8 Stoker Maintenance Access



GASIFICATION / COMBUSTION PROCESS

The Hurst combustion system has been specifically designed to gasify the biomass fuel in the lower portion of the furnace (gasification region) with ignition of the generated fuel gas occurring in the upper portion (combustion region), in close proximity to the water walled hybrid boiler section located immediately above the furnace, to make efficient use of the radiant heat component of combustion. This equipment arrangement is more efficient than using a stand-alone gasifier, producing "syn-gas", because a STAG unit is not designed to recover radiant heat. This process has been legally designated as close-coupled gasification by the I.R.S. for previous tax credit purposes.

The process begins with the entrance of the fuel into the furnace area. See, *Fuel Feed System* for a detailed description of the fuel system and its components. The lower portion of the furnace (gasification chamber) with its grates has been designed to function with an inventory/pile of fuel at all times. The pile is required to not only provide the fuel to

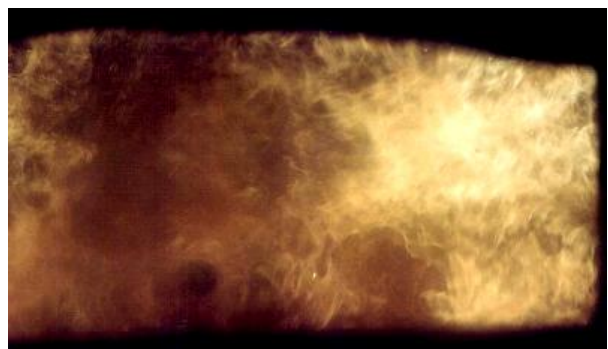


Figure 9 Combustion chamber front view

meet demand but act as a cushion between the hot surface of the fuel and the grates. **Insufficient pile depth will damage the grates.** As the fuel is forced into the retort it displaces existing fuel that spills over the cast iron grates, and onto the pinhole grates --- in units that have them --- through which under grate/gasification air is forced. The decomposition of the fuel (pyrolysis), due to the heat at this point occurs.

The furnace is maintained at a negative pressure, $-1/4$ " Water Column (W.C.) to $-1 1/4$ " W.C., by an Induced Draft (ID) fan that is controlled by a photohelic controller. Maintaining the furnace at below atmospheric pressure avoids "blow back", a potentially dangerous condition. The furnace (and stoker zones in some cases) temperature is also monitored. A k-type thermocouple is inserted into the refractory

wall of the chamber with its output going to the PLC, that may actuate, the fuel conditioning system, a high temperature alarm or shut the system down in the event a high temperature set point has been reached. Normal operating temperature will be in the 1000 °F to 1800 °F, depending on fuel. Under grate air is supplied by a dedicated fan that pressurizes the plenum from which the retort and pinhole grates are supplied. The air supply is modulated by means of a variable frequency drive or an electric actuator connected to the fan damper. The actuator receives its control signal directly from the PLC. As the actuator is mechanically connected to the damper through linkage the volume delivered at the extremes of the actuator's travel is set at time of installation. At installation the variable frequency drive limits or the damper linkage is adjusted to deliver sufficient air to maintain the desired pile height and maintain the lower furnace region in a substoichiometric (insufficient air for complete combustion) environment ---between 25% and 50% of the required air is normally supplied. Given that the under grate air supply follows the fuel --- both are controlled through the PLC and act linearly --- any changes in the nature of the fuel, higher/lower moisture content, will necessitate adjustment of blower damper linkage or the variable frequency drive limits. Pile height variance will be the first indication of an improper relationship between fuel input and under grate air. Because of the lack of oxygen in the lower portion of the furnace the fuel is not totally combusted but rather a combustible fuel gas is driven off as the fuel is reduced to ash --- gasification.

After the gases leave the pile it encounters combustion air in the upper portion of the furnace, the ignition zone. Ignition air is introduced into the area through air nozzles located on all four sides of the unit. A dedicated combustion air fan that is similarly controlled through the PLC and the use of an actuator supplies this air. As the PLC supplies the same, in value, 4 to 20 milliamp signal to both the gasification and ignition VFD's or air actuators the frequency or damper position for any given signal is determined by the blower speed or linkage position and thus the relationship between the two remains relatively constant throughout the entire operational spectrum. An oxygen trim system is employed the combustion air fan's VFD or actuator is controlled through the PLC and is adjusted to maintain a desired level of excess air, normally 50% or less.

The combustion process from fuel to gasification to ignition to combustion is now complete.

Although the combustion process has been completed, the products of combustion move on. The water walled section of the boiler above the furnace area absorbs both the radiant heat from its close proximity to the ignition zone and convection heat from the flue gases. After leaving the this area the flue gases pass through the convection generating section of the boiler where the major portion of the heat transfer takes place. Biomass fuel by its very nature will carry small particles of fuel out of the furnace before complete combustion can occur. The larger of these particles, referred to as "char", tend to impinge on the rear door of the boiler --- the first turn around of the gases. The boiler is fitted with a hopper to collect the "char". The "char" is pulled

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from the hopper by a venturi, powered by a high-pressure blower, into a rejection line which reintroduces the "char" into the upper section of the furnace to complete combustion. The gases exit the boiler at approximately 400°F to 500°F, they then pass through an air preheater --- preheaters are installed on units anticipated to be operating with moist fuel. It has been found that 1% of boiler efficiency can be realized for every 50°F increase of the combustion air above ambient. The temperature drop of the flue gases across the preheater is approximately 120°F with a similar combustion air temperature increase. The flue gases are then directed through a multi-cyclone to remove up to 90% of the particulate matter being carried along with the gases. The ash falls as it's collected in the lower cyclone bin through a rotary or flapper-type air lock from which it is removed via re-injection to assure complete combustion of all fuels, subject to state regulations, or deposited in a container. HBC also supplies feed water economizers, steam super heaters, steam combustion air heaters and HBC's FGR (flue gas recirculation) system. The flue gases exit the multi-cyclone, pass through the Induced Draft fan and ultimately out thru secondary emission controls and/or the exhaust stack.

Secondary pollution controls may be required depending on the types of fuels utilized, BTU input of the system and state or federal regulation. Hurst is prepared to accommodate and integrate all types of secondary controls into our systems. Typically, there are three types of secondary particulate control systems available. The first is the wet scrubber.



MULTI CYCLONE PARTICULATE COLLECTION

The typical Hurst 600 HP boiler will be equipped with as many as two multi cyclones -- commonly called collectors --- in series. Systems rated above 30 mmBTU input are required by the Federal EPA to use Best Available Control Technology (BACT). To meet these requirements HBC is prepared to provide, as an option, a baghouse, dry electrostatic precipitator, wet electrostatic precipitator and/or SNCR.

The principal of operation of HBC's standard cyclones is identical. Hot particle laden flue gases enter the unit and are directed down through the outer of two concentric tubes. Access to the outer cast iron tube is through spinner vanes that impart a centrifugal motion to the flue gases. The heavier entrained particles are forced to the outside of the larger outer tube and fall to the bottom of the cyclone hopper. The gases exit the larger tube through the smaller steel center tube.

The first of the series, the primary collector, will normally be fitted with 18 such arrangements, with the larger tube being 9" in diameter and the smaller, outlet/inner pipe being 6" in diameter. Approximately 95% of the particulate matter is removed at the primary collector. The ash/particulate drops to the bottom of the tapered hopper and passes through a rotary air lock to a dumpster, or either a drag chain conveyor for removal, or to a fan driven re-injection line back into the combustion chamber. The normal pressure drop across the collector may range from 1½" to 4" W.C. The pressure drop across the collector is an indication of the unit's restrictiveness --- dramatic changes from the norm indicate a clogged collector.

During periods when a high moisture content fuel is being used --- the moisture may cause the dropout to become sticky and adhere to the sides --- the collectors should be monitored more frequently. Extended periods of low stack temperature, during cold start up and/or periods of low boiler pressure will also have a negative effect by causing condensation to occur in the collector. Periodically banging, with a rubber mallet, on the lower portion of the collector will reduce the possibility of the ash adhering to the walls of the collector. In cases of consistently high moisture fuel a vibrator may be installed. In very cold climates the collector may be insulated.

The secondary collector contains a larger number of smaller cast iron and steel tube configurations. Approximately 95% of the remaining finer particulate matter is

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removed at the secondary collector. The drop out is similarly expelled through a rotary air lock, though re-injection is not an option at this point. Pressure drops similar to the primary collector can be anticipated with dramatic changes indicating a blockage.

Hurst Boiler Co. also has experience in designing its systems to incorporate the latest pollution technologies (scrubbers, core separators, bag houses, absorbers, SNCR, flue gas recirculation, urea injection, electrostatic precipitators (dry or wet)) that may be required to meet more stringent environmental regulations at different locations around the world.

Secondary pollution controls may be required depending on the types of fuels utilized, BTU input of the system and state or federal regulation, including the new Boiler MACT rules that are expected to come into effect soon. Hurst is prepared to accommodate and integrate all types of secondary controls into our systems.

Typically, there are three types of secondary particulate control systems available with extensive, successful application to solid fueled boiler systems. The first is the wet scrubber. The wet scrubber is fairly cheap to operate and has low capital costs. Wet scrubbers have a higher pressure drop (requires a larger induced draft fan) and require a waste water stream to reduce operational costs. The second is the electrostatic precipitator which uses charged plates to trap particulate very efficiently. These systems typically have the highest capital costs, lower pressure drops and do require additional electricity to operate their transformer(s). The last choice is a bag house. There are many different types of bag houses and bags that can be used to remediate particulate as well as some other regulated gases. Bag houses do have a large pressure drop across them and are efficient. However, industrial experience shows us that these systems will, eventually, suffer from internal fires. Sometimes the bags will burn and require replacement but most often the "cake" on the bags may catch fire and produce enough heat to cause structural damage. It is almost a certainty, thus making bag houses the last choice when evaluating remediation technologies.



SOOT BLOWERS

With all fuels, fly ash is generated when combusted. The fly ash, if allowed to accumulate in the boiler fire tubes, will reduce the efficiency of the heat transfer quality of the tube and in the extreme case may totally clog the tube preventing the flue gases from passing through. Soot blowers are used to periodically remove the ash from the tubes. The soot blowers, supplied as standard on HBC's systems, are used to automatically (using timer actuated valves) inject a stream of compressed air into a bank of tubes. Each bank is operated individually. It is recommended that the tubes be "blown" at least once a shift --- 3 times a day. The frequency of "blowing" the tubes is a function of the fuel. Fuel high in ash content may require a higher rate of soot blowing. This process greatly reduces the frequency and may eliminate the need to remove the system from service for "housekeeping" purposes and the brushing of tubes.



Figure 10 Soot blowers

FEEDWATER PUMP

The heart of any modern steam system is the feed water pump. It pumps the necessary water into the steam-generating vessel from which the steam is produced. The typical Hurst installation incorporates two Grundfos multi-stage centrifugal pumps, each capable of delivering, at minimum, 125% of the rated capacity of the boiler they supply. The pumps are intended to be run alternately for a minimum of a week at a time, thus each pump experiences the same amount of use/wear over a period of time and the failure of a pump due to wear should precede the failure of the second pump by the allocated run time. Selection of the designated pump is made by merely turning the pump "on" in the control panel.

The pumps typically take their suction from a HBC Feedmiser, open vented feed water system or an HBC Oxymiser deaerator normally located immediately above the pumps. Each pump is protected from foreign matter by a basket strainer located between the tank and the pump. The pumps are protected from boiler pressure by check valves located immediately after the discharge. A gate-type valve is located before each strainer and after each check valve thus allowing the pump to be isolated from the system as well as facilitating strainer or check valve removal. The pumps supply a common line that ultimately supplies the boiler. Located in the common line immediately before the boiler



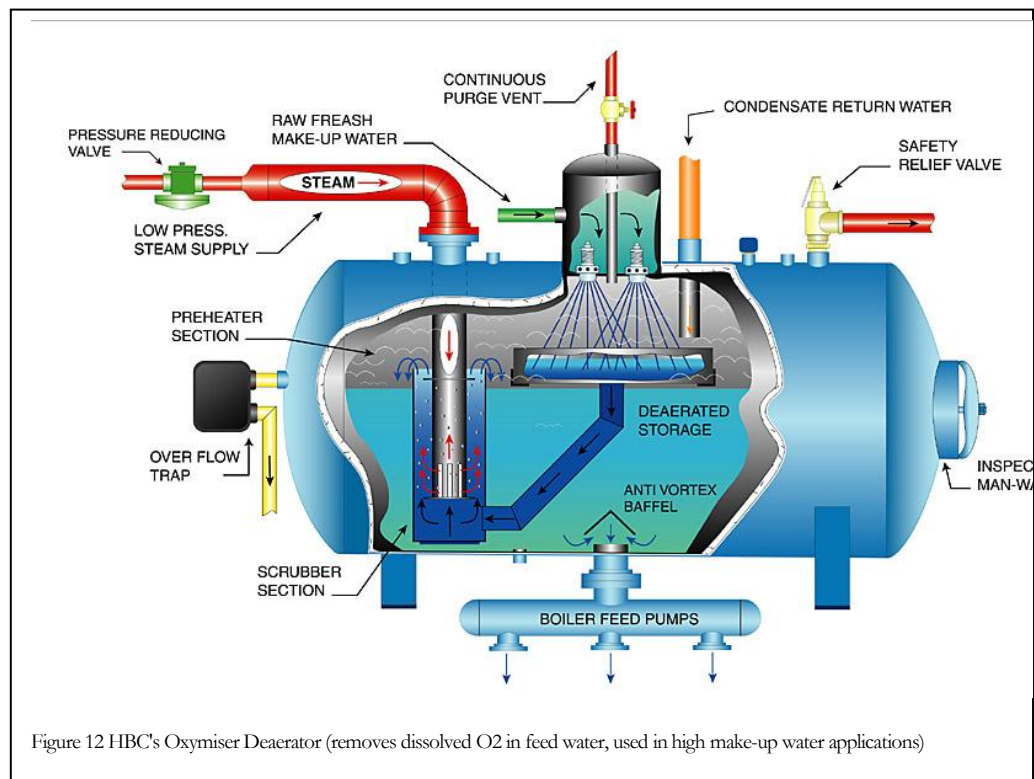
Figure 11 HBC Feedmiser, open vented feed water tank with pumps.

vessel is another check valve and globe valve. The feed water transitions from the feed water line into the boiler through a cross fitting which allows for line clean out.

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Operation of the feed water pumps (on/off or variable speed) is controlled by a pump control --- this is a pump control not a flow control. The pump control is located on the side of the boiler at normal boiler water level --- a sight glass is attached to allow a visual indication of level. The control has an internal float which senses changes in water level and mechanically actuates switches that start and stop --- it supplies the control voltage for the pump motor starter --- the designated pump as the boiler level dictates. Each pump is protected electrically by thermal overloads located in the motor starters and a three-phase circuit breaker or fuses.

When flow modulation (protects the boiler from thermal shock) with a constant running feed water pump is desired a proportioning valve is installed in the main feed



line before the boiler check valve. The valve has gate-type isolation valves on either side, to allow for removal, and a globe type by-pass valve, to allow for throttling in the event the valve should fail. Units operating below 250 PSI use a similar control, however, rather than actuate on/off switches the float is connected to a slide-wire potentiometer that controls the proportioning valve. Units operating beyond 250 PSI are fitted with a Hurst manufactured water column and a water level transmitter connected to the PLC which ultimately provides the control signal to the proportioning valve. Before the discharge isolation valve, the pump discharge lines are fitted with recirculating lines containing pump-matched orifices to assure minimum flow through the pump regardless of boiler load.

CONTROL SYSTEMS

The following narrative is intended to provide a better understanding of the workings of a typical Hurst solid fuel steam boiler system. The unit has been designed to respond in an appropriate fashion to accomplish the ultimate goal of the unit: to provide steam for the customer. Since steam demand and header pressure are directly related, as the steam demand increases the pressure drops and conversely as the demand decreases the pressure goes up, and the pressure is relatively easily monitored. This measurement of steam pressure provides the information upon which all other systems rely to reach the ultimate goal of meeting your steam demands.

PLC CONTROL

Hurst manufactures all its BIOMASter® control systems in our UL Listed cabinet shop. HBC is an OEM for Allen Bradley and Seimens control systems while having experience with most other major suppliers. Our current standard is based on Seimens controls and software packages. The BIOMASter® controls provide easy on site access to the boiler system's functions while also providing real time, remote monitoring capabilities thru HBC's BIOMASter® Client web site. The controls also enable HBC to provide "after the sale", remote technical support to each of its clients greatly reducing service and maintenance costs.

HBC has modified Seimens software with custom graphics to allow the system operator to intuitively interact with the system and monitor all electronically annunciated components. This system also gives the operator the option to monitor the system remotely via ethernet, cellular modem or a network using PC Anywhere or a similar software package.

ID/DRAFT CONTROL (Variable hertz control)

Units equipped with an adjustable speed AC drive control rely on the speed of the fan to maintain the proper pressure within the combustion chamber. Furnace pressure is transmitted through a



Figure 13 HBC's Boiler Fireman Control Cabinet

draft tube (piping) to a Magnehelic pressure transmitter that emits a 4 - 20 ma signal across its range, normally 0 to 6" W.C. The Magnehelic signal is routed through the BIOMASter® controls. The BIOMASter® control is programmed to maintain a specific furnace pressure, usually 0.5" W.C. The BIOMASter® controls the output, based on the programmed parameters of the variable hertz drive, of the ID fan. Programming of the variable hertz drive is covered in its own operator's manual

The combustion system relies on a negative draft pressure and is equipped with a low draft alarm. In the event of draft failure, i.e. fan motor failure, broken drive belt, damper failure, the entire combustion system will shut down. To accommodate momentary fluctuations the low draft alarm is programmed, on those units using mod motor modulation, through a time delay relay, internal to the BIOMASter® controls, giving the system a chance to correct itself. Units equipped with a variable hertz drive have built in response rates.

FUEL FEED & COMBUSTION AIR CONTROL

The demand for fuel is a function of the steam demand, which, as cited earlier, is directly related to the header pressure. The quantity of fuel delivered is a function of the speed of the metering bin discharge auger. Thus auger speed and pressure are related. Given this relationship, a 4 - 20 ma pressure transmitter provides the signal upon which the fuel delivery rate is ultimately determined. The pressure signal is sent to the BIOMASter® controls that outputs a similar 4 - 20 ma signal to the gasification air fan as well as the metering bin discharge auger. The BIOMASter® controls displays the current pressure and the percentage of output based on input. The auger signal is sent to an adjustable speed AC drive controller that controls the speed of the variable hertz drive used to drive the auger. By using the variable frequency drive, the auger motor speed limits can be adjusted, from 0.1 to 60Hz. Additionally a 5k variable ohm resistor is placed in the line to allow the control signal to be biased to provide a lesser or greater response than the input value.

All HBC solid fuel systems are equipped with an oxygen trim system to control the combustion air fan variable frequency drive by means of the BIOMASter® controls where a 4 - 20 ma input signal originates from the oxygen analyzer probe which is mounted in the rear smoke box of the boiler. The probe's output signal is oxygen value related. Thus the gas combustion (over-fire) fan is not reacting to pressure changes but rather to combustion process changes --- as more fuel is required and delivered the oxygen level will decrease causing the fan's variable frequency drive to increase the fan speed thus increasing the gas combustion airflow.

Units burning dry fuel are equipped with extended water membranes to "drain" heat from system locations susceptible to high ash fusion temperatures and a fuel conditioning system --- water spray. The furnace temperature BIOMASter® controls reading activates the system, opens a solenoid, when an operator-set temperature is reached. This simple function does not actually increase the moisture content of the

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fuel, rather it coats the fuel with just enough water to slow the gasification process and reduce the gasifier's temperature to acceptable levels. This process also helps to reduce the formation of "glass". These same units are equipped with a flood system to prevent fire in the stoker tube. A temperature probe is mounted on the stoker tube, at the feed end, and when a preset high temperature is reached a solenoid is opened preventing "burn-back" into the fuel transfer and storage system.



CONCLUSION

We hope that this short document has answered some of your questions related to Hurst's solid fuel systems. However, we believe in the old adage, "The more you learn, the less you know." In other words, we realize that this document may not have answered all your questions and may have actually generated new ones. Please do not hesitate to contact us or our representatives to obtain any additional information you may require.

Thank you for taking the time to review this document and for considering Hurst Boiler and Welding Co., Inc. as a potential partner in your next energy project.

NOTES

STEAM OUTPUT AND BTU INPUT FOR HBC HYBRID BOILERS W/ WOODY BIOMASS FUEL														
BOILER STEAM OUTPUT (Per Hour)							FUEL INPUT REQUIREMENTS							
							8% M.C. ~80% EFF.		20% M.C. ~76% EFF.		35% M.C. ~73% EFF.		50% M.C. ~70% EFF.	
BHP	LBS	KG	MBTU x1000	Gcal	THER M	KW	8000 BTU/LB	4445 Kcal/kg	6956 BTU/LB	3865 Kcal/kg	5652 BTU/LB	3140 Kcal/kg	4347 BTU/LB	2415 Kcal/kg
100	3,450	1,565	3,348	0.84	3,532	980	4,184,400	1,054,500	4,404,600	1,110,000	4,585,600	1,155,600	4,782,100	1,205,100
125	4,313	1,956	4,184	1.05	4,415	1,225	5,230,500	1,318,125	5,505,750	1,387,500	5,732,000	1,444,500	5,977,625	1,506,375
150	5,175	2,348	5,021	1.27	5,298	1,470	6,276,600	1,581,750	6,606,900	1,665,000	6,878,400	1,733,400	7,173,150	1,807,650
200	6,900	3,130	6,695	1.69	7,064	1,961	8,368,800	2,109,000	8,809,200	2,220,000	9,171,200	2,311,200	9,564,200	2,410,200
250	8,625	3,913	8,368	2.11	8,830	2,451	10,461,000	2,636,250	11,011,500	2,775,000	11,464,000	2,889,000	11,955,250	3,012,750
300	10,350	4,695	10,043	2.53	10,595	2,941	12,553,200	3,163,500	13,213,800	3,330,000	13,756,800	3,466,800	14,346,300	3,615,300
320	11,040	5,008	10,712	2.70	11,302	3,137	13,390,080	3,374,400	14,094,720	3,552,000	14,673,920	3,697,920	15,302,720	3,856,320
400	13,800	6,260	13,390	3.37	14,127	3,921	16,757,600	4,218,000	17,618,400	4,440,000	18,342,400	4,622,400	19,128,400	4,820,400
500	17,250	7,825	16,738	4.22	17,659	4,902	20,922,000	5,272,500	22,023,000	5,550,000	22,928,000	5,778,000	23,910,500	6,025,500
600	20,700	9,390	20,085	5.06	21,191	5,882	25,106,400	6,327,000	26,427,600	6,660,000	27,513,600	6,933,600	28,682,600	7,230,600
639	22,046	10,000	21,391	5.39	22,568	6,264	26,738,316	6,738,255	28,145,394	7,082,800	29,301,964	7,384,284	30,557,619	7,700,589
700	24,150	10,955	23,433	5.90	24,723	6,862	29,290,800	7,381,500	30,832,200	7,770,000	32,098,200	8,089,200	33,474,700	8,435,700
750	25,875	11,738	25,106	6.33	26,489	7,352	31,383,000	7,908,750	33,034,500	8,325,000	34,392,000	8,667,000	35,865,750	9,038,250
800	27,600	12,520	26,780	6.75	28,254	7,842	33,475,200	8,436,000	35,236,800	8,860,000	36,684,800	9,244,800	38,256,800	9,640,800
900	31,050	14,085	30,128	7.59	31,786	8,823	37,659,600	9,490,500	39,641,400	9,990,000	41,270,400	10,400,400	43,038,900	10,845,900
958	33,051	14,993	32,069	8.08	33,835	9,391	40,086,552	10,102,110	42,196,068	10,633,800	43,930,048	11,070,648	45,812,518	11,544,858
1000	34,500	15,650	33,475	8.44	35,318	9,803	41,844,000	10,545,000	44,046,000	11,100,000	45,856,000	11,556,000	47,821,000	12,051,000
1160	40,020	18,154	38,831	9.79	40,969	11,371	48,539,040	12,232,200	51,093,360	12,876,000	53,192,960	13,404,960	55,472,360	13,979,160
1200	41,400	18,780	40,170	10.12	42,382	11,764	50,212,800	12,654,000	52,855,200	13,320,000	55,027,200	13,867,200	57,385,200	14,461,200
1277.95	44,089	20,000	42,779	10.78	45,135	12,528	53,474,540	13,475,983	56,286,586	14,185,245	58,601,675	14,767,990	61,112,847	15,400,575
1300	44,850	20,345	43,518	10.97	45,913	12,744	54,397,200	13,709,500	57,259,800	14,430,000	59,612,800	15,022,800	62,167,300	15,666,300
1400	48,300	21,910	46,865	11.61	49,445	13,724	59,591,600	14,763,000	61,664,400	15,540,000	64,196,400	16,178,400	66,949,400	16,871,400
1500	51,750	23,475	50,213	12.65	52,977	14,705	62,766,000	15,817,500	66,069,000	16,650,000	68,784,000	17,334,000	71,731,500	18,076,500
1600	55,200	25,040	53,560	13.50	56,509	15,686	66,950,400	16,872,000	70,473,600	17,760,000	73,369,600	18,489,600	76,513,600	19,281,600
1800	62,100	28,170	60,255	15.18	63,572	17,645	75,319,200	18,981,000	79,282,800	19,980,000	82,540,800	20,800,800	86,077,800	21,691,800

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BIO MASS FUEL FEED RATES FOR HBC HYBRID BOILERS w/ WOODY BIOMASS FUELS

BHP	STEAM OUTPUT		8 % M.C. (Wet Basis)		20% M.C. (Wet Basis)		35% M.C. (Wet Basis)		50% M.C. (Wet Basis)	
			8000 BTU/LB / 4445 Kcal/KG		6906 BTU/LB / 3865 Kcal/KG		5652 BTU/LB / 3140 Kcal/KG		4347 BTU/LB / 2415 Kcal/KG	
	RS/HR	KG/HR	RS/HR	KG/HR	RS/HR	KG/HR	RS/HR	KG/HR	RS/HR	KG/HR
100	3,450	1,565	523	237	633	287	811	368	1,100	499
125	4,313	1,958	654	297	792	359	1,018	460	1,375	624
150	5,175	2,347	785	356	950	431	1,217	552	1,650	749
175	6,038	2,739	915	415	1,108	503	1,420	644	1,925	873
200	6,900	3,130	1,046	475	1,266	574	1,623	736	2,200	998
250	8,625	3,912	1,308	593	1,583	718	2,028	920	2,750	1,248
300	10,350	4,695	1,569	712	1,900	862	2,434	1,104	3,300	1,497
350	12,075	5,477	1,831	830	2,216	1,005	2,840	1,288	3,850	1,747
400	13,800	6,260	2,092	949	2,533	1,149	3,245	1,472	4,400	1,996
450	15,525	7,042	2,354	1,068	2,849	1,293	3,651	1,656	4,950	2,246
500	17,250	7,825	2,615	1,186	3,166	1,438	4,057	1,840	5,501	2,495
550	18,975	8,607	2,877	1,305	3,483	1,580	4,462	2,024	6,051	2,745
600	20,700	9,390	3,138	1,424	3,799	1,723	4,868	2,208	6,601	2,994
650	22,425	10,172	3,400	1,542	4,116	1,867	5,274	2,392	7,151	3,244
700	24,150	10,954	3,661	1,661	4,432	2,011	5,679	2,576	7,701	3,493
750	25,875	11,737	3,923	1,779	4,749	2,154	6,085	2,760	8,251	3,743
800	27,600	12,519	4,184	1,898	5,066	2,298	6,491	2,944	8,801	3,992
900	31,050	14,084	4,707	2,175	5,699	2,585	7,302	3,312	9,901	4,491
1,000	34,500	15,649	5,230	2,373	6,332	2,872	8,113	3,680	11,001	4,990
1,100	38,020	17,163	5,753	2,572	7,045	3,232	8,914	4,068	12,101	5,489
1,200	41,400	18,779	6,277	2,847	7,599	3,447	9,736	4,416	13,201	5,988
1,300	44,850	20,314	6,800	3,087	8,232	3,734	10,547	4,784	14,301	6,487
1,400	48,300	21,909	7,323	3,322	8,865	4,021	11,359	5,152	15,401	6,986
1,500	51,750	23,039	7,846	3,560	10,131	4,590	12,981	5,888	17,602	7,984
1,800	62,100	28,169	9,415	4,271	11,398	5,170	14,604	6,624	19,802	8,982

TYPICAL EFFICIENCIES --80% @ 8% M.C. --76% @ 20% M.C. --73% @ 35% M.C. --70% @ 50% M.C.
BARK (WET) = 22 LBS/H3 / 352.4 KG/m3 SAWDUST (DRY) = 18 LBS/H3 / 288.3 KG/m3 SHAVINGS (DRY) = 15 LBS/H3 / 240.2 KG/m3

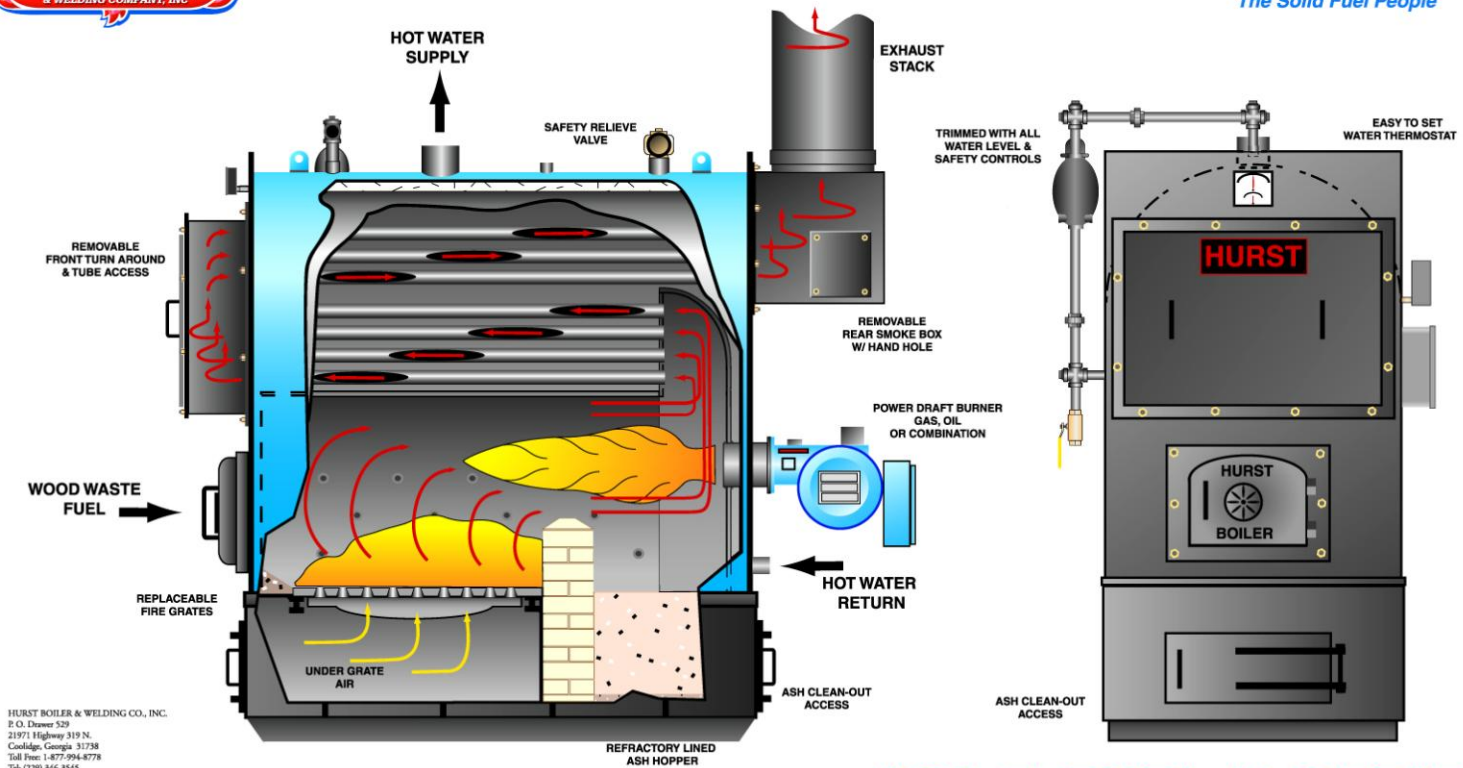
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 Web Site: www.hurstboiler.com





Hand Fired Feed

The Solid Fuel People



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 Email: info@hurstboiler.com

INDUSTRIAL RATED CONSTRUCTION THROUGH OUT

MULTI FUEL M-SERIES

HAND FIRED

THREE PASS FIREBOX



The Solid Fuel People

Pneumatic Fuel Feeder

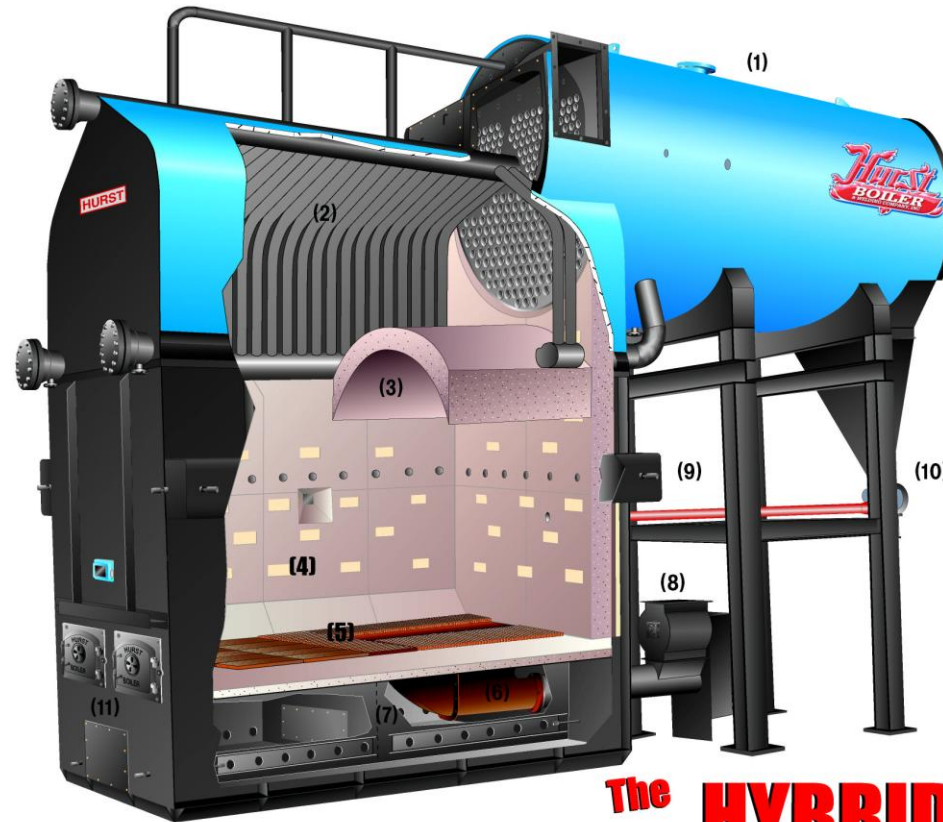


- (1) Hybrid Firetube/Watertube Vessel Design
- (2) Watertube Section
- (3) Radiant Arch
- (4) Combustion Chamber
- (5) Cast Grates
- (6) Pneumatic Fuel feeder
- (7) Air Control Dampers
- (8) Refractory Lined Furnace
- (9) Over Fire Air System
- (10) Ash Reinjection Blower
- (11) Fire Doors

The HYBRID SERIES
Modular Packaged II



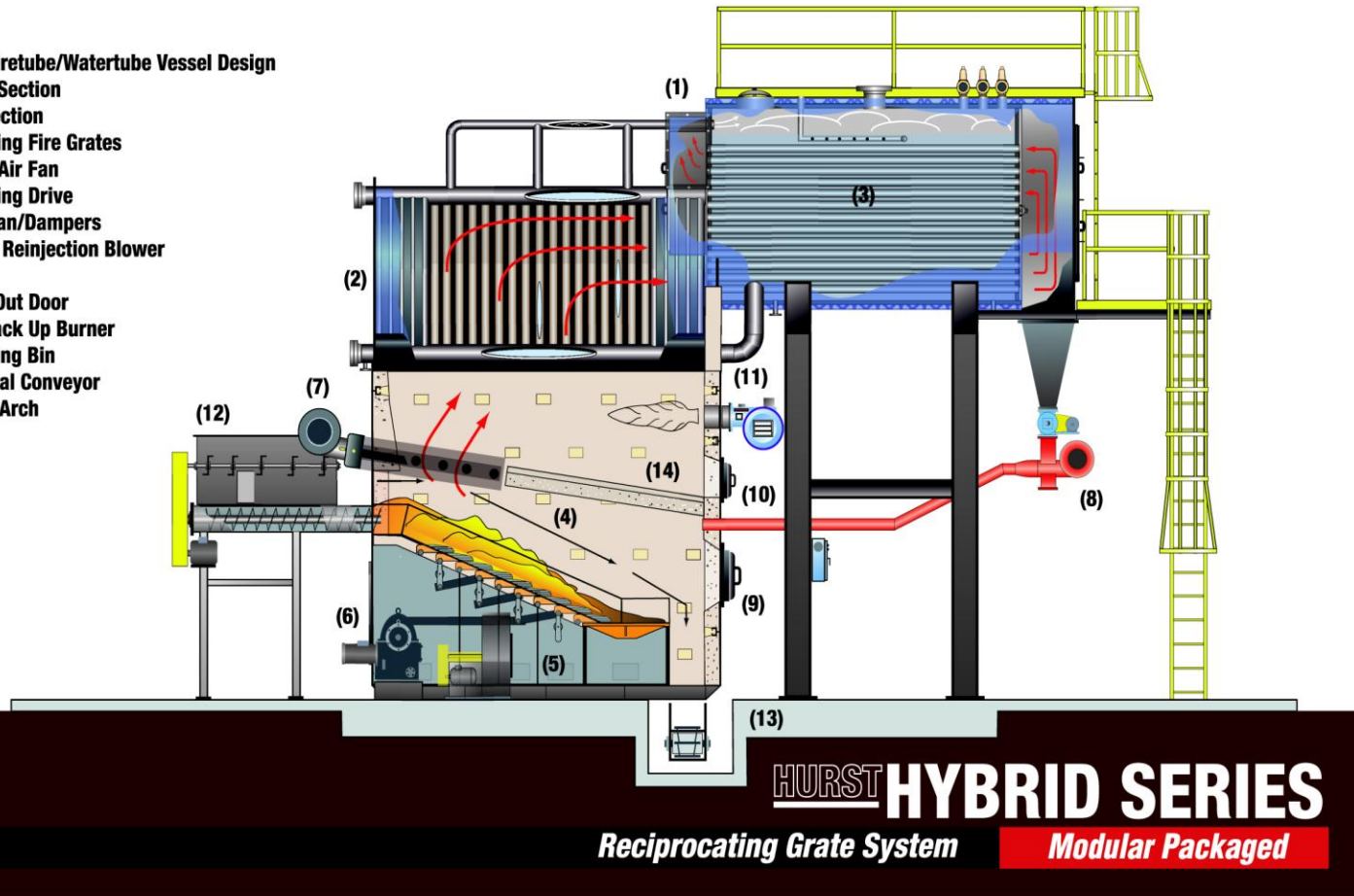
The Solid Fuel People



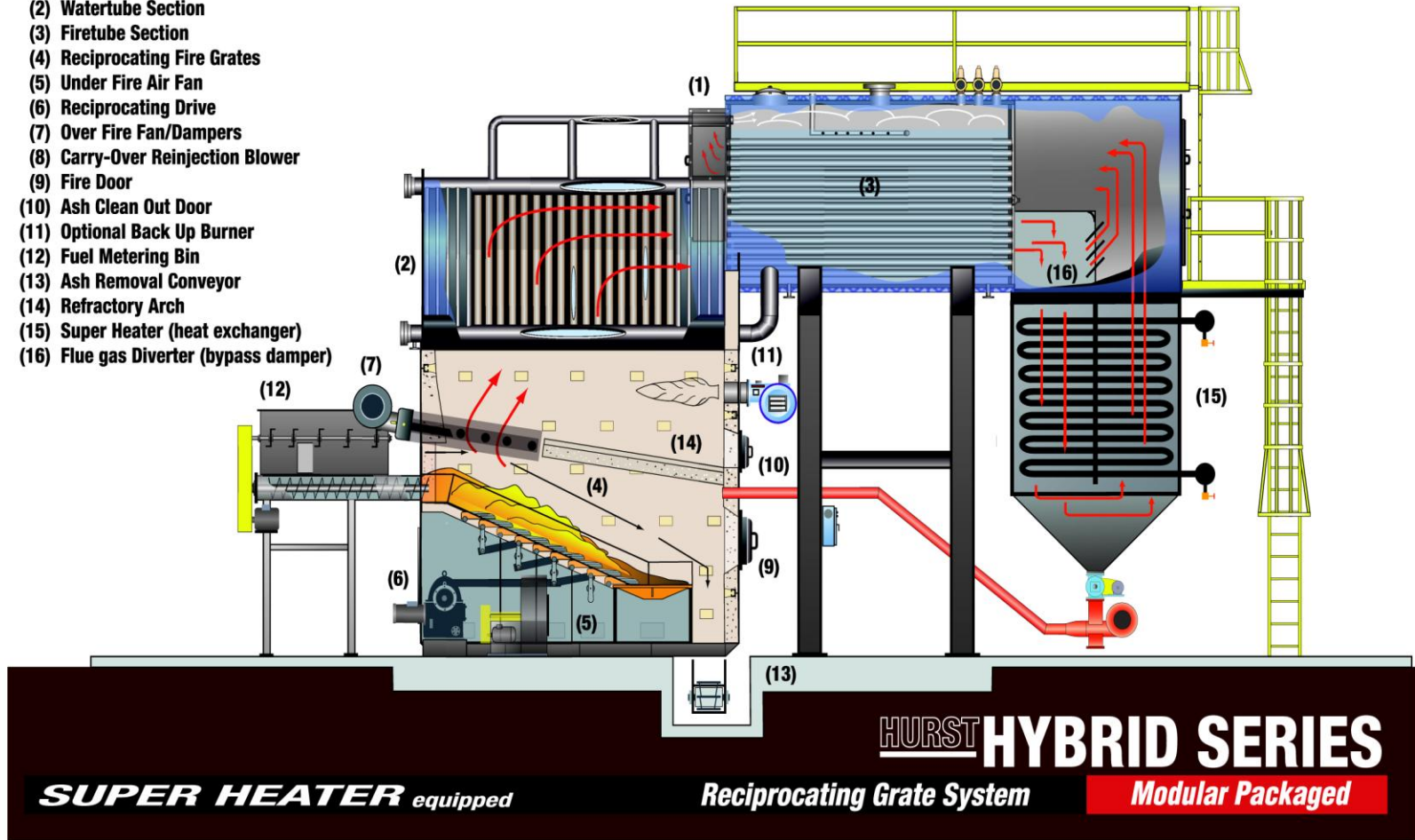
- (1) Hybrid Firetube/Watertube Vessel Design
- (2) Watertube Section
- (3) Radiant Arch
- (4) Combustion Chamber
- (5) Cast Grates
- (6) Under Fire Fuel Retort
- (7) Air Control Dampers
- (8) Rotary Air Lock Fuel Feeder/Stoker Screw
- (9) Over Fire Air System
- (10) Ash Reinjection Blower
- (11) Fire Doors

The **HYBRID SERIES**
Modular Packaged II

- (1) "Hybrid" Firetube/Watertube Vessel Design
- (2) Watertube Section
- (3) Firetube Section
- (4) Reciprocating Fire Grates
- (5) Under Fire Air Fan
- (6) Reciprocating Drive
- (7) Over Fire Fan/Dampers
- (8) Carry-Over Reinjection Blower
- (9) Fire Door
- (10) Ash Clean Out Door
- (11) Optional Back Up Burner
- (12) Fuel Metering Bin
- (13) Ash Removal Conveyor
- (14) Refractory Arch



- (1) "Hybrid" Firetube/Watertube Vessel Design
- (2) Watertube Section
- (3) Firetube Section
- (4) Reciprocating Fire Grates
- (5) Under Fire Air Fan
- (6) Reciprocating Drive
- (7) Over Fire Fan/Dampers
- (8) Carry-Over Reinjection Blower
- (9) Fire Door
- (10) Ash Clean Out Door
- (11) Optional Back Up Burner
- (12) Fuel Metering Bin
- (13) Ash Removal Conveyor
- (14) Refractory Arch
- (15) Super Heater (heat exchanger)
- (16) Flue gas Diverter (bypass damper)



SUPER HEATER *equipped*

Reciprocating Grate System

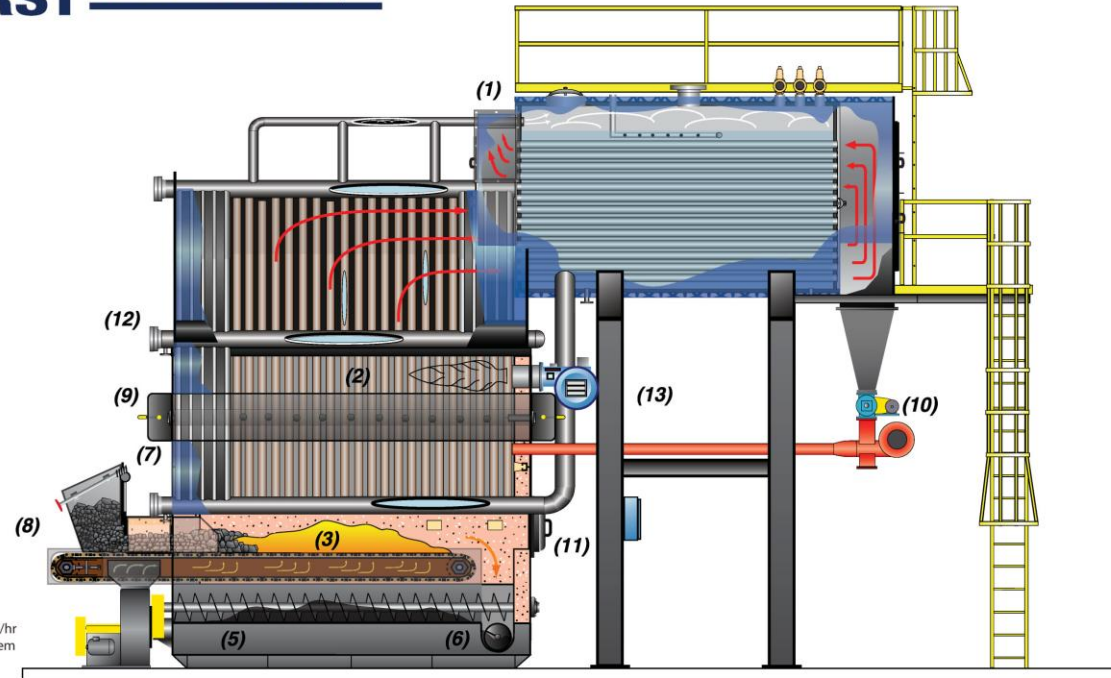
Modular Packaged



HURST *The Solid Fuel People*

Revolving Stoker Bed
Chain Grate Combustion System

- (1) "Hybrid" Firetube/Watertube Vessel Design
- (2) Watertube Section
- (3) Chain Grate Stoker System
- (4) Combustion Chamber
- (5) Primary Ash Collection Screw
- (6) Secondary Ash Removal Screw
- (7) Air Control Dampers
- (8) Metering Hopper
- (9) Over Fire Air System
- (10) Ash Reinjection Blower
- (11) Fire Doors
- (12) Water-Side Inspection Ports
- (13) Backup Gas/Oil Burner



The Hybrid WW CG design is suitable for applications to produce high pressure steam or hot water in ranges from 3,450 – 60,000 lbs/hr (3.4 mmBTU – 60 mmBTU) output from 100 up to 400 PSI. This system is designed by HBC to combine the best technologies from the "old school" of coal combustion and the latest advanced combustion control technologies. The new HBC chain grate-type stoker system permits either bituminous coal washed singles or smalls to be combusted in an efficient manner with the added advantage of automatic de-ashing. This combination is particularly suitable for industrial heating and process steam applications. The boiler vessel is a two pass hybrid design incorporating a water tubed boiler-type water membrane and a two-pass fire tube scotch marine vessel. This vessel's advantages over standard water tube boilers include much larger steam disengagement area providing high quality steam, larger steam storage capability for quicker response to sudden steam demand and much larger thermal storage that provides fast demand response times and safer operation. This system also incorporates extended water wall membranes that extend down the gasification/combustion chambers side walls thereby greatly reducing refractory requirements which is essential when utilizing highly volatile solid fuels.

CAT C-05

HURST HYBRID WW CG

COAL FIRED

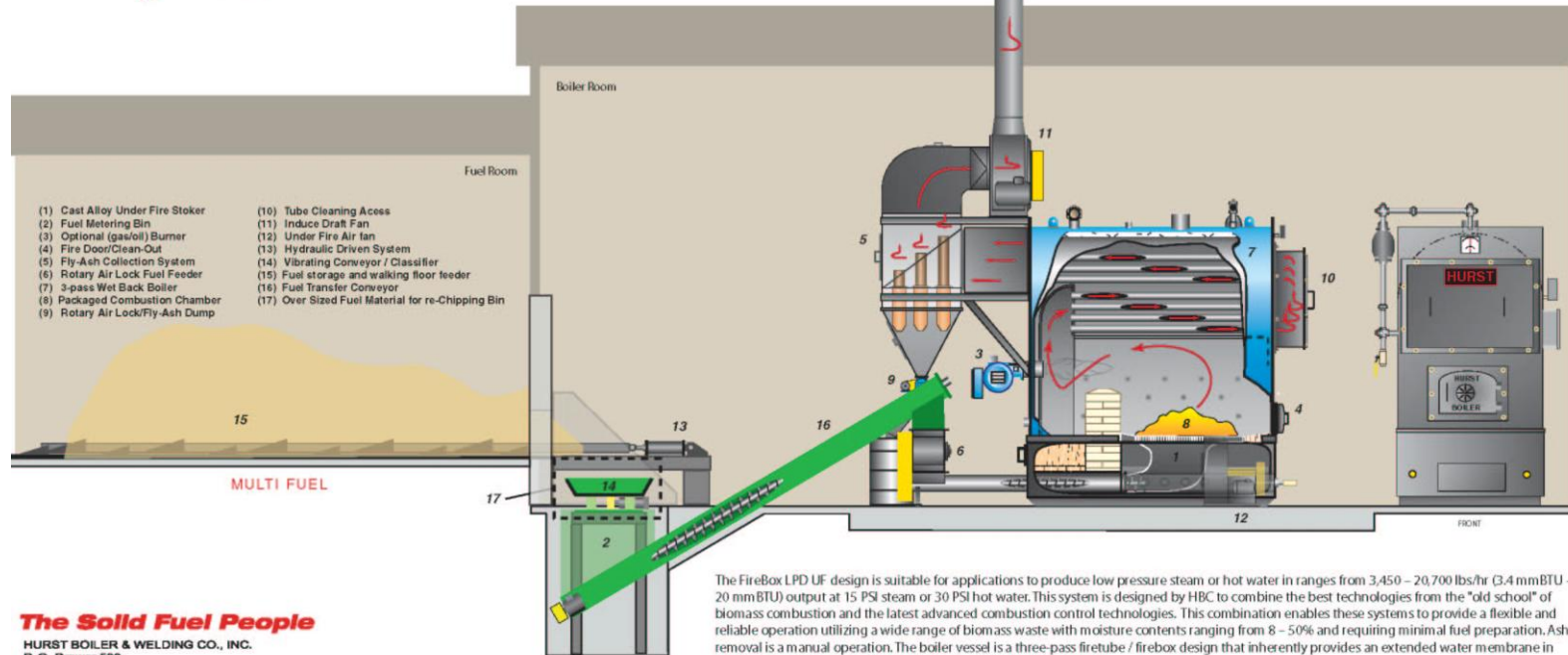
Modular Packaged

WATER WALL FURNACE



Solid Fuel Solutions

Under Feed Stoker
 Combustion System 



- | | |
|----------------------------------|---|
| (1) Cast Alloy Under Fire Stoker | (10) Tube Cleaning Access |
| (2) Fuel Metering Bin | (11) Induce Draft Fan |
| (3) Optional (gas/oil) Burner | (12) Under Fire Air fan |
| (4) Fire Door/Clean-Out | (13) Hydraulic Driven System |
| (5) Fly-Ash Collection System | (14) Vibrating Conveyor / Classifier |
| (6) Rotary Air Lock Fuel Feeder | (15) Fuel storage and walking floor feeder |
| (7) 3-pass Wet Back Boiler | (16) Fuel Transfer Conveyor |
| (8) Packaged Combustion Chamber | (17) Over Sized Fuel Material for re-Chipping Bin |
| (9) Rotary Air Lock/Fly-Ash Dump | |

The FireBox LPD UF design is suitable for applications to produce low pressure steam or hot water in ranges from 3,450 - 20,700 lbs/hr (3.4 mmBTU - 20 mmBTU) output at 15 PSI steam or 30 PSI hot water. This system is designed by HBC to combine the best technologies from the "old school" of biomass combustion and the latest advanced combustion control technologies. This combination enables these systems to provide a flexible and reliable operation utilizing a wide range of biomass waste with moisture contents ranging from 8 - 50% and requiring minimal fuel preparation. Ash removal is a manual operation. The boiler vessel is a three-pass firetube / firebox design that inherently provides an extended water membrane in the furnace area greatly reducing the amount of refractory required.

The Solid Fuel People

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 Coolidge, Georgia 31738
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 Email: info@hurstboiler.com

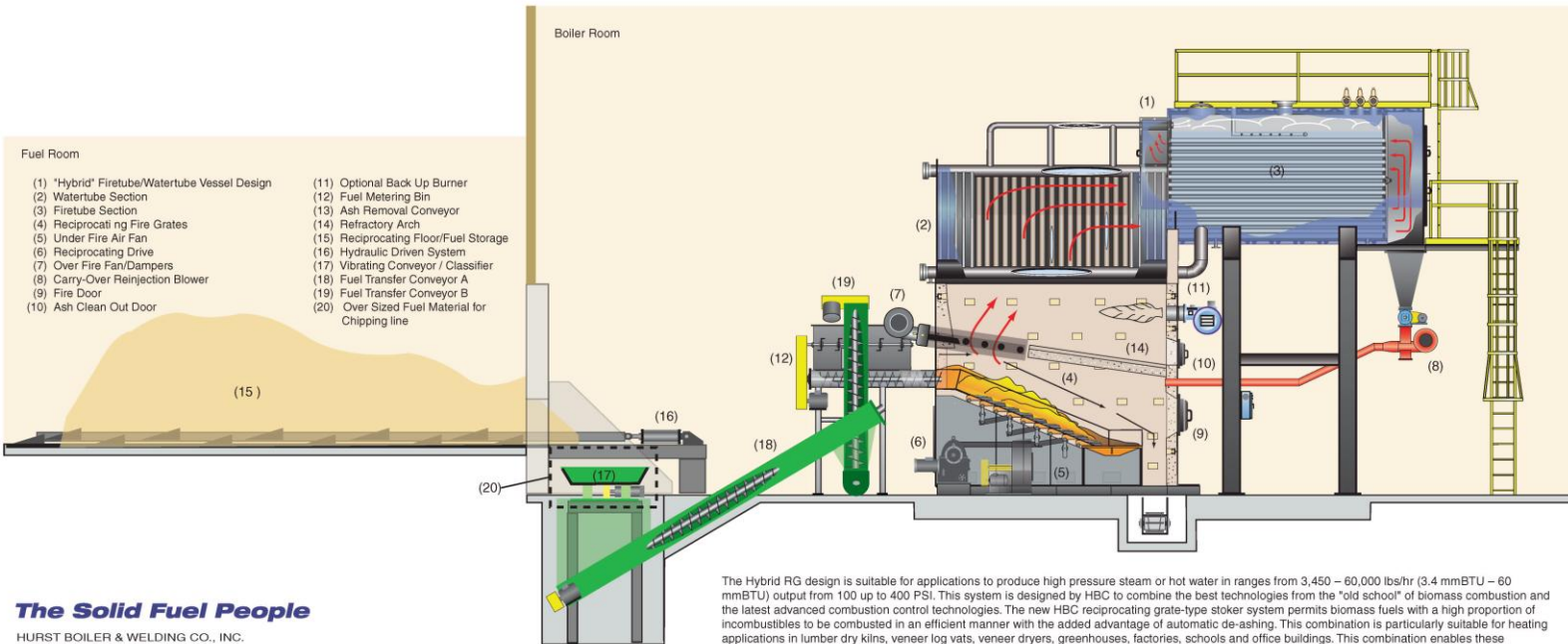
CAT# W-11

HURST FIREBOX LPD UF
 Under Fire Feed System

Modular Packaged



HURST



The Solid Fuel People

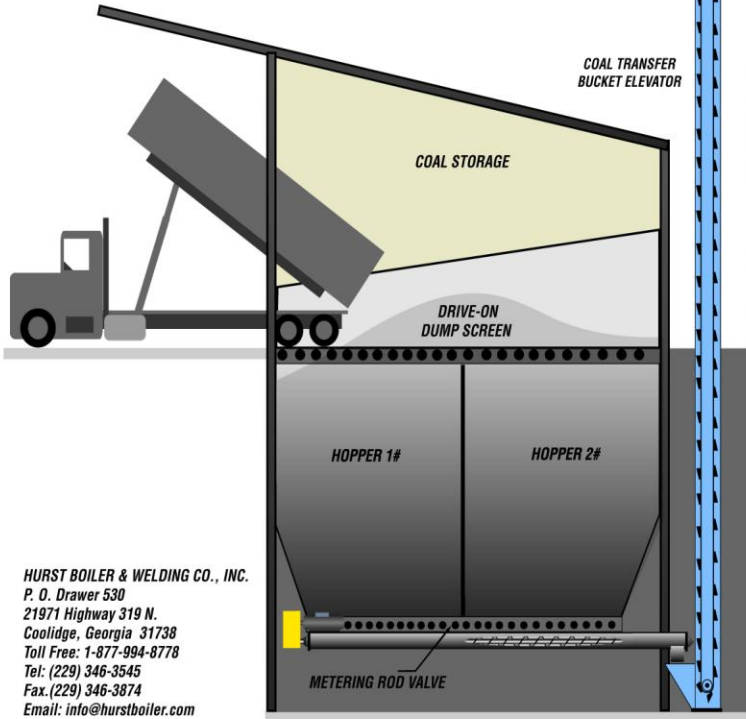
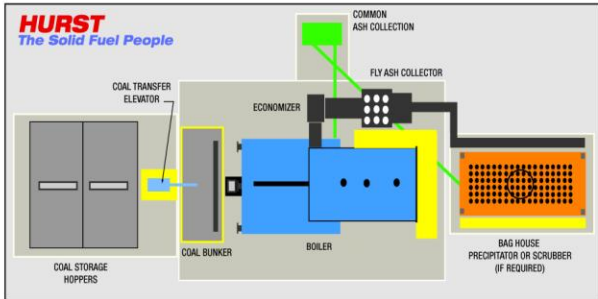
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The Hybrid RG design is suitable for applications to produce high pressure steam or hot water in ranges from 3,450 – 60,000 lbs/hr (3.4 mmBTU – 60 mmBTU) output from 100 up to 400 PSI. This system is designed by HBC to combine the best technologies from the "old school" of biomass combustion and the latest advanced combustion control technologies. The new HBC reciprocating grate-type stoker system permits biomass fuels with a high proportion of incombustibles to be combusted in an efficient manner with the added advantage of automatic de-ashing. This combination is particularly suitable for heating applications in lumber dry kilns, veneer log vats, veneer dryers, greenhouses, factories, schools and office buildings. This combination enables these systems to provide a flexible and reliable operation utilizing a consistent "grade" of biomass waste with moisture contents ranging from 30 – 50%. The boiler vessel is a two pass hybrid design incorporating a water tubed boiler-type water membrane and a two-pass fire tube scotch marine vessel. This vessel's advantages over standard water tube boilers include much larger steam disengagement area providing high quality steam, larger steam storage capability for quicker response to sudden steam demand and much larger thermal storage that provides fast demand response times and safer operation.

CAT # W-08 **HYBRID RG**

Reciprocating Grate System

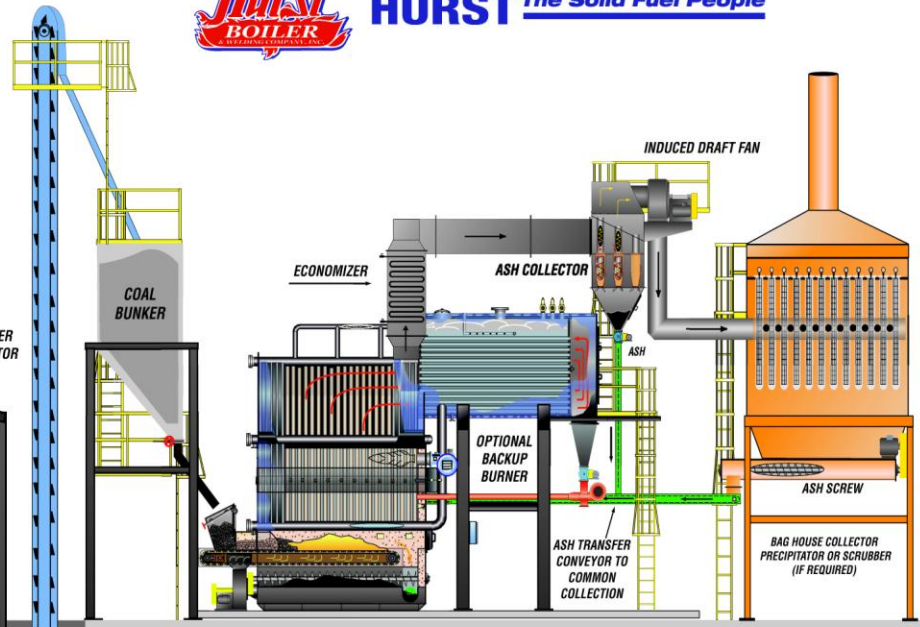
Modular Packaged



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HURST *The Solid Fuel People*



Hurst Boiler and Welding Co., Inc. provides its clients with the support and expertise necessary to design, fabricate and install complete coal fired boiler systems from the fuel storage system thru exhaust gas emission mitigation. This particular representation exhibits the application of HBC's Hybrid WW CG boiler system into a complete turnkey system. It should be understood that every application is different in some way: from coal quality and/or type, steam/heat requirements to site specific local and/or national emission regulations. Please contact our knowledgeable staff to discuss your particular application.

HURST HYBRID SERIES

COAL FIRED

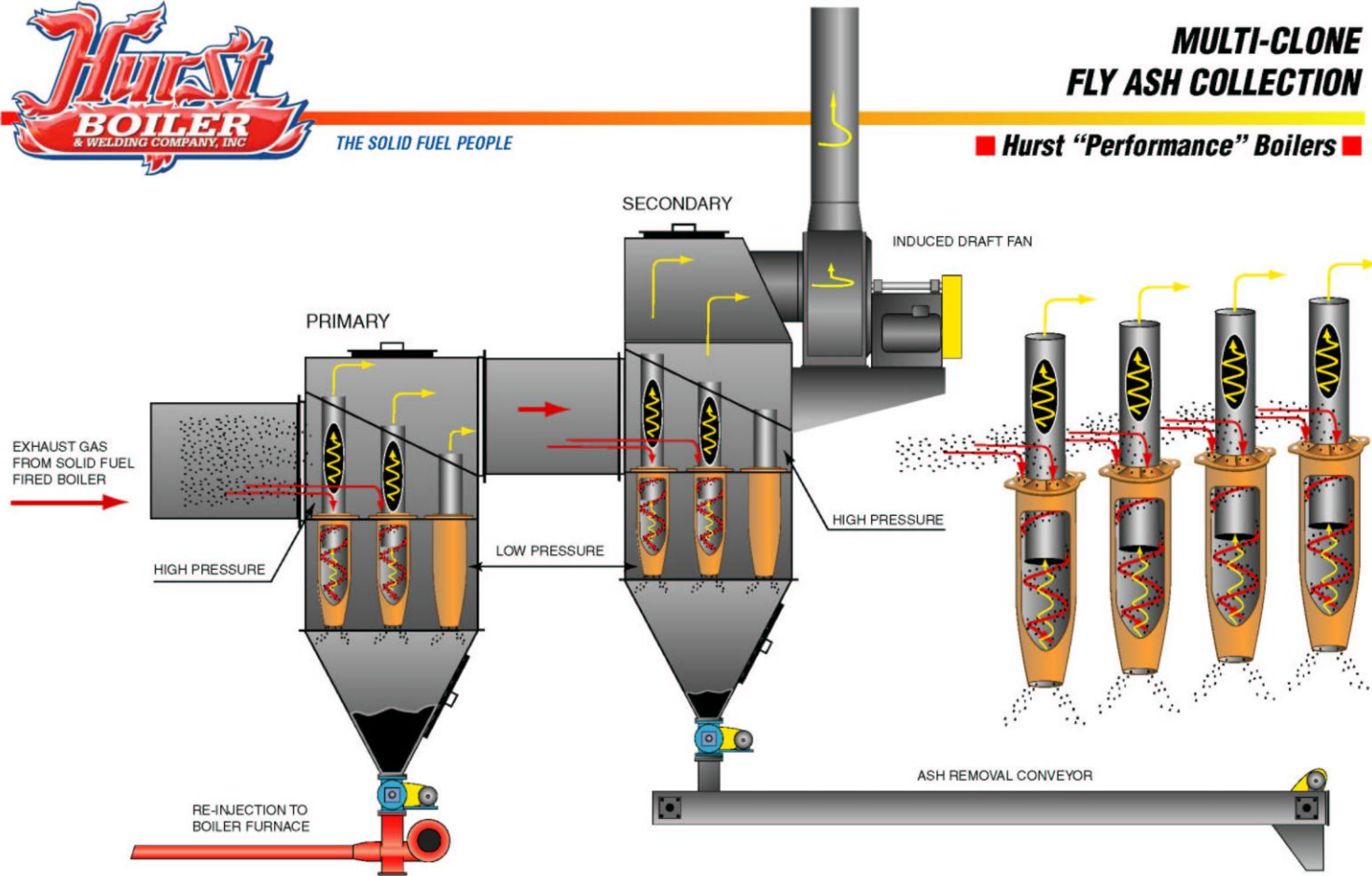
BOILER PLANT

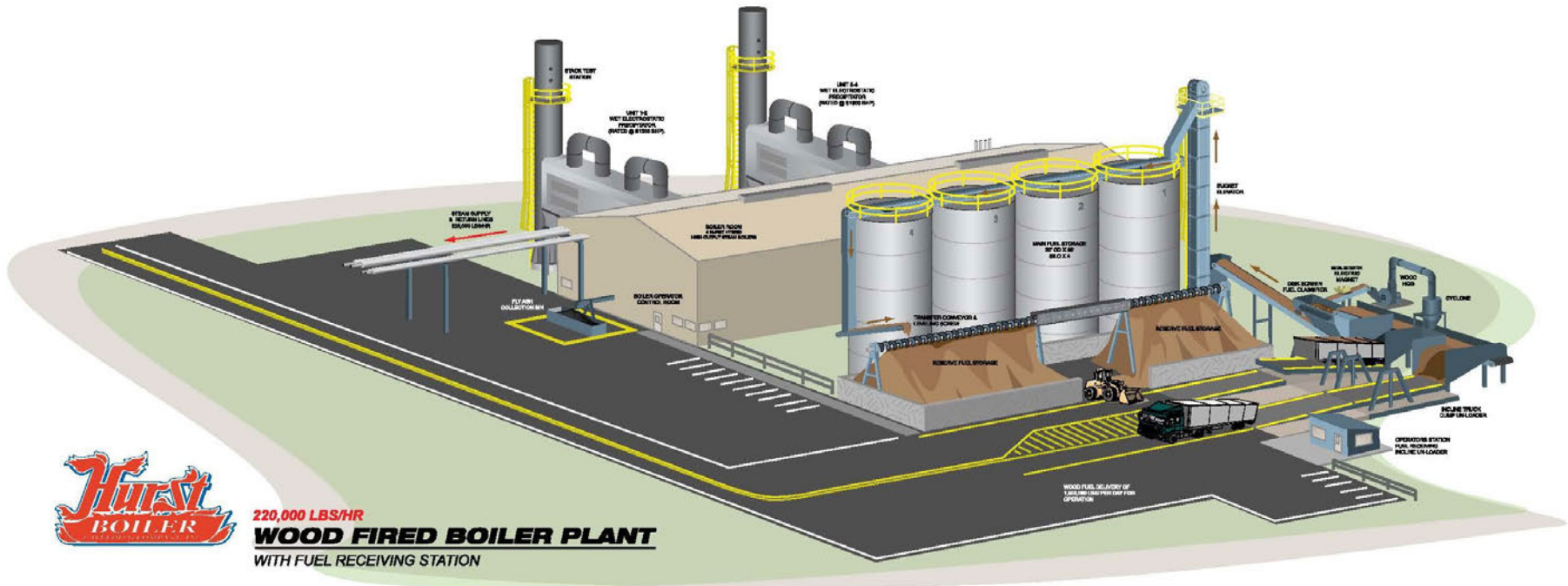


THE SOLID FUEL PEOPLE

MULTI-CLONE FLY ASH COLLECTION

■ Hurst "Performance" Boilers ■





220,000 LBS/HR
WOOD FIRED BOILER PLANT
 WITH FUEL RECEIVING STATION

CORPORATE GRAPHICS AND COMMUNICATIONS

Product Guide “MH”



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