Winter 2013-14
Volume 4, Issue 1

SOLAR MANUFACTURING
Vacuum Heat Treat Furnaces

the hot zone

Solar Manufacturing's Quarterly Newsletter

Engineering to Meet the Challenge

Although Solar Manufacturing has developed an extensive line of conventional vacuum furnaces over the last few years, there continues to be a demand for special furnaces to meet very specific or unusual processing requirements. These requirements could involve load size and capacity, unusual vacuum levels or filtration of by-products, high pressure metallurgical gas quenching or possibly higher than normal operating temperatures.

Solar Manufacturing engineers are always prepared to accept the challenge and have the skill and experience to provide an excellent design that fully meets the customer's requirement. Examples of Solar's successful achievements include the following:

Large Car Bottom Furnaces

Over the past ten years, we have been approached by several manufacturers to provide large car bottom furnaces for extra heavy workload capabilities. These furnaces have hot zones that range in length from 12 feet to 36 feet with load capacities of up to 150,000 pounds. These furnaces are now installed around the world and are performing successfully on a daily basis.

High Pressure Gas Quenching

Meeting metallurgical requirements on certain materials has always been a challenge to the design engineer when designing a gas cooling system for a vacuum furnace. In an attempt to eliminate the need for oil quenching of certain materials, higher gas pressures continue to be introduced. However, in addition to the high pressure, minimizing gas flow restrictions and pressure losses must be of prime concern.

The new Solar Manufacturing HPQ 20 Bar vacuum furnace has resolved many of these concerns and is now recognized as the most advanced in the industry.

In This Issue

Vacuum Gauges and Gas Correction Factors

There are many cycles processed in a vacuum furnace that require the introduction of partial pressure gas to minimize material vaporization.

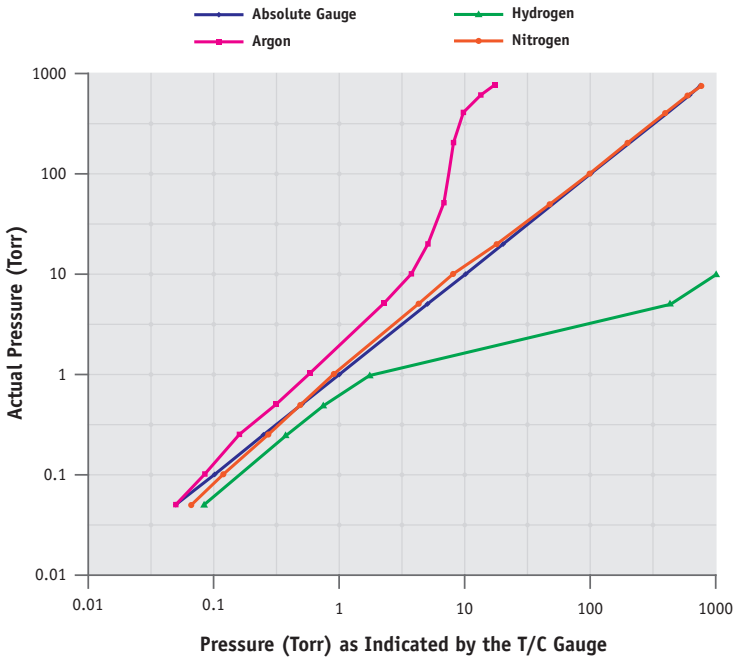
Typically, the partial pressure gas is nitrogen and the vacuum gauge has been calibrated for this gas. However, there are other cycles where the partial pressure gas is other than nitrogen and the readings of the vacuum gauge are greatly different than the true pressure reading.

This difference is most critical when operating in partial pressure gas above 1 Torr and correction factors for the gauge type must be introduced. Solar Manufacturing recently produced a paper on this processing concern entitled *Vacuum Gauge Sensitivity to Gases and the Need for Correction Factors* which is available for review on our website at www.solarmfg.com/technical-articles.

An example of what occurs in a thermocouple vacuum gauge above 1 Torr is illustrated in the figure below.

Please refer to our website for more information on this subject.

Gas Species Effect on Thermocouple Vacuum Gauges



The Problem Solvers

Damaged Hot Zone

A Midwest heat treating company, the owners of two Solar Manufacturing vacuum furnaces, recently suffered major damage to one of their furnaces. The accident happened late on a Friday evening. A workload shifted inside the furnace during a process run and parts fell, damaging some of the furnace heating elements and hot zone insulation components. Because heat treaters often have their furnaces in virtually continuous service, accidents like this one produce a crisis affecting scheduling and productivity.

In this case, the heat treat manager contacted Solar Manufacturing's Nick Cordisco, Electrical Engineer and Service Manager, on Saturday morning, notifying him of the situation and asking for Solar's help to get the furnace back in operation. Nick immediately contacted several others within the company including the Aftermarket Group to arrange for the appropriate replacement parts to be made over the weekend so that they were ready to ship to the customer's facility first thing Monday morning. Also, an experienced mechanic made travel arrangements to fly out to the customer's location on Sunday evening and was on-site Monday morning to begin the repair work on the furnace less than 48 hours after the damage was reported.

Within days, the customer's furnace was back in operation. Because of our relationship to our sister company, Solar Atmospheres, a commercial heat treater, Solar Manufacturing's experienced technical staff understands the need heat treat companies have for prompt, effective service to keep their furnaces productive. We challenge ourselves to be responsive to customers' needs, and to produce quality workmanship on a fast time track.

Unique Vacuum Requirements

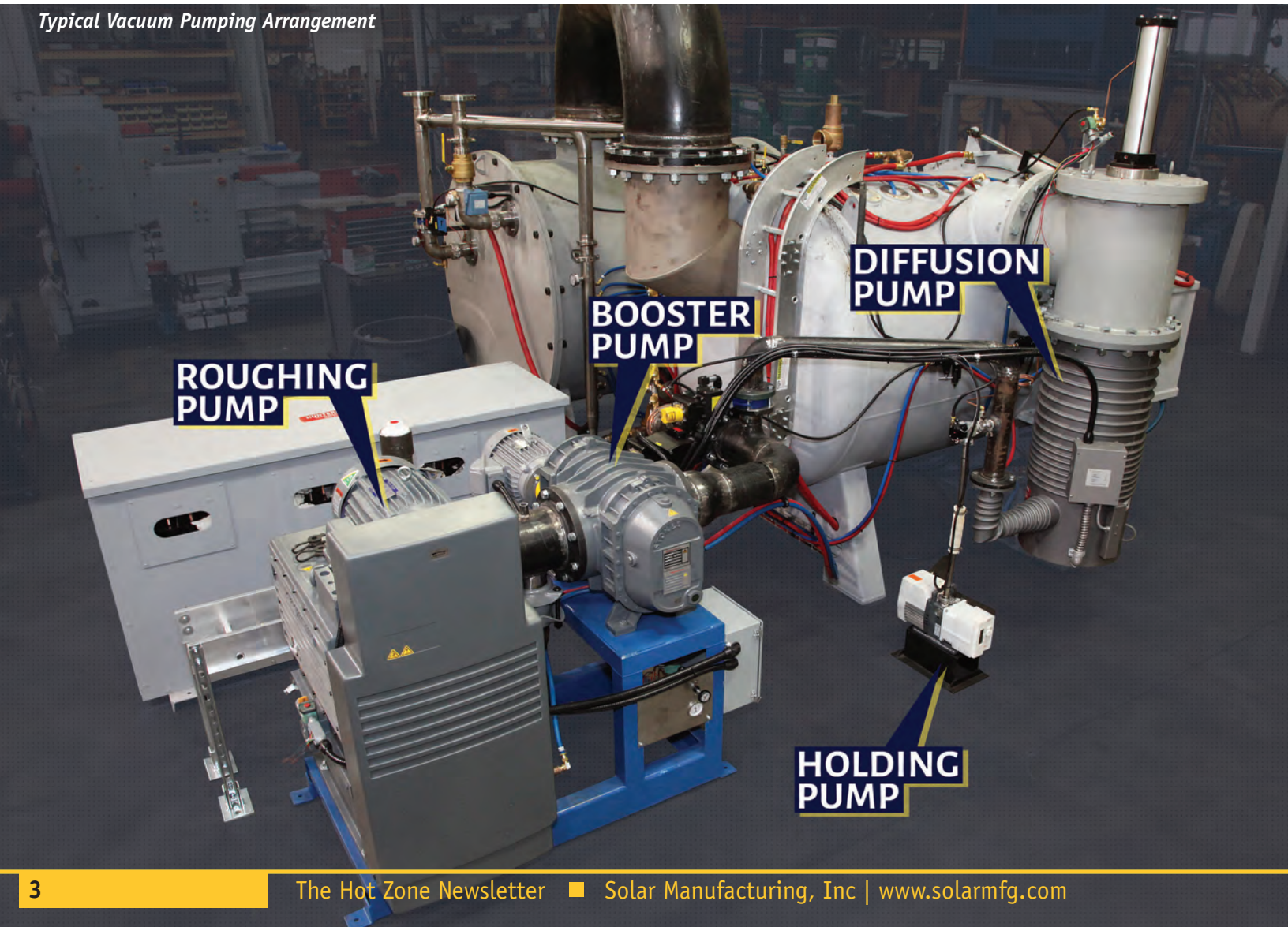
Vacuum furnaces are desirable for heat treating solutions because they provide a clean, high quality, low-distortion result compared to furnaces operating in air or gas atmospheres. To achieve the required vacuum pressure level in the furnace system for a particular heat treating process cycle, the furnace vacuum pumping system must have an adequate pumping capacity to handle the type of product that will be processed in the furnace and the time allowed for achieving the desired pressure level given the product's associated gas load. If a wide variety of process cycles and products will be processed, then the vacuum pumping system must be sized for the worst-case scenario. Two examples of challenging pumping system problems solved by Solar Manufacturing designers follow:

One recent customer requested that we design a furnace that would include a series of five mechanical pump/blower assemblies. These pumps were necessary to overcome very heavy gas loads emanating from their materials at heat treating temperatures. Our engineers found a workable solution to deal with the complex array of pumps.

Another customer performing coating processes requested that we provide a specialized vacuum pumping system consisting of a Busch Cobra Model NC0400 B Screw Type mechanical pump backed by a Stokes 615 Booster blower with in-line traps for binder and contaminant collection. Also included was a second bypass roughing line for initial pumping of the system to improve cycle times. A Varian Model HS-20 diffusion pump was also installed for high vacuum performance to the 10^{-5} Torr range.

Technical issues specific to materials and process requirements make the cookie-cutter approach to complex vacuum furnace pumping system design a mistake. Let Solar Manufacturing solve any unique vacuum process requirements you might have.

Typical Vacuum Pumping Arrangement



Using Thermocouple Test Blocks

There are many vacuum furnace cycles where the thermocouples needed to determine the true processing temperature cannot be inserted into the workload. This requires the use of thermocouple test blocks to simulate the load.

In a vacuum furnace, heat to the workload is provided by radiating heating elements. The ability and the time it takes for the load to absorb the heat is a direct function of the load surface condition including color and texture normally referred to as emissivity.

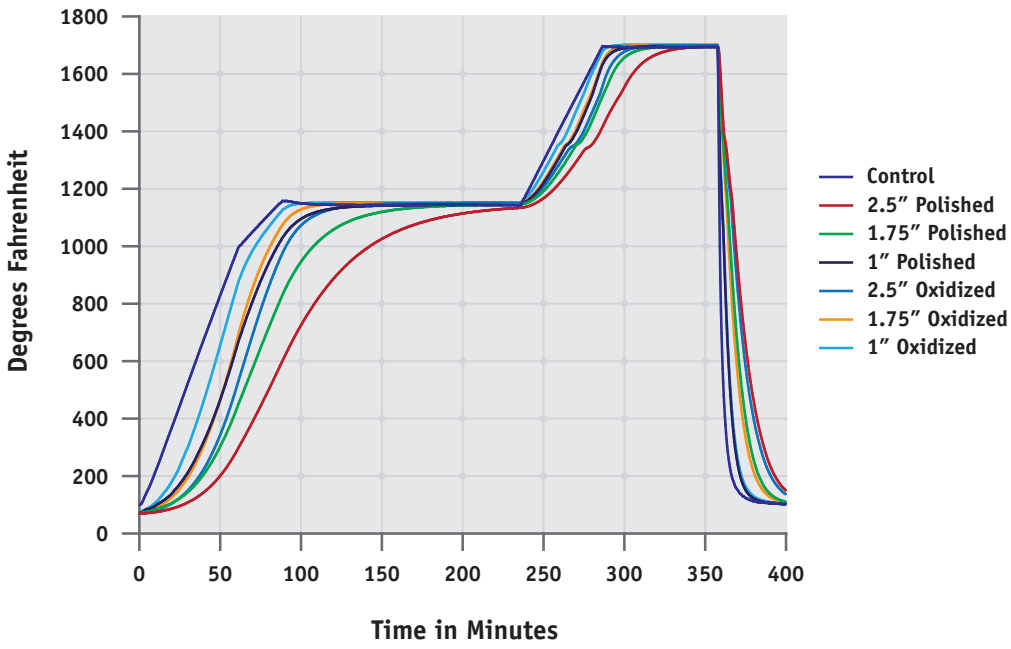
The surface condition of a material can greatly affect its ability to absorb radiant energy. The same material with equal cross-section and mass can take as long as twice the time to reach final temperature. Thus, the design of thermocouple test blocks must not only reflect the correct cross-section but must also represent the existing surface condition of the load.

Solar Manufacturing recently completed a study and paper demonstrating the critical nature of emissivity and heat absorption in the use of thermocouple test blocks. As an example of what was studied and tested, the figure below illustrates the heating rates of different size carbon steel blocks with different surface conditions.

This paper, entitled *Understanding Emissivity and the Use of Thermocouple Test Blocks in a Vacuum Furnace,* is available by going to our website at www.solarmfg.com and should provide an excellent guide to working with thermocouple test blocks.

Thermocouple in a Test Block

Emissivity & Block Characteristics Test



Vacuum Heat Treat Minute
Industrial Heating

Listen at
www.solarmfg.com/podcast

Solar Manufacturing has produced the Vacuum Heat Treat Minute since 2013. Hosted by Bill Jones, CEO and Jim Nagy, President, it is a bi-monthly podcast centered on pertinent heat treating topics like furnace maintenance and temperature uniformity surveys among other critical matters. February kicked off the 2014 season of the podcast with guest Bob Hill, President Solar Atmospheres of Western PA, and a timely examination of the current helium shortage and its effects on the heat treating world.

This newsletter is published quarterly by Solar Manufacturing, a leader in world-class vacuum heat treating furnaces.

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William R. Jones Receives MTI Heritage Award

William R. Jones, CEO of Solar Atmospheres, Inc. and Solar Manufacturing, Inc. received the Heritage Award at the Metal Treating Institute (MTI) Fall Meeting in Las Vegas, Nevada, on October 12th. This most prestigious award is given in recognition of the individual's lifetime commitment to the betterment of the commercial heat treating industry with one or more notable accomplishments. Only nine people in the seventy-eight year history of MTI have ever received this award.

MTI 2011-2012 President Buster Crossley presented the award by introducing Mr. Jones as an "icon in the world of heat treating." He went on to say, "When you hear his last name, you know who is being talked about. He is a graduate of Penn State with a degree in electrical technology, with more than 40 years of experience developing vacuum furnaces and processing technology. He is a Fellow of ASM International (FASM), and received the national Eisenman Award for applications of vacuum technology for outstanding contributions in practical industry applications. He served as President of Abar Corporation for five years, and in 1978 founded the Vacuum Furnace Systems Corporation (VFS) to engineer and build vacuum furnaces. In 1983, he and his son, Roger, formed their own company, Solar Atmospheres, to make use of the technology advancements they had discovered. Mr. Jones holds numerous patents related to vacuum furnace design and application. He has authored numerous technical articles and papers for ASM, the Metal Treating Institute, and *Industrial Heating* magazine."

Please visit www.solaratm.com for more information about Solar Manufacturing's sister company.

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