HOTSEAT

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Gas and electricity are both viable energy sources for heating furnaces, but there are ecomomic and energetic reasons to pick one over the other.

DO YOU HAVE GAS? EVERY YEAR WE ENCOUNTER at least one OEM or new heat treater looking at heat treating in-house, and we ask them that question when it comes to heating their furnaces.

Except for some regional exceptions, natural gas is the preferred choice in the U.S., primarily because it's less expensive than electricity per unit of energy. In Europe, natural gas is also more economical, but there are locations where the natural gas infrastructure is insufficient, so electric heating is the only real option. China and Russia have the same issues.

To manufacture everything that doesn't grow from Mother Earth requires energy at some time during its evolution. And the tools (and the tools we use to make those tools) that manufacture everything will use gears at some point; gears from gigantic mining machines to chainsaws are heat treated in some form.

Here is the breakdown for the electricity sources of furnaces, per the U.S. Energy Information Administration (August 2012): 37% coal; 32% natural gas; 17% nuclear; 6% hydroelectric; 2% wind. These total 94% — the remaining 6% are renewable sources, including solar (0.11%) and wood (0.81%). Various organic sources such as biomass and other obscure renewables make up the rest.

Electricity to drive motors, valves, switches, and the like doesn't generally consume huge quantities of power unless the motors become very large. Demand for electric energy skyrockets when used to generate heat. However, heating by electricity does have one thing going for it: Efficiency. Resistance-heating elements, for example, turn electricity directly into heat, as does the combustion or oxidation of fossil fuels. Electric energy gets very expensive as 1) efficiency decreases and 2) it is transformed via induced power to or from different voltages.

So what's the cost? Consider two items at opposite ends of the energy consumption spectrum: The everyday household toaster and a 3,000-pound batch-carburizing furnace. To operate the toaster with energy generated by a coal-fired grid in Ohio or Michigan would cost about $0.07 per hour. So if your toaster runs for two minutes it will cost you $0.002. The toaster requires probably 850 watts/hour [0.85 kWh].

A 3,000-pound capacity furnace heated to 1750°F [954°C] requires 144 kW for 90 minutes and will cost $15.12. If you're a renewable energy advocate living in the middle of an Arizona desert with a several thousand-panel solar array, running your toaster for two minutes with solar power will cost $0.42. If you live in the Great Lakes region, forget solar; you need at least five hours of direct sunlight all day, every day of the year. Needless to say, industrial applications for solar power are few and far between. Wind-produced electricity is a more viable option for industry when the wind is blowing (which is not a guarantee, so supplemental traditional power plants will still be required). Although wind turbines are more economical and practical than solar for industrial applications, they still present reliability issues.

Heating the 3,000-pound carburizing furnace with natural gas is not as efficient as electricity, because a portion of the combustion products and the associated heat must be released in order to keep only the hottest portion of combustion products within the furnace.

The carburizing furnace uses gas-fired radiant tubes in which burners, ignited by a special spark plug push a 10-to-1 air-to-gas mixture through the "U" shaped tube. The burner's air/gas velocity is designed to create a flame front long enough to travel down the length of the firing leg and allow only the products of combustion [flue gas] to return back up the exhaust leg and out of the hot zone. This assures that the hottest portion of combustion products remain within the return leg of the tube. By comparison, your home furnace, if built in the last 15 years, is designed to keep 85 to 90% of the heat produced within the combustion chamber. A carburizing furnace with 65% efficiency exhausts 35% of the 1,200,000 BTU's from the radiant tube. Even so, the cost of residential natural gas in Ohio and Michigan is approximately $4.20 per 1000 cu. ft. or 1,000,000 BTU. The industrial rate price is likely $2.50 to $3.50 depending on the monthly consumption. By comparison, when heated by electricity for $15.12, the 3,000-pound carburizing furnace operating for 1.5 hours heated with natural gas at $0.35 per therm [100,000 BTU] will cost $4.20, without any efficiency improvement. This is the reason natural gas is the preferred option: It is less than 1/3 of the traditionally produced electrical cost.

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