Janus Technology Group's
Foresight & Hindsight No. 4

Think of It as Water

Many people have trouble visualizing the concepts of heat and temperature and their relationships with each other and with their surroundings. This is where analogies often come in handy. In this case, an unlikely substitute, water, can help explain how heat and temperature behave.

Water flows downhill. So does heat — from high temperature to low temperature. If we want to create elevated temperatures (that is the point, isn't it?), we have to concentrate heat in a limited space -- the oven or furnace.

Think of ovens and furnaces as water buckets. We have to fill them to a certain level (temperature) with water (heat). From time to time, someone ladles out a drink of water (heat into the product). Despite our efforts to plug it (insulation), there's also a hole in the bottom of the bucket, letting a steady stream of water dribble out (heat losses). These both tend to lower the water level, or temperature, so we stay busy adding water or heat.

If the people with the ladles arrive at regular intervals, we can maintain the water level with regular additions, but if their visits are erratic, we have to adjust our additions to compensate. This is exactly what temperature control systems do — keep the operating temperature steady by adjusting the heat input to replace what has gone out.

There are two ways to add water -- pour in a cup every so often and wait until the level drops slightly before adding more, or use a hose, letting a steady stream trickle into the bucket. If the folks with the ladles begin showing up more often, we just crack the

valve on the hose a little wider. The cupful-every-so-often method is akin to on-off or high-low temperature control. As a tradeoff for not tending the water level or temperature every second, we accept that it will fluctuate above and below the ideal level. Proportional control, on the other hand, works like the hose, constantly making little adjustments to the input to keep the water (or temperature) level as close to the setpoint as possible.

Response time also affects how well we can maintain the water level or temperature. If the folks with the ladles start arriving faster than we can pour cupfuls of water into the bucket or adjust the valve, the level will drop. In process heating, this happens when a sudden increase in throughput or heat losses outstrips the control system's speed of response (short term temperature falloff) or the heating system's input capacity (long term temperature falloff). Conversely, if our refilling cup or hose is too large, we may have trouble avoiding overfilling or temperature overshoot.

If you've always wrestled with heat and temperature, we hope this helps.

Taking the Mystery Out of Flue Systems - Part 3

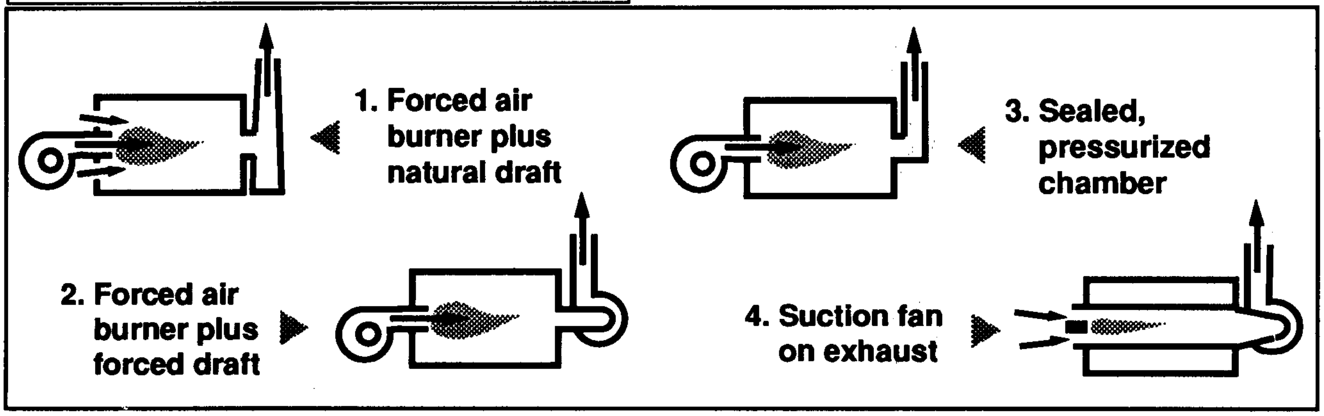
Gimme more air!

In Part 2, we looked at natural draft fireplaces and furnaces. These depend on combustion gases rising out the stack to create a negative pressure, or "draft", which pulls in more air for combustion. This is an inexpensive way to get air (once you've paid for that tall chimney), but draft is limited to the differential pressure the stack can develop, and, as a result, the amount of combustion air that can be drawn into the furnace. Thus, we bump into

> **Rule #5: The firing capacity of a naturaldraft furnace is limited by the draft that can be developed. This draft does not create strong differential pressures, even with high stacks.**

tive, so combustion gases can't leak out to the surrounding area.

Actually, there are four types of forced air systems. One, more common in years past, retains features of the old natural draft systems. The combustion chamber has openings to admit secondary air, either as part of the combustion air or to blend the combustion gases to lower temperatures. Draft is still needed to keep the secondary air moving through the oven or furnace. The second type also uses a divided air supply, but depends on an exhaust fan to draw secondary air into the chamber. Most modern ovens are built this way. The third type, totally sealed systems, have only one entrance point for air — the burners. The combustion chamber is built tightly enough that it can carry a slight positive pressure. This pressure pushes the combustion gases out through the flue system.



Further improvements required a fresh idea -- **forced air combustion.** By using a fan to push or pull air through the burner system, we can develop higher differential pressures and push higher air flows and more heat through the combustion chamber in a given period of time. That permits higher production capacities without installing additional or larger equipment. An alternative approach, common on immersion and radiant tubes and many older ovens, is to put an exhaust fan or draft inducer in the stack and **pull** the air through the burner. This provides the same benefits — higher firing capacity, closer control over fuel-air ratios and the ability to go quickly to full fire. It has one other feature — the combustion chamber or tube pressure is nega-

The last type is a variation on the third --a fan on the exhaust which performs double duty, pulling air into the burner and pushing exhaust out the stack. The last three types are almost completely insensitive to the conditions affecting draft, so firing rates, fuel-air ratios and combustion chamber pressures don't fluctuate much as atmospheric conditions change. In addition, stack heights are not dictated by draft considerations.

> **Rule#6: Forced draft systems permit higher firing capacity, closer control over fuel-air ratios and can go quickly to full fire.**

Next time: Combustion Chamber Pressures

Abridged portions of this article have appeared in *Process Heating* *magazine.*

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: janustech@compuserve.com. It is distributed free of charge to selected organizations and individuals.