

## STEAM BOILERS -- IN LANGUAGE YOU CAN UNDERSTAND

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Nearly all of us use steam to heat our dry kilns. While we are involved with steam every day, how often do we stand back and ask ourselves just what is the steam doing for us. More important, what can we do to get more out of steam and how to do it with less fuel?

In years past, fuel was cheap, so it really wasn't noticeable if we wasted a little here and there. But today, we might easily save our companies tens of thousands of dollars by running our kilns with tighter operating procedures. Steam is a difficult subject to understand completely, especially if you weren't schooled to be a steam engineer. I've tried to sit down and work out an oversimplified approach which will help you get down to the basics.

Let's start with a chunk of ice at 0°F., weighing one pound (Figure 1), and continuously add heat to it until we have transformed it completely into steam. One thing we have to know about, first, is a unit of heat called the BTU (British Thermal Unit). A BTU is not used for measuring temperature, but for measuring a quantity of heat; and adding BTU's to a substance raises its temperature. One BTU will raise one pound of water one degree Fahrenheit. So as you can see from this graph, as we add 32 BTU's to the pound of ice, we raise its temperature 32 degrees. But the ice still hasn't melted. We now have to add 144 BTU's to melt the pound of ice completely. This is called the heat of fusion.

The temperature of the water is still 32°. Now 180 BTU's are again added to bring the pound of water to 212°, the boiling point. But no boiling has taken place yet. We continue to add heat and the water begins to boil, but it stays at 212°. After we have added 970 more BTU's, all the water has boiled away into water vapor (steam).

All in all, we have taken a pound of ice at 0°F. and added 1326 BTU's of heat, to get a pound of steam. If we could gather all the steam together that got away from us, it would weigh one pound.

Now, take a look at a similar graph (Figure 2), showing how we would heat fresh water from our water supply, whether it's from a well or city water. If the water starts out at 52°F., we add 160 BTU's to get it to 212°, then add 970 BTU's to completely vaporize a pound of water. (The 970 BTU's are called the heat of vaporization.)

But if we allow the pressure to build up to 15 PSIG (Figure 3), you can see a difference in the heat we add to reach a higher boiling point, caused by the higher pressure. We have to add 38 BTU's more to reach the boiling point of 250°F. And then, at this temperature and pressure, it takes 946 BTU's to boil the pound of water.

It is this 946 BTU's -- the heat of vaporization -- which is so important to us in the kilns; because what happens inside the boiler, happens in reverse in your steam coils.

Pardon this drawing (Figure 4), but maybe it will crudely show what I mean. The flame heats the water, the water boils, the steam flows into the fin pipe coils. At the same time, the steam condenses to water and releases heat to the fin pipe, and the heat is absorbed by the

ONE POUND OF ICE BECOMES ONE POUND OF WATER THEN STEAM

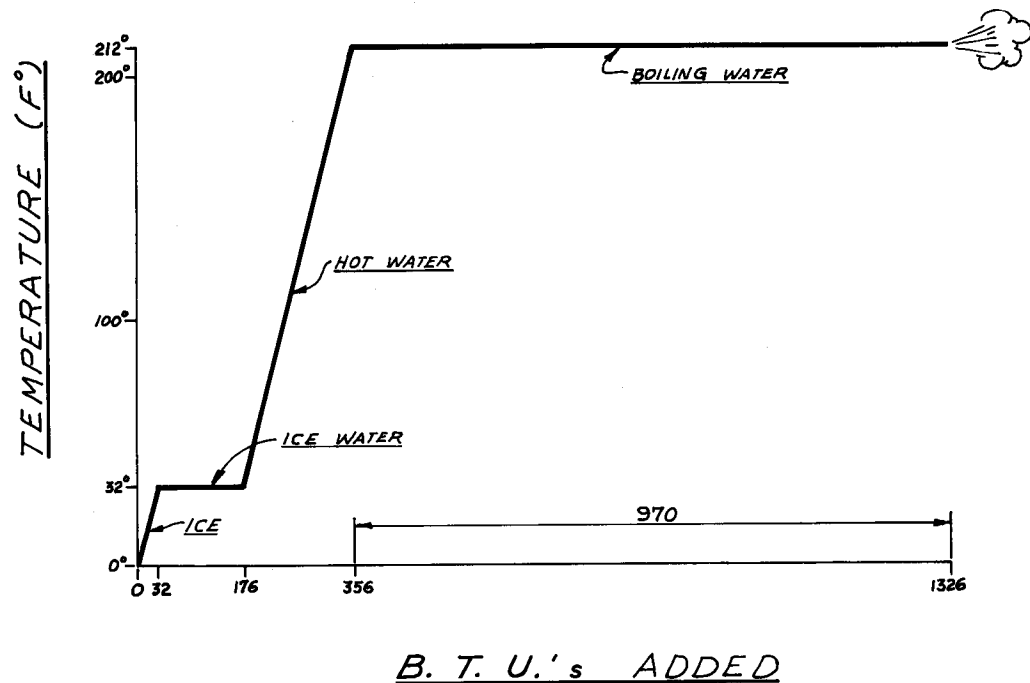
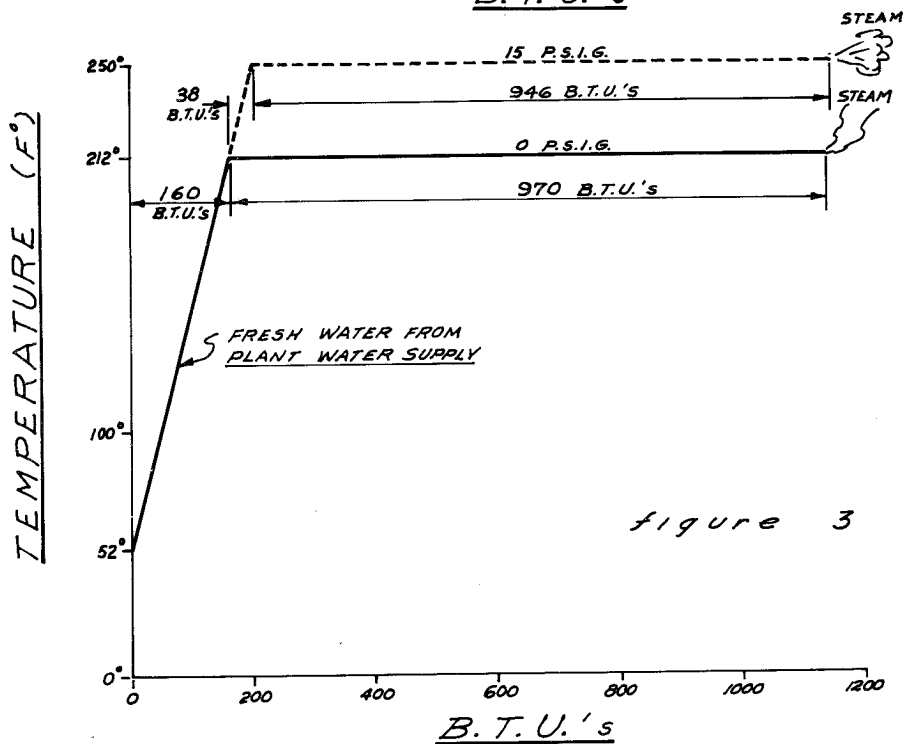
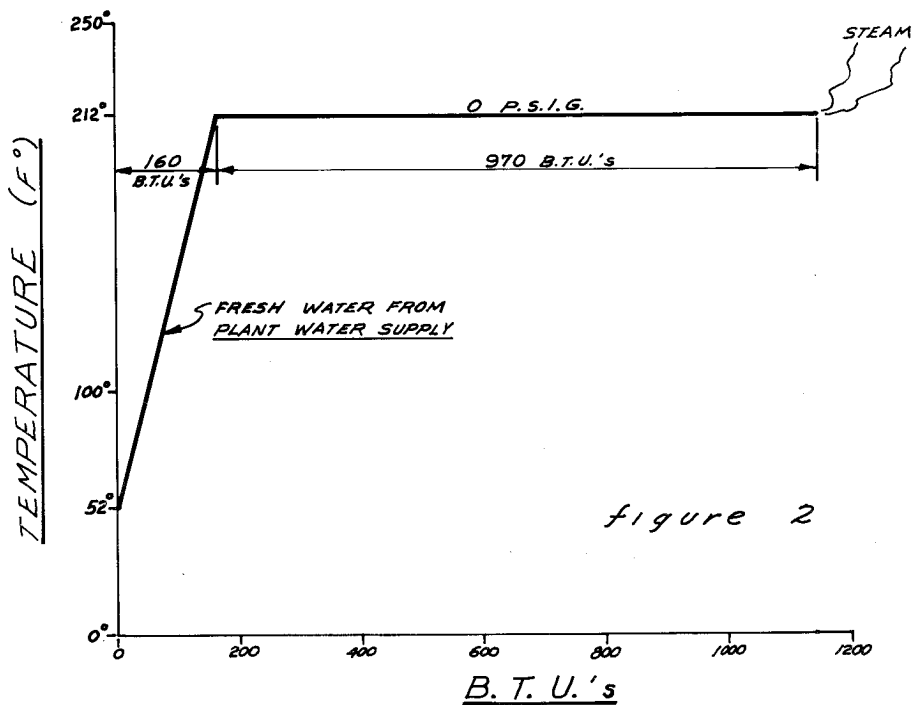


figure 1



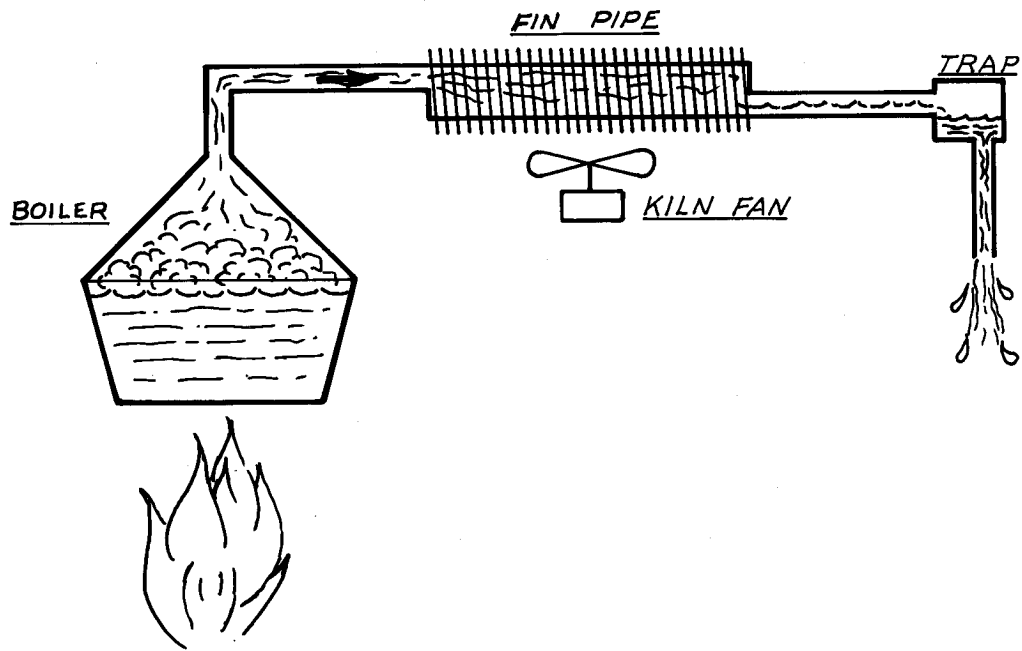


figure 4

air blown over the fin pipe by the kiln fan. If one pound of 15 PSIG steam were in the fin pipe, it would release 946 BTU's and the steam would condense into one pound of water at a temperature of 212°F. and 0 PSIG pressure.

So, rather than let it run out on the ground, we pipe it back to the boiler (Figure 5) at 212° so we don't have to heat fresh water. Turning back to a previous graph (Figure 6), you can see we save a lot of heat by returning condensate at 212°F.; 14%, to be exact, if our fresh water supply happens to be at 52°F. Fourteen percent doesn't sound like very much, but if you have a boiler making steam at a rate of 10,350 lb. per hour, 350 days a year (this is another way of saying 300 boiler horsepower), it would cost you \$34,800 per year extra to heat the city water if you did not return the condensate to the boiler -- figuring oil at 30¢/gallon.

And that's why we use condensate return systems. In other words, we want to 1) recycle all heated condensate possible and 2) we try to heat as little fresh water as possible. However, things we do not do are:

1. Dump condensate in a creek.
2. Ignore steam traps because they are a pain in the neck.
3. Bring a kiln up to temperature with the steam spray.
4. Let kiln roofs and walls and doors leak.
5. Allow steam valves and fittings to leak to atmosphere.

Because for every pound of condensate we lose, we have to reheat one pound of fresh water.

Getting as much condensate back to the boiler as possible is just half the battle. How efficiently can we get it out of the coils is the other half. I'll bet there isn't one person in this room who is having a love affair with a steam trap. Everybody hates steam traps! They're a pain. A good working steam trap, though, can be the heart of your system, if you let it do its work in the right way. However, a malfunctioning steam trap can be the heart of your trouble.

What is a steam trap? It's kind of like the trap in the drain on your kitchen sink. The sewer trap passes water, but keeps sewer gases in the sewer. A steam trap is supposed to pass only water and keep the steam in side your coils. But it wouldn't be surprising if 80% of the traps in our industry were in one of the following five categories:

1. Dirty or plugged shut.
2. Too large and inefficient.
3. Too small and unable to clear the drain lines.
4. Faulty, broken or just "plumb wore out" -- i. e., always open.
5. By-passed -- operator got so damned mad he simply left the blowdown valve open.

How can you tell if a trap is working? If it's cold, it's not working and your coils are waterlogged. If it's hot, it's passing steam or hot water -- sometimes hard to tell which. On our own dry kilns, we put a tee and a valve on the outlet end of the trap. Then you can visually see if the trap is working and how efficiently. (The normal blow-down valve is on the inlet side of the trap; you use the blow-down valve to flush out dirt and empty out waterlogged coils.) But the test valve we use shows if the trap is passing any steam. On a typical inverted bucket trap, water will flow, then stop, then flow again. If any significant steam escapes through the inspection valve, you know you should look into the trap.

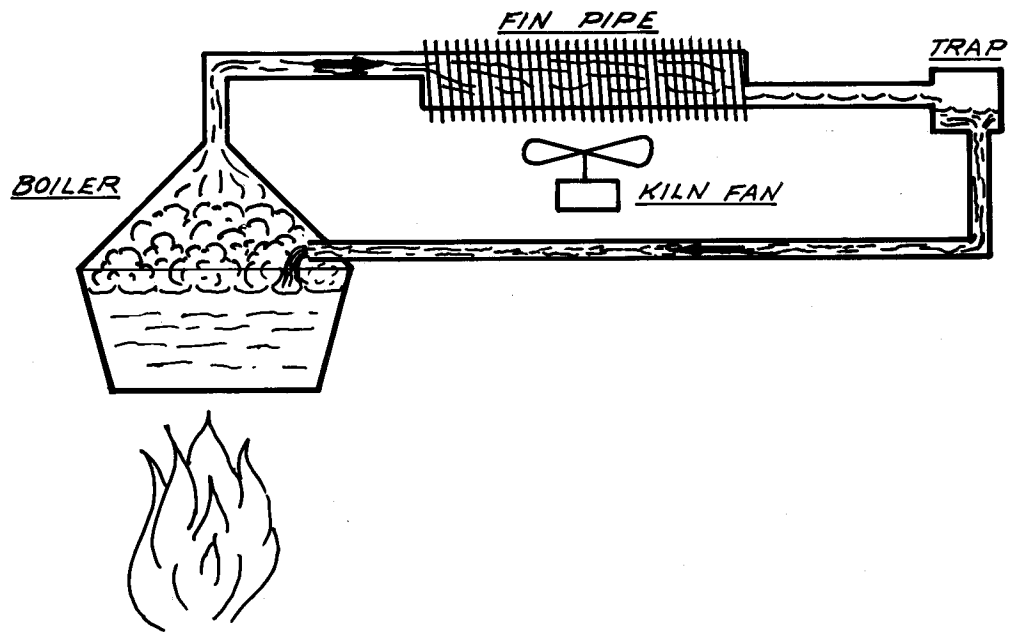


figure 5

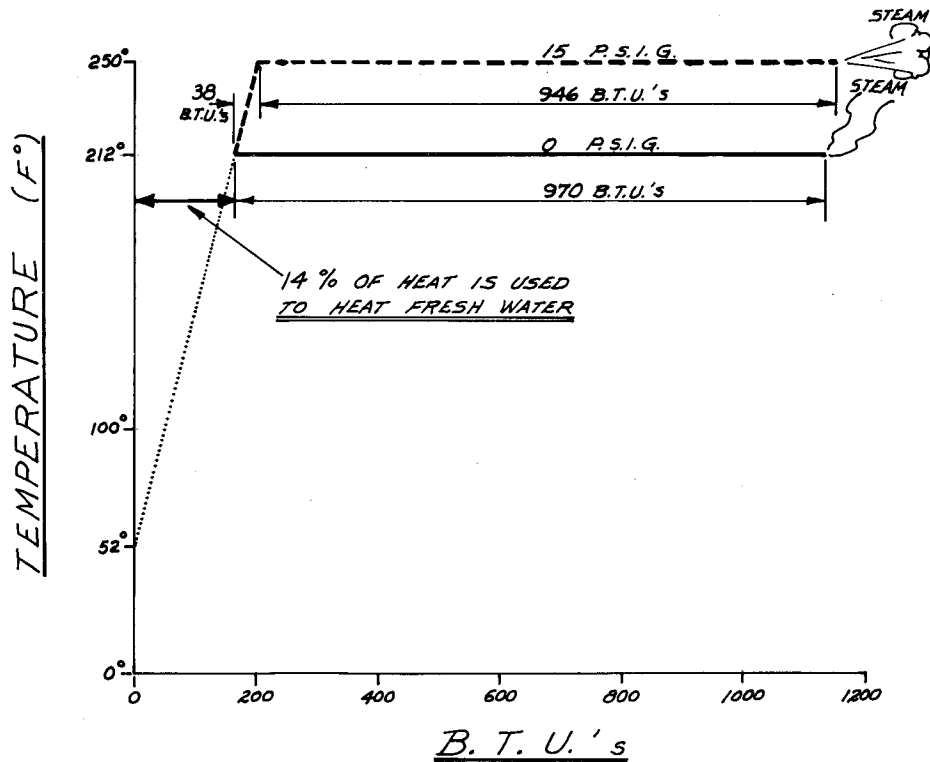


figure 6

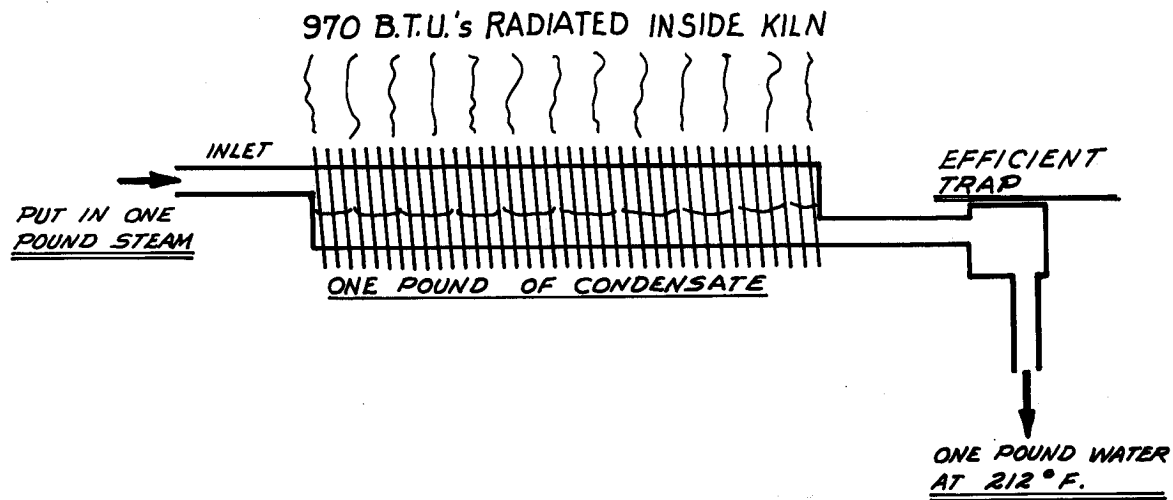


figure 7



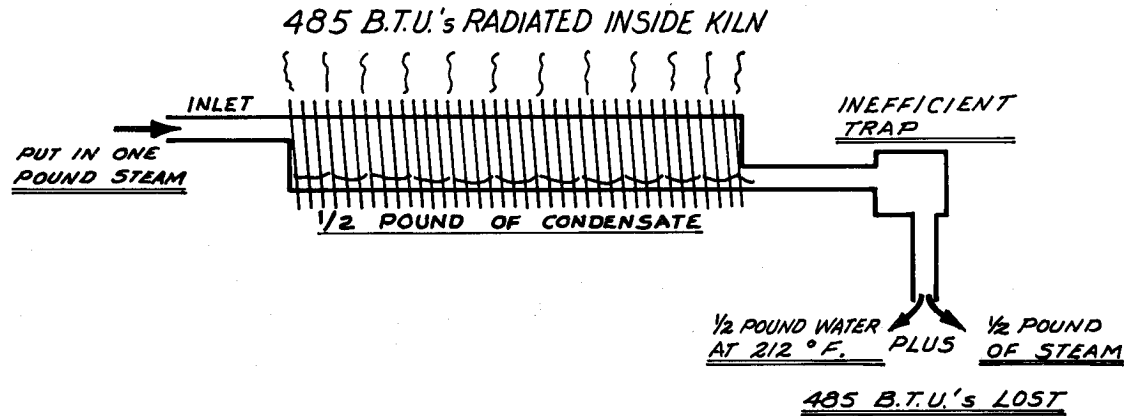


figure 8

STEAM PRESSURE

KILN  
TEMP.

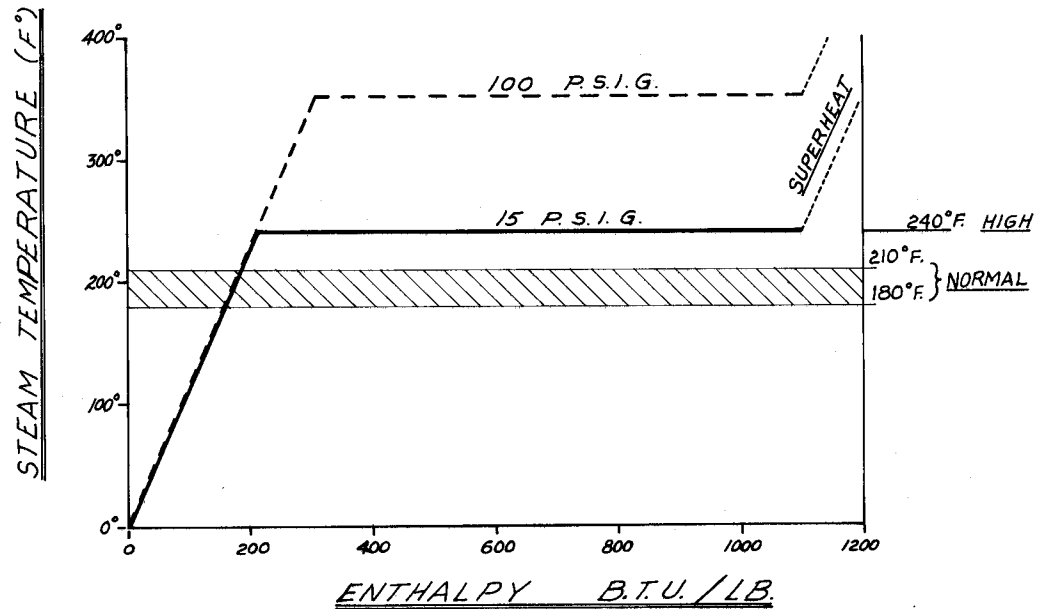


figure 9

Here's why it's important. This diagram (Figure 7) shows one pound of steam being put into a typical fin pipe. The efficient trap on the outlet end lets out only water -- no steam. Therefore, the steam gives up its entire heat of vaporization to the air inside the dry kiln. The water at 212° comes out and is returned to the boiler to be reused.

But look at this fin pipe (Figure 8). We put the same pound of steam in the coil, but the inefficient trap passes not only water, but half the steam, too! So, half the steam's heat of vaporization is lost outside the kiln. Sure, the full pound of condensate might find its way back to the boiler, but the boiler had to generate two pounds of steam for every one used inside the kiln. The other pound of steam was used to heat the town of Snakesnavel, Wyoming, where your kiln happens to be located. Bet your boss would appreciate that!

I may be stepping on some toes here, but there has been a trend towards using a floating disc-type trap, to get away from the inverted bucket trap and all its maintenance. But remember, if you like something, it is either immoral, illegal or fattening. Floating disc traps are of simple design and, as such, usually present few problems. But they are less efficient than an inverted bucket trap. They do pass more steam and if they wear out, they simply pass more and more steam; and all this time you think everything's fine. If your mill is purchasing fuel to fire your boilers, or if your boilers are on the verge of being overloaded, or if your waste fired boiler is competing with outside waste by-product sales, keeping your inverted bucket traps in good repair is a must. If your trap maintenance program is behind, make a concerted effort to get on top of it. After you do, periodic maintenance will keep you ahead of the game.

From all of this, you probably have concluded that steam is a pretty good way of heating a dry kiln, but it can be very inefficient and expensive if not handled wisely and with a good maintenance program.

A final question -- is 15 PSIG steam inferior to, say, 100 PSIG steam? It depends on what you're using it for. As this graph shows (Figure 9), 15 PSIG steam is quite acceptable for all but high temperature kiln schedules. In fact, when using the steam spray for humidification or conditioning your lumber, 15 PSIG steam is superior to high pressure steam because of its lower temperature and higher moisture saturation. So, you can proudly tell people your kilns are low pressure (as you shut the door behind you and go home for the evening -- the fellow across the road with the high pressure plant has to have someone monitor it hourly, around the clock, to keep with in the law).

And, of course, if you have a WELLONS' boiler plant and WELLONS' dry kilns, life will be so beautiful that you'll probably look after your kilns one day a week and go elk hunting the rest of the six days.