Process Safety News

Spring 2016
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Number 2

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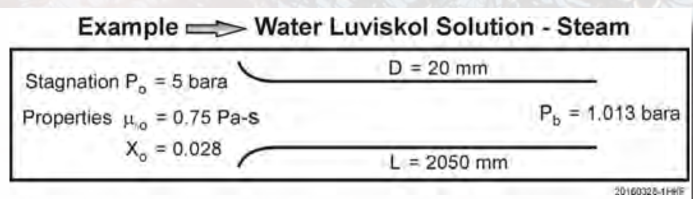
A SIMPLE HIGHLY VISCOUS TWO-PHASE FLASHING FLOW CORRELATION

By: Hans K. Fauske, D.Sc., Regent Advisor, Fauske & Associates, LLC (FAI)

$$G = \left[\frac{1 - x_o}{G_\ell^2} + \frac{x_o}{G_g^2}\right]^{-1/2} \quad (1)$$

Where G (kg m^{-2} s^{-1}) is the two-phase flashing flow rate including the effect of high liquid viscosity, x_o is the stagnation vapor quality, and G_ℓ (kg m^{-2} s^{-1}) and G_g (kg m^{-2} s^{-1}) are asymptotic flashing liquid and vapor flow limits, respectively. The model will be illustrated using the following example.



The asymptotic flashing liquid flow limit is given by

$$G_\ell = (\lambda / v_{fg})(TC)^{-1/2}(1 + 4f\ L/D)^{-0.39} \quad (2)$$

and the vapor (steam) flow limit by

$$G_g = 0.67(P_o\rho_g)^{1/2}(1 + 4f\ L/D)^{-0.39} \quad (3)$$

where λ(J kg^{-1}) is the latent heat of evaporation, v_{fg} (m^3 kg^{-1}) is the liquid-vapor volume change, T (K) is the saturation temperature, C (J kg^{-1} K^{-1}) is the liquid specific heat, ρ_g (kg m^{-3}) is the vapor density, and f is the turbulent friction factor given by

$$f = 0.08\ Re^{-0.25} \text{ where } Re = G_\ell D/\mu_\ell \text{ or } G_g D/\mu_g \quad (4)$$

where Re is the Reynolds number, and μ (Pa-s) is the viscosity.

Considering that flashing flows promote turbulence (Fauske, 1999), the correlation makes use of Eq. 4 for all values of Re, even when extending well into the laminar flow regime.

Considering the above Luviskol water solution example, this leads to

$$G = \left[\frac{1 - 0.028}{1480^2} + \frac{0.028}{580^2}\right]^{-1/2}$$
$$= 1380\ \text{kg m}^{-2}\ \text{s}^{-1} \quad (5)$$

It is to be noted that Re= $\frac{1480 \cdot 0.02}{0.75}$ = 39.5 and results in f = 0.0319 and a liquid discharge coefficient $C_{D,\ell} = (1 + 4f\ L/D)^{-0.39}$ = 0.356 Eq. 2 results in $G_\ell = 4163 \cdot 0.356 = 1480\ \text{kg m}^{-2}\ \text{s}^{-1}$. Finally, it is to be noted that the high viscosity (μ_ℓ = 0.75 Pa-s) example results in G = 1380 kg m^{-2} s^{-1} is consistent with Bell et al. (1993) highest viscosity blowdown test which resulted in a measured flow rate of 1353 kg m^{-2} s^{-1}, suggesting that Eq. 1 prediction is within 2%.

As an added feature, the use of steam quality equal to 0.028 is consistent with the Fauske coupling equation (1983) considering the bubbly viscous flow regime (C_o = 1.2) and the Bell et al. test geometry results in $x_o \cdot G$ = 38.64 kg m^{-2} s^{-1} which is consistent with G = 1380 kg m^{-2} s^{-1}.

References

Bell, K. et al., 1993, "Vent Line Void Fractions and Mass Flow Rates During Top Venting of High Viscosity Fluids," Loss prev. Process Ind., Vol. 6, No. 1, 1993.

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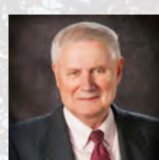

Hans K. Fauske is an original founding partner of FAI and currently serves as Regent Advisor

Upcoming Events

- Powder Bulk Solids - Show Exhibit Booth, May 3-5,Chicago, IL
- Fauske & Associates, LLC Relief Systems Design course, May 12-13, Burr Ridge, IL
- AIHce 2016
  "Combustible Dust Hazards, Prevention and Mitigation Practices" Presentation by Timothy Cullina, FAI, Baltimore, Maryland, May 21, 2016

Letter From the President

At Fauske & Associates, LLC (FAI) we realize that our success is driven by the relationships we create with our customers. We pride ourselves on providing data-driven solutions to complex process safety problems but also recognize that simply providing solutions does not necessarily result in satisfied customers.

I'm a strong believer in a very simple customer service philosophy – treat your customers how you would like to be treated. As a customer, for me personally, this means to be listened to, receive an honest, concise response, and that any promises made to me are delivered upon. I think it's safe to say that if we did this poorly, we wouldn't have developed the many long-lasting relationships we have over the years. That said, we can always get better and your feedback is invaluable in helping us improve both the service and products we provide.

For instance, a common question amongst our combustible dust customers is – where should I collect the sample from and how do I ship it to you? This question from our customers provided our team with an opportunity for improvement. In response, we created a short video that explains how to collect a sample and developed a Dust Sample Collection Kit for our customers to help simplify the process.

This is just one example of how listening to our customers need has helped us improve how we do business. I invite you to share your feedback regarding our service. We genuinely want to hear how we can improve. Please do not hesitate to email or contact me directly at kfauske@fauske.com or (630) 887- 5224.

Happy Spring,

H. Kristian Fauske
President

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Executive Director

H. Kristian Fauske

Art Director

Sara Peters

Contributors

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Kris Fauske
Zach Hachmeister
James A. Huddleston
Ursula Malczewski
Sara Peters
Carol Raines

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.

Inquiries:

FAI's "Process Safety News" is published by
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Publisher

Fauske & Associates, LLC

THE ROLE OF HAZARDOUS AREA CLASSIFICATION IN PROCESS SAFETY

By: James A. Huddleston, P.E., Senior Consulting Engineer, Fauske & Associates, LLC

Introduction

Electrical and electronic equipment such as motors, generators, transformers, circuit breakers, fuses, switches, relays, solenoids and resistors produce significant amounts of heat, arcing and sparking during normal and abnormal operation, which could pose a substantial risk of fire or explosion in facilities where chemicals are manufactured, processed or utilized. To minimize the risk of fires or explosions that could result from this arcing, sparking and heat dissipation, it is critically important that electrical/electronic equipment be designed, tested and labeled as being acceptable for use in the areas in which they are installed. This holds especially true for **hazardous (classified) locations,** i.e. locations where flammable, combustible or ignitable gases, vapors, liquids, dust, fibers or flyings may be present.

Hazardous area classification is the evaluation and classification of hazardous (classified) locations using scientific and engineering principles, within facilities where chemicals are manufactured, processed or utilized. Hazardous areas are classified solely for the purpose of ensuring the safe and proper specification and installation of electrical/electronic equipment located within them.

A hazardous area classification is typically shown on plan view drawings of the facility (and sometimes on elevation drawings) that are commonly referred to as **area classification drawings/diagrams**. Based upon the area classification drawings, electrical/electronic equipment can be properly specified and installed such that the risk of fires or explosions is greatly reduced.

Hazardous (Classified) Locations

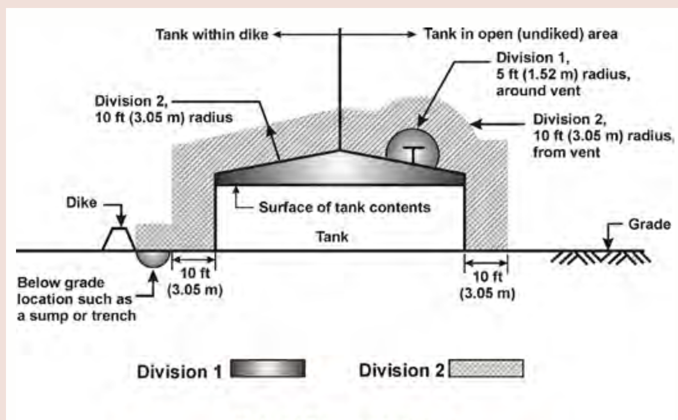
Article 500 of the National Electrical Code (NEC) (reference 1) defines the requirements for the safe and proper specification and installation of electrical/electronic equipment in hazardous (classified) locations. NEC Article 500.5 (A) states that "Locations shall be classified depending on the properties of the flammable gas, flammable liquid-produced vapors, combustible liquid-produced vapors, combustible dust or fibers/flyings that may be present, and the likelihood that a flammable or combustible concentration or quantity is present. Each room, section, or area shall be considered individually in determining its classification."

Hazardous Area Classification

Each room, section and area within a facility where chemicals are processed or utilized are evaluated individually and assigned a **Class I, II or III, Division 1 or 2, Group A, B, C, D, E, F or G** classification based on several criteria: (1) the types of chemicals that are present; (2) the probability of their presence during normal and abnormal operation; (3) the volume being processed or utilized; and (4) the physical properties (concentrations, densities, pressures, temperatures and flows) that are observed during normal and abnormal plant operating conditions.

Class I Locations

A Class I location is a location where fire or explosion hazards may exist due to flammable gases, vapors or flammable liquids. NFPA 497 (reference 2) provides recommended practice for the classification of Class I hazardous (classified) locations. NEC Articles 500 and 501 define the requirements for the safe and proper specification and installation of electrical/electronic equipment in Class I locations. NFPA 497 and NEC Articles 500 and 501 are relied upon heavily when performing area classifications and when specifying electrical/electronic equipment for safe and proper installation in Class I locations. Figure 1 (below) is an example of an area classification diagram for a Class I area.



Material Flammable Liquid

	Small/Low	Moderate	Large/High
Process Equipment Size		x	x
Pressure			x
Flow Rate		x	x

Figure 1 - Area Classification Diagram for a Class I Area (Flammable Liquid)

Class I Division 1

A Class I, Division 1 location is a location in which ignitable concentrations of flammable gases, flammable liquid-produced vapors, or combustible liquid-produced vapors may exist under **normal operating conditions.**

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Class I Division 2

A Class I, Division 2 location is a location in which ignitable concentrations of flammable gases, flammable liquid-produced vapors, or combustible liquid-produced vapors may exist under **abnormal operating conditions.**

Class I Group Designations

Class I flammable gases, vapors and liquids are grouped into one of four (4) groups **(Groups A, B, C or D)** based on their physical properties and the ease in which they can be ignited. Table 4.4.2 in NFPA 497 (reference 2) shows the physical properties and Group classifications of many commonly used flammable gases, vapors and liquids. **Acetylene** is an example of a **Group A** flammable gas. **Hydrogen** is an example of a **Group B** flammable gas. **Carbon Monoxide** is an example of a **Group C** flammable gas. Gasoline is an example of a **Group D** flammable liquid.

Class II Locations

A Class II location is a location where fire or explosion hazards may exist due to combustible dust. NFPA 499 (reference 3) provides recommended practice for the classification of Class II hazardous (classified) locations. NEC Articles 500 and 502 define the requirements for the safe and proper specification and installation of electrical/electronic equipment in Class II locations. NFPA 499 and NEC Articles 500 and 502 are relied upon heavily when performing area classifications and when specifying electrical/electronic equipment for safe and proper installation in Class II locations. Figure 2 (below) is an example of an area classification diagram for a Class II area.

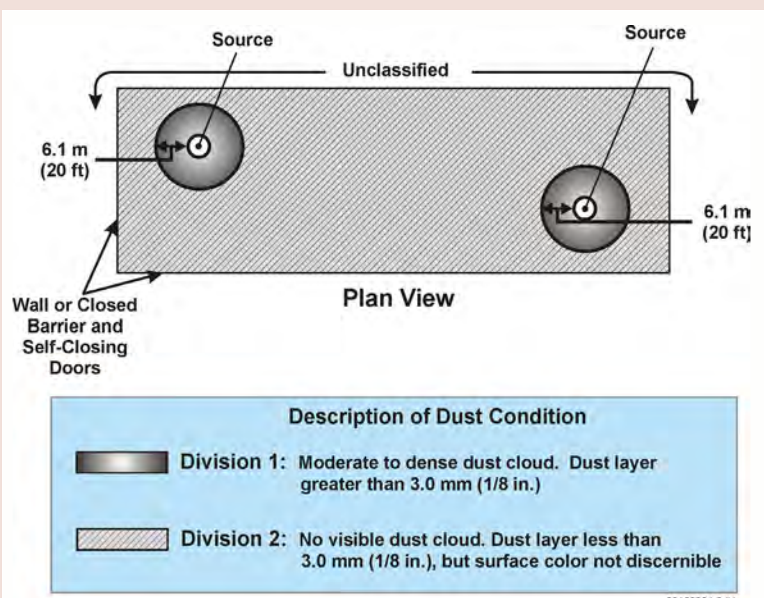

Figure 2 - Area Classification Diagram for a Class II Area (Combustible Dust)

Class II Division 1

A Class II, Division 1 location is a location in which combustible dust is in the air under **normal operating conditions** in quantities sufficient to produce explosive or ignitable mixtures, or where accumulations on electrical equipment are sufficient to interfere with the safe dissipation of heat generated by the equipment.

Class II Division 2

A Class II, Division 2 location is a location in which combustible dust due to **abnormal operating conditions** may be present in the air in quantities sufficient to produce explosive or ignitable mixtures, or where accumulations on electrical equipment **may be** sufficient to interfere with the safe dissipation of heat generated by the equipment.

Class II Group Designations

Class II combustible dusts are grouped into one of three (3) groups **(Groups E, F or G)** based on their physical properties and the ease in which they can be ignited. Table 5.2.2 in NFPA 499 (reference 3) shows the physical properties and Group classifications of many commonly used combustible dusts. **Titanium** is an example of a **Group E** combustible dust. **Carbon Black** is an example of a **Group F** combustible dust. **Nylon Polymer** is an example of a **Group G** combustible dust.

Class III Locations

A Class III location is a location where fire or explosion hazards may exist due to ignitable fibers or flyings. NEC Articles 500 and 503 define the requirements for the safe and proper specification and installation of electrical/electronic equipment in Class III locations.

Non-hazardous (Unclassified) Locations

Any area which cannot be classified as a Class I, II or III hazardous (classified) location is considered to be an **unclassified or non-hazardous** area.

Conclusion

Electrical and electronic equipment such as motors, generators, transformers, circuit breakers, fuses, switches, relays, solenoids and resistors produce significant amounts of heat, arcing and sparking during normal and abnormal operation, which could pose a substantial risk of fire or explosion in facilities where chemicals are manufactured,

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NFPA 652 IMMEDIATE ACTION ITEMS

By: Ursula Malczewski, Chemical Engineer, Fauske & Associates, LLC (FAI)

In the fall of 2015, the National Fire Protection Association (NFPA) issued its first edition of NFPA 652: Standard on the Fundamentals of Combustible Dust, 2016 Edition. This new standard establishes the relationship and hierarchy between it and the industry specific standards (NFPA: 61, 484, 654, 655, 664) to ensure that fundamental requirements are consistently addressed across industries, processes and dust types. Below is a summary of how this standard affects you and your combustible particulate solids handling process.

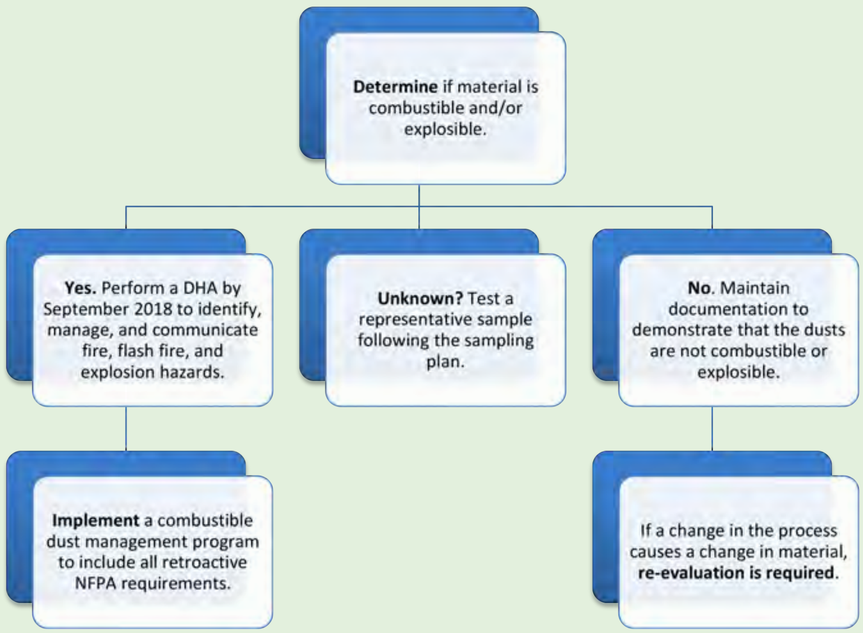

Figure 1 - NFPA 652 Immediate Action Items

Your Responsibility

The owner/operator of a facility (you) with potentially combustible dusts is responsible for determining whether the materials are combustible or explosible. The absence of previous incidents cannot be used as the basis for deeming a particulate to not be combustible or explosible.

"The absence of previous incidents cannot be used as the basis for deeming a particulate to not be combustible or explosible."

Any facility handling/generating dusts, powders, or materials that during processing are found to break apart into smaller pieces may in fact be dealing with a combustible particulate solid. This means that these facilities are required to determine if the material they handle is combustible or explosible. If so, the owner/operator (you) is responsible for characterizing the properties of the material as required to support the Dust Hazard Analysis (DHA). **The DHA must then be completed within 3 years of the effective date of this standard (by September 2018).**

Determination of Combustibility and Explosibility

The determination of combustibility and explosibility is based on:
(1) Historical facility data or published data that are deemed to be representative of current materials and process conditions; or
(2) Analysis of representative samples by testing.

It should be noted that a material can be combustible but not explosible, explosible but not combustible or both combustible and explosible. If the combustibility or explosibility is not known, determination of these properties must be determined by standard-specified tests. These tests must be performed on representative samples based on the sampling plan.

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Recognition

In recognition of his distinguished contributions to "nuclear and chemical reactor safety", **Hans K. Fauske, D.Sc., Emeritus President and Regent Advisor** of Fauske & Associates, LLC, has been elected a Member of the National Academy of Engineering (NAE). The Formal Induction Ceremony will be held October 9 at the NAE Annual Meeting, Washington, DC.

Election to the National Academy of Engineering is among the highest professional distinctions accorded to an engineer. Academy membership honors those who have made outstanding contributions to "engineering research, practice, or education, including, where appropriate, significant contributions to the engineering literature" and to "the pioneering of new and developing fields of technology, making major advancements in traditional fields of engineering, or developing/implementing innovative approaches to engineering education."

Acknowledgment

Congratulations to Martin Clouthier, MSc, PEng, Principal Consulting Engineer at Fauske & Associates, LLC (FAI)for obtaining his Professional Engineer (PEng) license for British Columbia this March. This is his fourth licensure in addition to holding a PEng for Nova Scotia, Quebec, and Ontario.

Mr. Clouthier's responsibilities include serving Canada and the United States for testing and consulting services.

Fauske & Associates, LLC Connected to the Community

April 22, 2015 is Earth Day.

Fauske & Associates, LLC strives to be a "Green" sustainable organization and Earth Day serves as a reminder of how special our planet is.

To help celebrate Earth Day and demonstrate our support for a healthy environment, our employees will be hitting the streets of Burr Ridge, IL that day to clean up and beautify our community.

"Try to leave the Earth a better place than when you arrived."

- Sidney Sheldon

Continued from page 6

The location of sampling is critical to obtaining meaningful results. The finest particles in your process represent the highest hazard. These tend to collect in dust collectors and on elevated surfaces.

It is permitted to assume a dust is combustible and/or explosible and proceed with all protections mandated by the standard, negating the need to perform the determination. However, further testing will need to be conducted in either case in order to determine the necessary safety protection systems specific to the material and process.

The findings (test results, historical data, and published data) shall be documented and, when requested, provided to the authority having jurisdiction (AHJ). **Your AHJ may include OSHA, your insurance company, or your fire marshal.**

Next Steps

Where dusts are determined to be combustible or explosible, controls to address the hazards associated with the dusts must be identified and implemented. The process will need to have a technical safety basis including equipment protection, controls, and safeguards identified in order to ensure that future fires and explosions can be prevented or mitigated. The owner/operator of the facility (you) is responsible for identifying and assessing any fire, flash fire, and explosion hazards (performing a DHA), managing the identified fire, flash fire, and explosion hazards, and communicating the hazards to affected personnel in accordance to the standard.

If combustible dust is present in your facility or handled in your process, several management systems need to be in place to manage this hazard. Implementing a combustible dust management program will include all of the retroactive requirements of NFPA 652 (Figure 2).

*Retroactive Requirements

Figure 2 - NFPA 652 Requirements

If materials are determined to not be combustible or explosible, the owner/operator (you) is required to maintain documentation to demonstrate that the dusts are not combustible or explosible. Your work here is done – for now…

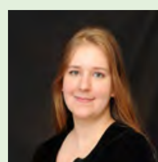
"If materials are determined to not be combustible or explosible, the owner/operator (you) is required to maintain documentation to demonstrate that the dusts are not combustible or explosible."

In both cases, if/when there is a change in your process that causes a change in your material (new raw material or product, change in supplier, etc.) or its environment (temperature, residence time, exposure to gases or other materials, etc.), new testing may be necessary to determine if the combustibility and explosivity properties have changed and what, if any, precautions are now required.

Contact us for additional information on determination testing, onsite dust hazard analysis (DHA), and implementing a combustible dust management program or to find out more about how this and other NFPA standards apply to your process.

References

1. NFPA 652 (2016) Standard on the Fundamentals of Combustible Dust, 2016 Edition. NFPA, Quincy, MA.



Ursula Malczewski is a Chemical Engineer in the Risk Management department of Fauske & Associates, LLC

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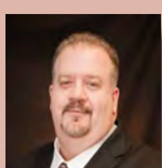
processed or utilized. To minimize the risk of fires or explosions that could result from this arcing, sparking and heat dissipation in hazardous (classified) locations, it is critically important that electrical/electronic equipment be designed, tested and labeled as being acceptable for use in the areas in which they are installed.

Hazardous area classification drawings provide a road map that ensures that electrical/electronic equipment can be safely and properly specified and installed in hazardous (classified) locations such that the risk of fires or explosions is greatly reduced. Fauske & Associates, LLC (FAI) has the expertise, experience and capabilities necessary to perform accurate and practical area classifications for hazardous (classified) locations within any process facility.

References

1. National Fire Protection Association (NFPA) 70, 2014 Edition, National Electrical Code
2. NFPA 497, 2008 Edition, Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas
3. NFPA 499, 2013 Edition, Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas



Jim Huddleston is a Senior Consulting Engineer in the Plant Services department at Fauske & Associates, LLC

FAI koi pond waterfall waking up for Spring

COMBUSTIBLE DUST RESEARCH AT FAUSKE & ASSOCIATES, LLC

By: Ashok Ghose Dastidar, PhD MBA, Vice President, Dust & Flammability Testing and Consulting Services
Fauske & Associates, LLC (FAI)

Dust explosions are a serious hazard in the process industries. They have lead to the injuries and fatalities of plant workers as well as destruction of capital equipment and business interruption. They occur in a wide range of industries such as agricultural, metal processing, fine chemical, woodworking and pharmaceuticals to name just a few. The "dusts" we generally speak about in these incidents include powders that are being handled or manufactured but also byproducts of a manufacturing process. Fauske & Associates, LLC (FAI) have been involved in combustible dust hazards testing and consulting since the early 1980's. We were one of the first labs in North America to have a spherical 20-L chamber for dust cloud explosibility testing. Today, after over 30 years, we are the preeminent laboratory testing facility in North America with world class facilities. We have grown from one 20-L chamber to four spherical units. We also have five Minimum Ignition Energy (MIE) testing apparatus as well as a one-cubic meter spherical explosion chamber. We perform hazard characterization using ASTM, ISO, VDI, IEC and CEN testing methods in our ISO 17025 accredited facility. However, we are not only a commercial testing facility. We do host and sponsor academic research as well.

During the 2014-2015 academic year we hosted three Post-Doctoral Students from the University of Ostrava in the Czech Republic conducting research on comparing dust explosibility parameters measured in the 20-L chamber with those measured in the 1-m^3 chamber. This year FAI have committed ourselves to a three-year research study headed up by

Dr. Paul Amyotte from Dalhousie University in Nova Scotia, Canada under a collaborative research grant from the Natural Sciences and Engineering Research Council of Canada.

Research will be conducted on a specific class of combustible dust known as marginally explosible dusts. These materials pose a unique challenge when designing dust explosion prevention and mitigation measures; while they appear to explode during laboratory-scale tests, their explosion characteristics in industrial-size facilities are less certain. Comprehensive investigation of this uncertainty is only possible by means of concurrent testing using standard laboratory-scale equipment and specialized larger-scale test chambers.

These marginally explosible dusts fall into two categories. The first one is materials that are susceptible to Overdriving. Overdriving is a dust cloud combustion phenomenon where the intensity of the pyrotechnic ignition source used to initiate the explosion in the 20-L test chamber may actually be enhancing the dusts combustibility. This can occur by either heating up the entire dust cloud making it more susceptible to ignition/autoignition or by directly burning the dust in the flame volume of the igniter (the "firecracker" used to initiate these experiments can take up to 50% of the volume of the 20-L test chamber). The second category is materials susceptible to underdriving. Underdriving can occur when the vessel walls of the the 20-L test chamber act as a heat sink and prevent/hinder dust cloud combustion propagation by quenching it out.

These phenomena have been observed in the 20-L chamber by several researchers. These two phenomena are not present in the 1-m^3 chamber. The enormous size of the test vessel means that the ignition source ("firecracker") only occupies a small portion of the chamber thereby minimizing the chance of preheating the dust cloud or that burning in the igniter volume will generate any appreciable pressure. Additionally, the enormity of the chamber means that wall quenching is minimized and dust cloud combustion propagation is allowed to progress and develop. The focus of the current study will be to characterize these phenomena. We at FAI are excited to begin this research as the results could help guide best practices on explosion mitigation strategies for these types of materials.

Dr. Ashok Dastidar is Vice President, Dust & Flammability Testing and Consulting Services at Fauske & Associates, LLC

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ACCREDITED ISO/IEC 17025
Certificate # L2252 Testing

Spring 2016 Combustible Dust & Flammability Hazards Training Courses

Thursday, April 21 - Friday, April 22, 2016

Fauske & Associates, LLC (FAI), presents two individual process safety courses, designed to identify hazards and control strategies that allow for explosion and fire hazard risk mitigation in the process industries. Each course may be attended individually.

Topics to be covered:

- Flammability and electrostatic hazards
- Prevention and protection practices for dust explosion hazards, including OSHA Combustible Dust National Emphasis Program

CEUs: 0.6 per course

Who should attend?

FAI designed these introductory courses for personnel including – but not limited to – chemists, engineers, technicians and operational staff in R&D, process development, kilo, pilot and full-scale production in the chemical, petrochemical, food, cosmetic, detergent, plastic, paper, agrochemicals and pharmaceutical industries.

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.

Day 1 – Thursday , April 21
8 am - 4 pm

Introduction to Understanding and Controlling Flammability Hazards

Description

This course will enable engineers and process safety personnel to identify hazards associated with combustible and flammable liquids and gases. A review of common flammable and electrostatic principles will be discussed using theory and case reviews.

Scheduled Agenda

- Introduction – Basic Theory and Definitions
- Review of Significant Incidents
- Conditions for Fire and Explosion
- Small-Scale Tests
- Theoretical Calculations (Predictions)
- Ignition Factors, Including Electrostatics
- Explosion Control
- Case Studies
- Daily Learning Assessment
- Questions and Answers
- Course Evaluation Instructions

Learning Outcomes

After completing this introductory course, participants will be able to describe and define the fundamental principles of flammability and electrostatic hazards in various industry settings, including:

- Defining what constitutes flammability and electrostatic hazards
- Identifying and mitigating conditions that create such hazards
- Interpreting and reporting on such hazards

CEU Credit Eligibility: FAI is an an IACET (International Association for Continuing Education & Training) Authorized Provider. In order to be eligible for CEU credit (0.6 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.

Please direct instructor or course related questions to: Lisa Karcz: karcz@fauske.com, (630) 887-5232, Fax: (630) 986-5481

Prices: $495.00 per day or $990.00 for both days
Hotel accommodations and travel expenses are the responsibility of the participant
Fees include continental breakfast, lunch and afternoon refreshments for each day of attendance.

Location:
Fauske & Associates, LLC
16W070 83rd Street
Burr Ridge, IL 60527
1+877-FAUSKE1

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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.

Day 2 –Friday, April 22
8 am - 4 pm

Introduction to Dust Explosion Hazards, Prevention and Protection Practices

Description

This course will ensure all participants are aware of important issues associated with OSHA's Combustible Dust National Emphasis Program, NFPA 654 and other relevant standards and codes. A logical approach to characterizing a powder's hazardous dust properties will be presented, 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
- Review of Recent Dust Explosions
- Fundamentals of Dust Explosions
- How to Comply With NFPA Codes and OSHA's Program on Combustible Dust Compliance
- Protection Options
- Daily Learning Assessment
- Questions and Answers
- Course Evaluation Instructions

Outcomes

After completing this introductory course, participants will be able to identify potential dust hazards and how to utilize appropriate test methods to determine levels of potential hazards; as well as apply appropriate mitigation techniques to prevent combustible dust hazards, including:

- Identifying hazard levels
- Determining appropriate methodology for hazard characterization
- Ascertaining process application and hazard mitigation

CEU Credit Eligibility: FAI is an an IACET (International Association for Continuing Education & Training) Authorized Provider. In order to be eligible for CEU credit (0.6 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.

Please direct instructor or course related questions to: Lisa Karcz: karcz@fauske.com, (630) 887-5232, Fax: (630) 986-5481

Prices: $495.00 per day or $990.00 for both days
Hotel accommodations and travel expenses are the responsibility of the participant
Fees include continental breakfast, lunch and afternoon refreshments for each day of attendance.

Location:
Fauske & Associates, LLC
16W070 83rd Street
Burr Ridge, IL 60527
1+877-FAUSKE1

SPRING 2016 COMBUSTIBLE DUST & FLAMMABILITY HAZARDS TRAINING COURSES

Introduction to Understanding and Controlling Flammability Hazards – Thursday, April 21, 8 am - 4 pm
Introduction to Dust Explosion Hazards, Prevention and Protection Practices – Friday, April 22, 8 am - 4 pm

REGISTRATION FORM

Course Location:
Fauske & Associates, LLC
16w070 83rd Street
Burr Ridge, IL 60527
1+877-FAUSKE1

Trainer/Host:
Fauske & Associates, LLC
16w070 83rd Street
Burr Ridge, IL 60527
1+877-FAUSKE1

First Name: ______________________ Last Name: ______________________

Company Name: ______________________ Position: ______________________

Address: ____

City: ______________________ State: __________ Zip: __________

Phone: ______________ Cell: ______________ Fax: ______________

Email: ____

Price:
$495.00 per day or
$990.00 for both days

Fee includes continental breakfast, lunch and afternoon refreshments for each day of attendance.
All fees must be received prior to course commencement.
We accept Visa, Mastercard, American Express, purchase order or company check.

Payment Method: _____Visa _____Mastercard _____AmEx _____ Purchase Order _____ Company Check

Name on Account: ____

Account Number: ______________________ Expiration Date: __________

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

____

Please select which day(s) you will be attending:

☐ Day 1: Thursday, April 21 - *Introduction to Understanding and Controlling Flammability Hazards*
☐ Day 2: Friday April 22 - *Introduction to Dust Explosion Hazards, Prevention and Protection Practices*

Hotel accommodations* and travel expenses are the responsibility of the participant

***A list of area hotels will be provided upon receipt of completed registration form**

Cancellation Policy: Cancellations will be accepted up to April 11, 2016

Contact Lisa Karcz: karcz@fauske.com, (630) 887-5232, Fax: (630) 986-5481

FAUSKE & ASSOCIATES, LLC
World Leader in Nuclear and Chemical Process Safety

www.fauske.com

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Spring 2016 Relief Systems Design Course

Thursday, May 12 - Friday, May 13, 2016

Location/Host:

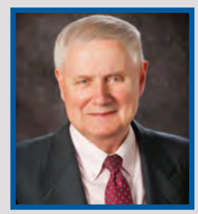
Fauske & Associates, LLC
16W070 83rd Street
Burr Ridge, IL 60527
(630) 323-8750

Course Description

Unlike other emergency vent sizing courses, this curriculum highlights "hand" calculation methods; capable of giving safe – but not overly conservative – relief system designs, with an emphasis on reactive systems and the role of two-phase flow.

Benchmarking of these methods will be illustrated with incidents and available plant data. Utilization of methods and equations will be demonstrated through practical design examples; covering condensed phase (vapor, gassy and hybrid systems), as well as gas phase (gas and dust deflagrations) reactions.

Featured Speaker



Hans K. Fauske, D.Sc., Emeritus President and Regent Advisor of Fauske & Associates, LLC, served as the principal investigator and leader of the DIERS research project team. He is widely known for having developed a simple and cost-effective approach to relief system sizing, including reactive systems and two-phase flow considerations.

Curriculum

Methodology Overview
- DIERS
- API
- ASME
- NFPA

Vent Sizing Models
- Condensed Phase Reactions (Vapor, Gassy and Hybrid Systems)
- Vapor Phase Reactions (Gas and Dust Deflagrations)

Capacity Certification of Pressure Relief Valves in Two-Phase Flow
- Sizing PRV Nozzles
- Sizing Inlet Piping (3% Rule)
- Sizing Outlet Piping (10% Rule)

Runaway Reaction Classification
- Condensed Phase Reactions & Adiabatic Calorimetry
- Vapor Phase Reactions

Single and Two-Phase Flow Overview
- Vessel Behavior and Flow Regimes
- Vessel Blowdown and Vent Line Behavior
- Subcritical and Critical Two-Phase Flows

Special Topics and Examples
- Non-Reactive Fire Sizing Models for Foamy and Non-Foamy Systems
- Discharge Reaction Forces
- Effluent Control / Containment Considerations

Learning Outcomes

After completing this course, attendees will:
- Understand the up-to-date DIERS vent sizing methodologies and models, as well as the role of single and two-phase flow in venting behavior
- Perform vent size calculations using the correct models and methodologies
- Apply adiabatic calorimetry data
- Be able to use hands-on techniques and "rules of thumb" to ensure that realistic vessel and vent size conditions are specified

Price: $1,500.00 USD
- 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 for each day of attendance

Spring 2016 Relief Systems Design Course

Thursday, May 12 - Friday, May 13, 2016
8 am - 4 pm

REGISTRATION FORM

Course Location/Host:
Fauske & Associates, LLC
16W070 83rd Street
Burr Ridge, IL 60527
(630) 323-8750

First Name: ______________________ Last Name: ______________________

Company Name: ______________________ Position: ______________________

Address: ____

City: ______________________ State: __________ Zip: ____________

Phone: ______________ Cell: ______________ Fax: ______________

Email: ____

Price:
$1,500.00 USD

- Fee includes course notes, continental breakfast and lunch for each day of attendance
- All fees must be received prior to course commencement
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Payment Method: _____ Visa _____ Mastercard _____ AmEx _____ Purchase Order _____ Company Check

Name on Account: ____

Account Number: ______________________ Expiration Date: ____________

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

____

Hotel accommodations* and travel expenses are the responsibility of the participant

***A list of area hotels will be provided upon receipt of completed registration form**

Cancellation Policy: Cancellations will be accepted up to May 2, 2016
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