

FUEL AND STEAM BOILERS

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Everyone in this room is involved with something which is very common, not only to our job of drying lumber from day to day, but in simply living day to day. This very common "something" is what we would shrug off as simply ... heat! Whatever we do, whatever happens --- almost anywhere, anytime, is involved with heat in one way or another, with few exceptions. But this "something" called heat, which is so involved with our everyday lives, can anybody here really describe it other than to say it is a form of energy?

When we measure heat energy, we can talk in terms of B. T. U.'s (British Thermal Units). There are other ways to describe and measure heat, but the B. T. U. is the unit most commonly used in commercial and industrial applications. Do not confuse a B. T. U. or a heat unit with temperature, though. Try to keep in mind that temperature is a degree of hotness of an object. But heat is energy which can raise the temperature of an object. A good illustration is a small gas flame compared with a large gas flame, say on the stove in your kitchen. Both flames may be the same temperature, but the larger flame is releasing more heat. The reason the flame does not get hotter is that just enough heat is present to maintain combustion; the rest of the heat escapes. It is the heat that escapes from the flame which does the work in our dry kilns. If we alter the ingredients of the fuel/air mixture, we can change the flame temperature and the amount of heat released, but just the same, the flame will reach a certain temperature for that mixture and a certain amount of heat will be released.

What will the B. T. U. do for us or, first things first, just how much is a B. T. U. ? A B. T. U. is the amount of heat that is needed to raise the temperature of one pound of water (about one U.S. pint) one degree F. In other words, if you heat one pint of water from 100°F. to 200°F., you will use 100 B. T. U.'s to do this job. Something to keep in mind too, is that heat always moves from a warmer object to a cooler object, so the stove always has to be hotter than what you're cookin'. To confuse you even more, there is no such thing as "cold." Cold really means an absence of heat. So, the next time you're out in a 60 mile per hour wind when it's 40° below zero, remember --- there is no such thing as cold just an absence of heat. Granted, an awfully big absence of heat, but there is no such thing as cold.

With a little understanding of heat now, let's turn our attention to heat sources, better known as fuels. Anything that burns can be considered as a fuel. We more commonly think of natural gas, propane, butane as fuels to use in gas burning equipment. Propane and butane are easily liquified which makes them easy to transport and store in tanks. Natural gas, while it is liquifiable, is more economically

transported by pipelines under pressure. Fuel oil, on the other hand, requires a different type of burner which must pressurize, then atomize, the oil to break it into very small droplets for instant ignition, and complete combustion. The fuel oils come in various grades anywhere from a watery appearing light diesel oil to a very heavy molasses, like Bunker C fuel oil, which must be kept heated to keep it flowing (otherwise it cools to a tar-like state). All of these fuels are popularly known as the fossil fuels, as they are taken from the earth and are the products of plant and animal life which have been changed by heat and pressure of the earth for millions of years. Coal is another fossil fuel but is not commonly used here in the West.

The beauty of fossil fuels is that they are very uniform, in other words, they change little, if any, from day to day. They are easily handled and metered into a burner, and provide a consistent flame. But then we get into burning wood, and a whole new ballgame begins. Wood burns well as a fuel but because there are so many variables, you can never quite predict exactly how it will burn from day to day. These variables are: the species of the tree, where it was grown, whether it is bark, sapwood, or heartwood, whether it contains a high percentage of resins and pitches or none, moisture content, dirt content, ash content (non-burnable minerals, etc. in the wood) how much extra dirt, water, etc. gets to the wood fuel in handling it, the size of wood particles, how long it is stored, just to name a few.

Because of all these different ways in which wood fuels may be changed, it is difficult to design automatic equipment to burn them, day in and day out. It is easy to see why gas and sometimes, oil have been used for direct firing dry kilns (i. e. blowing the hot combustion gases directly into the kiln for heating). Wood has been used for direct firing, but usually restricted to a very fine powder, much of which is a wood flour. It can be difficult to handle and very explosive as demonstrated by the recent explosion of a particle board plant in California.

Seemingly, direct firing a dry kiln should be the simplest and most straight-forward and economical. This would be true if natural gas was inexpensive and if steam spray humidification equipment was not required. However, times are changing and what was once regarded as waste around our mills is now a very valuable commodity as a by-product for sale elsewhere, or as a fuel. The easiest, safest and most feasible way to convert our wood waste to heat energy is through the use of a well designed wood fired boiler plant. Steam is an excellent medium to deliver heat into the dry kiln. It is safe, efficient, easily controlled and recyclable. A well-designed boiler plant will allow you to burn almost any wood fuel you develop in your plant, dirt and water included, however, there are limits! By nature of a boiler plant, there are some heat losses through the stack, but the boiler plant enables you to take an otherwise useless product and turn it into a valuable commodity. How valuable?

Remember those heat things we called B. T. U. 's? Each pound of bone dry wood waste, when burned, gives off 8,500 B. T. U. 's or

enough to heat ten gallons of water from 50° up to 150°. Of course, if the wood waste is not bone dry, but more like about 50 percent water, as we find hog fuel in our conveyors, one pound of wet hog fuel will give off half as much heat when burned, or about 4,000 B. T. U. 's.

In working with wood fuels, we normally express volumes in units, the same way wood chips are measured. One unit is 200 cubic feet in volume. The weights of a unit of wood fuel are not surprising. One unit of dry shavings weighs about 2,000 pounds. One unit of green hog fuel weighs about 4,000 pounds. A few minutes ago I told you how many B. T. U. 's a pound of fuel gives off. So, let's work with these figures.

Dry Planer Shavings:

8,500 B. T. U. /Lb. X 2,000 Lbs. /Unit = 16,000,000 B. T. U. /Unit

Green hog fuel:

4,000 B. T. U. /Lb. X 4,000 Lbs. /Unit = 16,000,000 B. T. U. /Unit

Look strange to you? Well, it works out in actual practice, and has been for some time. What it boils down to is that a unit of wood fuel, whether it is green or dry gives off about 16,000,000 B. T. U. 's when burned. This fact of life makes fuel figuring really easy.

Another rule of thumb is that it takes about one unit of green or dry fuel to produce about 10 to 12,000 Lbs. of steam (a pound of steam is what you get when you boil off a pound of water - don't confuse this with pressure, or pounds per square inch), depending on the boiler, furnace design and many variables. Incidentally, pounds of steam per hour is another way of saying "boiler horsepower." A 10,000 pound steam per hour boiler represents approximately 290 B. H. P.

As a final note, let's compare wood fuel with some fossil fuels:

One 200 Cu. Ft. unit wood fuel (green or dry)	16,000,000 BTU/Unit
One Therm Natural Gas (100 Cu. Ft.)	100,000 BTU/Therm
One Gallon Propane	92,000 BTU/Gallon
#2 light oil (diesel)	138,000 BTU/Gallon
#6 heavy oil (Bunker C)	152,000 BTU/Gallon

Dividing the fossil fuel figures into the wood fuel figures gives us the following equivalents:

One unit of wood equals -	160 Therms of gas
	174 gallons of propane
	116 gallons of #2 oil
	105 gallons of #6 oil

So, if oil is costing \$13.00 per barrel (42 U. S. gallons), this comes to about 30¢ per gallon. Therefore, if one unit of fuel is worth 105 gallons of #6 oil,

105 X \$.30 = \$31.50/unit value as fuel.

The same method of figuring can be used for the other fuels.

In conclusion I hope you can take this information back to your mills and help management to evaluate your waste wood resources. If your mill has more than three kilns it probably will take only three years to pay for wood waste fired equipment in fuel savings alone.

With even a greater number of dry kilns, the pay-back is that much quicker.

QUESTIONS AND ANSWERS

- Q. Can you attach some efficiency to your figures?
- A. Yes, but I was dealing with the fuel and boiler efficiency comes later. If you burn gas or wood in a furnace you have efficiency factors. As I stated, heat always flows from the hotter object to the colder object. Heating water to generate steam at 0 psi, 212° F. in a boiler, your furnace and stack gases have to be at least 212°F. or hotter. Heat exchangers further on in the stack after it comes out of the boiler are used to heat your forced draft air. Maybe your air is coming into your combustion air and you have to heat that, so you can take more heat out of that stack. Your air comes in at 50 degrees and your stack temperature is 212, you can further exchange some of the heat to your forced draft air.
- This begins to increase the efficiency. Also you heat incoming fresh water. If you get to the point where you can't exchange any more heat, then, you have attained the extremes in efficiency. The water in wood fuel actually competes with the water in the boiler, or to keep the plate going you have to boil off the water in the fuel first and then boil water in your boiler. So your efficiencies decrease and some wastefired boilers have efficiencies as low as 60%. Some plants were burning only dry planer shavings with efficiencies as high as 86-1/2%. This is better than some of the gas type boilers, because we have a heat exchanger on the unit.
- Q. I am going to argue a little bit about your unit measure. It is a primitive measure and if you want to calculate capacities you should talk weight.
- A. No, I just got through saying you should talk volume.
- Q. In Prince George we have taken measurements at one plant. They probably have a 10 knife planer and heavy dressing and the planer shavings weigh 10 pounds per cubic foot. In the same locality with a 16 knife Stetson Ross planer, dry planer shavings weighed 5 pounds per cubic foot at 1-inch board mill. At one time they come off the slab and the next time they come off in very solid form, almost like a chip. Consequently, your figure at so many BTU's per unit is not very reliable. You want to base your figures per pound of fuel not by volume weight at all.
- A. Now that's where you are wrong.
- Q. I don't think so.
- A. One thing you failed to consider here is wood fuel is stored in large bins. The bulk factor becomes less important but we are dealing in generalities with these figures. We did state the method of measure is primitive but I said you might argue plus or minus

a million BTU's. I bet if you sat down with a pencil and paper you could probably prove me wrong by 6 million BTU's. I said you can't measure fuel any more accurately than that and that's the reason we use it. Yes, measuring by pound is the way to do it where you are using 4,000 pounds per hour and varying fuels from minute to minute. We have cases where we are burning 50% wet one time and suddenly the planing mill sends over shavings that stratifies in the bin.