Olimpia Cisneros
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Common Hazards for Distilleries

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While owning a distillery can be a rewarding and profitable undertaking, it's not without risk. The process of making hard alcohol like whisky, gin and rum is not easy and often involves large, potentially dangerous equipment. What's more, those that manufacture alcohol often have to deal with dangerous fumes and other harmful factors.

To protect their business, employees and customers, distillery owners must take a proactive approach to identify and mitigate the unique exposures that affect their operations.

Carbon Dioxide

In order to create alcohol, carbohydrates like starch and sugar must be converted through fermentation. During this process, yeast eats carbohydrates and creates carbon dioxide—an odorless, colourless and toxic gas.

The following is a breakdown of how different concentrations of carbon dioxide can impact your employee's health:

1,000 parts per million (ppm) – Prolonged exposure can affect concentration.
10,000 ppm – An employee's rate of breathing increases.
30,000 ppm – The employee will begin breathing at twice the normal rate and may experience dizziness, a faster heart rate, headaches or hearing impairment.
40,000-50,000 ppm – The employee's breathing increases four times the normal rate, and he or she will experience signs of poisoning after only 30 minutes of exposure.
50,000-100,000 ppm – The employee will quickly begin to feel tired and will experience laboured breathing, headaches, tinnitus (a ringing in the ears) and impaired vision. After a few minutes, he or she will likely lose consciousness.
100,000-1,000,000 ppm – The employee will lose consciousness quickly. At this concentration, asphyxiation and death may occur.

Your workers could be exposed to carbon dioxide through inhalation. Thankfully, you can minimize these hazards by properly venting your fermentation area. Because carbon dioxide is heavier than air, you will want to ensure you take special care to vent the lower levels of your work areas.

If your distillery uses a converted chest freezer as a fermentation chamber, it should be noted that carbon dioxide can collect at the bottom of the cabinet. To address this, periodically prop the lid up and use a fan to introduce fresh air.

Intoxication

Distilleries can be a fun work environment, especially if you or your staff members are passionate about creating alcohol. This environment can sometimes create a loose work atmosphere where staff members are allowed to drink on the job.

This is ill advised, as alcohol can affect an individual's perception and reaction time. What's more, alcohol can negatively impact your worker's judgment, potentially leading to dangerous mistakes or accidents.

And, when you're working with large, expensive equipment, mishaps can be costly or even fatal. Avoid adding unnecessary hazards by banning alcohol consumption during work hours.

Fires and Explosions

Ethanol vapour is highly flammable and is one of the main fire and explosion hazards at distilleries. Ethanol can be released from leaks in tanks, casks, transfer pumps, pipes and flexible hoses.

Common ignition hazards to control can include the following:

Open flames
Torch cutting and welding operations
Sparks (static, electrical and mechanical)
Hot surfaces
Heat from friction
Radiant heat

In addition to being mindful of ignition sources, you can protect your distillery by keeping a dry powder or carbon dioxide fire extinguisher readily available. Ensure that any sprinkler systems you have meet industry and regulatory standards.

In addition, you will want to provide adequate ventilation in the distillery and ban smoking in and around the work area. Be sure to keep heaters and natural gas appliances at least 10 feet away from distilling areas.

It should be noted that dust formed from processing grain and chemical spills can also cause fires or explosions. As such, it's important to practise good housekeeping to avoid the accumulation of combustible debris or liquids.

Physical Injury and Other Employee Hazards

Distilleries can be an unsafe environment for your workers if you fail to take the proper precautions. There are countless risks you will need to account for, including the following:

Chemical hazards. A variety of harmful chemical and cleaning products can be found in distilleries. To protect workers, it's important to require personal protective equipment (PPE) like gloves, steel cap boots and liquid proof aprons. Be sure to clean up any chemical spills immediately.

Electrocution. Because distilleries require workers to handle large amount of liquids around powered equipment, electrocution hazards are common. To maintain a safe working environment, it's important to never run power cables through pools of liquid. Whenever possible, avoid using extension cords, power boards or equipment with damaged plugs, sockets or cables. For added safety, ground equipment and use a ground fault circuit interrupter (GFCI) or residual current device (RCD). These tools automatically shut off power whenever they discover that a current is flowing along an unintended path, including through water or a person.

Injuries caused by heavy lifting. Working at a distillery requires employees to lift and move heavy kegs and other items throughout the day. This can cause repetitive strain and other injuries if workers aren't trained to do the following:

Bend the knees, keep their back straight and lift with their legs.
Be aware of the weight of objects and don't overexert themselves.
Practise team lifting or use back braces to assist with moving heavy loads.

Physical hazards. There are many dangerous items at a distillery that could harm your workers. You will want to ensure the work area is free of trip and slip hazards. In addition, noise from equipment, high-pressure tools, boiling liquids, hot surfaces and confined spaces pose a serious threat and will need to be addressed. Consider conducting safety assessments on a regular basis and address hazards as they arise.

Above all, stills should never be left unattended, and employers should set clear policies and procedures related to workplace safety.

Protect Your Investment

Owning a distillery can be a challenging, yet rewarding, experience. Taking into account the above safety tips will help ensure that the investments you have put into your business are not wasted following an injury or other mishap.

For additional protection, consider speaking to your broker about your insurance options. He or she will be able to discuss potential policies to address common distillery risks.

Hazards of Distilleries

Kentucky has many stereotypes. There is the barefoot and toothless image, or the rumor that everyone from there is inbred. More positive thoughts about Kentucky are the Corvettes manufactured here, horseracing, and the distilled spirits. More than 95 percent of the world's bourbon is produced in Kentucky, where it has been made since the 1780s. More than a half-dozen distilleries are in the region, including Jim Beam, Maker's Mark and Wild Turkey. (Prostock 19) Are those actually positive? Many people, even from Kentucky, do not know about the negative effects of these prosperous businesses. The cars produced in Kentucky cause air pollution; the horseracing business euthanizes disabled, innocent horses. What negative things could happen from the distillation of simple bourbon, whiskey, vodka, and other spirits? Most people only think the negative effects of alcohol are the consumers fault. They could control their consumption, and then they would not have to worry about liver disease or fatal car accidents. What about the people who produce the alcohol though? Are they to blame? Distilleries will not say this is their fault; producers put warnings on their product's label. Distilleries do have a negative, less thought of, impact though.

Each year, U.S. factories spew 3 million tons of toxic chemicals into the air, land, and water. (Dosomething.org) Many people don't know about the impact of distilleries on the environment. Distilleries do not want a bad reputation especially during this major "Go Green" movement. More and more people are starting to care about the environment. Distilleries will probably be under more heat in the next 10 years, along with other factories. The pollution regulations will need to become stricter. A distillery is often forgotten as a factory. To make the common whiskey found in Kentucky, distilleries need grains. At Woodford Reserve, they use corn, barley, and rye. These ingredients are ground up and mixed together. Next, the grains are mashed. Water is added to the grains, and then it is left alone. The starches from the grains are converted into sugars. After sitting for a period of time, the mixture is sifted, and the liquid is separated from the wet grain. Yeast is added to the liquid and starts to ferment. After a few days the liquid is distilled. The alcohol evaporates, the vapor goes out the hole, into the tube, and then condenses back into liquid alcohol. Each time the liquid goes through the distillation, it becomes more pure. On average, it is run through 1-3 times, depending on the type of whiskey being made. The unwanted runoffs are poisonous and often burn off first, before the ethanol begins to burn. Once the whiskey has been distilled, it is put into barrels to mature. Depending on the company, it can mature for 3 to 10 years. The whiskey absorbs the nutrients in the barrels and gains the aroma, flavor, and color. Vodka isn't matured; that is why it is clear. (bavarianbrewerytech.com)

The distilling process makes ethanol, which is the main ingredient in alcohol that affects a person's mind. It also slows the central nervous system. The enzyme, alcohol dehydrogenase, takes a hydrogen atom from the ethanol molecule to break it down into acetaldehyde. This substance is something the body can handle. When dispersed into the air, ethanol can cause problems around it. People know alcohol is flammable; it says it on the container. When the ethanol vapor is released into the air, it has potential to form explosive mixtures. The hazards arise from leaks in the tanks, casks and contributory equipment such as transfer pumps, pipe work and flexible hoses, all of which can release large quantities of liquid on failure. (riskteknik.com) If it were to flow into a confined space, like a sewer or house, then it could explode. It can combust without oxygen, unlike most explosions. There have been no cases where ethanol has been directly linked to an explosion in the air in Kentucky.

Distilleries often contain flammable materials besides ethanol. The grain processing section also has a fire hazard due to the production of grain dust other particles generated in the process. These can easily catch on fire. Older distilleries are often made of wood in comparison to the newer metal distillery warehouses. The floorboards, holding racks, and holding/aging barrels are all wooden. Whisky maturating warehouses sometimes hold a variety of other hazardous materials. There is a natural gas supply to the boilers. These, as mentioned above, can leak. A liquidified Petroleum Gas cylinder contains these gases. If they are punctured or harmed, they can ignite. (risktech.com)

Aquatic systems are also affected by ethanol. Ethanol disperses quickly in water so it is not toxic to the touch. It is deadly in water to fish though because it causes oxygen depletion. This often carries downstream also. One of the Wild Turkey distillery warehouses caught on fire May 9th, 2000. The flame could be seen from 3 miles away. Inside the warehouse was 17,262 barrels of bourbon, each containing 53 gallons of 107 to 112 proof bourbon. Much of the alcohol escaping measured 50 percent by volume. Some of the bourbon had aged 15 years already. The liquid had to go somewhere since it couldn't all burn at the same time. It ran down through a small forest and into the Kentucky River. Some of the liquid was on fire as it rolled down the hill and caused smaller wildfires to erupt along its path. The path was so hot that the limestone bedding began to explode. There was now falling debris from that too. "I just tell them we're having Happy Hour at the river later. Just bring their own bucket," said city worker Debbie Steele. No one was killed from the fire, but the damage had just begun. This accident forced schools and businesses in this town of 8,000 to close the rest of that day and the next. The alcohol did not reach the water tap supply though, because the company shut down soon after hearing about it. The aftermath in the river was not obvious at first. Officials had said that there was harm to the environment but not devastating. People began to take that statement back two days later. People from Frankfort called to say that they could smell the bourbon from the water. A few dead fish had also floated to the surface. As a few more days passed, all people could see when they looked out to the river were dead fish. Numbers had reached into the tens of thousands of dead fish. The ultimate cause of the fish kill was not from alcohol poisoning, but to the depletion of oxygen. The alcohol was shown to be the accelerator food source causing a major bacteria outbreak that consumed all of the oxygen in the river and created a dead zone some 9-12 miles long at its peak. As the tainted water moved downstream, major fish kills would be observed as the dead zone approached and passed dam areas of the river as the fish would be trapped. (Shelley) The fish had no place to go. This is the largest fish kill in the history of Kentucky. (fireworld.com) Wild Turkey distillery was in charge of paying for the cleanup. They had to pay to have the river aerated for 4 days, until the oxygen levels were sustainable again. The people at Wild Turkey reportedly paid $256,000 to help restore the population of fish. (LB)

There was also a fire from a Jim Beam distillery. The seven story warehouse was reported to have been struck by lightning. It sent alcohol-fueled flames more than 100 feet in the air. The bourbon flowed down into a small creek, but officials were able to dam up the creek before it spread. It was estimated to only be two percent of the inventory of bourbon. Firefighters sprayed water on two nearby warehouses in an attempt to save them, while a fire truck stood by at a third. "Once the warehouse is engulfed in flames, the best course of action for the fire departments is to protect the surroundings," said Joe Prewitt, director of Nelson County Emergency Management Services. (Stapleton) Heaven Hill distillery caught fire November 7^{th}, 1996. It destroyed most of their warehouses, and 90,000 gallons of alcohol was lost. The wind was recorded around 55 mph that day, and caused the fire to spread from building to building. The environmental impact here was also minimal. The terrain allowed for the alcohol to pool up and burn in one spot. It did not spread to creeks or rivers nearby. (MassDep)

At the Woodford Reserve distillery, Steve B.was asked if they have ever had a major accident on the property. He replied by saying no, and he hopes they never will. He had heard about the Wild Turkey incident, and said that the warehouse didn't have the correct safety measures. On a tour of Woodford Reserve, Steve pointed to a large pond covered in algae on the property. He made a joke saying that that was the water they used in the distillation process and ended up in the bourbon. He then proceeded to explain how it was actually a reservoir for safety in case anything was to catch on fire. The fire truck could hook their hoses up there and reach any of the 3 main buildings used in distillation. Wild Turkey distillery should have used this idea. The Wild Turkey distillery was also lacking a fire sprinkler system in the warehouse, a containment dike, and an alarm system. Also on the tour, Steve showed people the fermenting room. Here, the yeast and ingredients are mixed together and left to ferment in 4 large oak bins. This produces carbon dioxide from the anaerobic process taking place. Carbon dioxide is a major contributor to global warming. Steve told everyone that the carbon dioxide wasn't harmful. People do not realize that all carbon dioxide is harmful to people and the environment. Steve had misinformed the tour group. This was an example of how the distilling industry tries to say they have a minimal impact on the environment.

Kentucky is also known for their illegal distilleries. Moonshine from Kentucky is known as the best moonshine in the United States. When illegal making of alcohol really became popular in the prohibition era, it began to cause problems. Producers often had to protect their stills. If people were caught trying to steal shine or tampering with the tools, they were shot. When bootleggers from Kentucky would go on deliveries, they brought gunmen with them. These gunmen were told to shoot people who tried to hijack the trucks. This led to the formation of gangs. It also increased the sale of guns on the black market. The distilling business in Kentucky was a growing black market. (prohibitopm8m.com) Since prohibition has ended, Kentucky's bootlegging jobs have declined. The bootleggers that are left do not need guns and hit men for protection. The main danger now of these distilleries in Kentucky is the safety hazards. People are supposed to know the person they are getting the moonshine from. Infamous distillers have been known to put bleach, paint thinners, chemical fertilizers and saw dust into their shine for added flavor. This is potentially dangerous for anyone who consumes it. (ehow.com) Moonshine is made the same way as any other whiskey, even the kind at Woodford Reserve. At Woodford Reserve though, the boiling stills are covered and set up for protection of the employees. In a former's backyard, the distilling pot is wide open. There have been cases where small animals, like raccoons and dogs, have fallen into the boiling mash and died. If the mash is emptied soon enough, the animals skeletons can be found at the bottom of the still; if the still is not emptied for few days, a farmer will never know because even the bones are cooked into the mixture. People's hands and arms are frequently burned while moving around the contraption. Three men had to be taken to the hospital when their moonshine still caught on fire in their garage. The men were making homemade wine in a 25-gallon still when it blew up and splashed them with hot mash. (wkrgnews.com) One of the men received third degree burns and had to be transferred to a more advanced hospital. An explosion that took place in a basement is another example of the dangers of these stills. Late one night, neighbors were awoken by a loud boom. They looked outside and saw a flame coming from a newly built house next door. They then heard two more detonations. Fire fighters soon arrived on the scene but found no one in the building. While in the basement of the house, four more stills exploded. The fire fighters were thrown to the floor and caught on fire. A few of the other fire fighters from upstairs rushed down to save them. Once they were removed from the flames they were rushed to the hospital. Upon examination, they were reported to have 3rd degree burns on their hands, arms, and necks. That same night in a nearby city, a still blew up. This fire was said to not harm anyone, but it did burn the house down. (nytimes.com) Distilling is a very dangerous process when certain safety regulations aren't followed.

Kentucky has had a profitable economy from their production of spirits. This is all people usually hear about. They rarely hear about the negative impacts of distillation until something tragic happens. Most consumers just hear the facts about liver failure, or they hear about the 240 drunk driving car accidents a year in Kentucky. Maybe people would not consume these products if they knew the risk workers and the environment face. Even if they did not slow their consumption, they could push for stricter safety regulations. Accidents like the Wild Turkey Distillery should not have been as bad as it was if they had had the sprinkler and alarm system installed. Also, a containment dike would have caught the excess running down the hill and destroying the soft limestone in its path. The more knowledgeable problems in Kentucky, such as coal mining, animal abuse, and poverty have been advertised and received support. Hopefully, distillery accidents will not happen again. They have a huge impact on the environments well-being. Distilling also produces as much damage to the workers on the outside of their body, as well as the inside of the consumers' bodies.

Hazard assessment in the brewing and distilling industries

Author : Richard Ball, Senior Process Safety Specialist, Chilworth Technology

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The production of beer and spirits produces solutions of ethanol, which is a highly flammable liquid. Raw materials for fermentation and mashing processes involve the handling, storage, and milling of wheat and barley, which generate flammable dust, while grain roasting and drying require huge quantities of fuel, which is usually natural gas. Hence, all types of flammable materials (vapour, dust and gas) necessary for an explosion are present in beer and spirits manufacturing facilities.

The UK brewing and distilling industry contributes significantly to the Food and Drink sector, which is estimated to be worth some £80 billion annually and representing around 7% of UK GDP.(1)

Since the introduction of the EU ATEX 1999/92EC Directive(2) (incorporated in the UK under DSEAR 2002 (Dangerous Substances Explosive Atmospheres Regulations(3))), a systematic hazard and risk assessment has to be undertaken to ensure personnel and the public are not at risk from fire and explosion. In this paper, problems unique to the brewing and distilling industries are aired and the systematic hazard assessment approach is discussed so companies can comply with EU Directives to keep personnel and public safe.

Introduction

Alcoholic drink production requires only a few raw materials; cereal grain plus yeast plus water, which are heated, fermented, matured and decanted, producing ethanol liquor. Thus, it would appear only the final product is flammable and if the ethanol is sufficiently diluted, in the case of beers, lagers and other alcoholic beverages, no flammable atmospheres exist. If only it were that simple!

Most brewers and distillers now buy their malt from specialist suppliers, with malt grains delivered to site by road truck, tipped, and conveyed to the mill house or storage silos. It is then elevated to upper floors of mill houses for destoning, sieving and milling. Milling breaks the grain to reveal the inner cotyledon containing the carbohydrates and sugars.

In the conveying, sieving and milling processes dust is generated, including fines, which can form flammable dust clouds, both inside equipment and if not well sealed, externally as well. Dust is generally extracted to independent dust collector systems. Milled malt or 'grist' is conveyed to and stored in silos ready for production in the 'masher' where water is added.

The intermediate beer brewing and spirit mashing processes are then largely water based and thus flammable atmospheres are no longer present.

Spirit manufacture uses similar raw materials. Malt grains have the outer husk and bran removed before milling to produce grist. In a 'mash tun' stirring encourages sugars to form and the liquor is then added to a "washback" where yeast is added before the fermentation process takes place. The resultant liquor contains less than 10% ABV (alcohol by volume) and is now passed to the 'Still', where concentration of alcohol takes place to create a maximum strength of 94.8% ABV.

The Law

Brewers and distillers handle flammable (explosible) materials so are subject to national law in Europe in the form of ATEX 1999/92/EC Directive or in the UK DSEAR 2002 Regulations. These force employers to ensure workplaces are safe from fire and explosion risk.

ATEX and DSEAR, in effect, state a hierarchical approach of 'Three Rules':

1. Do not have a flammable atmosphere, but if you do…

2. Do not ignite it, but if you do…

3. Do not hurt anyone.

To show compliance with the law, for existing plant a suitable hazard and risk assessment is necessary, which should document the following:

* Flammable materials on site

* Hazardous Area Classification (HAC) for all areas

* Assessment of ignition sources and their elimination in hazardous areas

* Assessments for "equipment" (i.e. mechanical and electrical equipment)

* If flammable atmosphere(s) and or ignition sources cannot be eliminated with certainty then:

* Explosion protection in conjunction with explosion isolation is necessary.

Each process requires a "Basis of Safety", for both normal and expected abnormal operation, which may be:

a) Avoidance of flammable atmospheres, and/or

b) Avoidance of ignition sources,

c) If a) and or b) are not suitable, then explosion protection with explosion isolation is required.

Corrective recommendations, if necessary, should be included in each section by the assessor.

For new build or plant modifications, all of the above should be undertaken as well as ensuring only suitable ATEX-certified equipment is installed in designated hazardous areas. Overall explosion safety should be verified by a Competent Person before going into operation for the first time.

Flammable atmosphere

Fuel explosions (i.e. gases, vapours mists, dusts, and hybrids ((mixtures of flammable materials e.g. dust and vapour)) occur in fractions of a second. In order to control the hazard, all flammable atmospheres must to be identified. For flammable dust, there has to be sufficient fine dust in a dust cloud at or above the 'Minimum Explosible Concentration'. Material safety data sheets (MSDS) can be used but rarely can specific dust data be found on MSDS's. Literature sources can be misleading as grain type, whether raw or roasted, particle size, and moisture content, all affect ignition sensitivity. Thus, care is required when generic data are used and it is always recommended to undertake specific ignition sensitivity and explosion severity testing.

Flammability data required may include Minimum Explosion Concentration (MEC); Minimum Ignition Energy (MIE); Minimum Ignition Temperature (MIT); and Layer Ignition Temperature (LIT), Maximum Pressure (Pmax); and severity constant (KSt), with all the required data dependent upon the defined Basis of Safety. It is often argued as grain moisture content is high and thus ignition sensitivity is low, an ignition is an unlikely occurrence. However, in the Blaye (4) dust explosion incident, the moisture content was greater than 10% by weight.

For ethanol, flash point for both solutions and concentrate, lower and upper explosion limits (LEL/UEL) and auto ignition temperature (AIT) are required. Ethanol data are readily available from literature and data for any flammable gases, whether in bulk or in cylinders, should also be obtained where applicable.

Preventing flammable atmospheres by inert gas, e.g. nitrogen, which is commonly used in pharmaceutical and fine chemical industries, is not appropriate for the brewing and distilling sector. Equipment is often not suitably sealed and introducing nitrogen (an asphyxiant) into an operational culture unused to handling it, presents increased hazards.

Hazardous area classification

Once flammable materials (vapour, gases, dust, etc.) have been identified, the presence of a hazardous explosive atmosphere must be identified. This is based upon frequency or probability of release or 'Grades of Release', which are:

* 'Continuous' - present greater than 10% a year, e.g. inside vessels

* 'Primary' - present between 10% and 1% a year or only occasionally in 'normal operation', e.g. sampling operations

* 'Secondary' present 1 % of a year, only in 'expected abnormal operation', e.g. leaks from vessels

Hazardous and non-hazardous areas should be identified for dust, vapour and gases within the site and findings should be documented and site drawings made. Once the sources and grade of release have been identified, Zone designation and extent can be assigned for gases and vapours. These are Zone 0 (Continuous grade), Zone 1 (Primary grade) & Zone 2 (Secondary grade) and for dusts Zones 20 (Continuous grade), Zone 21 (Primary grade), & Zone 22 (Secondary grade).

Blanket zoning of workplaces should be avoided - remember the hierarchical approach above.

Dusty mill houses are not acceptable. Layers of dust on floors, pipelines, and walls is fuel waiting to be raised into a dust cloud. Increasing the zone severity, say from non-hazardous to Zone 22 or Zone 21 to cater for layers means accepting personnel working in explosible atmospheres in normal operation. That means a dust concentration greater than 50 g/m3 in the workplace in normal operation, which is obviously unsatisfactory when occupational hygiene levels are in the mg/m3 level.

Keeping the fuel inside the equipment should be the primary aim by keeping plant sealed through good design and maintenance, and the use of secondary flexible connections also reduces leakage. There should be a focus of careful cleaning (avoiding dust clouds of course), sealing plant and improving extraction systems.

Similarly for distilleries, in spirit handling areas, pump rooms, etc. vapours should be eliminated by good ventilation removing heavier than air vapour at low points. These measures have real benefits on the working environment, reducing secondary explosion hazards in the workplace and can reduce the cost of equipment by using non-ATEX equipment, e.g. lighting.

Minimising the sizes of external hazardous areas in the workplace should be the aim of all brewing and distilling companies. Finally, hazardous areas should be properly identified by using the ATEX EX (explosible atmosphere) symbol at all entrances, so all personnel understand special precautions are necessary.

Ignition sources

EN1127-Part 1 lists thirteen types of ignition source. Usually in the brewing and distilling sector 1 to 8 are relevant but all 13 should be assessed:

1. Flames/hot gases (including hot particles)
2. Unsuitable/malfunctioning electrical plant
3. Hot surfaces
4. Mechanically generated sparks
5. Static electricity
6. Thermal decomposition (dust self-ignition)
7. Lightning – atmospheric static
8. Stray currents, cathodic protection
9. RF electromagnetic waves
10. Visible light electromagnetic waves
11. Ionising radiation
12. Ultrasonics
13. Adiabatic compression and shock waves.

An ignition source assessment requires applicable flammability data. An "effective" ignition source has to have more energy than the minimum necessary to ignite the fuel, for example electrostatic discharges are a real hazard with vapour or gas, but less so for grain dust.

Mechanical ignition is one of the main hazards for dust. Elevators, conveyors, mills etc. can all be potent sources of mechanical friction and sparks if a malfunction occurs. A preventative maintenance scheme should be in place for all mechanical equipment, including bucket elevators.

Explosion protection in grain handling

Where there is a high probability of a flammable atmosphere and reliably eliminating ignition sources cannot be achieved, then some form of explosion protection is necessary:

* Venting

* Suppression

* Containment

The above measures should be combined with suitable measures to prevent explosion propagation.

Protection systems are covered under ATEX and thus have to be suitably certified. During grain conveying, for example, bucket elevators are explosion vented, which is acceptable provided they vent to a prohibited "safe" area. (see image below).

Explosion venting into the workplace is not acceptable under ATEX, but is sometimes observed in the brewing and distilling sector. Venting inside increases risk of serious injury, and secondary dust explosions (see HAC above), and is a common issue found in the industry during assessments. However, explosion-venting indoors can be permitted by using flameless venting devices.

However, they are not 'fit and forget' items - they require regular inspection and maintenance to ensure they do not become choked.

Whether grain silos require explosion protection is often debated due to low dust concentration, large particle size and absence of ignition sources. Many new-build silos are explosion-vented but existing silos are generally of unknown strength, so whether retrofitted vents can be fitted is not always easy to verify. In these cases, precautions to minimise dust and control all effective ignition sources are essential, together with the exclusion of personnel during filling, which is when the main dust explosion risk exists.

Suppression systems are another satisfactory method of protecting plant, but specialist companies are needed to design, supply, fit, and maintain the equipment. Their use in brewing and distilling is increasing as there is no release of products of combustion, and systems always include explosion isolation such as chemical barriers, whereas in vented systems, explosion isolation has to be separately considered.

Building plant with sufficient strength to contain explosions is not generally undertaken in brewing and distilling: many plants are too large and the extra installation costs would be high. This is nevertheless becoming common in some other industries where smaller plant is used, materials are toxic and full containment is required at all times.

Explosion isolation of dust collector systems (and other plant items) fitted with explosion venting from non-protected plant is often overlooked. If a dust collector is not "de-coupled" and an explosion in this higher risk item occurs, it can propagate back through the entire plant system. Simple explosion diverters that stop pressure-piling effects can be used, but these may not stop flame propagation. Alternatively, some flap valves, chemical barriers, Ventex valves, slam-shut valves, etc., can be used.

It is often poorly understood that explosion-protected plant should not be opened when it is in operation. Examples include opening silo manways for level checking or inspection.

The image below shows a hinged flap on the boot of a bucket elevator that is opened daily for manual material feed where there is no explosion barrier.

Spirit Manufacture

The 'Basis of Safety' for spirit manufacturing includes ignition source controls which includes:

* good earthing and bonding (which includes ensuring operators are suitably earthed)

* avoiding splash filling tanks

* avoiding hotwork

* preventing mechanically generated sparks

* ensuring the use of suitable equipment

* good ventilation

* use of flame arresters on outside vents

Emergency relief vent systems have to be carefully designed, so releases of flammable liquid and vapours cannot not be made to the workplace. Often, spirit tanks are found indoors with the vent indoors, and flame arresters not suitably maintained.

In older distilleries, hazardous areas should be reviewed where blanket zoning has been used, as often the size of Zones can be reduced. Ventilation effectiveness should also be reviewed and all existing electrical and mechanical equipment should be assessed for suitability. Often, this is a case of individual item inspections and a judgement call made item by item. As equipment is replaced in hazardous areas, it should be to the appropriate ATEX category and installed and maintained by competent, appropriately trained personnel.

In the UK most distilleries produce Scotch whisky, which has to be matured for at least three years, and typically 10 years or more for unblended malt whisky. This has to be stored in wooden casks at 60% to 65% ABV (flash point ~ 20°C) and is stacked in warehouses. Casks are porous and evaporation occurs so ethanol vapour is released to atmosphere by natural ventilation. Thus, warehouses are hazardous areas but often there is no lighting or mechanical ventilation so forklift trucks are often the only ATEX Category 3 equipment. Where lighting is used, sometimes non-Ex lighting can be justified due to the vapour density of ethanol. In bonded warehouses, insurers tend to dictate the safety requirements. However, it should also be ensured that personnel take in no ignition sources, thus all torches, communications equipment, etc., should be certified as suitable.

Once matured, whisky has to be filtered, sometimes blended, and bottled. Bottling plants are often separated from distilleries and they receive spirit by road tanker, which is then stored before dilution to final bottle strength (typically 40% ABV, 26°C flash point, so often does not form flammable concentrations at ambient temperatures (depending on plant location)). However, realistic hazardous areas associated with all of these activities must be established and risk assessments undertaken.

Conclusion

In the brewing and distilling industry, both the raw ingredients and the finished product can form hazardous explosive atmospheres. It is important to minimise these explosive atmospheres, especially those external to plant items. However, poor plant layout can lead to the formation of an explosive atmosphere indoors, for example by venting spirit tanks indoors.

Other problems with venting often include a lack of design calculations and explosion isolation devices.

Ignition source control is important within the explosive atmospheres. Earthing of persons handling ethanol and the correct ingress protection on electrical equipment are often overlooked. Finally, where the presence of an explosive atmosphere and an ignition source cannot be avoided then explosion protection is required.

References:

1) http://www.foodsecurity.ac.uk/issue/uk.html

2) Directive 1999/92/EC of the EU on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres, commonly called the ATEX 137 Directive.

3) Dangerous Substances and Explosive Atmospheres Regulations 2002', S.I.2002 No.2776 (DSEAR 2002)

4) F. Masson 1998: Explosion of a Grain Silo at Blaye (France) Ministry for National and Regional Development & Environment