FAUSKE & ASSOCIATES, LLC

Process Safety News
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IN THIS ISSUE

Further Clarification of Non-Equilibrium and Equilibrium Flashing Flows Through Top Located Safety Relief Valves (SRVs)

By Hans K. Fauske, D.Sc., Emeritus President and Regent Advisor

Non-Equilibrium Flashing Flow

If all liquid exists at the stagnation condition (no vapor), extensive data suggest that a simple length criterion of the order of 100 mm characterizes the residence time (~ of the order of 1 ms) requirement for approaching equilibrium flashing flows which are well described by the Equilibrium Rate Model (ERM) (Fauske, 1985)

$$G_{ERM} = \frac{\lambda}{v_{fg}} (TC)^{-1/2} \qquad (1)$$

where λ is the latent heat of evaporation, v_{fg} is the change in liquid-vapor specific volume, T is the temperature and C is the liquid specific heat, all evaluated at the stagnation condition. In contrast, the maximum non-equilibrium mass flux as the length approaches zero is given by

$$G_{max} = (2P\rho)^{1/2} \qquad (2)$$

Where P is the stagnation gauge pressure and ρ is the liquid stagnation density. Considering that

$$G_{max} >> G_{ERM} \qquad (3)$$

determines the relevant velocity and the length requirement of about 100 mm for all liquid stagnation conditions (near saturated liquid and subcooling).

Equilibrium Flashing Flow

If a liquid-vapor mixture (void fraction $\alpha \sim 0.1$) exists at the stagnation condition, the length L (mm) required to satisfy a residence time of about 1 ms is given by

$$L\,(mm) = 1\,(ms) \cdot G_{ERM} / \rho\,(mm/ms) \qquad (4)$$

and in case $\alpha < 0.1$ at stagnation condition, the length increases to $L \cdot 0.1/\alpha$ resulting in length requirements different than 100 mm. In other words 100 mm length requirement is only relevant to all liquid stagnation conditions.

Given the above observations, Eq. 1 can be used without modification to estimate flashing two-phase flows through top located SRVs for relief sizing purposes using the following equation (Fauske, 1999)

$$G = \left[\frac{1-x_o}{G_{ERM}^2} + \frac{x_o}{C_{Dg}^2 G_g^2}\right]^{-1/2} \qquad (5)$$

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Letter From The President

Dear Customer,

We are very excited to offer expanded services and capabilities through growth initiatives and partnership opportunities within our parent company Westinghouse Electric Corp (WEC). By collaborating with WEC, we provide further expertise in nuclear services, relief system design, thermal hazards and flammability. Our on-site services are also better tailored to your needs in areas of plant services and process safety. And, we continue to lead the market in combustible dust hazards analysis and testing with our state of the art labs.

RefiningandPetrochemicalsme.com published a blog not long ago: "Process Safety Culture: Key Trends in Downstream Industry". Per the article, "Every year, complexity of equipment and processes increases, needing upgraded operational guidelines and procedures. Some of these requirements are set by state regulations. Taking action to implement the best hazard and operability (HAZOP) practices allows not only the use of latest technologies, but also the improvement of economic efficiency of a project via higher operational readiness level." No one is more focused on complex issues, technologies, safety and bottom line than FAI. It's what excites us.

As always, we are eager to hear your feedback. We strive to be responsive and forward leading. If there is something you anticipate needing or are contemplating, don't hesitate to contact us.

Best Regards,

JW Fasnacht

John W. Fasnacht, President

This photo was taken near Osaka, Japan by Dr. Jim Burelbach, Director, Waste Technology and systems Modeling at FAI, while training customers on the Advanced Reactive System Screening Tool (ARSST™), FAI's small-scale adiabatic calorimeter for characterizing runaway chemical reactions.

Harold Grossman, Sr. Consulting Engineer, and Ashok Dastidar, Vice President, Dust & Flammability Testing and Consulting Services, facilitate work groups during a recent NFPA 652 – An Introduction to Dust Hazard Analysis Course held at our main office.

Follow us on social media for industry and company updates

Flow Regime Determination in Emergency Relief System Design - Blowdown Testing

Flow regime determination in emergency relief system (ERS) design is important because it can impact your required vent size and will impact the quantity and rate of liquid material that is vented.

By Benjamin Doup Ph.D., Senior Nuclear and Chemical Engineer

Flow regime determination in emergency relief system (ERS) design is important because it can impact your required vent size and will impact the quantity and rate of liquid material that is vented. In the summer edition of the Process Safety Newsletter, we discussed the characteristics and showed the modeling of the churn-turbulent (or churn) and bubbly flow regimes. In the current issue we'll provide practical guidance on how to determine the expected flow regime under emergency relief venting conditions.

The flow regime during venting can be determined by running a blowdown test in the Vent Sizing Package 2 (VSP2™). The VSP2 blowdown test procedures, test interpretation, potential missteps, and benchmark test results that are applicable for vapor systems will be discussed.

VSP2 blowdown test procedures

The suggested approach is to simulate the upset scenario in the VSP2 and then depressurize the test cell using a vent located on the lid of the test cell. Figure 1 shows a schematic of the VSP2 setup in blowdown configuration. This configuration is applicable for many materials and tests. However, depending on the specific design of the blowdown test the following modifications may be investigated:

- If your material is not hazardous you may be able to route the vent line to an open vessel filled with room temperature water. The water will act as a quenching fluid for the hot effluent from the test cell.
- Multiple or larger vents on the containment vessel may be necessary in order to depressurize the containment vessel at a similar rate to the depressurization of the test cell.
- If the material being tested has a high vapor pressure at room temperature, valves may need to be installed on the fill line and vent line inside the containment vessel to prevent mass loss after the blowdown is complete.

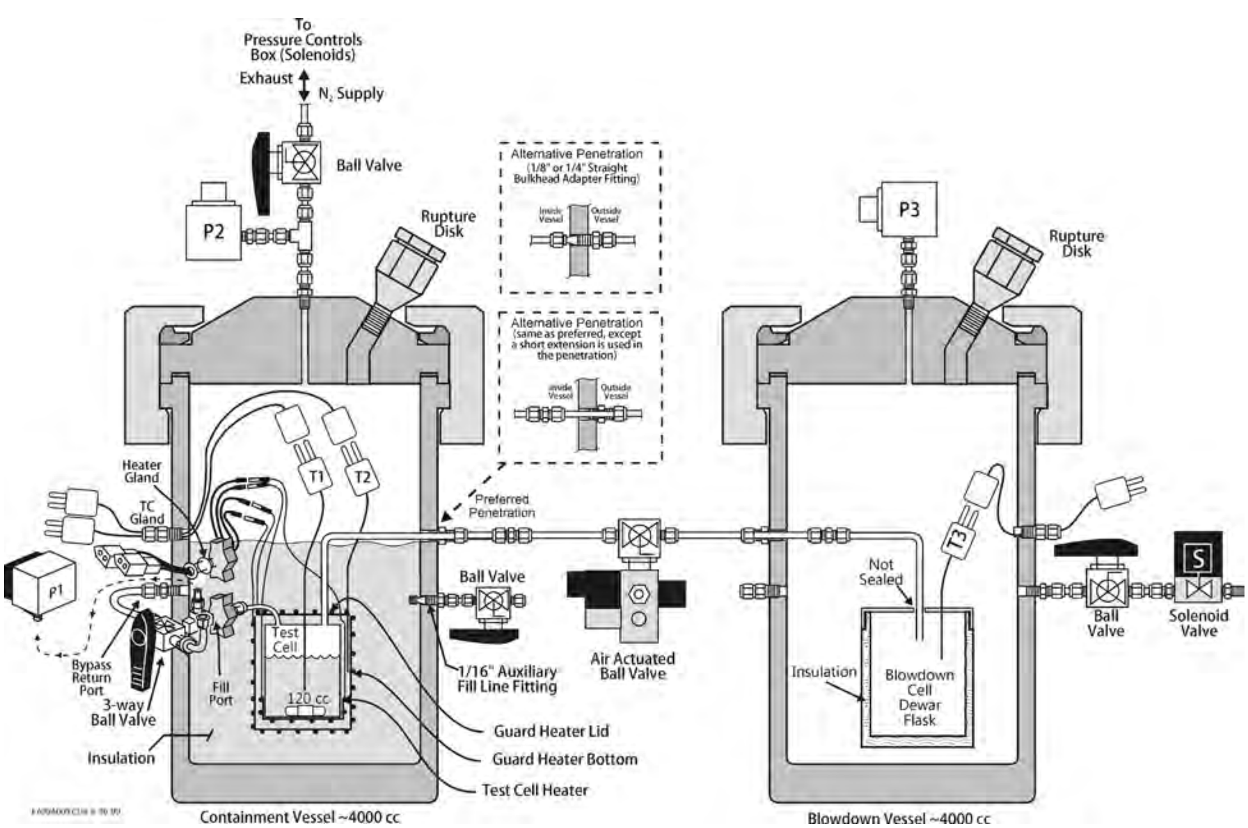

Figure 1 Schematic of the VSP2 setup in blowdown configuration

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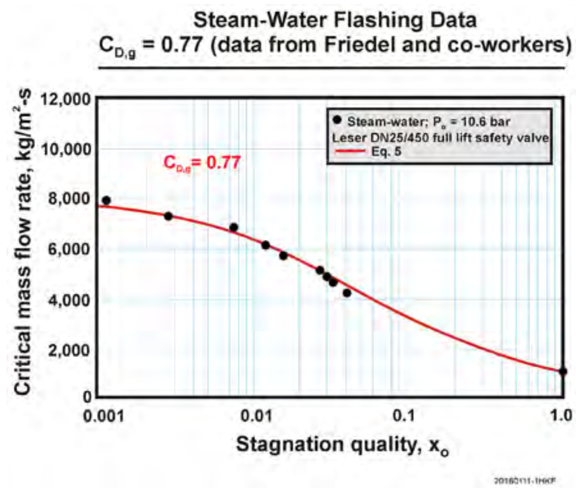
where x_o is the stagnation quality, C_{Dg} is the valve manufacturer certified discharge coefficient for gas flow, and G_g is the gas flow (sonic or subsonic) through an ideal nozzle. An example of comparison with Eq. 5 and experimental data is illustrated below. In this case, Eq. 4 suggests a length L of only about 10 mm to satisfy equilibrium flashing which is clearly satisfied by the SRV. Furthermore a stagnation quality of $x_o = 0.001$ is equivalent to $\alpha = 0.14$ at the 10.6 bar stagnation pressure.



Both requirements to satisfy equilibrium flashing flow are sensitive to the stagnation pressure. As an example, a stagnation pressure of 62 bar and $x_o = 0.0049$ ($\alpha = 0.1$) resulting in $L = 40$ mm and x_o which is consistent with experimental data (Sozzi and Sutherland, 1975).

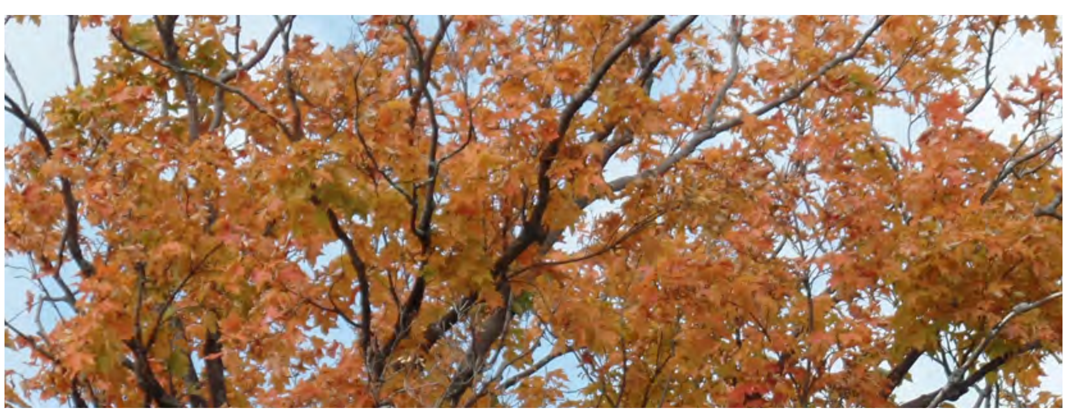
References

Fauske, H.K., 1985, "Flashing Flows Or: Some Practical Guidelines for Emergency Releases," Plant/Operations Progress, July, 1985

Fauske, H.K., 1999, "Determine Two-Phase Slows During Releases," Chemical Engineering progress, February, 1999.

Sozzi, G. L. and Sutherland, W. A., 1975, "Critical Flow of Saturated and Subcooled Water at High Pressure," Report NEDO-13418, General Electric Company, San Jose, CA (July).

Dr. Hans K. Fauske is an original founding partner of Fauske & Associates, LLC and currently serves as Regent Advisor



ONE OF THESE THINGS IS NOT LIKE THE OTHER: DIFFERENTIATING HAZARD AND RISK IN SAFETY?

By Sara Peters

If you look up the word 'hazard' in the thesaurus, one of the synonyms listed for it is "risk". However, in the language of chemical engineering, these two words are not equal or interchangeable at all.

According to the American Chemical Council, the difference in meaning between the two words is described as follows: Risk is "the possibility of a harmful event arising from exposure to a chemical or physical agent, for example, under specific conditions." And, Hazard is "the inherent properties of a substance that make it capable of causing harm to human health or the environment." So to simplify, the hazard is associated with the material, but the risk is associated with the manner/environment in which it is used.

Risk is "the possibility of a harmful event arising from exposure to a chemical or physical agent, for example, under specific conditions." And, Hazard is "the inherent properties of a substance that make it capable of causing harm to human health or the environment."

As an example, in any one of our labs at Fauske & Associates, LLC, one can find materials that are considered hazards. Meaning, that due to their composition, those materials can have a damaging effect on anyone or anything they come into contact with. The risk factor of those materials refers to the likelihood of that dangerous material actually causing harm based on how it is handled.

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Risk in these instances can be impacted by variables such as condition or frequency of exposure. The hazards posed by the materials are inherent to our business. In order to mitigate that risk we follow rigorous chemical safety protocols with considerations of instrumentation, temperature, pressure, engineered safety controls, proper personal protective equipment (PPE), good housekeeping, storage, etc.

Now, why this is important? Mostly, because it is helpful in demonstrating how meanings of words can be interpreted differently according to the context in which they are used. And, the main takeaway here is that in the scientific context of chemical process safety; risk and hazard are different and applied safety measures should be based on one (the risk) and not the other (the hazard).

It is important to evaluate and identify the hazards that are part of a process. This can be accomplished through various means including combustible dust and vapor/gas flammability testing to characterize material hazards, calorimetry testing to characterize desired and undesired reactions and emergency relief design calculations. Risk can be gauged using tools such as safety walk downs, quantitative risk assessments, process hazard analyses (PHA), combustible dust hazard assessments (DHA), desktop reviews etc. where one can study the probability of an accident occurring along with how catastrophic the accident would be.

The information gained by understanding the hazards and likelihood of hazardous occurrence in a facility is critical to developing an effective safety plan. If you have questions.regarding hazard or risk mitigation, our experts are here to help. Contact info@fauske.com to learn more.

Sara Peters is Senior Communications and Brand Specialist at FAI

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The general blowdown test procedures are:

1. Use set temperature to determine properties that are required for all-vapor critical flow and bubble rise velocities
2. Determine bubble rise velocity (u_∞) for the material of interest and for both bubbly and churn flows using Equation 1
3. Determine critical all-vapor mass flux at the set conditions using Equation 2
4. Determine the superficial vapor velocity through the test cell (j_g) at disengagement using Equation 3
5. Target a j_g/u_∞ between 0.8-4 by adjusting the vent diameter and/or all-vapor discharge coefficient (i.e., length of the vent line)
6. Start the VSP2 blowdown test using a specific upset scenario procedures
7. Begin blowdown of the test cell and containment vessel when the set temperature is reached by opening the valves on the test cell and containment vessel.
   a. It may be necessary to begin the containment blowdown before the test cell blowdown to avoid crushing the test cell.
8. Close the valves when test cell pressure reaches ambient pressure, which often occurs within 8 seconds.

The bubble rise velocities are

$$u_\infty = C_\infty \left(\frac{\sigma g \left(\rho_f - \rho_g \right)}{\rho_f^2} \right)^{0.25} \qquad (1)$$

where C_∞ = bubble rise velocity coefficient, 1.18 for bubbly flow and 1.53 for churn flows, -
g = acceleration due to gravity, m/s^2
ρ_f = liquid density, kg/m^3
ρ_g = vapor density, kg/m^3
σ = surface tension, N/m

The critical all-vapor mass flux at the set conditions can be estimated using

$$G_g = \left[P_s \rho_g \right]^{1/2} \left[k \left(\frac{2}{k+1} \right)^{(k+1)/(k-1)} \right]^{1/2} \qquad (2)$$

where G_g = critical all-vapor mass flux kg/m^2/s
k = isentropic coefficient, -
P_s = set pressure, Pa

The vapor superficial velocity through the VSP2 test cell can be estimated using

$$j_g = \frac{G_g \, A_{vent}}{\rho_g \, A_x} \qquad (3)$$

where A_{vent} = effective flow area of the vent on the VSP2 test cell, in^2
A_x = cross sectional area of the VSP2 test cell, in^2

The VSP2 blowdown test interpretation

The interpretation of the VSP2 blowdown test is as important (if not more important) than the design and execution of the blowdown test and is necessary for determining the flow regime of your material. The main indicator is mass remaining in the test cell after the blowdown. The final mass is used to obtain an average void fraction. The final void fraction is then compared with the disengagement void fraction for the bubbly and churn flow regimes to obtain similarities. The disengagement void fractions for the bubbly and churn flow regimes are determined using Equation 4 [1].

$$j_g = \begin{cases} \dfrac{\bar{\alpha}\left(1-\bar{\alpha}\right)^2}{\left(1-\bar{\alpha}^3\right)\left(1-C_0\bar{\alpha}\right)} u_\infty & \text{Bubbly} \\ \dfrac{2\bar{\alpha}}{1-C_0\bar{\alpha}} u_\infty & \text{Churn} \end{cases} \qquad (4)$$

where C_0 = distribution coefficient, 1.01 or 1.2 for bubbly flow and 1.5 for churn flow
$\bar{\alpha}$ = vessel average void fraction, -

Additional items that will aid in the interpretation of the blowdown test are estimating the mass loss from the test cell assuming all vapor flow and simulating the depressurization of the test cell. The simulation of the depressurization of the test cell allows the time dependent temperature and pressure measurements to be used in the comparison of churn and bubbly flow regime comparison along with the mass remaining in the test cell.

Potential missteps

The results of the blowdown testing may not always be extremely clear. When disengagement

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occurs while the flow is subcritical, the vapor superficial velocity can be much lower than the vapor superficial velocity used in the test design This will affect the expected vessel average void fraction for complete disengagement. In this case simulating the VSP2 blowdown test may be necessary in order to provide the temperature and pressure comparison and aid in helping predict the superficial velocity when disengagement occurs. Crushing the test cell indicates that the size or number of valves used to depressurize the containment may be too small. In this case, the test may need to be repeated using a larger number or size of valves to depressurize the containment vessel. Alternatively a heavier walled test cell could also be used.

The interpretation of the VSP2 blowdown test is as important (if not more important) than the design and execution of the blowdown test

Benchmark test

Benchmark tests have been performed using tap water and soapy water. Table 1 shows the initial conditions and the results of the benchmark tests. Figure 2 plots Equation 4 and the final void fractions of the benchmark test. Dynamic simulations were performed to aid in the interpretation of the blowdown tests. These tests show that tap water is predicted to behave as churn flow with a distribution coefficient of 1.5 and soapy water is expected to behave as a foamy or bubbly flow with a distribution coefficient equal to 1.01, which is consistent with the large scale test results [1]. One of the reasons that the average void fractions for the tap water tests, derived from the final mass of the VSP2 blowdown tests, are above the churn-turbulent predicted average void fraction is that disengagement occurs before the depressurization is over. This leads to all-vapor flow during a portion of the depressurization and additional mass loss from the test cell. Figure 3 shows the comparison between the depressurization transient and dynamic simulations for the tap water and soapy water blowdown tests with 1/8" diameter vent lines. The good agreement between the depressurization data and the dynamic simulations provide further evidence that the flow regime classification based on the blowdown tests is consistent with large scale data.

Table 1 Initial VSP2 blowdown test conditions and results

Contents	Tap water	Tap water	Soapy water	Soapy water
Test cell type	Hastelloy C, 1/16" pressure line, 1/8" vent line, 1" Teflon stir bar	304 SS, 1/16" pressure line, 1/4" vent line, 1" Teflon stir bar	304 SS, 1/16" pressure line, 1/8" vent line, 1" Teflon stir bar	304 SS, 1/16" pressure line, 1/4" vent line, 1" Teflon stir bar
Effective vent area, m^2	2.39×10^{-6}	6.72×10^{-5}	1.03×10^{-6}	6.72×10^{-5}
Initial mass, g	Water: 95.005	Water: 65.579	Water: 64.783 Ajak: 0.065	Water: 64.627 Ajak: 0.065
Set temperature, °C	155.7	151.0	154.0	155.4
j_g/u_∞ - Bubbly, -	1.80	5.1	0.78	5.1
j_g/u_∞ - Churn, -	1.39	3.9	0.60	3.9
Void fraction at set temperature, -	0.09	0.40	0.41	0.41
Final void fraction, -	0.47	0.69	0.92	0.99

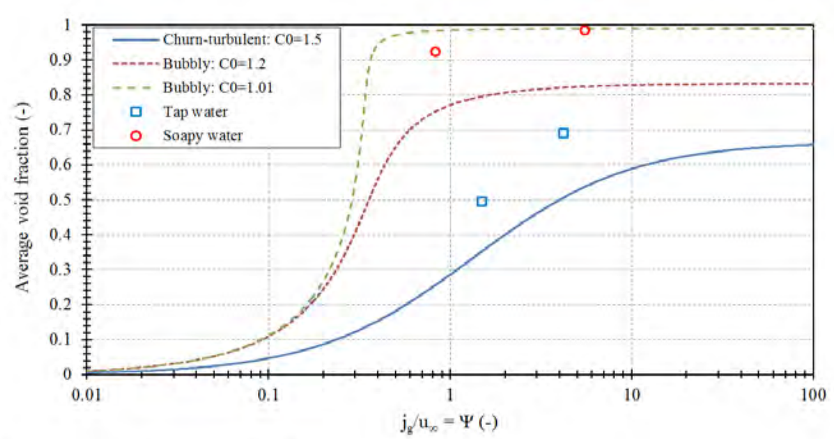

Figure 2 VSP2 blowdown benchmark results

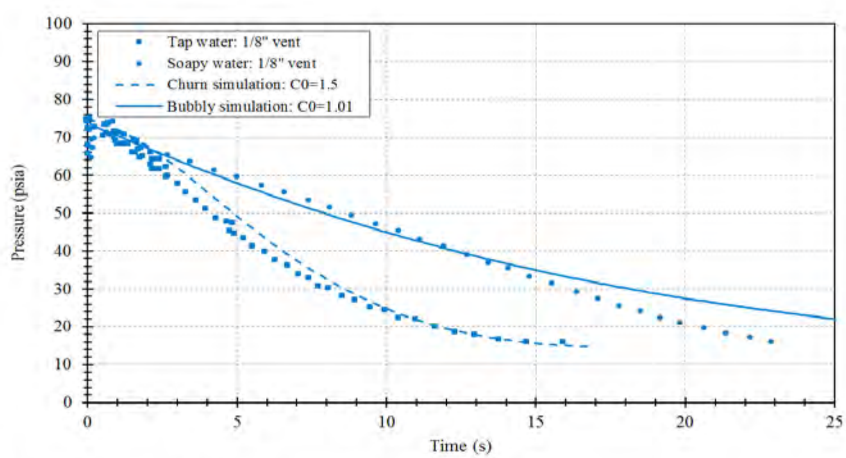

Figure 3 VSP2 blowdown depressurization comparison with a dynamic simulation

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Dr. Benjamin Doup is Technical Lead for the Thermal Hazards department at Fauske & Associates, LLC

GC/MS Applications: Combustion Analysis

A Gas Chromatograph (GC) and Mass Spectrometer (MS) are instruments that are commonly used in analytical labs.

By: Jeffery Griffin, Chief Commercial Officer

The combined equipment generally referred to as a GC/MS is an analytical technique used to separate, identify and quantify different compounds within a sample.

Fauske & Associates, LLC (FAI) has recently added these instruments to our tool set to support our growing flammability testing and analytical testing businesses as the tool is helpful in numerous applications:

In a safety scenario, identification of combustion products is important, especially when reviewing an event such as a fire or an explosion.

1.) Combustion analysis
2.) Post-reaction mixture analysis (this has applications for reaction calorimetry and thermal hazards)
3.) Quality control (QC concerns/assessment
4.) Vapor-liquid equilibrium (VLE) studies
5.) Environmental /pesticide

This article will explore how the GC can be used for combustion analysis. The primary applications for combustion analysis are twofold:

1.) Before combustion – GC can be used to accurately ascertain fuel/oxidizer ratio (especially in mixtures with multiple components)
2.) After combustion – GC can be used to measure the composition and quantities of combustion gases generated by an event

Dr. Ashok Dastidar, Vice President, Dust & Flammability Testing and Consulting Services explains, "Generally, when flammability testing is performed, the mixture composition is estimated based on partial pressures of the materials as they are added into the test chamber and the assumption that the mixture is adhering to the ideal gas law. While this approach can result in an acceptable approximation of the fuel-oxygen ratio under investigation, there is opportunity for improvement that can be helpful in certain applications. Specifically, more detailed understanding of the composition can be important if a client has a safety concern or if they are interested in having a high-level of accuracy."

FAI uses an Agilent Mass Spectrometer and Gas Chromatograph in our flammability laboratory

In a safety scenario - identification of combustion products is important especially when reviewing an event such as a fire or an explosion. Depending on the mixture (fuel-oxygen ratio), different combustion byproducts can result. For example, a test with a fuel rich mixture might result in hazardous byproducts that could be dangerous for people or the environment. Better knowledge of a material could help inform a risk-based approach to mitigate potential exposures.

As an example, if a company has a solvent tank, and an explosion occurs in the headspace, combustion gases will be released. With a more robust assessment of their combustion products, the company would have a better idea of what safety conditions they should design for. They might implement different controls to mitigate the risk of explosion or keep the fuel/oxygen ratio under different conditions because the environmental impact would be lower. For a company interested in mitigating risk, this could be very helpful. Depending on the specific composition of the fuel or the nature of the fuel/oxygen ratio when you test, you might end up with different combustion products.

While someone could perform theoretical calculations to develop a model of what combustion products could be in an explosion scenario, test data is helpful in quantifying reality. Testing is a good complement to models and can provide validation input when performing dispersion modeling or developing a safety plan.

Is There Any Standard That Requires This Analysis?

There is no specific standard for the combustion application of the GC, however, there have been discussions by some international testing bodies on putting requirements for measuring composition by GC into the standard. For other applications mentioned above, regulatory bodies like the EPA and others have standards available.

For more information regarding GC and your testing needs, contact us at info@fauske.com.

Jeffery Griffin oversees all commercial business matters for Fauske & Associates, LLC

Equipment Qualification (EQ) and Obsolescence

Maintenance of aging components can extend their useful life. However, when either the maintenance becomes too costly, or the component wears out and/or is beyond repair – the component needs to be replaced.

By AnnMarie Fauske, Customer Outreach & Digital Media Manager

Cables in FAI LOCA Chamber

Given the robust designs of some components, some component lifetimes are greater than the longevity of the company that manufactured the component. Likewise, as technology advances, component models are replaced with new models that at times are not backwards compatible with existing models.

When a component needs to replaced and there is no off-the-shelf qualified replacement, there are three approaches which can be implemented: Commercial Grade Dedication, Reverse Engineering and New Replacement for an obsolete component. These three options offer considerable benefits including utilization of existing design documentation and component knowledge to identify/create a suitable replacement, establishment of a reserve inventory to facilitate future obsolescence needs, reduced downtime and ultimately, cost savings.

Commercial Grade Dedication is the process of taking an existing commercial grade component, which is identical to the component to be replaced, and performing a defined dedication process that will validate the commercial grade component for its intended use. Depending upon the component's function and operating environment, this may be an effective method for updating components.

Reverse Engineering involves studying and analyzing a select component in detail to obtain a fundamental understanding of the device. It can also involve the physical process of taking the select component apart to analyze its geometry, design, construction and operation to identify the functional requirements of the component and design and improve an existing component or manufacture a like replacement to replace one that is no longer available.

New Replacement of an obsolete component with a new one that has similar or improved function and/or performance can become necessary when the original component or an existing replacement cannot be found. Replacement of an obsolete component with a new component involves a complete understanding of the component function and operating environment in order to design the new component either from scratch or by using select existing components. Depending upon the component function, an Equipment Qualification (EQ) process may be required.

Complete EQ solutions for the nuclear and industrial sector obsolescence issues start with experienced engineers and technicians who provide testing services using state-of-the-art laboratories and facilities, including a Design Basis Accident (DBA) test facility that is capable of supporting current generation nuclear power plants along with the Generation III+ plants. In addition, extensive know-how of performing and supporting EQ programs provides a leading engineering lab with the proven experience to support all aspects of equipment and programs needed.

Comprehensive engineering and testing facility Fauske & Associates, LLC (FAI) provides critical support to nuclear equipment manufacturers and suppliers, OEMs and utilities with a range of services and testing designed to qualify equipment, parts and components for many applications. These include both mild and harsh nuclear environments to NRC guidelines and to meet industry and plant-specific requirements. Industrial applications in railways/railroads, aeronautical, automotive and many areas continue to grow.

TESTING

Design Basis Accident

Our state-of-the-art stainless steel Loss of Coolant Accident (LOCA) chamber and test facility can easily achieve the required temperature and pressure transients representative of harsh environments for all existing and new Generation III+ reactors. In addition to our LOCA chamber, our High Energy Line Break (HELB) test facility is available to qualify components for mild environments.

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Statement of Purpose:

FAI's "Process Safety News" is intended to be a forum on recent advances in chemical process safety and FAI's current and related offerings in this area. It will address subscriber's concerns regarding issues and practices for relief system design as well as laboratory testing and techniques for process safety management.

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Explosions in the Grain Industry – Why?

One of the first recorded and studied dust explosions occurred in a bakery in Turin, Italy in 1785.

By Ashok Dastidar, PhD MBA, Vice President, Dust & Flammability Testing and Consulting Services

Count Morozzo from the Academy of Science in Turin investigated the incident to conclude that the explosion was caused by the flour dust suspended in the air and not gases generated by mold or fungus eating the flour. Dust explosions are very common in industry. They occur in all industries from wood working, sawmills, pharmaceutical plants, chemical plants; and more importantly for this discussion at agricultural facilities.

Grain Silo Explosion

Photo by Tim Hynds, Sioux City Journal

In April of 1980 there was a large explosion at a grain terminal in Saint Joseph, MO. One person was killed and four were injured. An electric arc from a damaged level indicator initiated an explosion in one of the silos. The explosion traveled through the headhouse to the other silos and caused over two million dollars in damages. Later, in June of that same year an explosion occurred at a river grain terminal in Saint Paul, MN. Luckily there were no fatalities but 13 workers were injured. An electrician was working on live electrical circuitry while grain loading operations were taking place. The arc from the electrical work initiated an explosion that traveled along the tunnel to the headhouse and through the bucket elevator to the other tunnels resulting in $300, 000 in damages. A month later in Fonda, IA an explosion occurred at a train-loading country grain terminal where electrical welding on a bucket elevator initiated an event. No one was killed or injured in that event.

Nine months later in April 1981 a large explosion at an export grain silo plant in Corpus Christi, TX killed nine people and injured 30. Smoldering lumps of grain entered a bucket elevator and initiated a dust cloud explosion. The resulting explosion propagated to other elevators, and then onto the headhouse, tunnels, conveyers and silos, resulting in thirty million dollars of damage.

It was after this last event that the Occupational Safety and Health Administration (OSHA) released the "grain handling standard" 29CFR1910.272 in 1987. This standard is the backbone of the government's safety program to protect grain elevators, feed mills, flour mills, rice mills, dust pelletizing plants, dry corn mills, soybean flaking operations, and the dry grinding operations of soy cake from violent dust explosions. Some of the key requirements of the standard are that employers develop an emergency plan to deal with dust explosions, train their employees and contractors to recognize dust explosion hazards and safely work in that environment, establish a hot work permit system to minimize potential ignition sources, keep fugitive dust at bay with a documented housekeeping program, and requirements for emergency escape. Additionally, it provides requirements for the safe use of driers, bucket elevators and air filtrations systems.

This standard, according to OSHA's figures, has been effective. The average number of grain elevator explosions has decreased from 20 per year in the 70's and 80's to 13 per year in the 90's and to less than 8 per year in the 21st century. However, that still amounts to 503 incidents between 1976 and 2011 with 677 injuries and 184 fatalities in that time. The latest incident to occur is the Andersen

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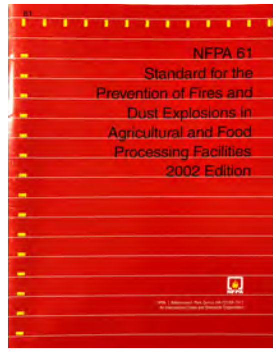
Farms Inc. grain elevator explosion in South Sioux City, Nebraska, on Tuesday, May 29th of this year. The accident resulted in one fatality and one injury. The cause of the event is still under review.

Compounding this great tragedy is that the OSHA standard that would have kept the employees safe does not apply to family-farm owned facilities with less than 11 non-family employees. As a result they cannot enforce the 29CFR1910.272 at the facility or investigate the incident.

What potentially could have kept the employees safe and avoided the accident is enforcement of the Nebraska Fire Code, Title 153 and the Grain Elevator Fees and Guidelines, Title 161. Both these documents have adopted NFPA 61 "Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities" and reference it for safety inspections. Compliance with NFPA 61, a document that greatly influenced the OSHA standard, would have reduced the risk of a catastrophic explosion. NFPA 61 is one of the oldest NFPA standards dating back to 1923 and was initially developed to prevent dust explosions in grain terminals and flour mills. Gradually, over time, the standard was combined with other NFPA documents to become a universal fire and dust explosion prevention and protection standard for agricultural and food facilities. The document has a long history and is adopted by most state and local fire codes. Therefore, state/local building inspectors and state fire marshals should be very familiar with the document and on how it should be enforced.



Additionally, many insurance carriers require agricultural facilities to comply with NFPA 61 for property loss and business interruption protection. These companies have engineers and inspectors who are trained in the NFPA 61 requirements and frequently audit facilities for compliance before offering them insurance coverage. They can spot deficient housekeeping, or bad hot work/electrical work practices or building/machinery construction without explosion/fire protection. Their enforcement of NFPA 61 as an authority having jurisdiction can greatly reduce the risk of an explosion or fire.

With these three layers of protection; the OSHA Grain Handling Standard, State Fire Codes that adopt NFPA 61 and insurance companies that require NFPA 61 compliance for coverage to be offered, why do we still have explosions in the grain industry? Even if one of these three layers were to fail; for example, the OSHA standard not being enforceable on small family-farm facilities, the other two layers of protection should be able to catch any deficiencies and protect workers and the surrounding community.

Need help evaluating the safety of your facility? We can help. Contact us at dust@fauske.com to learn more.

Dr. Ashok Dastidar is a leading industry expert in the areas of combustible dust and flammability and provides leadership for those businesses at FAI

Continued from page 8

Aging Services, Electromagnetic Compatibility (EMC), Electromagnetic Interference (EMI) And Seismic Qualification

We provide all testing and aging services to qualify components including thermal and irradiation aging, EMC/EMI and seismic qualification.

Activation Energy Determination, Material Testing, Forensics and Identification

Utilizing an extensive database of activation energies we can provide referenced activation energy values for numerous components. We also have a complete laboratory that can perform actual activation energy tests using one of our test instruments including micro-watt calorimetry, DSC, TGA and others.

Our material testing laboratory is also equipped with instruments including a Fourier Transform Infrared (FTIR) Spectrometer utilized for various applications related to Material Forensics and Identification testing to identify what the component material is and to perform forensics. Additionally, aged materials can be evaluated to determine the response of the material as a result of the environment conditions.

Material Performance testing is delivered using our INSTRON material property test rig which is able to perform industry standard tests including tensile strength and strain to determine mechanical properties of components.

SERVICES

Consulting Services

Along with our testing services, we also provide engineering consulting services to assist with your qualification process. Our engineering services include determining solutions for components that fail or do not perform well during testing, and the ability to perform analytical calculations (thermal lag, seismic, radiation shielding, etc.) to properly account for environmental conditions at the equipment location.

Establish Actual Plant Normal Service Conditions

Using around the clock monitoring instrumentation, our engineers can establish actual normal service plant conditions (temperature, radiation, etc.). Actual plant conditions may be less than calculated design conditions offering improvement with the environmental conditions.FAI can provide these time dependent temperature profiles using appropriate calculations and/or software tools.

Establish Representative Temperature Profiles

If upper boundary maximum temperature conditions within a given room are the basis for your equipment environmental qualification, having representative time dependent temperature profiles could remove these conservatisms and margins. FAI can provide these time dependent temperature profiles using appropriate calculations and/or software tools.

Evaluation of Failure Criteria

An evaluation by our team can determine the particular types of accident conditions the piece of equipment being tested will need to respond to. For instance, if the specified equipment is required to operate following a High Energy Line Break (HELB), but not a Loss Of Coolant Accident (LOCA),

the conditions corresponding to the HELB will be used to evaluate the corresponding environmental conditions, rather than defaulting to the generic "worst" case conditions.

Failure Modes and Effect Analysis (FMEA)

Our team can evaluate the overall effect on plant safety by evaluating the potential equipment failure modes of safety related equipment during the various stages of plant operation. If, for example, the selected piece of equipment does not impact the safe shutdown of the plant, potentially the piece of equipment can perform its safety function even though it may not be qualified for the environmental conditions.

Industry Experience Data Mining

Up-to-date Industry experience and databases are available to assess instrument qualification profiles.

Location Specific Evaluations

Rather than using a conservative broad zone to categorize the conditions a piece of equipment will be exposed to, we can determine location specific conditions. This includes the ability to perform thermal lag or radiation shielding calculations to properly account for equipment location.

Vendor Test Reports Data Mining

A complete review of vendor qualification reports can provide additional margin. In addition, if you have acquired a new revision of a particular piece of equipment, it may be possible that new qualification data may expand upon the qualified criteria.

Nuclear and industrial plants seek equipment qualification and obsolescence issue solutions on an ongoing basis. Fauske & Associates, LLC (FAI) provides overall project management and Quality Assurance requirements for each project

For a full list of EQ services offered by FAI, or information on how we can assist with your obsolescence needs, contact us at info@fauske.com.

AnnMarie Fauske, leads all marketing and customer outreach efforts for Fauske & Associates, LLC

NFPA 652

FAUSKE & ASSOCIATES, LLC
WORLD LEADER IN NUCLEAR AND CHEMICAL PROCESS SAFETY

– An Introduction to Dust Hazard Analysis

2019 Date and Location:

February 6-7, 2019

Fauske & Associates, LLC, 16W070 83rd Street, Burr Ridge, IL 60527

New Date Just Added

Course Description

Day 1** (Prerequisite for Day 2)* — ***Time: 8 am - 4:30 pm — ***CEU's: 0.7***

This course will ensure all participants are aware of important issues associated with NFPA 652 and describe how this standard interacts with other relevant NFPA codes and guidelines. A special emphasis will be placed on explaining the requirements for a Dust Hazard Analysis (DHA) and an overview of the methodologies that can be employed to perform a DHA. The course will also include a logical approach to characterizing a powder's hazardous dust properties, as well as a description of various techniques used to control and/or avoid dust explosions in a safe and compliant manner.

Scheduled Agenda

- Introduction
- Overview of NFPA 652
- Fundamentals of Dust Explosions
- Introduction to DHA methodology
- Mock DHA on a Small Blending Operation

Outcomes

- Protection Options
- Daily Learning Assessment
- Questions and Answers
- Course Evaluation Instruction

Day 2 — ***Time: 8 am - 4:30 pm*** — ***CEU's: 0.7***

Advanced DHA Workshop

The Advanced DHA Workshop will focus on how to organize, lead, and implement the DHA study. This will include how to utilize appropriate test methods to determine potential dust hazards; as well as how to apply appropriate mitigation techniques to prevent or control combustible dust hazards. During the workshop, participants will have the opportunity to apply DHA methodologies to realistic combustible dust scenarios.

Pricing

Two Day Course: $895
Day 1 only: $495
Day 2 only: $495

ACCREDITED IACET PROVIDER

Fauske & Associates, LLC is accredited by the International Association for Continuing Education and Training (IACET) and is authorized to issue the IACET CEU

For hotel information or to register, please contact: FAIUniversity@fauske.com
Please direct instructor or course related questions to Ashok G. Dastidar - dastidar@fauske.com

www.fauske.com **(630) 323-8750**

FAUSKE & ASSOCIATES, LLC
WORLD LEADER IN NUCLEAR AND CHEMICAL PROCESS SAFETY

ACCREDITED IACET PROVIDER

REGISTRATION FORM

NFPA 652 - An Introduction to Dust Hazard Analysis

Time: 8:00 am - 4:30 pm each day **CEU's: 0.7 per day**

Pricing: ○ **Day1 only - $495** ○ **Day 2 - $495** ○ **Both Days - $895**

☐ **February 6-7, 2019, Fauske & Associates, LLC, Burr Ridge, IL**

First Name: ______________________ Last Name: ______________________

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Name on Account: ____

Account Number: ______________________ Expiration Date: ________ Security Code: ________

Signature authorizing Fauske & Associates, LLC, to charge credit card: ______________________

- **Fees must be received prior to course commencement**
- **Hotel accommodations and travel expenses are the responsibility of the participant**
- **Fees include course notes, continental breakfast and lunch**

Technological/ Education Requirements:
There are no technological requirements for this introductory course. Grade 12 or higher education and 2-3 years professional experience are required.

CEU Credit Eligibility: FAI is an accredited by the International Association for Continuing Education & Training (IACET) and is authorized to issue the IACET CEU. In order to be eligible for CEU credit (0.7 per course), attendees must be present for the duration of the course, score 85% or higher on the course assessment and complete the course evaluation.

Privacy: Fauske & Associates, LLC has a written policy to ensure privacy and confidentiality of participant training records and information. Training records will only be released with the expressed written permission of the participant. The participant record will be released to the participant or designated third party within 14 business days of the request.

Cancellation Policy: Cancellations will be accepted up to one month prior to course date.

To register, please email: FAIUniversity@fauske.com, Fax: (630) 986-5481
(Please direct instructor or course related questions to: Ashok Dastidar, dastidar@fauske.com)