the hot zone
Solar Manufacturing's Quarterly Newsletter

SOLAR MANUFACTURING

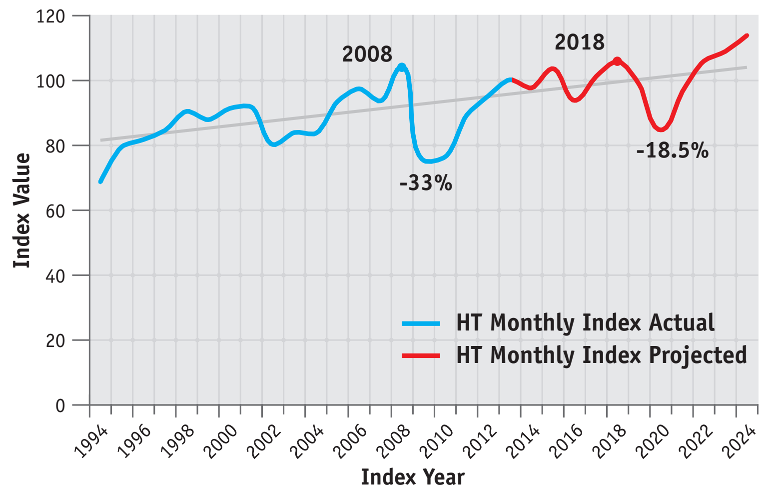
Heat Treating Past, Present, and Future

At the recent Furnaces North America (FNA) conference in Nashville, William R. Jones, CEO of the Solar Group of Companies, presented his and the company's view on the Heat Treating Industry and what can be expected for the future.

Based on input from several sources and historical information from the Metal Treating Institute (MTI), we were able to create the following curve of the Heat Treating Index of the past twenty years and our prediction of what will happen for the next ten years.

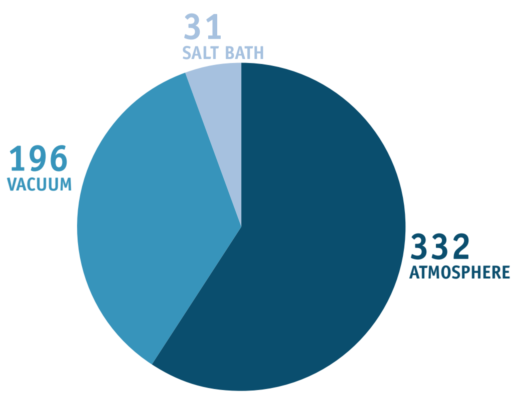
The above curve highlights a growth of approximately 17-18% over the past twenty years and a projected growth of approximately 15.5% for the next ten years with a major downturn around 2020.

HT Index History and Projection

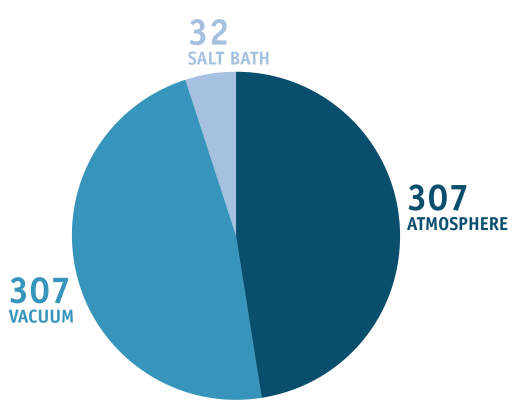


The presentation also focused on the continuing growth of vacuum furnace processing as compared to atmosphere furnace processing with the two reaching an equal share around the year 2024. The following two pie charts reflect the current and future equipment sales of the two industries with a very small percentage for salt bath equipment.

Furnace Sales 2014
In Millions of Dollars



Furnace Sales 2024
In Millions of Dollars



The equal heat treating industry share of the two by 2024 is primarily due to environmental concerns regarding atmosphere equipment and the introduction of new vacuum processing applications occurring each year. Some of these new vacuum applications include:

- Heat treatment of emerging specialty alloys
- Refractory Metals Processing (molybdenum, niobium, tantalum, tungsten)
- Additive manufacturing – (3D printing)
- Heat treatment of titanium for aerospace market
- New sintering applications
- Heat treatment of medical components –implants, surgical instruments, electronic instrumentation
- Diffusion bonding and diffusion processes
- Nano materials processing
- Low pressure vacuum carburizing
- Vacuum purge gas nitriding
- Low temperature (≈800°F) vacuum carburizing and nitriding of stainless steels

Look for Mr. Jones's entire FNA presentation in the January issue of *Industrial Heating* magazine.

Solar CEO is Featured Presenter in Webinar on Vacuum Pumping Systems

An example of a typical vacuum pumping system

Vacuum furnaces are in use around the world for a variety of heat treat processes with high quality, low contamination end results. In order to get the most value from the vacuum furnace it is critical that owners and operators be conscientious with regular scheduled maintenance on all components of the vacuum furnace. In one aspect of component care, a vacuum furnace atmosphere is only as good as its vacuum pumping system's performance. In a December 4th webinar hosted by ASM International, Bill Jones, CEO of the Solar group of companies, provided essential guidelines for keeping pumping systems operating at peak performance levels. Mr. Jones has more than 40 years of vacuum furnace experience. He gave tips for maintaining the vacuum pumping system as a means to avoid costly failures and down-time.

A vacuum furnace is a high dollar investment. Only functioning furnaces can process parts to bring in revenue. Down-time results in loss of revenue; however, amortization and bank payments must still be made. Off-line operation also results in missed production where furnace time and money are lost. Downtime has the potential for creating dissatisfied customers, or even driving valuable customers away.

Keeping a vacuum furnace in peak operating condition requires diligence in planning and maintenance. A properly engineered and maintained furnace will give several decades of quality performance.

ASM INTERNATIONAL

Featuring acknowledged experts in their fields, ASM webinars share information of interest to many in the diverse materials industry. Viewing is free to ASM members.

To view the webinar, please visit
www.asminternational.org/news/webinars

Topics Covered in this Webinar

Vacuum Pumping Systems

An overview of the basic components of the vacuum pumping system was given in this section. This includes the types of roughing pumps and "Roots blowers" as well as valves required to obtain the various vacuum levels for rough, low and high vacuum processing.

Mechanical Pumps

The mechanical roughing pump is the first pump that begins to remove the air from the vacuum furnace. Its function and performance are critical to the integrity of the vacuum level achieved. The potential problems which may occur during initial pump down and a typical maintenance schedule and testing procedure necessary to keep the pump running smoothly were addressed.

Vacuum Booster Pumps

The "Roots blower" serves as the secondary pumping component found in production furnaces. It works in conjunction with the roughing pump and has the ability to move large volumes of gas. The design, function, and vacuum levels achievable when the roots blower is well maintained were described in this section.

Vapor Diffusion Pumps

The vapor diffusion pump is necessary to achieve high vacuum levels necessary to heat treat specialty metals and alloys such as titanium, tantalum and various specialty stainless steels. The function, design and care of the vapor diffusion pump were detailed in this section, including proper maintenance and schedules. Types of diffusion pump oils were discussed with respect to application.

Holding Pumps

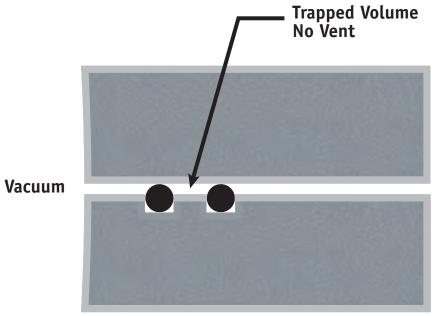
Any vacuum furnace that includes a vapor diffusion pump must also have a holding pump as a back-up feature. Its use and maintenance procedures were covered in this section.

Vacuum Valves

The type and use of vacuum valves within the vacuum pumping system were discussed, including the holding pump valve, the roughing pump valve, the fore-line valve, and the main high vacuum valve.

Leak Check Procedures in Detail Available from Solar

All vacuum furnace users have at some time needed to find a leak that was occurring within their vacuum system and causing unacceptable performance levels. Although there are existing documents recommending approaches to finding vacuum leaks, there is no complete paper fully explaining vacuum leaks and best repair methods. Our new Solar Manufacturing document titled "Vacuum Furnace Leaks and Detection Techniques" is now available to all vacuum furnace users.



■ *Unvented double o-ring design*

Subjects covered in the paper include:

- Types of leaks – real leaks vs. virtual leaks (pictured above) with examples of both
- Distinguishing a true leak from furnace "outgassing"
- Understanding vacuum pump-down performance
- How to perform and understand a vacuum furnace leak rate test and its findings
- Examples of where typical leaks occur
- Safety concerns in leak checking
- Methods of leak checking: noisy leaks, vacuum gauge/solvent detection, and helium leak detection
- Typical procedure for leak checking a vacuum furnace

We are pleased to acknowledge that much of the input for this paper was provided by personnel from our affiliate company, Solar Atmospheres, Inc., where more than 60 vacuum furnaces are in production daily and leak checking experience is highly valued and readily available.

Copies of this paper are available for download on our website at www.solarmfg.com.

■ *A technician using a Varian helium mass spectrometer to test for leaks at a pump valve.*

Solar Manufacturing Builds Large Furnace for California Affiliate

In order to accommodate its ever-increasing vacuum processing requirements, Solar Atmospheres of Fontana, California recently placed an order with Solar Manufacturing to supply a large capacity, horizontal, heat treating and brazing furnace. This Solar Manufacturing Model HFL-84144-2EQ has a work zone that measures 54″ (1371 mm) high x 54″ (1372 mm) wide x 144″ (3658 mm) deep and is capable of processing a work load of 30,000 pounds at 2200°F. It is expected that this furnace will increase plant processing capacity by more than 25%.

This furnace is being designed to not only satisfy the normal heat treating requirements, but to be available to handle larger loads at higher processing temperatures. The furnace will have a normal operating temperature up to 2650°F and will be capable of achieving an operating vacuum in the 10^{-5} Torr range. Temperature uniformity will be +/- 10°F (5°C) between 900°F (482°C) and 2200°F (1204°C).

The entire hot zone utilizes 1″ rigid graphite board with a .015″ foil bonded face. This is backed by four layers of one-half inch highly efficient Rayon graphite felt supported in a 304 stainless steel ring structure. The heating elements will be thin, durable ISO 63, curved graphite design and divided into multiple trim zones. Elements are segmented for ease of replacement. High velocity, tapered gas nozzles surround the workload for improved velocity and cooling uniformity.

The vacuum chamber is double walled for water cooling. The inner wall is constructed of 304L stainless steel and the outer wall is fabricated of A-36 carbon steel. The front door utilizes a pneumatically operated autoclave locking ring to facilitate positive pressure quenching to 15 psig (2 bar).

The pumping system includes a Stokes Model 412J, 300 CFM mechanical pump, two Stokes Model 615, 1300 CFM booster pumps, and a Varian Model NHS-35 diffusion pump to provide for an ultimate vacuum in the 10^{-6} Torr range.

The gas cooling system includes two external assemblies each housing a 300 HP motor, and an all copper, water cooled heat exchanger, and blower fan.

A SolarVac® 5000 control system is provided for complete automated control and recording.

Solar Atmospheres of California's new furnace under construction in the Solar Manufacturing shop

New Employee Spotlight

Keith Reim
Corporate Marketing Manager

Keith Reim recently joined Solar Atmospheres as Corporate Marketing Manager. Mr. Reim was formerly the Marketing Manager of an industrial automation company and has over 19 years of experience in business-to-business marketing. Keith is experienced in all aspects of marketing including marketing communications, business planning, marketing analysis, and much more. Mr. Reim is a graduate of Ursinus College with a B.A. in Business Administration with a marketing concentration.

In his new role at Solar Atmospheres, Mr. Reim will focus on providing strategic direction for all of Solar's marketing activities such as corporate branding and communications; advertising; website development; trade shows; public relations and social media for all of the Solar group of companies.

Podcast

Industrial Heating Vacuum Heat Treat Minute

Listen at
solarmfg.com/podcast

The latest podcast, released in October, is the second in a four-part series started with the August edition discussing furnace preventive maintenance.

New Inner Furnace Wall Coating SolarVacSeal™ Gives Superior Results

For many years, vacuum furnace manufacturers have struggled with what was the best and most economical design for the inner wall of their vacuum chambers. A typical vacuum furnace chamber is a double wall construction of carbon steel that allows cooling water to circulate between the walls and provide a minimal outer wall temperature to the room environment. Unfortunately, the surface of the carbon steel inner wall will rust. Oxidation on bare carbon steel walls increases surface area, and is "sticky," attracting moisture and dirt. This condition must be avoided. One solution to this problem involves constructing the inner wall of stainless steel.

A stainless steel inner wall was always available but is more expensive than a basic carbon steel structure. Many inner wall coatings have also been applied to the carbon steel wall to provide a low emissivity for optimum heat reflection and overall vacuum capabilities. Radiating energy losses from the internal hot zone supporting structure must be considered and minimized to provide for an ideal processing situation. Whatever coating is used must also be minimal, because these materials can emit gases that make pumpdown more difficult and prolonged.

Recent emissivity tests were concluded at Solar Manufacturing regarding various painted and unpainted surfaces to establish which provided the best solution for this inner chamber wall design. The painted surfaces indicated that a high-temperature aluminum paint, a metallic paint, and a chrome paint were the best. Tests on unpainted surfaces indicated a clean stainless steel and an aluminum surface were equal to or better than the painted surfaces. Since aluminum was impractical for our application, the decision was made to try to simulate the stainless steel surface.

The solution was a stainless steel coating applied to the carbon steel wall. This coating, which we have named SolarVacSeal™, provides corrosion protection when applied to the inner wall of new furnaces that are subject to repeated process cycling. During application and drying, the stainless steel particles rise to the surface of the coating and dry in place, forming a stainless steel metallic barrier. This now essentially provides the same results as a complete stainless steel inner wall.

Maintaining a clean vacuum chamber inner wall is important in continually achieving good vacuum levels when processing. With each cycle, contaminants emanating from the workload continue to collect on "colder" surfaces including the inner chamber wall. Maintaining a good reflective and low adhesion surface such as the SolarVacSeal™ will minimize these problems.

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

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