In the living tree, wood and water are natural partners. In the living tree, wood serves as the "plumbing" for the tree, conducting water from the roots to the leaves for continued growth. In finished wood products, however, wood's love for water often creates problems related to shrinking and swelling. Thus, the need for steam!! Steam is the lifeblood of the dry kiln industry. Steam provides the method for drying the wood which in turn produces the end product, kiln dried lumber. But, what is the best method to produce the steam required for drying this wood. This question brings us to our discussion today, "Waste Wood vs. Natural Gas Fuel Boilers." In general, natural gas falls into a category of fossil fuels which includes, propane, multiple grades of oil such as #2 or diesel, and heavier grades such as #6 or bunker oil.

The end of the year 2000 and the beginning of the year 2001 has brought many new challenges for the future of boiler operation and steam generation. The past year has brought higher fossil fuel costs, including the tremendous increase in natural gas, as well as rising costs for oil and probably the increase in cost for waste wood as the supply decreases. The cost of natural gas has risen very sharply and in some instances has experienced a 200-300% increase. Not to be forgotten, oil has also increased in cost and continues to increase based on supply and demand. While waste wood has not risen as sharply, it has also increased in cost due to its availability which in turn has affected the quality.

Power or electricity is one comparison between wood waste and fossil fuel boilers. All steam generating facilities consume various amounts of electricity and with the rising costs must be considered as part of the comparison between waste wood boilers and natural gas boilers. We have seen some abnormal increases in electricity in the last few months, and even though the cost may average out, it will undoubtedly continue to rise.

Air pollution is another factor which involves steam plant operation. Regarding this factor, particulate matter, which is fine particles of ash residue containing carbon deposits, is of most importance, especially to waste wood. Natural gas and most oil fuels are referred to as "clean burning" fuels primarily due to their lower tendency to form solid combustibles, such as smoke, soot, and carbon, and their low ash content. On the other hand, waste wood boilers produce particulate matter to some degree. Air pollution requires not only a great amount of time and cost to cope with the various authorities and regulating agencies, but should also include the cost for providing "best available technology" in order to provide continued steam plant operation. In the case of waste wood boilers one such best available technology is ESP's or Electrostatic Precipitators to reduce smoke and particulate matter. And in the case of natural gas boilers this best available technology might be low NOx burners for gas burners in order to reduce nitrous oxides.

We as Americans are used to having it all, endless and secure energy supplies; low prices; no pollutants; less global warming; no new power plants near people or pristine locations, and lets not forget no oil and gas well drilling. This is a great wish list, but has the shortcomings of inconvenience and high energy costs.
Comparing a gas or oil boiler versus a waste wood boiler, would appear to heavily favor the waste wood boiler. With the tremendous increase in natural gas prices it would seem that the waste wood boiler would far outdistance the gas or fossil fuel boiler as a choice. A closer look at the boiler operating factors, as viewed on the overhead, will provide a little clearer picture into the comparison. Our discussion compares natural gas and "hogged" waste wood, but obviously there are other fuel choices.

Wood is a complex vegetable tissue composed principally of cellulose, an organic compound having a definite high fibre composition and is known as a solid fuel. It would therefore seem reasonable to assume that equal weights of different dry wood species would have practically the same heat content. However, owing to the presence of resins, gums and other substances in varying amounts, this heat content is not uniform.

The accepted standard of wood measurement is the "unit", equivalent to 200 cu. ft. of hog fuel as measured in the containing vehicle of transportation, most likely by truck, without packing. The weight of the unit will vary from 1700-2300 lb of dry wood, depending on the species, moisture content, and other "materials" within the mixture. These other materials usually consist of dirt, rocks, and other foreign material, which lower the overall BTU content, as well as increasing cleaning times. The BTU content per pound of dry wood is around 8600 to 9050 BTU/lb.

Fuel Cost Comparison Example:

For the following example assume a steam boiler generating a maximum capacity of 40,000 lb/hr. A 40,000 lb/hr boiler rated at 80% efficiency would require approximately 50,000,000 BTU/hr to produce the required steam output. Obviously, if the efficiency of the boiler is more or less, the required BTU input will change accordingly. This same BTU value can also change based on boiler condition, age, whether it has other energy saving devices such as an economizer, air heater, or blow down heat recovery. For our example we will also assume the cost of the natural gas is $.60 per therm and there are 100,000 BTU/therm.

\[
\frac{50,000,000 \text{ BTU/hr}}{100,000 \text{ BTU/therm}} = 500 \text{ therms/hr}
\]

\[
500 \text{ therms/hr} \times \$0.60 = \$300 / \text{hr}
\]

The above cost, $300 per hour, represents the cost of generating 40,000 lb/hr of steam at 80% efficiency. Multiplying this figure by 24 would represent the cost per day of operation. If the cost of fuel changes, so will the actual cost of operation. Also, this figure represents a boiler operating at full firing rate. This number was chosen for example only and is not generally the way a natural gas boiler operates. Generally, a gas fired boiler will modulate between minimum and maximum and average out at something less than 100% firing rates, which in turn lowers the hourly cost of operation.

For our example we will assume waste wood or hog fuel @ 5000 BTU/lb and a moisture content of 40%. Obviously, if the species of wood changes or the moisture content changes so will the BTU/lb. We will assume that the cost of the hog fuel is $30.00 per unit.

\[
5000 \text{ BTU/lb} \times 1800 \text{ lb/unit} = 9,000,000 \text{ BTU/unit (Hog fuel is generally purchased as a unit)}
\]
50,000,000 BTU/hr / 9,000,000 BTU/unit = 5.56 units/hr

5.56 units/hr x $30.00 /unit = $167 /hr

The above cost, $167 per hour, as compared to the cost of operating on natural gas at $300 per hour would at first glance appear to be an obvious choice. The difference in cost per hour of operation is about $133. ($300 - 167 = $133) But, there are other factors in the above equation in order to make a more effective comparison. One being delivery costs which have to be entered into the hog fuel equation.

Let us consider another factor in our comparison, efficiency. A newer fossil fuel boiler (gas/oil) will operate at about 80 - 84% efficiency. These numbers are easily obtained and are generally guaranteed by the boiler/burner manufacturer. Most boiler/burner manufacturers design their boilers and burners as a single unit, so that they become integral parts between the two and the result is higher efficiency.

On the other hand, most waste wood boilers are much older and probably operate around 65 - 70% efficiency at best. We have not seen many new hog fuel boilers being placed into service, probably due to the tight air pollution restrictions. Not more than 10 years ago, waste wood was burned in "teepee" burners just to incinerate the waste to get rid of it. This was also true of many sander dust boilers which operated as "incinerators" where steam was vented to atmosphere to burn massive quantities of "waste" dust. Now this same sander dust "waste" has become a major source of the raw produce and is re-injected back into the board being produced. This product represents flake board, medium & high density board, pressed boards, etc.

Referring to our hog fuel example above, it was assumed cost at 80% efficiency. The gas boiler was a true 80% efficient, but now we need to look at the waste wood boiler operating at only 65% efficiency. This now requires a new BTU/hr value, which is 61,500,000 BTU/hr based on 65% efficiency to generate the same 40,000 lb/hr steam. This increase now requires an increase in waste wood volume as follows:

61,500,000 BTU/hr / 9,000,000 BTU/unit = 6.83 units/hr (Waste wood required)

$30.00 x 6.83 units/hr = $205 (Difference is now only $300 - 205 = $95)

Some of the factors affecting waste wood costs consist of delivery or those charges of delivering fuel by either truck, rail, barge, etc. Another factor is the cost of the waste wood when it consists of higher than normal moisture content, thus reducing the available BTU's and the maintenance required for the delivery and handling equipment such as augers, chains, motors, etc., and for the removal of ash, again trucking costs if the ash must be removed from the site. Another cost associated with waste wood boilers is the maintenance required for cleaning grates, normally requiring more than one operator. The ash cleaning procedure can be as little as once a day or in some cases almost continuously, depending on the quality of the waste wood fuel.

The higher cost of power or electricity is another factor which will have to be factored into our comparison. Compare the motor requirements for a waste wood boiler versus a natural gas boiler. As you can see there are a number of motors required for operating waste wood boilers versus gas boilers which in turn increases cost of electricity. This does not account for the increase in cost for maintenance, motor failures, and other related maintenance issues. The natural gas boiler consists of only one motor, a combustion air fan. But, the waste wood boiler requires a multiple array of motors such as fuel feeders, underfire air fan (which provide air through the grates), overfire air
(providing air over the grates), mixing air fan (to properly mix the fuel/air within the combustion chamber, stoker fans to distribute the fuel over the grates, fuel handling chains to get the fuel to the feeders, and ash removal equipment motors. There may be more than those represented but it will give you an idea of the cost for burning waste wood versus natural gas.

The final factor in our comparison and certainly not the least is the requirement for air pollution and related permits required. Today all boilers burning fuel and any equipment emitting an exhaust to atmosphere will require an operating air permit. Due to the stringent requirements for air pollution a lot of waste wood boilers are operating at much lower steaming capacities then the boiler can actually generate. This is usually done because the boilers will generate lower quantities of air pollution at lower steaming capacities which in turn satisfy the air pollution authorities. A source test is conducted to set these maximum operating parameters and limits on the boilers. A newer natural gas boiler can generally meet the air permit requirements for air pollution without the rigorous steps needed on a waste wood boiler and provide maximum steaming rates.

Summary

Consider all the options and choose the boiler wisely. In most cases steam plants are considering changing from waste wood boilers to gas and not the other way around. Before making any decision, have a survey done to investigate the steam plant and your particular situation, analyze the availability of waste wood for the future, look into the requirements for air pollution, and last calculate the labor costs. There are many opportunities to improve steam plants, especially waste wood boilers.

Some of these opportunities include:

Improvement of the combustion control system to decrease fuel consumption and possibly lower air pollution which in turn may increase steaming capacities and lower operating costs.

Have a combustion analysis performed on the waste wood boiler to assure proper combustion and correct location of air insertion into the combustion chamber to provide complete combustion with less air pollution and reduced fuel consumption. Check into new methods for injecting air into combustion chamber, such as mixing air for increased improvement.

Where feasible increase condensate return to reduce not only fuel consumption but also reduce chemical treatment, due to virtually "clean" water being returned to the boiler. Use higher pressure DA or flash tanks so as to increase feedwater temperature, thus increasing efficiency.

Inspect existing equipment such as multi-clones, air heaters, economizers, etc. to assure proper operation, which in turn improves efficiency as well as reduces stack emissions and air pollution.

Investigate alternate methods for burning other fuels into existing waste wood boilers. There are methods to add alternate fuels to waste boilers. Use of natural gas, sanderdust, oil, RFO (refined fuel oil), etc. to increase waste wood boiler steam pressure stability and possible reduction of on-site waste fuels, such as sanderdust.
Investigate new methods of increasing efficiency by use of feedwater economizers, air pre-heaters, high pressure flash tank system, improved methods of waste wood combustion.

Again, choose wisely.

Thank you.