HOT SEAT

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Heat treating—no matter the process—is an energy hog where three energy sources or utilities directly find application: natural gas, electricity and fuel oil.

A CONUNDRUM EXISTS in that natural gas, coal, and fissionable metals are used to make electricity and, in some shape or form, electricity is used to produce natural gas, coal, and crude oil. Fracking shale requires motor driven pumps to drive mud into the ground a push natural gas and crude back to the surface.

So, will the "Green Initiative" influence the future of generating electricity for heat treating? Not much. Solar and wind derived electricity operate on the extreme fringes of the process. Solar can only be applicable where the sun shines at least 55% of the day, and there's no way to store solar power. Near continuous wind energy is also localized mostly in offshore regions. Again, like solar energy, it cannot be stored when wind velocities slow.

The only way the green revolution will impact heat treating is by improving the efficiency of existing fossil derived energy.

Believe it or not, while it was once produced by fossil fuels, electricity can be the most efficient utility in heat treating. However, it's not the cheapest. Resistance heating such as that in your home toaster is the purest form where the electricity after it enters the building is not altered or modulated in any way. Why? Because all other forms of electricity where induction in heat treating is most prevalent create losses at each change in frequency or voltage, up or down. The higher the voltage can be used, the greater the effectiveness such as it is in Europe and Asia where the primary voltage for the home is 220.

A classic example of lost efficiency in heat treating is the power applied to vacuum furnace heating elements exposed to the reduced pressure. As the pressure in vacuum furnaces is reduced, the potential for arcing increases. Therefore, the exposed heating elements must be specially isolated from ground. When carburizing at reduced pressures, voltages must be reduced to or near 24 volts (alternating current) or vac 60 Hz. So, if the power supply of a vacuum furnace requires 300 kW, the voltage must be reduced or transformed down from 480 vac where it enters the building to 24 volts. To provide 300 kW at a reduced voltage, the current or amperage must then increase significantly necessitating large cables in many circumstances water cooled to reduce in some cases heat buildup further reducing the final efficiency.

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Transforming devices have many names. Variable reactance transformer or VRT is one such system. Comprised of three water-cooled transformers, they reduce the incoming three-phase 480 vac to 24 vac or three single-phase systems. The core of each "can" is "excited" by a signal from the temperature controller modulating a four to 20 milliamp or zero to 10 volt signal driving a silicon controlled rectifier (SCR) further modulating a 120 vac signal inducing the transfer via inductive energy to a series of copper wound steel cores. This sounds complicated, and it consumes a lot of energy by things known as inductive reactance and impedance. Despite how the vacuum furnace heating element isolation design has over the decades has improved, the negative efficiency issues still prevail.

Another method of employing electric heating and retaining the primary untransformed plant 480 voltage is to insert rod-over-bend elements into a radiant tube. This concept separates the vacuum or any atmosphere from the heating element, thereby eliminating the need for short circuit-prone insulators. The element inside of the tube is exposed only to air or, in some cases, nitrogen.

AFC-Holcroft employs this type of element in batch and continuous furnaces. Vacuum furnaces can benefit from this assembly by using either heat resisting alloys or reaction bonded silicon carbide radiant tubes. If used in vacuum applications, the cold end of the tube must be designed with an elastomer seal.

By employing this indirect heating system, no power transformation is applied, creating the most effective application of electricity. Efficient electric usage is one that operates at or near a unity power factor (PF) of 0.9 or greater. As presented above any manipulation of the in-plant power and the methodology used to modulate it will lower the usable power vs. the apparent (actual) power.

Power controllers that interrupt the sinusoidal or sine-wave of the incoming ac power in an on/off or time-proportioning on/off PID loop and does not alter the current to voltage lead/lag relationship is the most efficient method of electrical heating control.

ABOUT THE AUTHOR: Hot Seat columnist Jack Titus has an additional column in *Thermal Processing for Gear Solutions* in which he discusses scheduled maintenance of furnaces, distortion control, and low-pressure carburizing. Jack Titus can be reached at (248) 668-4040 or jtitus@afc-holcroft.com. More information can be found online at www.afc-holcroft.com or www.ald-holcroft.com.