American Glovebox Society
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Summer 2019

Bubbler Flow Testing

By: Clayton G. Turner, Aaron L. Balsmeier, and Ryan J. Shawler
Contributors: Paul J. Parker and Mark Borland; Idaho National Laboratory

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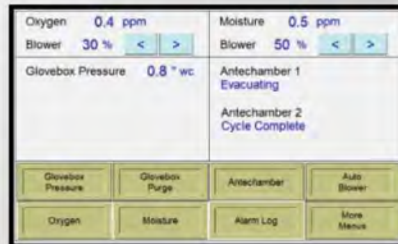

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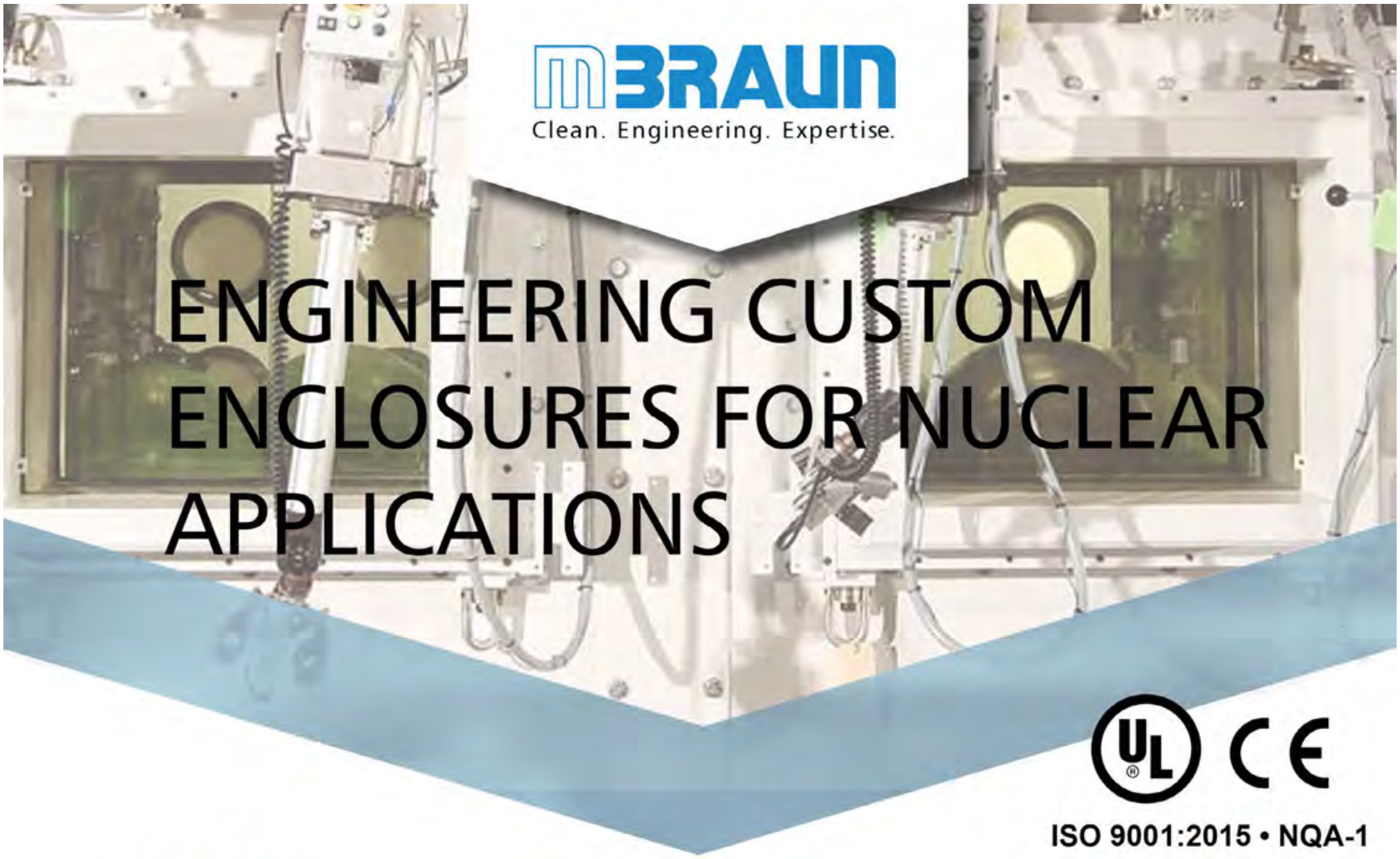

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President's Message

By: Tony Heinz

This is my last President's address for this term in office and before I turn the responsibilities over to Gary Partington, President Elect; I want to share with you what a great pleasure and opportunity it has been for me. Working with the society is an amazing experience and it's hard to believe how much an all-volunteer organization can accomplish! Just since last year's conference, the Standards Development Committee has revised the Guideline for Gloveboxes and the Standard of Practice For Glovebox Fire Protection. These are complicated documents that rely on the assistance of subject matter experts who have graciously taken the time out of their busy schedules to help us put these together. We are grateful for all the assistance that has been given and continues to be given to help our society!

We also have a great conference planned in Boston with unique speakers, exhibitors, and events. The participation rate at the Standards Development Committee meetings is at an all-time high and the Board of Director's participation has increased. To top it off, new for this year's conference, we have added a 4-hour topic-specific class the day after the conference. This year's topic will be Nondestructive Examination – What is it?

This is such an important topic within our industry. In this class you'll learn not just what it is, but why it is important, why we need it, and what happens if we don't utilize it. You'll learn about the various NDE Methods used today and the basic principles of each method. I hope to see you all there as we continue to learn and grow our knowledge base, reminding ourselves why we do what we do each day.

With success comes great expectations, and we are up to the challenge; however, we do need your help. AGS as a society has a lot of ideas that will be great for the industry, the manufactures, and the end users, but we need to get these ideas out in front of all the existing and potential new members and users. To move these ideas forward, we need additional volunteers. There are many more committees that need support: Outreach, Membership, Training, etc. Please think about who you know and who may be interested in helping us continue to grow and expand. The work involved is not only beneficial to the committee, but to our industry as a whole. The more knowledge and understanding we put out there, the more improvements we can make for all of us.

I look forward to seeing everyone in Boston! We have a lot planned, new information to learn, and new friends to meet and share our knowledge with!

On my final note, I want to thank you all for your continued support and for the support of this society. It's been an honor to be your elected President.

Regards,

Tony Heinz
AGS President 2018-2019

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Editor
Justin Dexter
j.dexter@mbraunusa.com

Advertising Manager
Crissy Willson

Design and Production
Tony Monaco

Publisher
American Glovebox Society

The Enclosure is published for the benefit of the glovebox engineering profession serving nuclear, biomed, pharmaceutical, semi-conductor, aerospace technology, and other industries.

Circulation: Our continually increasing circulation is now at 3,100 copies. We have subscribers throughout the United States, Canada and around the world.

Readership: Glovebox designers, users, engineers, fabricators, manufacturers, suppliers, contractors, libraries, and universities.

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The Enclosure is published by:
American Glovebox Society
526 So. E Street
Santa Rosa, CA 95404

Tel.: (800) 530-1022 or (707) 527-0444
Fax: (707) 578-4406
E-mail: ags@gloveboxsociety.org
Website: www.gloveboxsociety.org

Postmaster: Send address changes to:
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joseph.mcveigh@cns.doe.gov

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j.newman@mbraunusa.com

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dan.payne@wagstaff.com

Jose Rodriguez
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Bubbler Flow Testing

By: Clayton G. Turner, Aaron L. Balsmeier, and Ryan J. Shawler

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The ability to control pressure within gloveboxes is critical. Gloveboxes at the Idaho National Laboratory (INL) are typically rated to withstand between 5-10 inches of water gauge (inH2O, pressure or vacuum), depending on the box design. Pressures too large could compromise the glass windows. Therefore, the gloveboxes are equipped with devices used to control the internal pressure. One such device is the bubbler.

Bubblers, as shown in Figure 1, are a passive pressure relief device used to help manage the pressure generated inside the glovebox during abnormal conditions. It has been assumed that a glovebox with three bubblers can flow 45 cubic feet per minute (CFM) through the system; therefore, each bubbler is expected to flow 15 CFM. This flow rate value was considered common knowledge and was never tested for accuracy. This knowledge came into question during an acceptance test of a glovebox where the flow rate and pressure control of the bubbler were not in the anticipated ranges. To understand the flow properties and the resulting differential pressures of the bubblers, a series of tests was developed and performed.

The test series consisted of flowing different gases through different fluids in a MBRAUN® bubbler [3]. These tests were used to collect data of flow rates and the maximum differential pressures across the bubbler. The gases used were compressed air, argon, and nitrogen. The bubbler fluids used were water, Inland® 45 Mechanical Pump Oil [1], and Leybold Leybonol® LVO 210 Ester Oil [2]. Inland 45 and Leybonol LVO 210 are commonly used vacuum oils in INL glovebox bubblers.

The test setup consisted of filling the bubbler to a specific fill level with one of the fluids. Figure 2 shows the orientation depiction and fill level measurement used during the tests. The fill levels varied from 0.5 inches to 3 inches of bubbler fluid. The recommended bubbler fluid fill height from the bubbler manufacturer was close to 3.5 inches using the convention shown in Figure 2. At each fill level, compressed gases were used to develop flow through the bubbler. The flow rates for the tests varied from 1 CFM to 15 CFM. The test results use an adjusted flow rate which was corrected using an equation provided by the flow instrument manufacturers to compensate for the different gases used at the test conditions. The flow instruments were

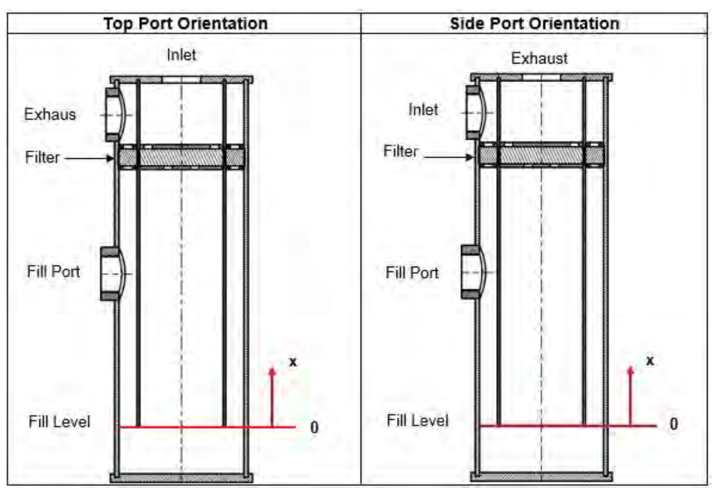

Figure 1 (Left) Bubbler

Figure 2 (Above) Bubbler Orientations and Fill Level

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Bubbler Flow Testing

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calibrated for air at standard temperature and pressure. Each test also had a specific orientation for flowing the gases, which was either the side port or the top port.

To develop an idea for the range of variability of the differential pressure across the bubbler, two series of five similar tests were performed. Each test used Inland 45 filled to 0.5 inches flowing compressed air from 1 to 15 CFM through the side port orientation. From this series of tests, it was determined that a differential pressure greater than 0.5 inH2O was a reasonable threshold for the variability inherent to running the test. These same tests also showed that there is little to no effect from a filter that has been saturated with oil. The first five tests were with a clean filter, while the second series of five tests were performed after many tests had been completed where oil saturation occurred. The average differential pressure between the old and new filter were very similar, as shown in Figure 3. An example of a saturated filter is shown in Figure 4.

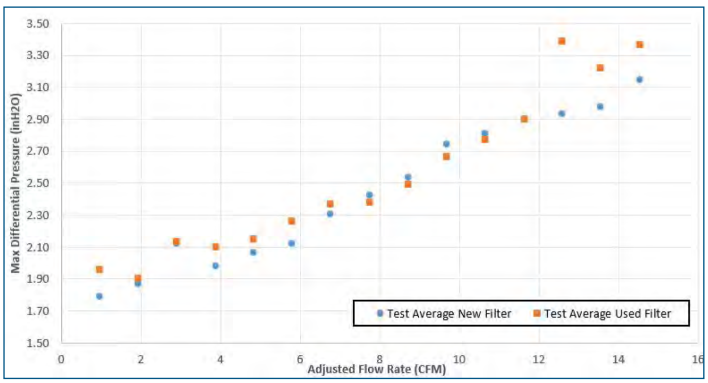

Figure 3 Effects of a Saturated Filter on the Maximum Differential Pressure

Figure 4 New Filter Saturation from Test using Compressed Air through the Top Port with Inland 45 filled to the 0.5" Level

During testing, two points of interest were considered: filter saturation and filter breakthrough. Filter saturation was defined as when the bubbler fluid reached the filter and began to saturate the filter. Filter breakthrough occurs after filter saturation and was defined as when the bubbler fluid escaped downstream of the filter and entered into the exhaust piping. Once filter breakthrough would occur, testing would stop and the excess bubbler fluid in the filter would be blown out. All tests performed resulted in the filter becoming saturated and only 13 of the 60 tests were able to flow above 15 CFM without the bubbler fluid passing the filter and entering the exhaust pipe. Out of the 13 passing tests, 12 tests had their bubbler fluid filled at or below one inch. Figure 5 shows a test where filter breakthrough occurred with the bubbler fluid entering the exhaust pipe. Figure 6 shows a test where filter saturation occurred with the bubbler fluid saturating the filter.

Figure 5 Filter Breakthrough using Compressed Air flowing at 10 CFM through the Top Port with Inland 45 Filled to 1.5" Level

Testing revealed that the bubbler was more efficient at maintaining a lower differential pressure using the top port orientation compared to the side port. The difference between flow orientations can be seen in every test, with almost all data points varying by more than 0.5 inH2O. The side port orientation often saturated the filter before the top orientation as well.

It was assumed that a difference in area within the bubbler could have caused the difference between the two flow orientations. After reviewing the bubbler manufacturer's data, it was determined that the outer column of the bubbler had a 7.96 % larger area. The difference in areas resulted in unequal changes in level between the inner and outer column and caused the pressure to be higher for the side port orientation compared to the top port orientation. However, this change was small and there remained a difference

Continued on page 12

Glove Integrity Testing or leak testing, how often should it be done?

Glove leak testing to monitor the integrity of glovebox & isolator gloves is often only done periodically. This practice is normally based on the thought that it takes too long. Years ago with old rudimentary leak test devices taking up a lot of space and only allowing very few gloves to be tested at one time, leak testing all gloves on a line use to take hours.

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Bubbler Flow Testing

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Figure 6 Filter Saturation using Compressed Air flowing at 15 CFM through the Top Port with Leybonol 210 Filled to 1.5" Level

between the two flow orientations that was generally greater than the 0.5 inH2O threshold mentioned earlier. There were some cases where the pressure fell within 0.5 inH2O when the change in area is considered, but there was still a distinct difference between the two flow directions. This is shown in Figure 7.

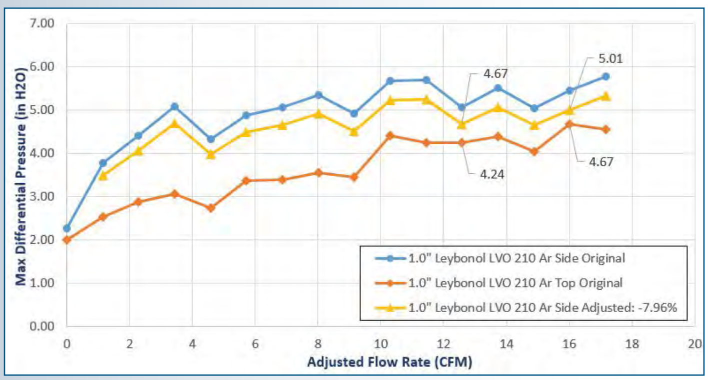

Figure 7

It was hypothesized that there would be a noticeable difference between the different gases due to their densities. There appears to be no noticeable difference between the different gases. Nitrogen, Argon, and compressed air all performed similarly with respect to the maximum differential pressure achieved and no clear tends emerged; however, all three gases were used only with Inland 45. Most of the data from these tests fell within the 0.5 inH2O threshold. The tests used to compare gases used the same parameters. The results can be seen in Figures 8 and 9.

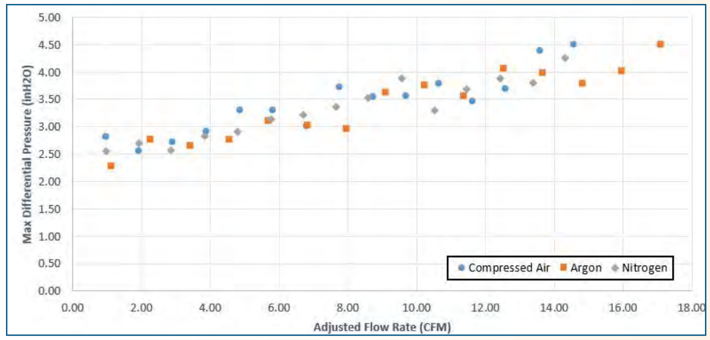

Figure 8 Gas Comparison Tests using the Top Port with Inland 45 Filled to the 1.0" Level

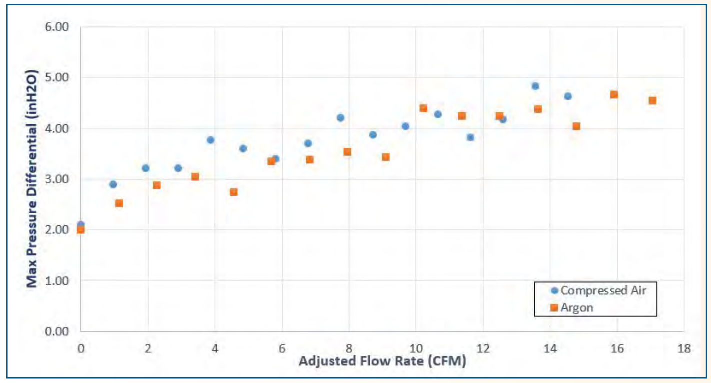

Figure 9 Gas Comparison Tests using the Top Port with Leybonol 210 filled to the 1.0" level

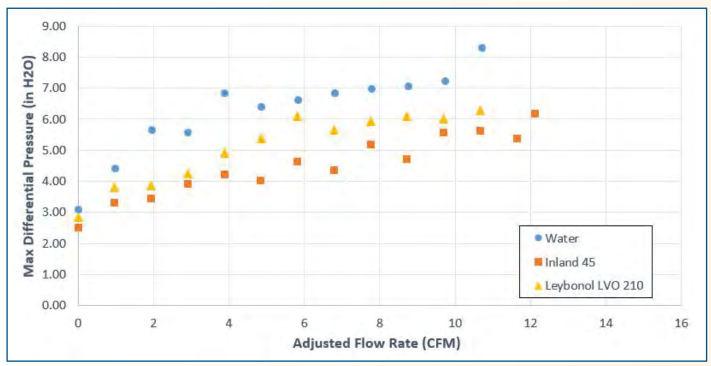

Figure 10 Bubbler Fluid Comparison Using Compressed Air through the Top Port with Fluids Filled to the 1.5" Level

Another hypothesis for the test was that there would be a noticeable difference between the different bubbler fluids. Testing revealed a weak correlation that water results in the highest differential pressure, Leybonol LVO 210 resulting in the second lowest, and Inland 45 resulting in the lowest differential pressure. This is shown in Figure 10 and 11. However, the difference between the two oils often times fell within the 0.5 inH2O threshold which indicates that there may be no real difference. There is also a difference in the specific gravities of the fluids, which was also considered.

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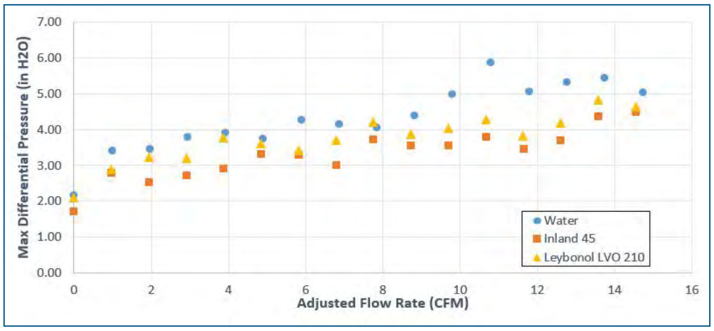

Figure 11 Bubbler Fluid Comparison Using Compressed Air through the Top Port with Fluids Filled to the 1.0" Level

When the specific gravities are considered and the effects of the fluid are removed from the maximum differential pressure, the results become similar. Since the normalized differential pressures are similar, the specific gravities of the fluids may be the main reason for differences in the maximum differential pressure between the fluids. The results are shown in Figures 10 and 11.

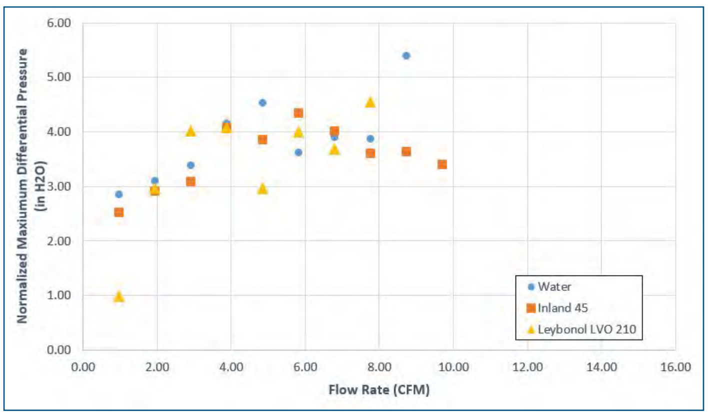

Figure 12 Normalized Bubbler Fluid Comparison Using Compressed Air through the Side Port with Fluids Filled to the 1.5" Level

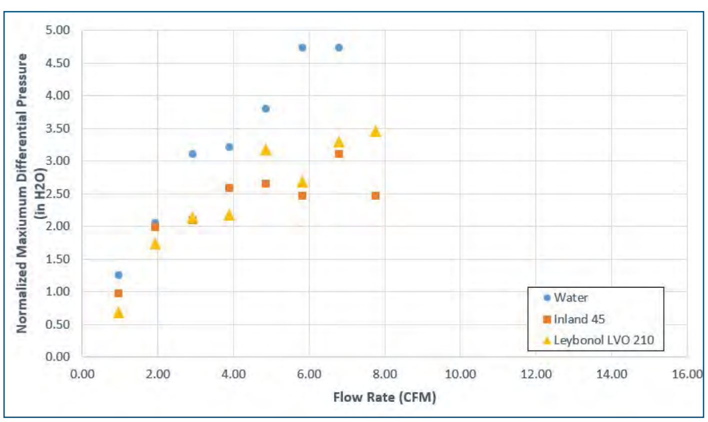

Figure 13 Normalized Bubbler Fluid Comparison Using Compressed Air through the Top Port with Fluids Filled to the 2.0" Level

It is also important to consider the exhaust system to which the bubbler may be connected. The strength of the exhaust system connected to the bubbler will determine a starting offset in the bubbler fluid levels between the inner and outer column. This offset will limit the minimum allowable fill level to prevent flow through the bubbler with a glovebox differential pressure of zero.

Overall, the testing was performed and analyzed to determine if the bubbler could flow 15 CFM and maintain the glovebox within the designed pressure. The testing revealed that the bubblers met the anticipated flow rates generally without filter breakthrough when the fill level was 1" or less, shown in Table 1. However, it should be noted that the flow rate capacity diminished with increasing fluid level.

Gas	Fluid Type	Fill Level	Port	Filter Saturation CFM	Filter Saturation DP
Argon	Leybonol 210	0.5	Side	12.52	3.09
Compressed Air	Leybonol 210	0.5	Side	6.78	2.84
Nitrogen	Inland 45	0.5	Side	8.57	2.85
Argon	Leybonol 210	0.5	Top	11.37	2.48
Argon	Inland 45	0.5	Top	9.12	2.26
Compressed Air	Water	0.5	Top	9.82	2.25
Compressed Air	Leybonol 210	0.5	Top	10.66	2.44
Compressed Air	Inland 45	0.5	Top	7.76	1.84
Nitrogen	Inland 45	0.5	Top	6.70	2.14
Argon	Leybonol 210	1.0	Top	10.23	4.40
Compressed Air	Leybonol 210	1.0	Top	6.79	3.71
Nitrogen	Inland 45	1.0	Top	4.78	2.92
Compressed Air	Water	1.5	Top	3.90	6.85

Table 1 Tests Passed without Filter Breakthrough

The tests also showed that there was no noticeable increase in differential pressure due to the use of different glovebox test gases or by changing the bubbler fluid viscosity. A trend was identified that the flow entering the top port was more efficient than flow entering the side port.

In conclusion, each glovebox has specific requirements for maximum relief flow and relief pressure points; therefore, bubblers should be properly analyzed to verify they would meet the system requirements. Following installation, a complete system test should be performed under worst-case conditions (over pressure and under pressure) to ensure pressure relief is adequately sized. In the case where increased flow is desired beyond the capability of a given bubbler, it should be possible to simply add more bubblers in parallel to the system to achieve the needed flow rate. ❖

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3 MBRAUN Products. Bubbler P/N 7015489. https://www.mbraun.com/index.php.

By: John T. Newman, P.E.

Communication Breakdown

The older I get, the more convinced I am that we humans are simply not capable of communicating with each other. I have to quote from an old movie from 1967, Cool Hand Luke, starring Paul Newman, where the prison warden says in classic southern drawl, ,"What we've got here is failure to communicate." How often that happens is astounding. Throughout the history of mankind, major wars have been fought over some breakdown in communication. I think I read someplace that our emotions developed as the main method of communication before language was created. This sometimes worked but could be easily misinterpreted. If someone was coming at you with a mean looking scowl on his face, you would most likely run like hell because that may indicate imminent attack, but then who knows, the scowl could have been pain as the approacher actually just stubbed his toe on a rock and had no intent of attacking at all. Language was created and things got better, but not a lot, as the obscenities normally hollered from stubbing a toe could very easily be misunderstood as indication of attack. When you look at communication between a man and a woman, or between an adult and a teenager, forget it altogether. I am not even going there.

We struggle with communication in the business world today just as horribly as the cave man. Not much has changed over the years and it may even be worse. Most business communication is with someone that is not standing in front of you. When I first started in the business world, many years ago, we communicated primarily by the telephone and the US Mail service. Sure, we could dial up someone and talk, as we can still do today. The written part was a little more involving. In those days we didn't have a PC with word processing software on our desk. We had to write everything by hand, and give it to the office secretary, and yes we called them secretaries, to type it up for you. She, and yes, usually she, would type away to create your document, along with massaging the words to make it coherent by someone who was going to read it. There was always a bit of back and forth with corrections and re-writes until the final version. Although, if you changed it enough to cause a whole page to be re-typed, you would be in big trouble. Once the document was complete, it would be another week or so, before it reached its destination through the US Mail Service.

We struggle with communication in the business world today just as horribly as the cave man.

Along came the FAX machine and what a wonderful device that was. You could send and receive written information, through the phone line, in the same day, in a matter of minutes. Well, maybe sometimes, that's if the machine didn't jam, run out of paper, or someone answering the phone instead of letting the FAX machine pick it up. The early machines were not the plain paper fax that we are phasing out today, the paper was fed from a roll and the data was etched on to the paper by a heat process that rapidly faded into something completely unreadable. Warts and all, it was fantastic, allowing us to get written communications in the same day. Being in the machine design business, catalog information for purchase parts was one common item that was sent by FAX. In those days we didn't have the internet with search engines to find design components as we do today. We searched for components, by spending hours looking through a set of huge green books called the Thomas Register. Then, you had to call and order a catalog from said vendor, which would eventually show up a week or two later in the mail. The fax machine was a game changer, you could call a vendor and get them to fax you their catalog and have it in the same day, WOW!

Today, we have all of these amazing machines that we use for communicating. Virtually everyone has some type of PC, laptop, or tablet equipped with word processing software, allowing engineers the ability to create documents

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without the need of the secretarial services of the past. But unfortunately lost, is the oversight of these skilled wordsmiths that always seemed to decipher the cryptic writings of the engineer, transforming them into understandable language. We all know that the average engineer does not possess the skills required to write words and string them together in a manner that others can understand. Sorry, but it's true.

We can instantly search the internet and get information for any product out there for use in our designs. Gone are the rooms full of book shelves chocked with all the outdated component catalogs that we had delivered in the mail, along with the volumes of the green Thomas Register books. I have to say, that I don't miss them at all. Now we are all spoiled with this instagasm of information at our fingertips and no one remembers or even knows how hard we had to work in the past at finding the right component for the job.

Then along came the miracle of email. You would think that the convenience of it all would make us better communicators, but not really. And what a time suck that has turned into. Every day we are continually bombarded with a barrage of emails, and very few of them contain any viable information. A good part of my day is now spent sorting through the endless stream of emails, from business associates, customers, vendors, copies for information only and the spam, oh my god. All this has to be read, sorted through, replied to, filed away, and deleted. Everyone also expects replies immediately, and some people get really upset if you can't respond right away. Don't you just love the email that come with that little red asterisk, that supposedly means high importance, and the person that puts them on every one they send you? Yeah, I'll get right on it…

But yet we still continually miss-communicate. I see email as a very dangerous medium. It is very hard to truly communicate in an email, especially when you bang it out quickly without putting any thought into it. First of all, as I said before, engineers are notoriously poor at writing, and now your every thought has to be written in a legitimate form that can be interpreted by others. Without the facial expressions, the smile or frown used in face-to-face, how it is written will determine the tone. If you are not very careful with your phrasing and choice of words, you can send the wrong message or the reader will perceive something totally different than what you intended. This can also be amplified when writing to someone from a different culture than yours. A joke understood here in the States can be taken as an insult to someone from another country.

There are some basic email rules and etiquette that I have learned, usually from bad communicating experiences that I can share. Keep emails as brief and to the point as possible. Resist the temptation to add jokes and humorous references; although sometimes it is tough and I occasionally let one or two slip out. Always try to be courteous and polite, and be conscious of the tone that you are projecting from your choice of words. You don't want to come off sounding mad when you really aren't. Sometimes you can use a smiley face emoji to reinforce that you are conveying a happy message. Don't send out any of those scathing emails when you are really mad, as you will usually always say something you will regret later, and once it is out there, it will be there forever. Be sure to absolutely always proofread emails before hitting the send button. When you will be out of the office and away from your email, be sure to turn on the out of office automatic replies. It will let people know that you are not intentionally ignoring them and it will also help cut down on the mountain of email that takes hours to sort through when you get back.

One thing that seems to be declining is the face-to-face project meetings that we always used to have in the old days. Now days everyone wants to have conference calls instead of getting together. You can use web conferencing, which works pretty well, visual information can easily be shared between all parties. A design review meeting can be held online where design concepts can be shared with 3D CAD models that everyone can see and talk about. But, a little advice; when you are sharing your screen with the whole project team, be sure to turn off those annoying email notifications that continually pop up. No one wants to read all your incoming mail announcements and it can be embarrassing when something personal pops up on the screen for everyone to read. Although, in my opinion, the really important project meeting, the "Kick-Off Meeting", still should be held face-to-face. This allows the project team to meet, get to know each other a bit, and will tremendously help future project communication by understanding all of the personalities involved.

Cell phones today are absolutely amazing to an old guy like me. Everyone today has one and it is the ultimate communication device, you would think, but…why is it we still can't seem to effectively communicate with each other? It's that texting thing, which in the right perspective can work well I guess for many people, if you understand the language. BFF, LMAO, LOL, BTW…OMG what does it all mean? Good thing cell phones come with the internet so you can Google search for the meaning of all that stuff. I can handle short messages which can be very convenient, like meet you here at noon kind of thing, but holy cow, some people want to have extensive conversations by text. I can't keep up with it, and as their fourth message hits my phone, I'm still trying to craft a response to their first message.

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Thoughts from Newman

Bottom line here, hello people, it's a cell PHONE and you can actually call someone on it…Just dial the number and talk, like we have done since Alexander Graham Bell invented it back in 1876. Telephones have been the best communication device other than face-to-face, which you can actually hold a real-time back and forth conversation. You can communicate not only verbal language but you can also get the emotional facet that is missing from everything else, which at least gives us half a chance of understanding each other. So, forget the email and cryptic text; just pick up the damn phone, call someone and have a conversation. ❖

LESSONS LEARNED

By: Justin Dexter
Lessons Learned Committee Member

We are approaching a very historic milestone. July 20th marks the 50th anniversary of the Lunar Module Eagle landing on the moon. This was a "giant leap" for mankind. We couldn't have achieved this without learning some lessons along the way. Starting with the first crewed Mercury mission, and then advancing to the Gemini missions, NASA learned an incredible amount of information in a short amount of time. Making the leap to the Apollo missions finally brought the first human beings to the moon. As Stanley Trujillo mentioned in the last Enclosure, we focused on not what went wrong, but more on the best way to get there, or best practice.

As a reminder - best practice as defined by Merriam-Webster is: *"a procedure that has been shown by research and experience to produce optimal results and that is established or proposed as a standard suitable for widespread adoption."*

This year the AGS is turning 33, and the focus from a lessons learned standpoint is to celebrate your successes and process improvements. We have learned so much since 1986, and we continue to benefit from the lessons learned in glovebox design, fabrication and testing over the years. This summer we will focus on the best practices, just as NASA did in 1969.

Please share any lessoned learned or best practices with the AGS and OPEXShare. You never know what impact you might have on others who might be struggling with a similar challenge. See you in Boston!

Justin Dexter
Lessons Learned Committee Member ❖

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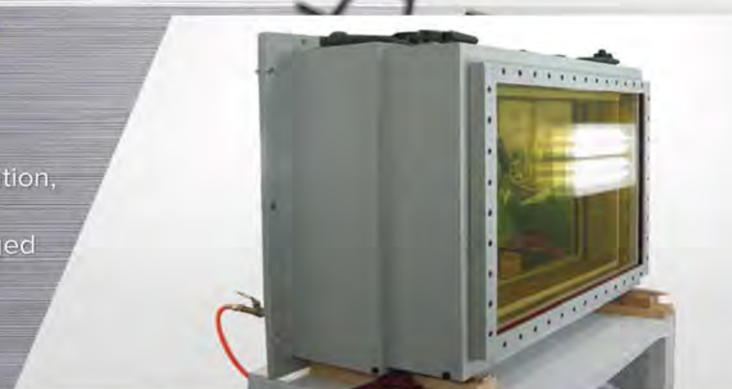

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CONTACT US

John Davis
Account Manager
Cell: 208-681-3005
Email: jdavis@ptius.net

Kevin Kotter
Account Manager
Desk: 208-782-9126
Cell: 208-680-6222
Email: kkotter@ptius.net

Corporate Headquarters
1858 W. Bridge Street
Blackfoot, Idaho (USA) 83221
Phone: 208-785-2274
Website: www.ptius.com


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