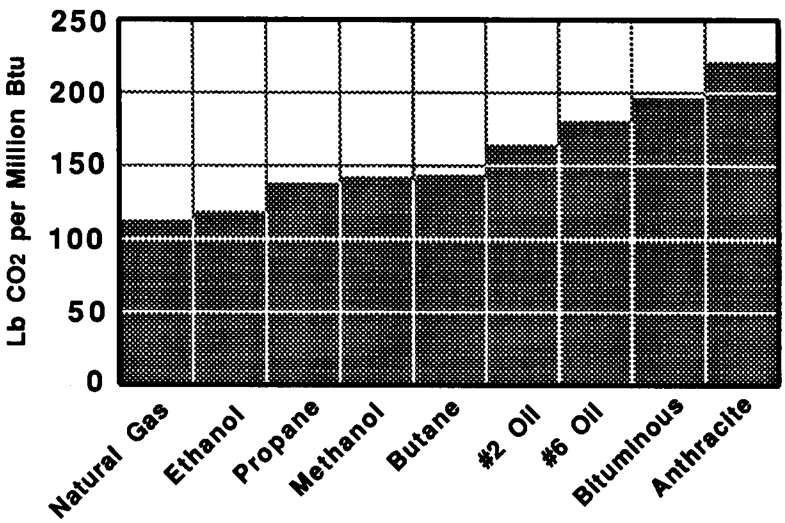
Janus Technology Group's

Foresight & Hindsight No. 2

Janus Tech Fact - How much CO_2 am I producing?



Although a couple of cool years have relegated it to the back pages, the global warming debate continues to rage. Whether or not we believe it's real, there's no disputing that the CO_2 content of the atmosphere is increasing, and many experts are urging governments to act to reduce atmospheric CO_2 emissions. This action could take the form of compulsory fuel changes or financial penalties such as a carbon tax.

Most people have no concept of the amount of CO_2 produced by fuel-burning operations, so we've prepared this chart, which shows the number of pounds of CO_2 generated per million Btu of heat from various fuels. As you might expect, natural gas has the lowest CO_2 production; what may come as a surprise is the amount of difference between the various fuels.

This graph was based on the gross heating values of typical examples of each generic type of fuel -- the numbers will vary slightly if their chemical makeup changes, but usually not enough to change their rankings. Pounds of CO_2 per million Btu of **net** heating value is higher --- as much as 15.5% for methanol and as little as 2% for anthracite, so the spread between the fuels decreases, but their relative ranking is almost the same. Only butane and methanol exchange places, and their values are nearly identical.

Lose the Flue Blues

"I was thinking of closing off the flues so we could hold the heat in."

That statement was made by a forge shop superintendent several years ago, and he was serious.

Although it's an extreme example, it points out one area of combustion technology that seems to give a lot of people trouble --- the exhaust systems of ovens, boilers and furnaces. When the discussion turns to stacks, draft and furnace pressure, brows furrow and opinions come out as inaudible mumbles. And if you really want to get someone to leave the room, ask him how to size a flue system.

Well, fools rush in .....

We're going to take a crack at making the subject a little less mysterious. Beginning on page 2 of this issue,we'll discuss the phenomenon of furnace draft and pressure and how stacks and flues operate. By the way, we'll be using the terms flue gases, combustion gases and furnace gases throughout these discussions --- they're all the same thing, but just at different times in the process.

Foresight & Hindsight is published by Janus Technology Group Inc. to share information and discuss issues of interest to the industrial heating and energy technology fields. Please accept it with our compliments. If you have any suggestions for improvement or ideas for future topics, please write us.

Dick Bennett

Taking the Mystery Out of Flue Systems - Part 1

Combustion Gases Aren't Heat — They Just Carry It.
Go back to our shop superintendent on page 1. By trapping the combustion gases in the furnace, he thought he'd trap the heat as well. Although he might have succeeded in slowing down the furnace's heat losses for a few minutes, the furnace temperature would soon begin dropping.

He lost sight of the fact that if you don't let the gases out of the furnace, you can't put any more in, and it's these gases that carry in the heat. This leads us to

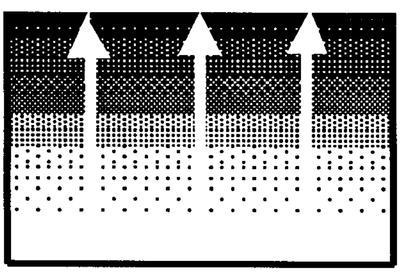
Rule #1: To heat a furnace, there must be a continuous flow of combustion gases through it.

Heat Rises – or More Correctly, Hot Gases Rise. When I was a little kid, my father would carry me around on his shoulders, and that's when I made the first observation that eventually led to this article --- it was warmer up close to the ceiling. "Heat rises," my Dad explained.

To be correct, hot gases rise, because they are less dense and more buoyant. This is what makes hot air balloons fly, produces thermals for sailplane pilots to ride and leads to something combustion engineers call "thermal head".

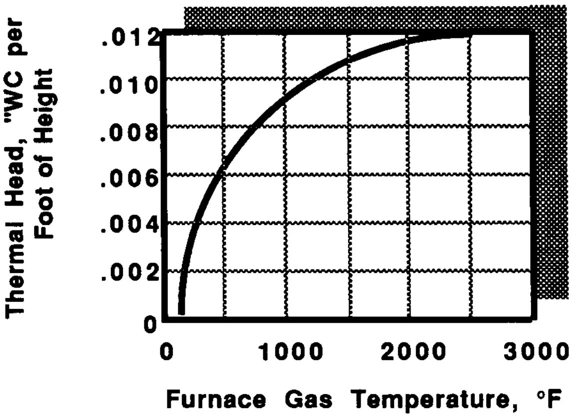
As long as those gases are allowed to rise without interference, they will, but if they're closed up in a container like a furnace or oven, they'll pile up against the roof, trying to get out. Because they are trying to pull away from the floor and push off the roof, their pressure is higher at roof level than at the floor.

Higher Pressure



Lower Pressure

This difference in pressure is called <u>thermal head</u>, and its strength increases with the temperature of the gases and the distance from the floor to the roof.



The graph above lets you calculate thermal head. Estimate the average temperature of the gases in the furnace. (As a rule, they're slightly hotter than the indicated furnace temperature --- maybe by 50 to 100°F.) On the graph, read up from that temperature to the curve and then left to the thermal head. Multiply that number by the inside height of the chamber containing the hot gases, and you'll have the difference in pressure between the floor and roof of the chamber.

For example, let's say you have a furnace eight feet high, containing gases at 2000°F. From the graph, thermal head for 2000° gases is about 0.0115 inches water column per foot of furnace height. Multiply that number by the height (8 feet), and you get a total pressure difference of

$$0.0115 \times 8 = 0.092 \text{ inches WC.}$$

This differential pressure is what leads to stack draft, cold air leakage into furnaces and a host of other things that take place in a furnace, but we'll leave that discussion for another time. For now, just remember ---

Rule #2: Hot gas buoyancy causes higher pressure at the roof of a furnace than at the floor. This is called Thermal Head.

Foresight & Hindsight is published by Janus Technology Group Inc., P. O. Box 2872, Rockford, IL 61132-2872, Phone 815-282-8044, FAX 815-282-8043, e-mail 104635.1603@compuserve.com.
It is distributed free of charge to selected organizations and individuals.