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Peak Shaving: What Impact Does It Have On The Heat Treater?

Heat treating requires energy and lots of it. We have all heard that the cost of natural gas is going up this winter, possibly to record levels. Availability is always questionable. What we haven't heard that much about is the type of gas being delivered to our doorstep. As heat treaters, we have learned to respect and perhaps dread the words "peak shaving." Once only an occasional concern, it is becoming a fact of life, one that we must deal with on almost a daily basis. It can play havoc with our generated atmospheres, change the way in which our heating systems perform and worst of all adds variability to our heat treating processes. This means we must look carefully at our process control devices to assure that we have the correct ones and that they are operating properly. Let's learn more.

In a perfect world...

Demand for clean-burning natural gas is growing around the world. And in North America, the gas-energy marketplace now offers an array of competitive choices–and risks–from wellhead to burner tip.

Natural gas is a clean-burning, highly efficient fuel used in many heat treating furnaces as a source of heating and in gas generators to create a furnace atmosphere most typically endothermic or exothermic gas. Natural gas is typically 90-95% methane, depending on location. The issues and problems associated with controlling equipment being heated with or generating atmospheres from natural gas are well understood. Manual or automatic dew point analyzers, infrared controllers (single- and three-gas analyzers), and oxygen probes are common control devices.

In the new gas-energy marketplace, there is a reliance on propane peak shaving and standby systems to provide supply security and flexibility for most gas utilities and consumers. Our challenge as heat treaters is to manage this change.

Peak shaving explained

Peak shaving involves the use of fuels and equipment to generate additional gas to supplement the normal supply of pipeline gas during periods of extremely high demand. Dilution of the incoming natural gas supply is usually done with another hydrocarbon gas (typically aerated propane) to achieve a heat content (Btu value) close to that of natural gas. The objective of peak shaving (from the supplier's point of view) is to save natural gas and to ensure that a constant fuel supply is available. The challenge for the heat treater is to detect and control the variability induced by a change to the gas supply.

Aerated propane

Propane is one of several liquified petroleum gases derived during both natural gas production and crude oil refining. The gas we call propane actually consists of a mixture of different gases, which depending on source, will vary in composition, typically between these limits: propane (87.5-100%); ethane (0-7%); propylene (0-5%) and butanes such as n-butane and iso-butane (0-2.5%). An odorant, ethyl mercaptan (0-50 ppm) is often added. In the case of propane, the percentage of heavy hydrocarbons is a significant concern since they tend to form soot and tar.

Commercial propane, under the trade names LPG, LP-gas and HD-5 Propane, is widely used as peak shaving fuel. Stored as a liquid, a gallon of propane contains the energy equivalent of over 90 ft^3 of natural gas. Eleven gallons of propane have about the same energy as 1-million ft^3 (Mcf) of natural gas, or about 1 million million Btu (MMBtu). Therefore, the use of "propane-air" for direct replacement of natural gas makes sense.

Propane-air is a highly versatile and scalable commodity. The argument for its use is that it offsets costly ongoing

LDC (local distribution company)
- LDCs operate natural gas-distribution systems linking consumers and pipelines.
- LDCs may also provide gas storage and peaking services.

LNG (liquified natural gas)
- Methane becomes a liquid for storage or transport when cooled to about -260°F (-160°C) in insulated tank cars, trucks and ships.

LPG (liquified petroleum gas)
- LPG, or LP, gas refers to several liquids, including propane and butane.

NG (natural gas)
- NG is a mixture of methane and various other hydrocarbons and inert gases.

NGL (natural gas liquids)
- NGLs are hydrocarbon components of natural gas other than methane, including ethane, propane and butane.

demand charges with a fixed asset supply. The reality is that it offers a way to expand system capacity without adding the costs associated with off-site development, extension of gas mains, and adding more pipelines. The anticipated benefit to customers is lower cost gas energy.

Most peak shaving systems operate as follows: liquid is drawn from the tank(s) and the pressure raised via motor-driven pumps. The liquid is heated in the vaporizer and converted to a superheated vapor. A gallon of liquid propane will produce about 36 standard ft^3 (scf) of vapor. The energy content of 1 scf of propane vapor is about 2,520 Btu with a specific gravity of 1.52. Propane vapor is mixed or blended with air, producing a propane-air mix. Propane-air mixtures can vary in their heat content (Table 1). For example, a propane-air mixture containing 1,383 Btu/ft^3 has burning characteristics similar to natural gas containing 1,000 Btu/ft^3 with a specific gravity of 0.60. The mix is then injected into the natural-gas distribution system.

The volume of propane-air is normally limited to less than about 50% of the combined natural gas/propane-air stream, keeping the specific gravity of the combined stream at less than 1.00 (air = 1.00). A common mixture is 45-55% propane-air mix in natural gas with 95% methane.

Control issues

As energy prices spiral to new heights, and supply interruptions become a more frequent occurrence, the use of energy and active management of energy demand are more important than ever since electric and gas utilities are under constant pressure to reduce peak demand, and today this affects all industrial customers, large and small. The frustration for the heat treater is that often we are not given the choice of accepting or controlling when these alternative energy sources are provided to us. Peak shaving is one such instance.

One of the ways in which we must adapt is to understand the importance of the analysis of the incoming supply fuel. The use of specific gravity analyzers and gas chemistry analysis using gas chromatography or other gas analysis techniques is mandatory.

Propane-air additions to natural gas can play havoc with generator ratios, and unsaturated hydrocarbons, such as ethylene and propylene, break down quickly into oily soot and coke, which can be carried along with the gas stream into the furnace. It is essential, therefore, that the gas supply be kept under close observation, and that all critical components of the system be inspected and cleaned on a regularly scheduled basis. It is always advisable to inform your gas/utility supplier of your special needs or concerns, whether they can act on them or not.

What control devices are necessary?

Oxygen probe control has been shown to minimize the effect of peak shaving. However, the use of oxygen probes on furnaces and generators has been so successful that routine dew point or infrared analysis has become less and less frequent and in some cases, abandoned altogether. This means that we are only seeing a portion of what we need for complete process control. Rapid response, on-line multigas analyzers are now available, and when used in conjunction with temperature and pressure monitoring, can provide real-time understanding of the furnace atmosphere. When set up with the proper feedback loops, this allows for complete process control, reduced variability and improved product quality.

Where do we go from here?

The secret to detecting and controlling the effects of peak shaving on the end product quality after heat treatment begins and ends with the constant monitoring of the changes that are taking place; in the incoming gas stream, in the generated atmosphere and in the heating system performance. Benchmarking results obtained with the data gathered from multiple devices is the best way to keep in control. Peak shaving is here to stay, and to combat its negative effects, the heat treater will need to spend both time and money on effective process control devices. It is well worth the investment. **IH**

Table 1 Typical Propane-Air Data(a)

Btu/ft^3 of propane air mixture	Vol % propane	Vol% air	Vol% oxygen	Specific gravity of propane-air mixture
1450	57.54	42.46	8.874	1.299
1440	57.14	42.86	8.957	1.297
1430	56.75	43.25	9.040	1.295
1420	56.35	43.65	9.123	1.293
1410	55.95	44.05	9.206	1.291
1400	55.56	44.44	9.289	1.289
1390	55.16	44.84	9.372	1.287
1380	54.76	45.24	9.455	1.285
1370	54.37	45.63	9.538	1.283
1360	53.97	46.03	9.621	1.281
1350	53.57	46.43	9.704	1.279
1340	53.17	46.83	9.787	1.277
1330	52.78	47.22	9.869	1.274
1320	52.38	47.62	9.952	1.272
1310	51.98	48.02	10.035	1.270
1300	51.59	48.41	10.118	1.268
1290	51.19	48.81	10.201	1.266
1280	50.79	49.21	10.284	1.264
1270	50.40	49.60	10.367	1.262
1260	50.00	50.00	10.450	1.260
1250	49.60	50.40	10.533	1.258

(a)Source: Ruffcon, S. D., Hoch, J.P., Energy Gases Data Extensions (1994), Standby Systems Inc.

Sources

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Daniel H. Herring is president of The Herring Group Inc. Elmhurst, Ill., a business specializing in practical solutions to problems facing the heat treating and sintering industries (www.heat-treat-doctor.com)

Dan Herring has spent more than 25 years working for furnace equipment manufacturers in a variety of roles, including senior management and new business development. Now an independent entrepreneur, Dan lectures, write, teaches and consults. A frequent speaker at local, national and international conferences, he is dedicated to advancing the state-of-the-art in thermal processing. He has published more than 100 technical papers, written three books, and contributes not only to Industrial Heating, but also to other industry publications.

Dan's credentials include his appointment as a research associate professor at the Thermal Processing Technology Center, Illinois Institute of Technology, Chicago. He also is active on several HTS Committees.