ENGINEERED SYSTEMS FOR FORGING OPERATIONS

AN INSIDE LOOK INTO SECO/WARWICK'S STRUCTURE AND GLOBAL OPERATIONS WILL ALLOW YOU TO LEARN MORE ABOUT FORGING PROCESSES AND TECHNIQUES.

By Paul Huber

Forging is a diverse industry, and Seco has a number of different furnaces, atmosphere generating systems, and quenching systems to accommodate its many needs; not only in producing the forging product itself, but in the manufacture of dies to accomplish the forging process.

Our operating philosophy is built on teamwork, and we are divided into four global teams, with various companies participating in these teams. One, Aluminum Process and Melt, takes industrial furnace products primarily to the aluminum industry. This includes molten metal furnaces as well as those for processes involving treating aluminum in its solid form, including billet heating for forging. The second is our Vacuum Team. Our definition of vacuum is anything that is under one pressure, so the partial pressure processes such as chemical vapor deposition and vacuum carburizing are covered by this team. Our Thermal Process Product Team is by far the most diverse team—containing somewhere between 30 and 40 different products and processes for industry—and our fourth group is the Braze Team. This team is focused on the braze process and encompasses primarily aluminum brazing, copper brazing, and cupre brazing; a relatively new, low-temperature copper-based brazing process. With the exception of the Braze Team, all have a major role in the forging industry.

Furnace Types

One of the most versatile types of furnaces in industry is the car furnace. This is widely applied in the forging industry as well. The car furnace is so attractive because it can be designed to accommodate almost any physical size or weight of forged products for the processes, such as forging, stress relieving, annealing, normalizing, tempering, and drawing.

The load patterns are very forgiving, and the versatility that you have with the car furnace carries also to the potential heat sources such as oil, natural gas, propane, or electric. Some car furnaces can be designed with a single moving device to move the car in and out. The door is affixed to the car itself, which means you have a very simple operation.

These furnaces are designed to capacity of 1,000 tons or more in temperature ranges going up to 2,400°F. Most furnaces in the forging industry are gas-fired, and a number of

them use fiber linings for the insulation system, which is quite forgiving because it has the ability to change temperatures quickly and not cope with the problems associated with a brick-lined furnace. The main reason for the popularity of the car furnace is that they are simple to build, operate, and maintain. Properly maintained, they will give you years of trouble-free service.

All furnaces need some form of a control system. It's actually the customer who will determine the type and complexity of the controls for his particular furnace. A furnace system with discrete temperature controls for both control as well as over-temperature protection will be the least expensive of these options by far, but with the addition of PLCs, PC combinations can allow you to store recipes and select them for any process you would like to run. The more complex control systems can be adapted with pulse-fired combustion, which allows you to reduce fuel costs from a normal combustion by up to 30 percent. A unique advantage of pulse-firing combustion is that the combustion zone controls are in the PC or PLC vs. in the hardware that is mounted to the furnace. This not only changes the thermal input, but changing the combustion zoning itself can be accomplished quite simply.

The second most common furnace is the box furnace. Like the car furnace, a substantial amount of versatility is present with this design. The major disadvantage of the box furnace is the access to the hearth. Quite often this disadvantage is overcome with the addition of a material handling system that allows you to load the furnace with a fork-truck type device or rollers, including roller rail or roller hearth. This eliminates the major drawback with these furnaces, but it does introduce an additional material handling device. If you use the roller rail or roller hearth, those devices are in the heat.

Adding Automation

Like most other industries, forging needs automation, and a major shift in the furnace design is necessary for that automation to occur. The rotary hearth furnace has a great deal of flexibility with regard to processes used in the forging industry such as billet heating, normalizing, hardening, carburizing, and carbonitriding. It does have limitations, however, with regard to what you can place on the hearth. Rotary hearth furnaces are commonly purchased and centered around a single sized product, whether it's a billet, a forge product such as a gear, or a rough forging. Process flexibility is the primary advantage of a rotary hearth furnace, and the

ROTARY HEARTH

ability to automate comes a close second.

The cost of automation is generally coupled with versatility, meaning that as the automation goes up, the price goes up as well, and the versatility goes down. The process flexibility mentioned earlier carries over into the use of atmospheres in the rotary hearth furnace, and the mere fact that this furnace can be quite tight allows you to operate with almost any atmosphere controlled process.

A rotary hearth system is a good candidate for incorporating automation. With a robot in the center of this layout, the parts can be taken from the load station, positioned in the furnace, heated, quench pressed, placed into the sub-zero treatment center, and then returned to an unload position to go on to further processing. This system can be programmed with "lights out" operation, and while the process flexibility is quite high, the ability to use different sized parts that are larger or smaller than the original design is quite limited.

Production Volumes

Up to this point we've discussed batch systems, or relatively low production continuous systems with either high volumes with limited automation, or high automation with limited volumes. The roller hearth furnace is a way to handle large volumes of forgings with some consistency in the process and still have a high degree of automation. Continuous workflow for these high production rates does come with a price, which is that generally, smaller parts are batched prior to being able to use a roller hearth furnace. This batching process leads to the process of baskets or trays so that the material handling system sees a consistent pattern with the tray or basket regardless of the variations in the load. Temperature range, like it is with the car furnace, is quite wide. These furnaces will range in operation up to 2,200°F and can be used for all of the processes one might want in a forging operation. Here again, the customer—depending upon the needs in a particular plant—determines the automation and the control complexity or simplicity. In the forging press, it is quite common that there will be no human interface until after the product has been delivered from the heat-treating system.

Recipes can be set up in the control system so that variations in a plant can be applied quickly and easily by simply selecting a number. This data can also be collected and stored for process improvement or tracking of a particular product in the production process.

Generally, the roller hearth deals with high volumes (5,000 or even 10,000 # / hour is not uncommon). When you get into the higher numbers, such as 3,000 # / hour, a good commercially viable approach would be to use batch-type integral quench furnaces. These furnaces have an advantage similar to that of the roller hearth. Batching is required for the utilization of this system, but the Casemaster (as our integral quench is known) has a high degree of flexibility from the operation standpoint and can be coupled with washing machines and tempering furnaces so that you can have a complete operable system that is very flexible from a production capacity stand-

ROLLER HEARTH

BOX FURNACE

point because furnaces can be added for the batching process and furnaces can be shut down or idled when their capacity is not needed. These systems are also flexible in that they can utilize different quenching media, and by having multiple furnaces with integral quench tanks those quenching media can be in the same system. Here again, as production capacities vary, simply idling one or more of the furnaces in the system can change your production output. The key to any integral quench system is the material handling system with which it is coupled. This is true, of course, of a number of the other furnaces already discussed, including the rotary hearth and the roller hearth.

Handling and Atmospheres

Material handling systems are something that most full-service industrial heating companies need to supply out of necessity for proper operation of an industrial heating system. If you're using trays or baskets, the handling of these trays becomes a critical piece of any heat-treating system. If you're handling the product itself, the material handling system is equally as critical. We can supply conveyors, cross transfers, or load cars to move the material from one section of the industrial heating system to the other. Seco/Warwick can build a number of these systems, and others can be purchased when the requirement is beyond our capability, such as robotics. In any case, we feel it is absolutely necessary that the software for operation of the material handling system coupled with one of our furnaces must be done by our in-house software engineers. This assures that the interfacing is done properly and the customer will receive a production system to meet their long-term needs.

Protective atmospheres are a critical part of a number of the processes used in the forging industry, despite the fact that a substantial number of furnaces use air as their atmosphere. Seco/Warwick manufactures several different kinds of protective atmosphere generating systems, including endothermic or endogas, exothermic or exogas, or dissociated ammonia or ammogas. The selection of one of these generators is dependent upon the process, and any good furnace vendor can help with the proper selection. These

CASEMASTER INTEGRAL QUENCH

generators use various feedstocks and can use different methods of heating, depending upon the particular customer's requirements. Control of the generator in the production of gas, as well as the control of the atmosphere once in the furnace, is critically important to a successful industrial heating system.

Up to now our discussion has focused on furnaces for the ferrous industry. However, some of them do have applications in the non-ferrous industry. One of these is a cast-link type conveyor for large volume production of aluminum billets. A lot of the features already described for the roller hearth and other furnaces are applicable to this particular furnace as well, including the material handling system to get the parts into, through, and out of the furnace and into the press. The control parameters for the simplicity or complexity are also applicable to this type of furnace.

So far we've covered the pre-heating or thermal processing of the forgings themselves. Our vacuum furnace product line is quite unique in that these systems are commonly used in the preparation of dies for the forging industry. One such furnace is our high-pressure gas quenching system. These furnaces are on the tooling side, and they are built to meet stringent specifications for ASM, mill specs, and the various specs for companies like GM and DaimlerChrysler. This is a batch type furnace, so the versatility that I described for a batch type furnace is applicable to this furnace also. Generally, the need for large volumes of dies in tooling is not present in most forging operations and therefore, the batch type furnace lends itself very well to those heat-treating needs. Precision control of the system allows for hands-off operation, and several options are available for heat-treating a variety of different die steels used for industry.

One of the unique advantages of this furnace is the fact that it uses gas for quenching. Omely gas is like hydrogen or helium, eliminating the need for oil, water, or other fluids handled in their liquid form. This can truly be positioned and operated in a clean room.

Service is Central

We are an engineering company, but we only sell engineering when it's coupled with our equipment. We have extensive R&D activities in our three manufacturing centers worldwide, and we have a full staff

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of engineers with expertise in heat transfer, mechanics, electronics, and metallurgy so that we can use the modern tools of engineering to provide these services for our customers.

Product development is another service we provide, and our in-house products include a variety of processes and equipment to help serve customers better. Over the last several years we have had active development projects in jet heating, short cycle solution heat-treating, multi-chamber vacuum carburizing systems, and cooling with hydrogen. The success of these products has been tied very heavily to the affiliation we have with technical universities around the world, including those in the United States, Poland, Russia, and Germany.

Field service and technical support are also critical. With over 10,000 systems operating worldwide, many of our customers call upon us to "sure up" their operating and maintenance staffs. Things like remote communications gives us the ability to monitor the operation of temperature control systems found anywhere in the world on our electrical engineers' computers. The rebuild, repair, and relocation of older equipment is also a significant part of our capabilities and our present business. Upgrading combustion systems, improving electrical heating systems, and the revisions in control systems to take advantage of the revolutionary changes that have come in this field all feed strongly into our field service and technical support.

Conclusion

The final insight I'd like to share with you regarding our company involves manufacturing. We have nearly 360,000 square feet of manufacturing capacity worldwide in our three facilities. Manufacturing anywhere in the world is sourced to the most efficient facility for the particular product being manufactured. These manufacturing operations contribute to best practices of the Seco/Warwick products. We consistently look around the globe to improve our manufacturing capability by taking advantage of those we find in other associated companies. We have a group of technical supervisors who are responsible for assuring our customers that, regardless of where their products are manufactured, they will receive the best practices of Seco/Warwick and the full advantage of our global vendor network.

The products and services outlined here should give you a good idea of what goes into creating a well-engineered system that will meet your long-term heat-treating needs.

ABOUT THE AUTHOR:

Paul Huber is thermal process team leader for the Seco/Warwick Corporation. He can be reached at (814) 332-8497 or phuber@secowarwick.com.
Company Web site [www.secowarwick.com].