American Glovebox Society

ENCLOSURE

Winter 2016/17

The Gloves We Use and Why at the World's Premier Nuclear Facility

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ENCLOSURE

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President John F. Kennedy at CMR
in December 1962
Courtesy of the LANL Archives

The Enclosure

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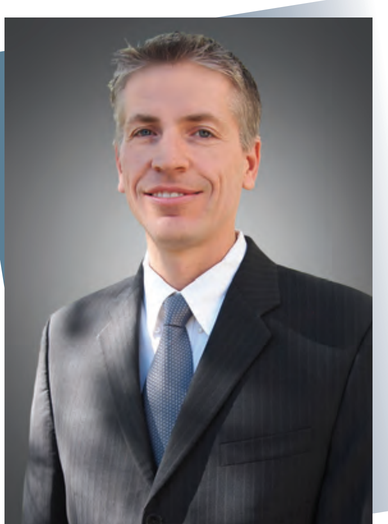


President's Message

By: Greg Wunderlich

Hello members of the American Glovebox Society (AGS). I hope this message finds you well. I am excited to be the President for this year. Like every year, we have a lot of things to oversee and to execute. We had a great conference in 2016 under the leadership of Justin Dexter, and the AGS Board. All of them are instrumental in organizing the yearly conferences. We are planning an exciting conference for 2017 in Las Vegas. We have a great tag line for next year's conference in Las Vegas. Rick Hinckley coined it perfectly and you could probably guess. "What happens in a glovebox, stays in a glovebox." Awesome… I like it already. Expand the term glovebox to containment box, enclosure, isolator, hot cell, vacuum vessel, etc.; whatever device you are using to contain a material as to protect operators, or to protect the material inside.

The American Glovebox Society Board of Directors and Standards Committee have already been hard at work, and I want to thank them for their contribution and sacrifice being away from work. Especially when the everyday work and responsibilities don't slow down "back in the office" when they are volunteering their talents, knowledge, and time. The Board of Directors spent the whole day in Nashville Tennessee in October discussing and developing a strategic plan. It's important to have a plan that strengthens our primary objectives of (1) promoting safety and quality of containment systems, (2) promoting communication, (3) disseminating knowledge in the field of containment technology, (4) provide standards and guidelines for containment technology, and (5) promoting adoption of standards and guidelines to reduce cost. At the same time trying to grow and expand our base in part by reaching out to other organizations with similar interests and reaching out to the future operators, engineers, technical specialists, and scientist. We must always stay true to our core values but at the same time plan for the future to have continued growth and success.

As you will see in this Enclosure, we are continuing to focus on Lessons Learned which will become a part of everything we do moving forward from Enclosure articles, to conference presentations, to content on the AGS website, and social media. This will occur primarily through OPEXShare resource (opexshare.doe.gov). I encourage everyone to sign up for an account with OPEXShare. I signed up during the last AGS conference, and selected various topics that I am interested in. I now get frequent emails of various Lesson's Learned from lifting to chemical to nuclear related hazards. I am able to use these emails during Safety Moments at work which we have at the beginning of every meeting. These emails help me keep Safety in the forefront of my mind or at least forefront in my Email Inbox ☺

I want to give a special thanks to all of those that participated in the 2016 Conference from the Sponsors, Vendors, Presenters, Exhibitors, LANL Demonstration Team, and especially to Dorothy and Crissy who hold us together. Without you our conferences wouldn't be possible. I also want to thank those that are already helping with the 2017 Conference, and I encourage you, our members to participate in our next conference in the various ways that are possible. Let us know if you are willing to participate. May you have a successful year and be able to enjoy the holidays.

Regards,
Greg Wunderlich
AGS President 2016-2017

The Gloves We Use and Why at the World's Premier Nuclear Facility

By: Jose Rodriguez, LANL

Part 1: Let's Talk History, Shall We?

Where is Los Alamos?

Los Alamos National Laboratory (LANL), formerly the Los Alamos Scientific Laboratory (LASL), is located in North Central New Mexico on the Pajarito Plateau. Los Alamos is on the east side of the Jemez Mountains at the foothills of an ancient volcanic caldera (depression) known as the Valles Caldera. The Valles Caldera is responsible for the deep valleys and beautiful vistas of Northern New Mexico which was a bonus when scouting a secluded location for the Manhattan Project. There were just a couple of problems, the area was home to the Los Alamos Ranch School and numerous homesteaders.

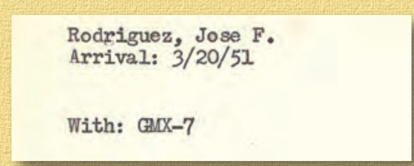
Homesteading on the Pajarito Plateau

The very first homesteader on the Pajarito Plateau was my great-great-grandfather Juan Luis Garcia. He applied for his homestead in 1887 and received his patent for 160 acres in 1892. His homestead was located in a previously unnamed canyon that now bears his name, Garcia Canyon. In addition to Juan Luis, three of his four eldest sons (Adolfo, Esequiel, and José L.) also applied for and received patents for homesteads in and around Garcia Canyon. My great-grandfather, Adolfo, was the second born and was the executor of Juan Luis' estate upon his passing in 1931. These homesteads were still occupied by my family where they cultivated produce—including beans, corn, potatoes and sugar cane—and operated a sawmill, when J. Robert Oppenheimer convinced General Leslie Groves that Los Alamos should be the location for Site Y in 1942. My grandmother, Marina Rodriguez, worked on the homestead as a "stay-at-homestead" wife, mother, and daughter where she had household chores to do including chopping wood, cooking for the men that worked at the sawmill and tending to the farm. Her husband and my grandfather, Jose Filadelfio Rodriguez, Sr., worked at the sawmill as a lumberjack. Although Garcia Canyon is located approximately 5 miles north of the original Technical Area and was never utilized during the Manhattan Project, it was still part of the Pajarito Plateau that was acquired during this time.

Juan Luis Garcia
Source: La Iglesia de Santa Cruz de la Canada, 2nd Edition

Some More Personal History

On top of my ancestors being homesteaders, I am a third generation LANL employee. My grandfather, Jose Filadelfio Rodriguez, Sr., began his career at the Laboratory as a carpenter with the Zia Company during the Manhattan Project. As a carpenter, and outstanding stair builder, he helped build numerous homes and Laboratory buildings to support the scores of people that were arriving for the Manhattan Project. In 1951, he became a Laboratory Employee, in GMX-7 which still exists under a different name today, as documented in his McKibbin Card from the LANL Archives. McKibbin Cards were filled out by those who came to Los Alamos to work on the Manhattan Project as well as the Laboratory shortly thereafter. He was a jack of all trades and did most any task assigned to him. His last day at the laboratory was June 30th, 1971, with an official retirement date of July 1st, 1971. My father, Jose Filadelfio Rodriguez, Jr., spent 36 years from January 2nd, 1972, to January 10th, 2008, at the Laboratory as an electronics technician. During his time at LANL, he supported scientists and engineers with scientific research, as well as design, development, calibration, maintenance, and modification of radiation detection instruments utilized by radiation protection. More specifically he spent time at the Los Alamos Meson



Rodriguez, Jose F.
Arrival: 3/20/51

With: GMX-7

Jose F. Rodriguez's McKibbin Card
Courtesy of the LANL Archives

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Marina Rodriguez (seated) with Jose F. Rodriguez, Sr. (right) on their wedding day with their padrinos, Apolonia Garcia and Feliciano Garcia

Physics Facility (now the Los Alamos Neutron Science Center) the pioneering facility for radioisotope production used in cancer radiation therapy to this day. He also assisted in the research and development of a real-time pulsed photon dosimeter which was then used in conjunction with TLDs to drastically reduce the amount of time required for experiments. This reduction in time from a couple weeks to instantaneous contributed to ensuring the health and safety of the worker and protection of the environment during an experiment. He was also an active participant during the construction and commissioning of the Plutonium Facility.

About Me

I am a Professional Engineer registered in the State of New Mexico and hold a BS in Civil Engineering from the University of New Mexico. Prior to LANL, I worked in the water/wastewater department of a civil engineering consulting firm in Albuquerque, NM. I have worked at LANL for 3 years in the Engineering Services Group. I am a qualified Cognizant System Engineer (CSE) assigned to gloveboxes, glovebox support stands, Type B packages, and the Offsite Source Recovery Project pipe overpack containers at the World's Premier Nuclear Facility, also known as the Plutonium Facility. I devote much of my time as a CSE to gloveboxes due to the sheer number of gloveboxes we have at the Plutonium Facility.

Los Alamos in the Beginning a.k.a. The Manhattan Project

In 1939, Leo Szilard enlisted the help of his friend and world renowned physicist Albert Einstein to write a letter to President Franklin D. Roosevelt informing him that uranium could be turned into a source of energy. Einstein's letter warns that, although less probable, the development of a powerful bomb is also possible; however, it would be so big that it would have to be delivered by boat. At the time, this letter prompted the President to allocate $6,000 to Enrico Fermi in Chicago for the development of a reactor which would serve as the "birth" of the Manhattan Project.

Einstein-Szilard Letter

Albert Einstein
Old Grove Rd.
Nassau Point
Peconic, Long Island

August 2nd, 1939

F.D. Roosevelt,
President of the United States,
White House
Washington, D.C.

Sir:

Some recent work by E.Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future. Certain aspects of the situation which has arisen seem to call for watchfulness and, if necessary, quick action on the part of the Administration. I believe therefore that it is my duty to bring to your attention the following facts and recommendations:

In the course of the last four months it has been made probable - through the work of Joliot in France as well as Fermi and Szilard in America - that it may become possible to set up a nuclear chain reaction in a large mass of uranium,by which vast amounts of power and large quantities of new radium-like elements would be generated. Now it appears almost certain that this could be achieved in the immediate future.

This new phenomenon would also lead to the construction of bombs, and it is conceivable - though much less certain - that extremely powerful bombs of a new type may thus be constructed. A single bomb of this type, carried by boat and exploded in a port, might very well destroy the whole port together with some of the surrounding territory. However, such bombs might very well prove to be too heavy for transportation by air.

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The United States has only very poor ores of uranium in moderate quantities. There is some good ore in Canada and the former Czechoslovakia, while the most important source of uranium is Belgian Congo.

In view of this situation you may think it desirable to have some permanent contact maintained between the Administration and the group of physicists working on chain reactions in America. One possible way of achieving this might be for you to entrust with this task a person who has your confidence and who could perhaps serve in an inofficial capacity. His task might comprise the following:

a) to approach Government Departments, keep them informed of the further development, and put forward recommendations for Government action, giving particular attention to the problem of securing a supply of uranium ore for the United States;

b) to speed up the experimental work,which is at present being carried on within the limits of the budgets of University laboratories, by providing funds, if such funds be required, through his contacts with private persons who are willing to make contributions for this cause, and perhaps also by obtaining the co-operation of industrial laboratories which have the necessary equipment.

I understand that Germany has actually stopped the sale of uranium from the Czechoslovakian mines which she has taken over. That she should have taken such early action might perhaps be understood on the ground that the son of the German Under-Secretary of State, von Weizsäcker, is attached to the Kaiser-Wilhelm-Institut in Berlin where some of the American work on uranium is now being repeated.

Yours very truly,

(Albert Einstein)

Source: http://www.fdrlibrary.marist.edu/archives/pdfs/docsworldwar.pdf

Over the next few years, it was realized that an atomic weapon could be much smaller and actually deliverable which led to the Manhattan Project—so named because it's headquarters were originally in Manhattan—gaining steam with General Leslie Groves being selected as the project's leader. Prior to becoming the head of the Manhattan Project, Leslie Groves was a colonel who oversaw the design and construction of The Pentagon in 18 months. However, recognizing that the Manhattan Project lacked proper leadership he marched into his boss' office and suggested that a promotion was in order. He received the promotion thus acquiring the title of Brigadier General. His next order of business was to request additional budget and raise the priority of the Manhattan Project and much to his satisfaction he received two things that have likely never been issued together in the history of the United States, a blank check and top priority. The final tally for the Manhattan Project was approximately two-billion-dollars ($2,000,000,000) with plenty of people across the country working on this top secret project.

General Leslie Groves
Courtesy of the LANL Archives

J. Robert Oppenheimer
Courtesy of the LANL Archives

General Groves' new title was intended to demand more respect from the civilian scientists he was now overseeing, including J. Robert Oppenheimer. Oppenheimer was the nation's leading theoretical physicist, but he had a few skeletons in his closet. Although Oppenheimer never joined the communist party, he was a communist sympathizer and was romantically involved with two members

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of the communist party; his wife, Kitty and his mistress, Jean Tatlock. This lead to the army's refusal to issue Oppenheimer a security clearance. However, General Groves was so impressed by Oppenheimer that he insisted on granting him a security clearance to be in charge of the scientists at Site Y. In a letter, General Groves asked Oppenheimer not to go anywhere without his military escort because Oppenheimer was far too important to the success of the project. Which meant that General Groves wanted to ensure Oppenheimer was followed at all times.

A Tradition of Innovation

President John F. Kennedy at CMR in December 1962
Courtesy of the LANL Archives

Following the Manhattan Project, Oppenheimer wanted to return to the world of academia, so Lieutenant Commander Norris Bradbury became the 2nd Director of the newly minted Los Alamos Scientific Laboratory. During his 25 year run as director, Bradbury recognized there were innovations the Laboratory could contribute to outside the nuclear arena that made the Laboratory famous, so he nurtured and transformed the Laboratory from a nuclear development laboratory to a nuclear science laboratory. Following Bradbury's tenure as director in 1970, another Manhattan Project Scientist took the reins of the Laboratory, Harold Agnew. During Agnew's tenure, he continued to diversify the Laboratory's Mission while also maintaining focus on the nuclear weapons complex. Siegfried Hecker was the 5th Director of LANL and continues to be at the forefront of nuclear non-proliferation. To this day, he speaks on nuclear non-proliferation to the press when the topic arises. Below are just a few of the accomplishments that LASL/LANL has contributed to in its 70+ year history:

- 1946: The Monte Carlo method is devised by LASL scientists
- 1963: LASL-developed Vela satellites are launched
- 1967: Gamma-ray bursts are first detected by Vela Satellites
- 1974: Los Alamos Meson Physics Facility ships its first medical radioisotopes
- 1982: LANL's Cray X-MP named world's fastest computer
- 1990: LANL begins participation in experiments that ultimately confirm neutrino mass
- 2009: LANL begins teaching the Homemade Explosives Course
- 2012: Curiosity Rover lands on Mars equipped with LANL instruments
- 2015: LANL scientists develop a breakthrough portable medical MRI device

Thanks to...

LANL Historian, Alan Carr, for his wonderful talks about the Manhattan Project, the history of LANL in general, and the wonderful historical photos he provided for my presentation at the AGS Conference and this article. Additionally, thanks to Judith Machen, Ellen McGehee, and Dorothy Hoard for documenting the history of the Pajarito Plateau Homesteaders. I would also like to thank my father, Jose F. Rodriguez, Jr., for recounting his and his father's time here at LANL and also for the use of my grandparent's wedding photo.

Stay Tuned…

…for Part 2 where I will discuss the actual gloves we use and why at the World's Premier Nuclear Facility. ❖

Microwave Furnace Technology in Glovebox Applications Part 2

By: Greg Wunderlich, AECOM

This article is a second part of a two-part article on Microwave Furnace Technology in Glovebox applications. The first article as presented in the previous Enclosure Magazine (Winter 2016 Issue) discussed common furnaces used in the glovebox industry, provided an overview of microwaves, and discussed the common components of a home microwave oven. This article is a follow-up to that article and discusses how to melt metals in a microwave furnace, the integration of microwave furnaces into gloveboxes, and their advantages/disadvantages.

The microwave oven has been put on its side to provide extra height in the chamber. After 18 minutes firing, the door has just been opened.

Although the metal is molten at about 1000 °C, the insulation blocks remain cold enough to handle with bare hands.

The mold is inverted to allow the metal to run from the melting chamber into the ceramic shell cavity.

The casting is allowed to cool on the rack.

Figure 1 – Melting Metals in a Domestic Microwave.

Melting Metals in a Microwave Furnace

The question was posed in the previous article, "how can metals be melted in a microwave furnace in a controlled process if they are largely reflective and do not heat-up directly by microwaves?" There are two additional key items not present in your home microwave necessary to melt metals. The answer lies in the fact that we need a material (key item 1) that will interact (suscept) with the microwaves that will in-turn heat up the metal. This is commonly done my adding susceptors inside of the microwave oven. This article will not discuss the specific material or material technology that is used to interact with the microwaves. However, as discussed in the previous article, the susceptors are dielectric materials, typically a ceramic material in the form of bricks, plates, crucible and/or other shapes that "absorb" the microwaves and heats up. The susceptors heat up which heats-up the material in a microwave. This is dangerous in and of itself because of the temperatures that can be achieved. Thus, insulation (key item 2) is normally put around the susceptors, crucible, and the metal being melted. This keeps the inside temperatures of the microwave between the insulation and the applicator (microwave walls) relatively cool. Figure 1 shows a metal casting process that has been performed in a domestic microwave oven (see Reference 3). This is amazing as you can see that the insulation is relatively cool on the outside while there is molten metal on the inside.

Complete laboratory microwave packages can be purchased consisting of the insulation package, susceptors, microwave and control system.

Industrial Microwave Furnace Integrated with a Glovebox

Similar components that are used in a domestic microwave oven are used in industrial microwave furnaces that can be integrated with a glovebox. Generally, many of the resistance and induction furnace configurations can be applied to microwave furnaces designs. Similar to other furnace technologies there are a couple of general ways a furnace can be integrated with a glovebox: (1) placing the entire furnace completely inside of the enclosure, and (2) in-

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tegrating the furnace with the glovebox boundary in various configurations such as front loading (i.e., door on the front of furnace), bottom loading (i.e., furnace door on bottom with the furnace body above the door), top loading (i.e., furnace door on top with the furnace body below the door), and connecting multiple enclosures commonly referred to as a tunnel furnace or configuration. Door configurations and locking mechanisms can vary widely. Common door configurations are double hinged doors, sliding doors, cam action doors, clamped doors, bolted doors, wedged doors, etc.

There are several challenges associated with placing the entire furnace inside of an enclosure, the primary issues being the heat required to be removed from the inside of the glovebox, the size of the furnace and thus the size of the glovebox required, material handling, ergonomics, operator interface, and maintainability. The "holy grail" so to speak of gloveboxes is to get as much of the equipment outside of the enclosure as possible so that maintenance can be performed without the risks to the operator associated with breeching containment and physical injury. In regards to furnaces, this is commonly overcome by integrating the flange of the furnace with the glovebox shell at which point the furnace body (i.e., applicator in the case of a microwave furnace) becomes part of the containment barrier while the door of the furnace is on the inside of the glovebox. The heating elements if a resistance-type furnace and thermocouples can be placed on and around the body of the furnace which is external to containment. One difficultly of this arrangement is the thermal stresses that can be generated between the body of the furnace which is normally at "high" temperatures while the flange of the furnace connected to the glovebox needs to remain cool. The flange is commonly cooled with water to protect the glovebox boundary, flanges, and seals. Microwave furnaces will not have this issue if designed properly and is one of the primary benefits.

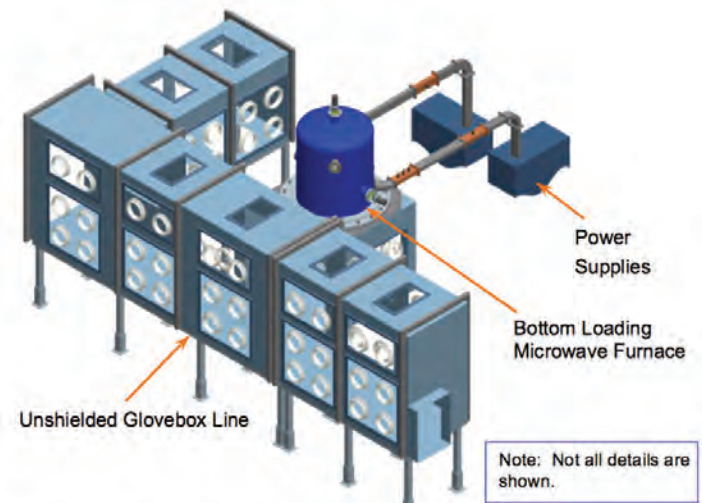

Figure 2 – Bottom Loading Microwave Furnace Integral with a Glovebox

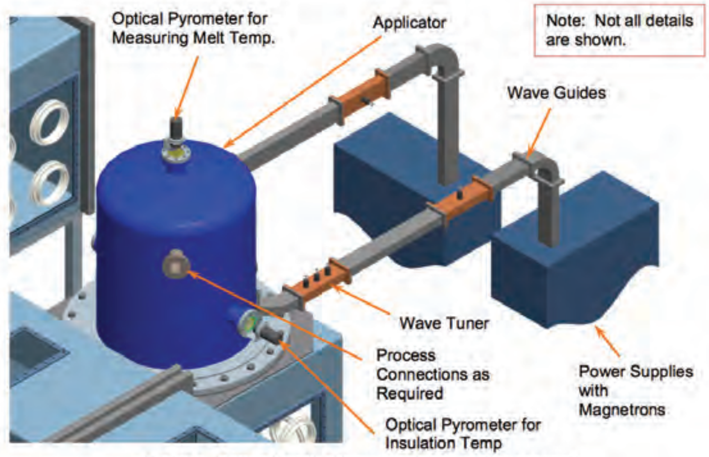

Figure 3 – Bottom Loading Microwave Furnace Components

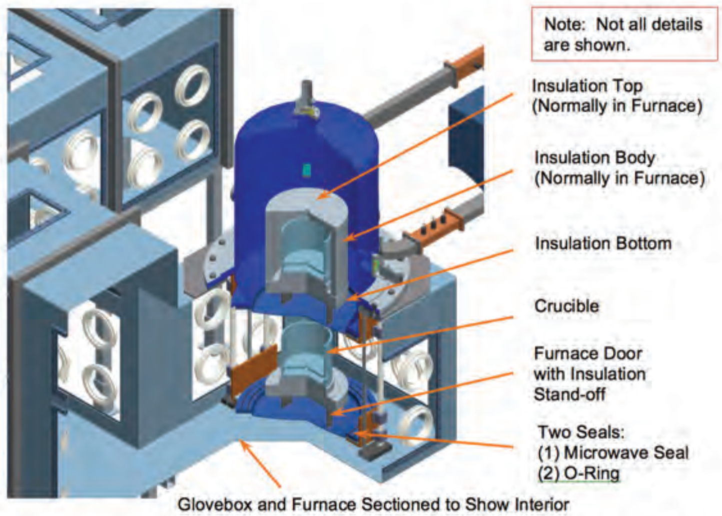

Figure 4 – Bottom Loading Microwave Furnace Components Inside of the Glovebox

Figure 2 through Figure 4 shows a conceptual design of a bottom loading microwave furnace integrated with a glovebox, and all of the various components. There are a few advantages of a bottom loading configuration as it generally allows visibility to the inside of the furnace door, provides accessibility to door seals for maintenance/replacement, and clears up space on the floor of the glovebox to allow for a material handling device for the door. This configuration also minimizes residual heat from flowing into the glovebox space due to thermal buoyancy effects which causes the heat to rise. Figure 5 and Figure 6 (on page 14) show a conceptual design of a front loading microwave furnace integrated with a glovebox, and all of the various components. The inside of the furnace, the inside of the furnace door, door seals and product inside of the furnace are generally blocked visually and physically by the front door and thus is not desirable. A top loading furnace is generally not desirable in the nuclear industry as it creates a "large" internal volume on the inside floor of the glovebox which

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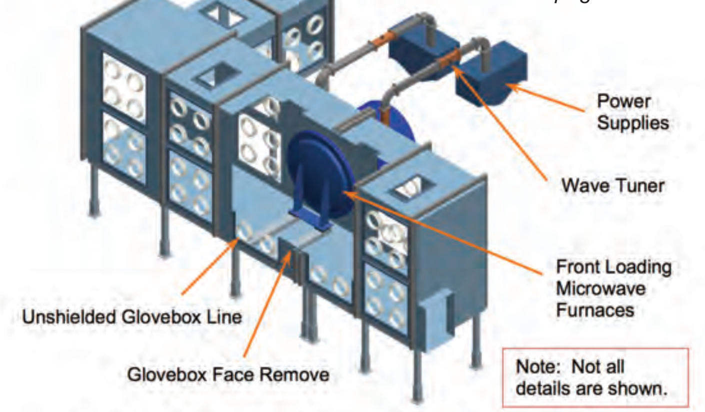

Figure 5 – Front Loading Microwave Furnace Integral with a Glovebox

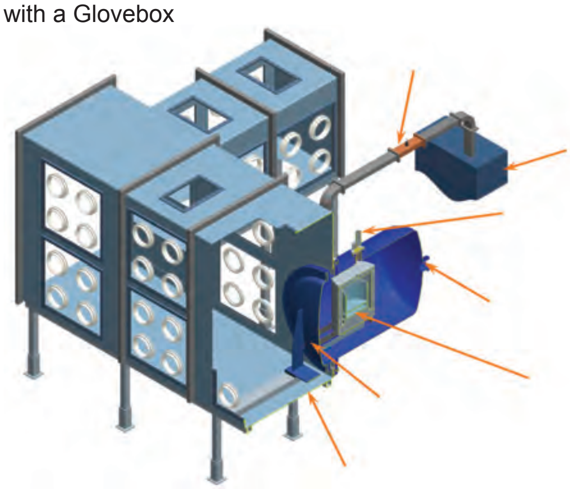

Figure 6 – Front Loading Microwave Furnace Cross Section

can collect water in sufficient quantity and shape where criticality events are a significant risk. A tunnel style furnace is similar to the top, front, bottom, and side loading furnace with the primary difference being that the furnace connects two gloveboxes with the material transferring from one of the gloveboxes to the other.

Industrial Microwave Furnace Insulation and Crucible Stack-Up

Figure 7 shows the inside of an industrial microwave furnace designed for melting metals while maintaining a relatively "cool" furnace. As discussed previously the crucible is made out of a material that is able to suscept with the microwaves causing it to heat-up while the insulation is primarily transparent to the microwave and only heats up due to the crucible heating up. This is why it was stated in the previous article that "microwave furnaces are cool." If designed properly, the walls of the furnace remain relatively cool as compared to the molten metal on the inside of the furnace. The insulation stack-up acts as an "oven" inside of the microwave furnace, and is thus the "heart" or hearth of the microwave furnace for melting metals.

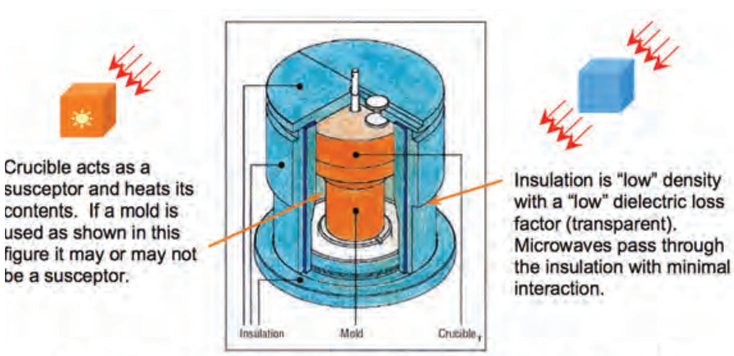

Figure 7 – Insulation, Crucible and Mold Stack-Up (Adapted from Reference 2)

Keeping the Microwave Furnace "Cool"

A steady state thermal analysis of a fictitious microwave furnace (see Figure 8) has been performed using Computational Fluid Dynamics (CFD). The crucible and mold are subjected to a uniform heat load, and the maximum crucible/mold temperature of ~2000°C at steady state is obtained. The atmosphere of the furnace is air, although it is

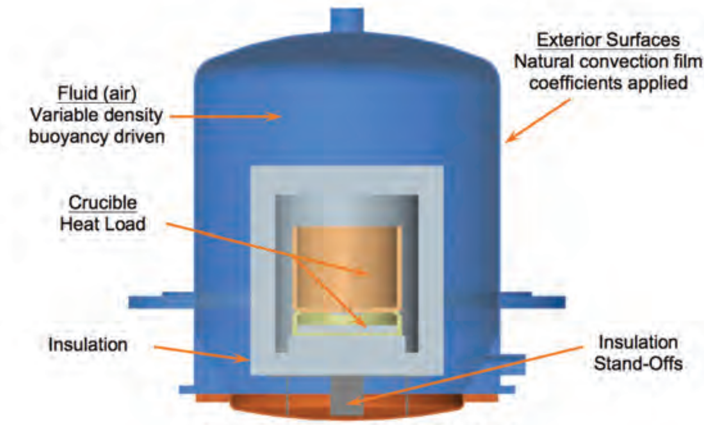

Figure 8 – CFD Thermal Analysis Model

common for furnaces in the nuclear industry to have inert atmospheres (argon, helium, nitrogen) and/or are operated at a vacuum. The internal atmosphere is fully contained for this example (i.e. no sweep gas), and natural convection is applied to all outside surfaces with the surrounding

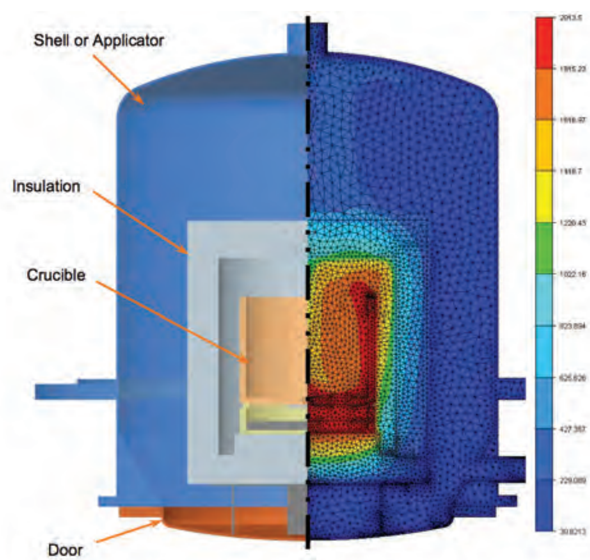

Figure 9 – CFD Thermal Analysis Temperature Profile

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temperature outside the glovebox at 72°F and inside the glovebox at 90°F.

As can been seen in Figure 9, the heat is mainly contained in the insulation package. The top of the insulation is the hottest as the heat rises in the microwave chamber. Figure 10 shows the velocity profile of the air inside of the microwave furnace. It can be seen that the fluid velocity is

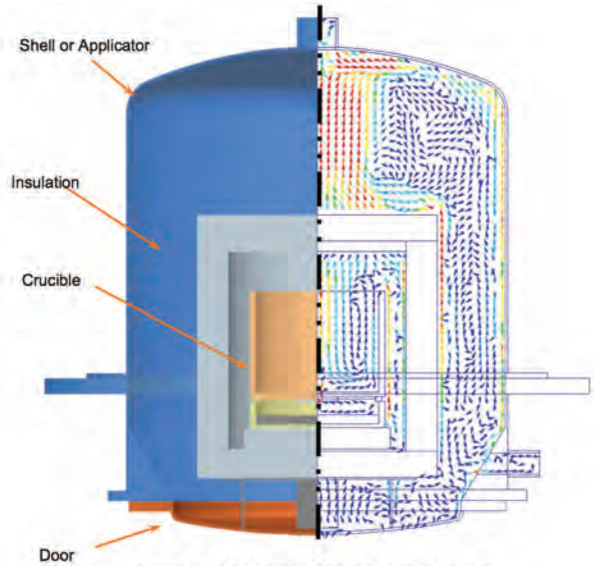

Figure 10 – CFD Thermal Analysis Velocity Vectors

induced by buoyancy driven forces (natural convection) as the hotter air rises and cooler air is displaced to the bottom of the furnace. Natural convection cells form in the chamber, and a warm air plume forms on top of the insulation lid.

Temperature of the door and standoff plate raises 7°F from 90°F to 97°F. If designed properly, the insulation standoff on the door will conduct minimal heat to the door. The maximum temperature of plate underneath insulation is 429°F, and the touch temperatures in a glovebox are generally

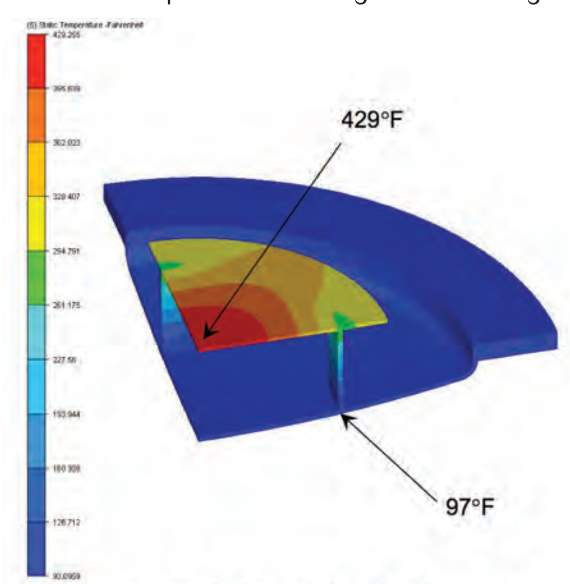

Figure 11 – CFD Thermal Analysis Door Temperatures

limited to 140°F. Since the heat is contained in the insulation package, water cooling of the shell or applicator is not required which is a significant advantage in the nuclear industry. Thus microwave furnaces really are "cool".

One potential disadvantage of microwave furnaces is the cool down time can be excessive because the insulation package works so well at minimizing the heat to the shell of the furnace. It is difficult for the heat to transfer from the molten metal to the outside of the insulation. The thermal

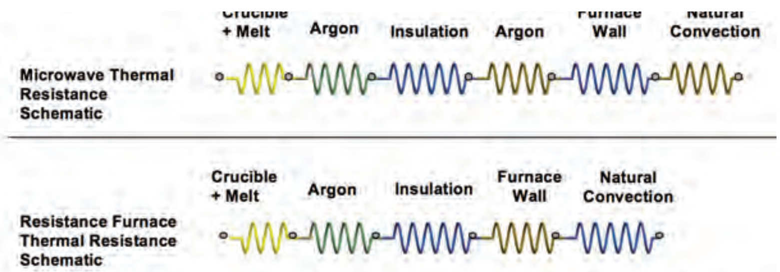

Figure 12 – Basic Thermal Resistance Circuits for a Microwave and Resistance Furnace

resistance of a microwave system and a basic resistance furnace is graphically shown in Figure 12 with argon shown as the inert atmosphere inside of the furnaces. There is a second volume of argon in the microwave furnace which can be relatively large to keep the external surfaces "cool", and adds significant thermal resistance to the cool down process. This can generally be overcome by implementing a forced cooling system.

Advantages and Disadvantages of a Microwave Furnace

There are several advantages and disadvantages of using Microwave Furnaces in glovebox applications which are important to understand. Here is a brief list of some of the advantages of microwave furnace technology:

- The only item inside the furnace that may need to be replaced is the insulation. There are no heating elements to replace.
- No cooling of the furnace body is required if insulation package and applicator is designed correctly.
- Water cooling of the shell is not required (magnetrons are water cooled, but these are located outside of the glovebox).
- There are generally no concerns about thermal excursions as active cooling is not required for the furnace body. There is very little thermal momentum. When the microwave is switched off, the source of heat is immediately removed from the object.

Continued on page 16

Continued from page 15

- Magnetrons can be replaced without penetrating the glovebox or furnace boundary.
- Magnetrons are 65 to 70% efficient.
- Microwave furnaces can ramp to temperature relatively quickly.
  - Furnace heat-up rates can be achieved on the order of 35-40°F per minute. Heat-up time is approximately 1-hour to get to 2000°C.
- The inside of the furnace remains relatively "clean" due to the insulation package surrounding the crucible. Much of the metal off-gassing is contained in the insulation package.
- There are claims that the crucible is less likely to crack due to the crucible itself being heated by the microwaves resulting in a more uniform heating profile.
- High temperatures of approximately 2300 °C can be reached with a relatively low power demand (2-6 kW) using the microwave process.
- Graphite is not required for the furnace process which can be an issue with certain materials processed in the nuclear industry.

As with any technology, there are disadvantages as well that need to be considered when exploring the potential to implement microwave furnaces.

- Generally, microwave furnaces that are to be integrated into a glovebox are proprietary designs.
- Microwave furnaces are more of a specialized technology that requires vendors to have specific experience and knowledge.
- Proprietary materials are required to interact with microwaves (i.e., crucible or charge needs to couple with the microwaves, and insulation needs to be 'transparent' to the microwaves).
- Not widely used for melting metals. Induction and resistance furnaces are more common.
- Excessive cool down times in a glovebox due to the thermal resistance of the furnace system. Cool down times are a concern in glovebox applications as the furnace can't be open (in general) until the contents of the furnace are cooled below a certain temperature (e.g., 140 °F). Overall cycle time consists of a minimum of ramp-up, hold, and cool down. Chilled gas can be circulated inside of the furnace to assist with cooling.
- There are a couple of hazards associated with microwave furnaces: microwave exposure, and electrical hazards around the magnetrons.
  - Exposure to microwaves can damage the lens of the eye which can lead to a higher incidence of cataracts later in life.
  - The magnetrons require a high voltage power supply. Operating a magnetron with the protective covers removed and interlocks bypassed should be avoided.

There are other intricacies associated with microwave furnaces not discussed in this article. One example is that traditional thermocouples can't be used inside of a microwave furnace, thus "high" temperature optical pyrometers are typically used with sight glasses to measure the temperature of the melt, crucible, and insulation package inside of the furnace.

Summary

Microwave furnace technology used for melting metal is relatively new and has several advantages as compared to other melting technologies (induction, resistance, arc melting, etc.). The National Research Council (Reference 3) has stated that, "It is very clear that the microwave processing of materials has some major advantages and has had major successes. But it is clear that potential users should take the time to become knowledgeable about microwaves and their interaction with materials before embarking on a program of using microwaves to process materials." This two part article on Microwave Furnace Technology for melting metals as it relates to gloveboxes and the glovebox industry has discussed common furnaces used in the glovebox industries, has provide an overview of microwaves, presented the common components of a home microwave oven, shown how to melt metals in a microwave oven, discussed the integration of microwave ovens with gloveboxes, and has provided some of the advantages and disadvantages of their use.

Hopefully this article has peaked your interest in microwave technology and microwave furnaces as they are really "coo.l"

References

1. Reid, David. MELTING METALS IN A DOMESTIC MICROWAVE. https://www.talisman.org/~erlkonig/misc/microwave-metal-casting.html.

2. Ripley, Edward B. and Jason A. Oberhaus. Melting and Heat Treating Metals Using Microwave Heating.

3. Committee on Microwave Processing of Materials: An Emerging Industrial Technology, Commission on Engineering and Technical Systems, National Research Council. Microwave Processing of Materials. 1994. ❖

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Improvement by Experience: Why Lessons Learned?

By: Stanley Trujillo, LANL

Traditionally, human error has been viewed as the primary cause of most accidents and unexpected events. Lessons Learned then, are opportunities to learn from our mistakes and the mistakes of others. By sharing operating experiences in the form of lessons learned and best practices in corporations, companies, government agencies and facilities we learn how to anticipate how an event or error can be prevented. Being proactive is a more cost-effective means of preventing events and problems from happening or further developing. For these reasons, the American Glovebox Society (AGS) will begin incorporating Lessons Learned (LL) and best practices into the annual conference process and agenda proceedings.

By creating opportunities for AGS members to share LL and best practices, the AGS continues to serve as a network where glovebox subject matter experts (SME's) can share and transfer important technical knowledge and expertise.

The dissemination of lessons learned and best practices dovetails nicely with the primary reason the AGS was developed: "…to promote the safety and quality of glovebox systems; promote communication; disseminate knowledge in the field of glovebox technology." Incorporating this information and networking with others helps promote the overall safety culture in the containment industry.

By creating opportunities for AGS members to share LL and best practices, the AGS continues to serve as a network where glovebox subject matter experts (SME's) can share and transfer important technical knowledge and expertise. This knowledge can then be archived and easily referenced when updating glovebox standards, guides and practices. In addition, it can be readily available for glovebox operators nation-wide prior to beginning work, particularly if the job is new to the operator(s), or has never been performed. The Lessons Learned process also helps managers and employees share operating experiences in order to avoid repeat events and improve overall operational performance.

More importantly, a robust Lessons Learned program can raise awareness about workplace hazards, prevent accidents, and possibly save a life. By sharing best practices and operating experiences, we contribute to safer work environments for our colleagues and peers; those we currently work with and those who will someday follow. In support of AGS's overall goal to continually promote safety of glovebox systems and disseminate knowledge in the field of glovebox technology, it makes perfect sense to formally incorporate Lessons Learned into the AGS communications fabric. Why not? If you think about it, we've been doing it all along!

As a Lessons Learned Coordinator and former radiation control technician at Los Alamos National Laboratory, I have seen firsthand how the application of Lessons Learned can prevent workplace accidents. In the spirit of continuous improvement, we (LANL) began evaluating our Lessons Learned program in search of opportunities for improvement. Benchmarking activities with other DOE sites revealed a near Complex-wide consensus that OPEXShare is largely considered the premier operating platform for LL databases. OPEXShare supports the implementation of the U.S. Department of Energy's Corporate Operating Experience Program. With the spirit of collaboration and sharing of best practices in mind, LANL has begun the process of developing a new LL database with the intention of using OPEXShare as the actual vehicle or as the model for its new program.

The AGS Standards Development Committee (SDC) has been discussing the challenge of disseminating glovebox and isolator lessons learned throughout the AGS for the last five years. The committee has been tracking these and sharing with the other members of the committee, but struggling with how to consolidate the information and disseminate the information to all AGS members. OPEXShare provided a solution that the SDC had been seeking for years. This past spring, during the quarterly SDC meeting, OPEXShare was introduced and although some members were already registered users, other SDC registered as well. Thus, the AGS has opted to partner with OPEXShare as a central repository for glovebox safety lessons learned and best practices.

OPEXShare was developed for the Department of Energy by Mission Support Alliance in Richland Washington and is managed by Gerry Whitney. ❖

Thoughts from Newman

By: John T. Newman, PE

Glovebox Technical Tips, Advice, and Stories

I remember as a young man, back in 1981, walking into a small stainless steel fabrication shop for a job interview. They specialized in manufacturing a strange product that they called a glovebox. The owner of the place was this old white haired gentleman named Victor Molitor, had that crazy Albert Einstein look, but he also had this incredible magic twinkle in his eyes. That day, I had no idea what was in store for me. It was just a box, how hard can it be to make a box? I had entered the world of containment and little did I know how my life would change. Over the years I have learned to greatly respect that box and the people who make and use them.

At that time, gloveboxes were primarily used at the National Laboratories for work in support of the cold war. Each lab had their own standard designs and, in their secret way of operating, no one would share what they had learned. Being one of the few manufacturers who built gloveboxes, we had the unique opportunity to see what everyone was doing. There were good and bad designs along with an occasional disaster. Vic used to say "If we could only get them to talk to each other it would sure make life easier." That vision, along with the hard work and devotion of a few individuals, resulted in the formation of the American Glovebox Society.

Last summer the AGS celebrated its 30th anniversary and if Vic was alive today I think he would be amazed and proud of this group of containment professionals, who are so passionate about their gloveboxes and isolators. After all, it started as just filler work to fill his shop when the Commercial Kitchen Equipment business was slow. Well, today everyone is speaking to each other and sharing all of the critical information that is necessary for a successful containment project. ❖


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