And Now, the Bad News

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How much are those losses really costing you?

One of the common complaints leveled at the news media is their seeming obsession with bad news. People complain that the happy stories get squeezed out by accounts of war, natural disasters, crime and other miseries. The good-natured joking by the smiling, affable weather forecaster belies the fact that he is part of the Tornado Team, or some equally scary-sounding organization. Why don't the papers and TV get it?

The point is they do get it. More people will pay attention to bad news than good, so that's why most broadcasts and front pages make it sound like the world is coming apart at the seams.

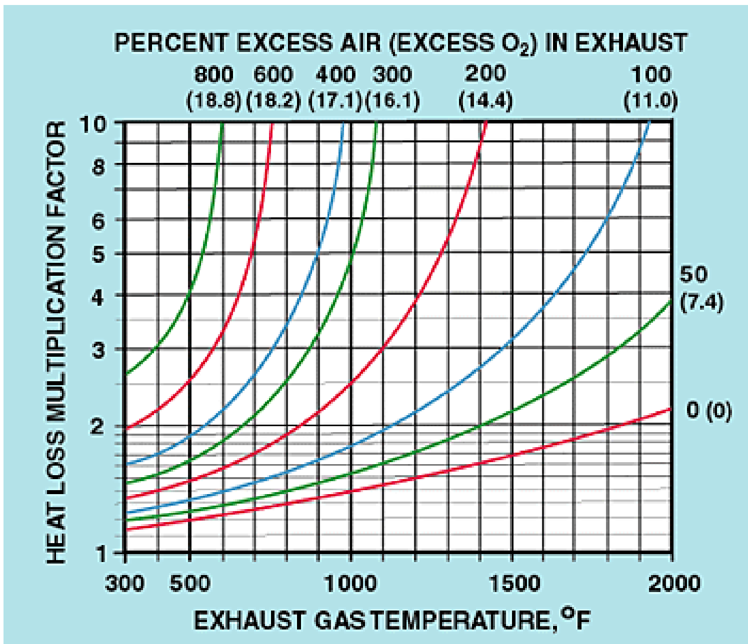

Figure 1. To use this chart, start at the exhaust temperature, read up to the curve representing your oven's air/gas ratio and then to the left to get a heat loss multiplication factor.

Maybe I've been missing the boat. For years, I've talked about the concept of available heat in this column, technical papers and seminars. Available heat is sort of the good news of fuel-fired ovens and furnaces -- it represents that portion of the fuel consumption that heats the load and makes up for heat lost through oven walls, carried out by conveyors or radiated through openings. Its Bad Guy counterpart is exhaust loss, the energy contained in the heated gases that leave the process through the exhaust stack, without ever having done any useful work. Calculating available heat is an essential step in figuring the total fuel consumption of a heating process. It also seems to lull people into ignoring the magnitude of the exhaust losses -- they seem to fade into the background. Problem is, understanding the effect of those exhaust losses is the key to targeting and correcting inefficiencies in the process.

Well, no more Mr. Nice Guy -- now you're going to get it square between the eyes with the evil effect of exhaust losses and the failure to control them.

One way to do it is simply to stand the available heat chart on its head -- show exhaust losses, instead of available heat, as a function of exhaust temperature and excess air. That's fine, but let's take it a little further to see how the exhaust loss multiplies the effect of all the other losses in the process. To do it, you need a chart like figure 1. It's calculated for 1,000 BTU/ft^3 natural gas, but it will be close enough for other gas fuels.

Exhaust gas temperature is displayed across the bottom. Each of the curves represents a different air/gas ratio, including secondary or makeup air, for the heating system. Ratios are expressed as percentages of excess air, with the corresponding percentages of oxygen in parentheses. To use the chart, start at the exhaust temperature, read up to the curve representing your oven's air/gas ratio and then to the left to get a heat loss multiplication factor.

OK, fine -- you have a multiplication factor. What does it mean? To understand that, we have to go back to the losses mentioned above:

- **Wall Loses** -- the heat conducted out through the oven or furnace wall insulation.
- **Conveyor Losses** -- Heat taken from the oven when the product conveyor leaves at a higher temperature than it came in.
- **Radiation Losses** -- heat lost as radiant energy (not hot gases) through doors, conveyor slots or other openings in the enclosure.

If you've ever analyzed the energy flow into and out of process heating equipment, you're probably already aware that wall losses are relatively modest on most well-designed and maintained ovens, and radiation losses often are ignored if the oven temperature is below 1,000^{o}F (538^{o}C). In fact, the relatively low values of these losses may lead you to ignore them when searching for ways to improve process efficiency. But, if you look at them in a different way, maybe they aren't such small potatoes after all.

For example, suppose you have an old oven operating at 500^{o}F (260^{o}C). You're considering upgrading the insulation to more modern standards. Studies have shown it can cut the wall loss from 120 to 90 BTU/hr-ft^2. Total skin area of the oven is 4,000 ft^2, so the projected energy saving is

4,000 x (120 - 90) = 120,000 BTU/hr

You run payback calculations and find the savings won't justify the investment. Project shelved.

Now let's look at the Bad News scenario. You find the exhaust gas temperature is 550^{o}F (288^{o}C). Oxygen analysis shows an O2 content of 18.2 percent, or about 600 percent excess air. From the chart, you find a multiplier of 2.8. This means for each BTU of wall, conveyor or radiation loss, you must consume nearly three times that amount of energy to offset it -- 1 BTU for direct replacement of the loss and 1.8 more that go directly out the stack. In other words, the wall loss is really costing you

2.8 x 120,000 = 336,000 BTU/hr

Puts things in a whole different light, doesn't it? Maybe it's time to dust off those payback calculations and take another run at it.

One other thing to consider: By reducing the losses, you have freed up 120,000 BTU/hr that might be useful for increasing product throughput. If your burner system is maxed out, this might give you the extra productivity you need.

See? Sometimes bad news isn't all that bad.