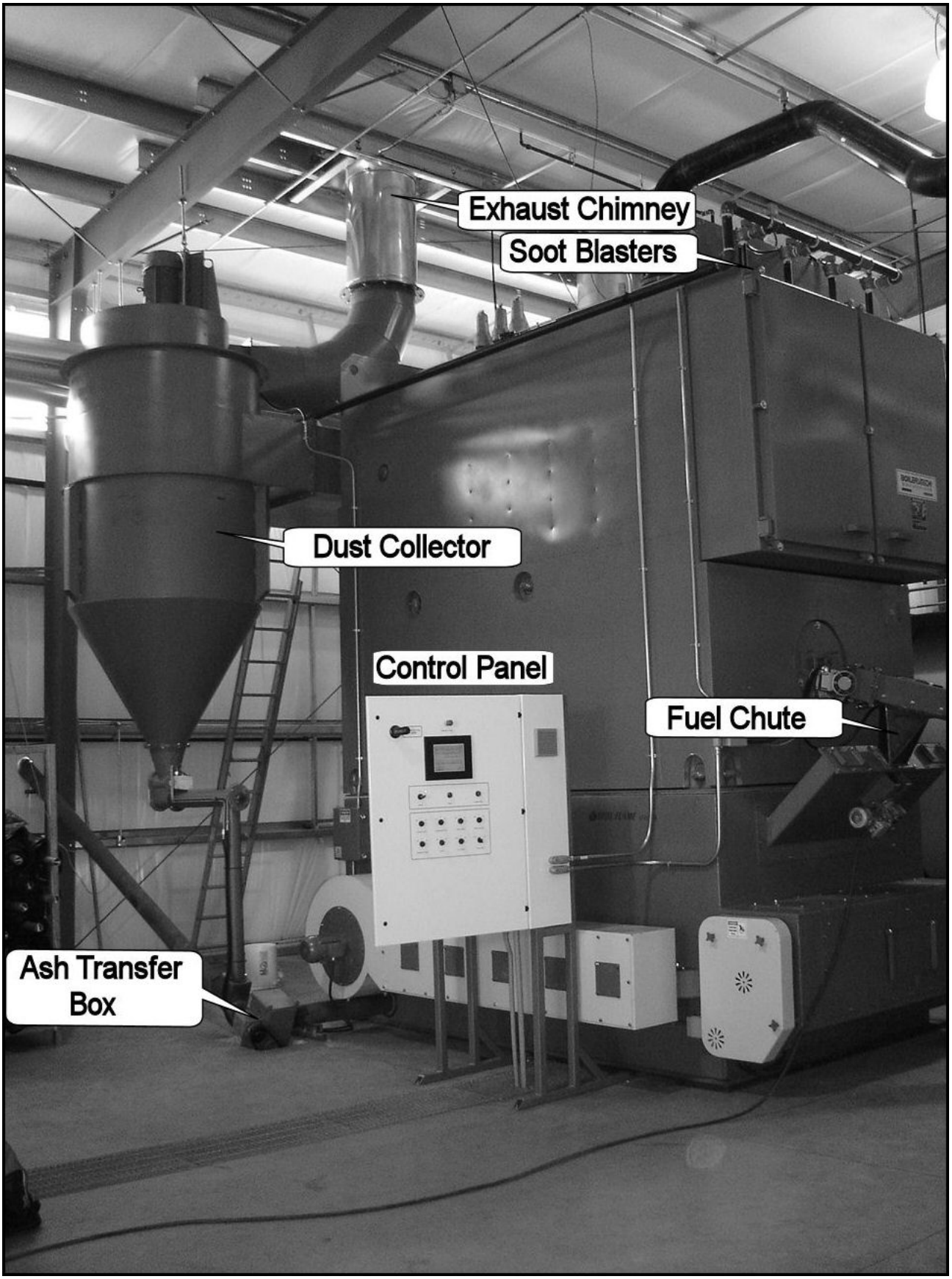

Exhaust Chimney
Soot Blasters
Dust Collector
Control Panel
Fuel Chute
Ash Transfer Box

1. INTRODUCTION

Our system design incorporates the three components required for efficient combustion of any solid fuel. They are:

- **Time**
- **Temperature and**
- **Turbulence**

Time is achieved in the Btu/Hr per square foot of grate area and the Btu/Hr per cubic foot of furnace volume. The chain grate stoker design has a significant advantage over other systems. The system provides a large area of the grate that is conservatively designed to assure a complete combustion of any solid fuel. For example, a 100 BHP (3,500,000 BTUs) solid fuel combustion system requires (based on 7,000 Btu/Lb of solid fuel) approximately 10 FT^2 of grate area for proper fuel combustion. Only chain grate stoker system design can meet these criteria.

Temperature is achieved by the amount of refractory near the fuel feed and on the walls of the combustion chamber. Our combustion chamber is lined with high temperature insulation and refractory that keeps the heat in and provides the required environment for solid fuel combustion.

Turbulence is achieved by supplying additional combustion air above the second zone from the front wall directed toward the top of the grate at the rear of the stoker. The combination of combustion air (air passing through the fuel bed) and over-fire air (OFA) provides turbulence required for rapid and complete combustion of solid fuel.

Control of both the quantity and the distribution of combustion air are apportioned by the combustion control system via the use of dampers and Variable Frequency Drive (VFD).

The following is an outline of all the system components that are required for a proper operation of the system and are part of a package sold.

2. EQUIPMENT CONSTRUCTION

2.1. BOILER

Type "C" Style, low pressure boiler rated for 30 Psig water pressure or 15 Psig steam pressure (other pressures available). Supplied boiler is a fire-tube, three-pass style boiler. Three-pass firebox boilers are designed and constructed to the **ASME boiler code** and meet all the requirements of the authorities of the Provinces of Canada.

The objective of the boiler is to provide a large heat transfer surface to optimize thermal efficiency. Type "C" boilers are designed for maximum heat transfer efficiency with low stack temperatures. The large firebox with arched crown sheet provides an exceptionally high proportion of the primary (radiant) heating surface which is many times more efficient than secondary (indirect) heating surface. Its extra large furnace volume assures complete combustion, clean firing and unrestricted gas flow.

Like most fire-tube boilers, it is easy to clean and maintain. Fire-tubes can be cleaned with automated soot blasters. Generous water content and steam space offer instant reserve capacity and high quality steam.

FIRE-TUBE 3-Pass BOILER

2.2. STOKER

The stoker base is constructed of mild steel with factory installed **chain grate**. Chain grate is made of hundreds of individual chain links that are cast from a high heat resistant alloy cast iron. The links of the chain grate stoker are so assembled that they break with scissor-like action at the return-bend section. This action helps to loosen any clinker which may adhere to the grate surface.

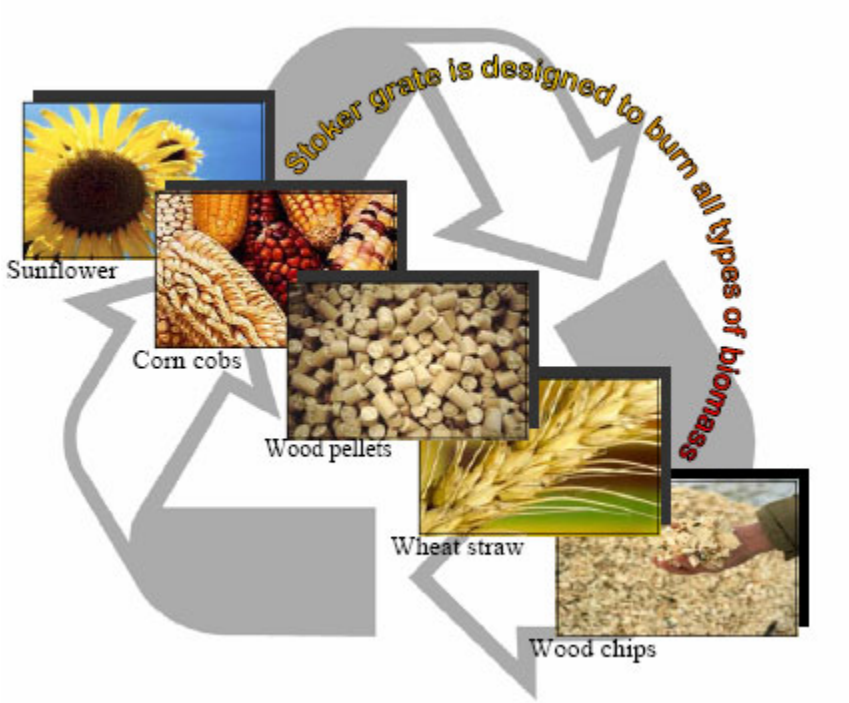
Stoker walls are lined with 6" high temperature insulation and with a high temperature refractory. Included, as part of the stoker, is under-grate air (combustion air) fan and modulating-feed rate control. The quantity and control of air to the various sections of the stoker are very important. The stoker is zoned or sectionalized and is equipped with individual zone dampers to control air pressure and quantity to the various sections as the fuel travels along the stoker length from front to rear. Air for combustion enters the compartments through the side.

Chain grate stoker is extremely flexible in its ability to burn fuel with a wide range of burning characteristics, including high moisture fuels. There are many successful installations of chain grate stokers burning wood waste, wood chips, flax shive, wood pellets and other biomass fuels.

STOKER BASE

2.3. FUEL HANDLING

The chain grate stoker is designed to burn various fuels (as depicted below). The basic system incorporates VFD driven fuel-metering conveyor – multi-screw for biomass system or twin-screw conveyor for coal combustion system. The system is designed to transfer fuel from customer supplied hopper bottom bin to the stoker chute. It is designed to convey compressed biomass fuels (wood pellets or cubes) or loose biomass.



2.4. AUTOMATED ASH HANDLING

The system shall incorporate automated ash removal as follows. Each of the combustion air duct is equipped with ash removal auger that drops off the ashes onto the transfer-auger and further onto the cross auger. The cross auger shall be factory installed into the stoker base. Ash will drop off the end of the moving chain grate onto the cross auger. This auger will then transport ashes out of the base automatically. In some cases an additional ash transfer box is used to transfer the ashes to the outdoor ash container.

The ash augering system is powered by the hydraulic system and is controlled automatically from the supplied electrical control panel.

An outdoor ash storage container is not included in the equipment quote but could be provided to the customer as optional equipment.

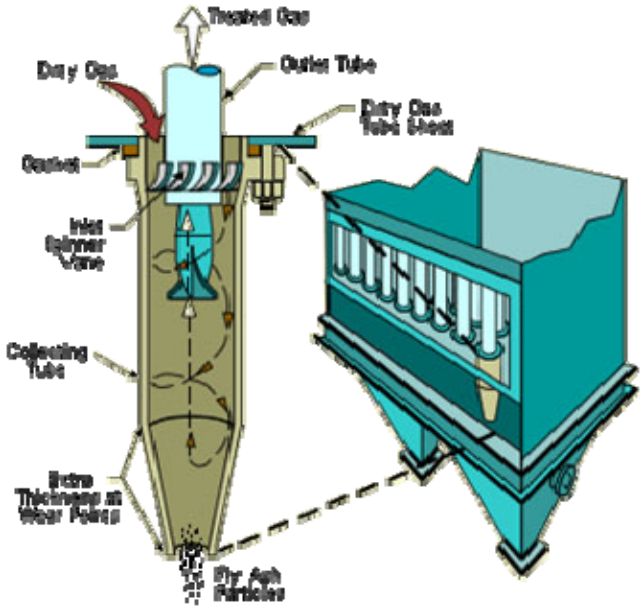
2.5. AUTOMATED SOOT BLOWERS

The soot blowers are factory installed into the boiler (in some cases on site installation is required). The function of the soot blowers is to eliminate any soot build-up within the boiler tubes, thus increasing its heat recovery efficiency. Included is an automatic soot blower control system. PLC controlled soot blowers are programmed to blow the tubes at predetermined intervals, guaranteeing a maximum boiler heat recovery 24 hrs a day. Compressed air (min. 40SCFM at 100PSIG) is required for proper operation of the soot blower system.

2.6. DUST COLLECTION SYSTEM

The dust collection system consists of a mechanical dust collector (multi-cyclone) system that is designed to remove up to 90% of the fly ash from the exhaust air stream. The small diameter of the cyclone tube creates more rapid spinning of the gas stream than is possible in large diameter cyclones. This allows to collect to collect considerably smaller particles with much greater efficiency than larger diameter cyclones. The multi cyclones are capable of removing particles having diameters down to 5 micrometers.

The supplied dust collector is equipped with exhaust fan, air lock, ash removal auger and elbow connection between the dust collector exhaust fan discharge outlet and chimney inlet.



The chimney is not part of the package sold – will be quoted as an option.

2.7. PNEUMATICS

The equipment requires compressed air approx. 40 SCFM at 90 Psig for a proper operation of the soot blower system.

For proper system operation we recommend at a minimum 5 HP compressor with a minimum 250 USG storage tank – **supplied by the customer.**

2.8. HYDRAULICS

The equipment is fitted with hydraulics for the operation of chain grate main drive, main ash removal auger and dust collector fly ash removal auger.

The hydraulic system consists of 3 HP pump rated at 3 GPM at 1,500 PSIG, hydraulic fluid holding tank with site gauge and manifold c/w solenoids. Most of the hydraulic lines are factory fitted. Some installation is required on the job site.

3. SYSTEM CONTROL

3.1. ELECTRICAL

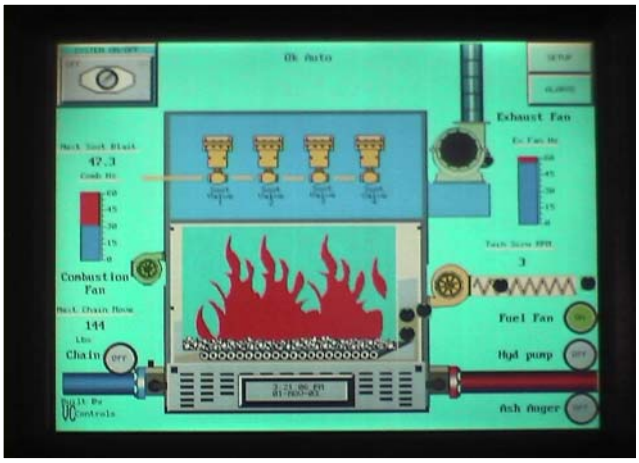
The electrical control equipment is enclosed in a wall-mounted cabinet. Air-cooling fan is fitted into the electrical control cabinet to prevent the cabinet from overheating. We shall supply a 3-Phase 230V or 460V **(575V Optional)** electrical control panel designed to operate the stoker, twin-screw (or multi-screw) fuel metering conveyor, ash removal auger, combustion and over-fire air and draft-inducing fan. Electrical panel is PLC controlled, completed with visual user interface for visual function display (touch screen). The PLC control system is designed to deliver many years of trouble free operation and allows the operator to make changes as required for proper system function.

All wires including earth connections will be separately identified with the same numbers as are shown on the electrical schematic diagrams.

The system electrics will be to CSA standards where possible. Local approval of the system will be obtained when the equipment is installed at the customer location.

Options – not included in standard quote:

- 575V Control Panel configuration



3.2. CONTROL SYSTEM

The PLC control will be enclosed in the electrical panel. This will be used to provide control of the main system and other components.

An 8" color touch screen mounted on the electrical enclosure will display all necessary component selections, equipment set-up and program status information. All the system control software is allowing the operator to open and close selected windows as necessary.

Components:

Panel Enclosure (36"Wx48"Lx8"D)	Qty 1
Touch Screen Control (8" Color)	Qty 1

PLC	Qty 1
15 HP VFD (exhaust blower)	Qty 1
3 HP VFD (combustion air blower)	Qty 1
3 HP VFD (over-fire air blower)	Qty 1
0.5 HP VFD (twin screw auger or multi-screw auger)	Qty 2
3 HP hydraulic motor starter	Qty 1
Line Side Reactors	Qty 3
100 AMP Disconnect	Qty 1
Photohelic Switch	Qty 1
Alarm Buzzer	Qty 1
Contactors	
Relays	
Overloads	
Hand / Off / Auto Switches	

3.3. SYSTEM CONTROL

A switch button will be mounted on the control panel. On the start-up the system will automatically fire at a user pre-set speed. On/Off time and cycle times will be pre-set by the user and stored in the PLC.

All motors will have Hand/Off/Auto selectable switches. During a normal system operation all the switches will be in the Auto position. The "Hand" (manual) mode will operate all motors at the pre-set speed. The "Hand" option will also be used during equipment testing and troubleshooting.
The set-up will be performed via touch screen controller directly connected to the PLC. The touch screen will display all the functions of the system (including alarm status). The set-up screen will be password protected (for authorized personnel only).

3.4. CONTROL FEATURES

Type J thermocouple will be used in combination with the temperature controller. Temperature controller will have a PID function with 4-20 mA output to control the fuel feed rate, combustion and over-fire air volume (in order to maintain a proper coal combustion).

Photohelic switch will be used to maintain a negative pressure inside the boiler cavity. The switch has a 4-20 mA output that controls Exhaust Air blower speed.

Hold Fire:

Used only during the periods of low heat demand. The operation of the "Hold Fire" is as follow:

When the system reaches the set point temperature the system will stop feeding fuel. If the temperature remains at the set point for a long period of time the system will start up at a pre-set time intervals in order to maintain fire (i.e. the system will feed. The time interval is selectable by the user on the touch screen.

Alarms:

High Priority Alarms (will sound the alarm and shut down the system and will require a manual reset):
Low Water Level
High Water Temperature
Low Water Temperature

Low Priority Alarms (will sound an alarm only):
Twin Screw Auger Jam
Motion Detection on the Chain Grate
Motion Detection on the Ash Removal Auger

4. SITE CONDITIONS AND MAINS SERVICE SUPPLY

Unless otherwise shown, our standard equipment is designed to operate within the following standards and conditions.

4.1. SUPPLY VOLTAGE

208V, 3 Phase, 60Hz + Earth or as requested and confirmed in the purchase order. Single phase voltage is available upon customer request.

4.2. FOUNDATIONS

The equipment must be installed on a stable foundation, depending upon the nature of the sub soil, a site having at least a 8" depth of concrete 30 Mpa or better c/w 15M rebar spaced 12" on center would normally be adequate.

We **strongly recommend** that the customer has the site surveyed by a qualified engineer and follows their advice in respect of the construction of the "below floor level" foundation while observing the "floor surface" requirement prescribed by the Floor Plan provided.

The equipment is mounted directly onto the floor preferably on **housekeeping pad** approx 2" above floor level.

5. INSTALLATION AND COMMISSIONING

5.1. EQUIPMENT ACCEPTANCE

Prior to dispatch of the machine from our shop the equipment will be fully inspected and will undergo a few days of testing.

Proposed tests include:

Correct functioning of the equipment

Safety Review

Temperature Control

5.2. INSTALLATION

The customer would be responsible for unloading the equipment, moving to the site, placing on to foundation (housekeeping pad if one is made), and installation of the dust collecting system, fuel delivery system and ash removal.

The customer would be responsible for making connection of the incoming electrical supply to the main control panel and between the control panel and junction box located on the stoker.

Our technician will complete the verification of all the mechanical, electrical and electronic checks.

5.3. COMMISSIONING AND FINAL ACCEPTANCE TESTS

Our Service Technician will commission the system during this time. It is the customer's responsibility to provide a supply of components, services of the customer's Inspection Department and necessary equipment to ensure that the capability of the machine can be proven without delay to provide an Acceptance Certificate.

Our Service Technician will start up the system and verify all the functions of the system during this time.