Micro-Distillery Hazards Common in Alberta

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The hazards associated with ethanol distillation may be significant if not fully understood. This document means to provide a basic overview of common micro-distillation hazards, as to help inform stakeholders so that we can create a safe and lasting industry. This document is for information purposes only. This document is broken into 3 parts:

Part 1: The Characteristics of Ethanol

Part 2: Ignition Sources

Part 3: Typical Micro-distillery Operations, and their common Hazards and Hazard Mitigations

Note that much of the information provided in this document was excerpted from *Recommended Fire Protection Practices for Distilled Spirits Beverage Facilities* Third Edition, 2005, Prepared by the Distilled Spirits Council of the United States (DSCUS).

Part 1: The Characteristics of Ethanol

The practice of distilling alcohol for the purposes of making consumable spirits primarily involves the alcohol "ethanol", who's chemical formula is C_2H_5OH. The act of distilling ethanol is the act of separating water and ethanol through the selective boiling and condensing of the two different compounds.

Although other compounds are an important part of the flavour profile of a spirit, it is ethanol which is the ingredient that poses a risk of fire or explosion. Through the various distilling processes, ethanol will be mixed at a range of concentrations causing it to have varying levels of flammability and combustibility:

Flammable and combustible liquids are classified by the National Fire Code (Alberta Edition) (NFC(AE)) by their flash points (the lowest temperature in which it can be ignited). Ethanol at various concentrations in water fit into these classifications:

ABV Concentration	Flash Point (degree C)	National Fire Code (Alberta Edition) Classification
Less than 20% ABV	Greater than 37.8°C	Class II, Combustible, non-Flammable
Between 20% and 60% ABV	22.8°C – 37.8°C	Class IC, Flammable
Between 60% and 96% ABV	Below 22.8°C	Class IB, Flammable

Because of ethanol's miscibility with water, the ability to fully mix with water at any concentration, water is the most effective extinguishing agent, unlike most petroleum products which do not mix with water.

Alcohol vapour is 1.6 times the density of air, causing it to sink collect in lowered areas such as drains or trenches.

Part 2: Ignition Sources

Simply put, a fire or explosion occurs when three items are present:

1) flammable material (ethanol),
2) ignition source, and
3) oxygen.

It is imperative to attempt to limit any releases of flammable material, but most effectively, limiting the exposure of possible ignition sources prevents fires and explosions. This section provides a high-level review of possible ignition sources and how to mitigate their hazards:

Open Flames

An existing fire is very obviously an ignition source, and therefore a still that's heated by an open flame or a natural gas flamed boiler could be significant hazards and ignition sources.

Electrical Equipment

If electrical equipment must exist within an area where a release could occur, it should be designed to minimize the risks of sparking. There are many methods of 'safeing' electrical equipment, including using explosion-proof, or intrinsically safe equipment. The degree of electrical protection is typically determined by an engineer based on the likelihood of a release of flammable material. The classifications of electrical equipment are as follows:

Class I – Vapour and Gas Environments	Zone 0 – Explosive Atmospheres are present constantly or for prolonged times
	Zone 1 – Explosive Atmospheres are likely to occur
	Zone 2 – Where explosive atmospheres are not likely to occur
Class II – Dust Environments	
Class III – Fibers and Flyings environments	

The classification of hazardous areas in distilleries is suggested to follow the figure below, in which any potential leak source has a 'sombrero' shaped Class I Zone 2 radius surrounding it. However a Professional Engineer should determine this for every specific case.

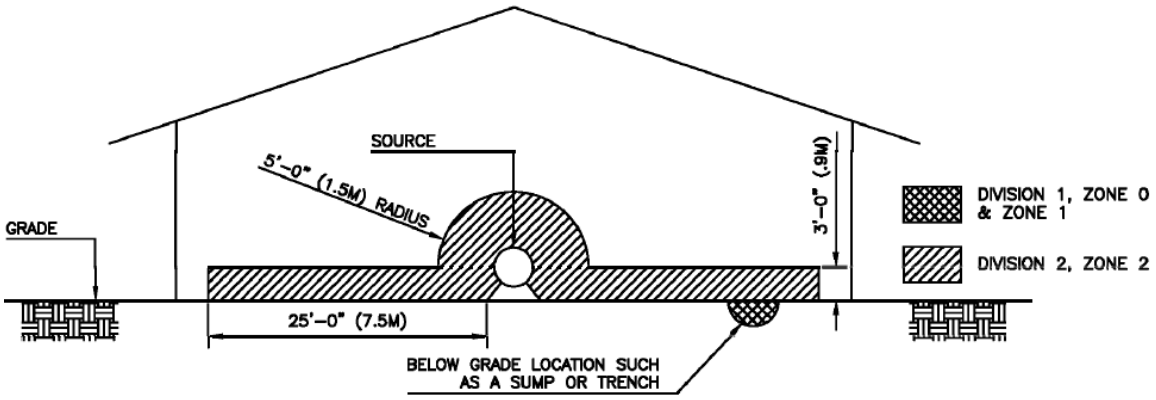

Figure 1: Sombrero of Death

Heat/Temperature

All flammable substances have what's called an 'auto-ignition temperature', this is the temperature at which a substance will ignite without a spark. Hazardous area classified equipment typically have a temperature classification which determines the maximum temperature at which it's outside surface will heat up to, and it's imperative that equipment within a hazardous area does not exceed the auto-ignition temperatures of the substances in the hazardous areas. For distilleries, the auto-ignition temperatures of important substances is below:

Substance	Auto-Ignition Temperature
70% ABV Ethanol	363 °C (685 °F)
Methanol	464°C (867 °F)
Grain Dust	300 °C (572 °F)

Static Electricity Discharge

Static electricity can be very dangerous because it's not often considered in an industrial setting, however static electricity is generated in any mixing, blending, pumping and transfer operations. A common method of preventing static electricity to build up during a fluid transfer is "Grounding and Bonding". The figure below shows an example of grounding and bonding, where a ground wire and bond wire connect both transfer vessels to ground, preventing electrical charge to collect in either vessel.

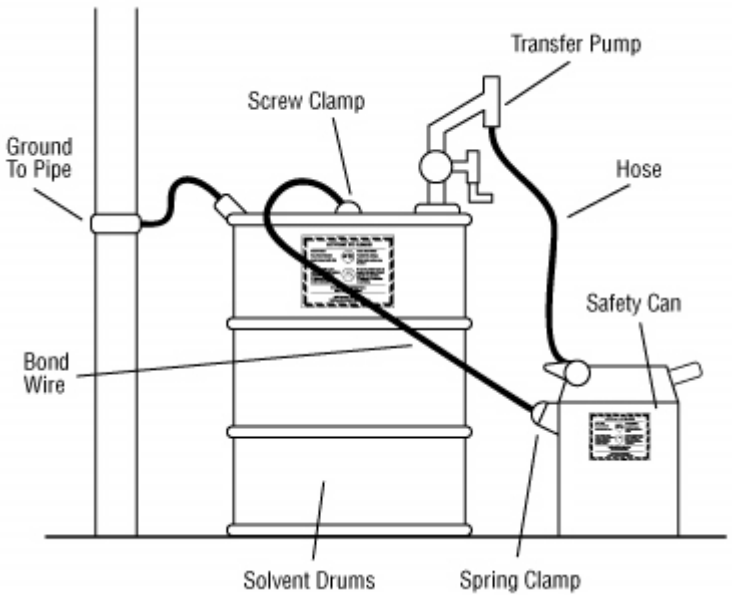

Figure 2: Grounding and Bonding

Chemical Reaction

Distilleries typically have many chemicals on hand for various operations, and spilling or mixing them could cause any number of dangerous outcomes. Care should be taken when dealing with any chemicals.

Lightning

Lightning is a source of possible ignition, and should be considered in design, especially with larger distillery operations.

Part 3: Typical Micro-distillery Operations, and their common Hazards and Hazard Mitigations

Distillery operations can be broken down into a few steps. Some distilleries do not complete all of these operations:

1. Grain Handling/Malting/Milling
2. Fermentation
3. Distilling
4. Blending/Mixing/Diluting/Transferring
5. Storage/Aging
6. Bottling

The following goes through each operation and describes some of the common distillery hazards associated, and some of the ways to mitigate these hazards:

Grain Handling/Malting/Milling:

Grain and grain dust are flammable and explosive in certain conditions, and should be considered dangerous hazards. Most distilleries in Alberta do not do their own malting, but the act of heating grain is a dangerous operation where care should be given during design and operation of any malting operations. In any milling operation, the accumulation of dust is major source of hazard. Isolating milling to a room with separate ventilation, and control of any ignition sources that could ignite dust is an excellent way to minimize risk. A less effective way is to develop a frequent cleaning schedule so that dust doesn't accumulate – particularly on equipment surfaces that could heat up or are near other ignition sources.

Fermentation:

Fermentation processes in a distillery are generally the safest in a fire hazard perspective, but have their own unique hazards. Operationally, there could be a lot of climbing ladders, or the occasional requirement to enter a vessel. During fermentation, carbon dioxide fills the volume of air in a tank, so someone could suffocate if they stuck their head into a fermentation tank for too long. Additionally adequate monitoring of CO2 and engineered ventilation systems are advisable for the safety of workers.

Distilling:

The hazards associated with distilling can generally be mitigated by purchasing reputably made equipment. Because a still contains pressure, it is an absolute must that a still has a pressure relief valve (PRV), which are typically set between 3-5 psi. A still with direct flame heating is another design that is not recommended by the ACDA, because of its inherent hazards. Copper in stills will wear away over time, and needs to have regular maintenance to ensure the walls of the still are sufficiently thick to be structural and pressure containing components.

Because there's generally a number of potential ignition sources in the same building as a still, a permanent gas/ethanol monitor is a great way to reduce risk. By setting a monitor close to the still, and at a height of 3 feet or less, it can monitor if there is a leak. Interlink this to other electrical equipment in the area, making it so that the equipment shuts off if there is a detected leak, or forces on a ventilation system to activate. Another way to reduce risk is to layout your distillery in a way so that the still is isolated from any ignition sources. The 'sombrero of death' figure shown in the previous section and below are a good start when considering placement of the still and surrounding electrical equipment.

Any electrical equipment connected to a still, whether it be an agitator or automated valves, should be rated for the appropriate hazardous area classification (Class I Zone 2).

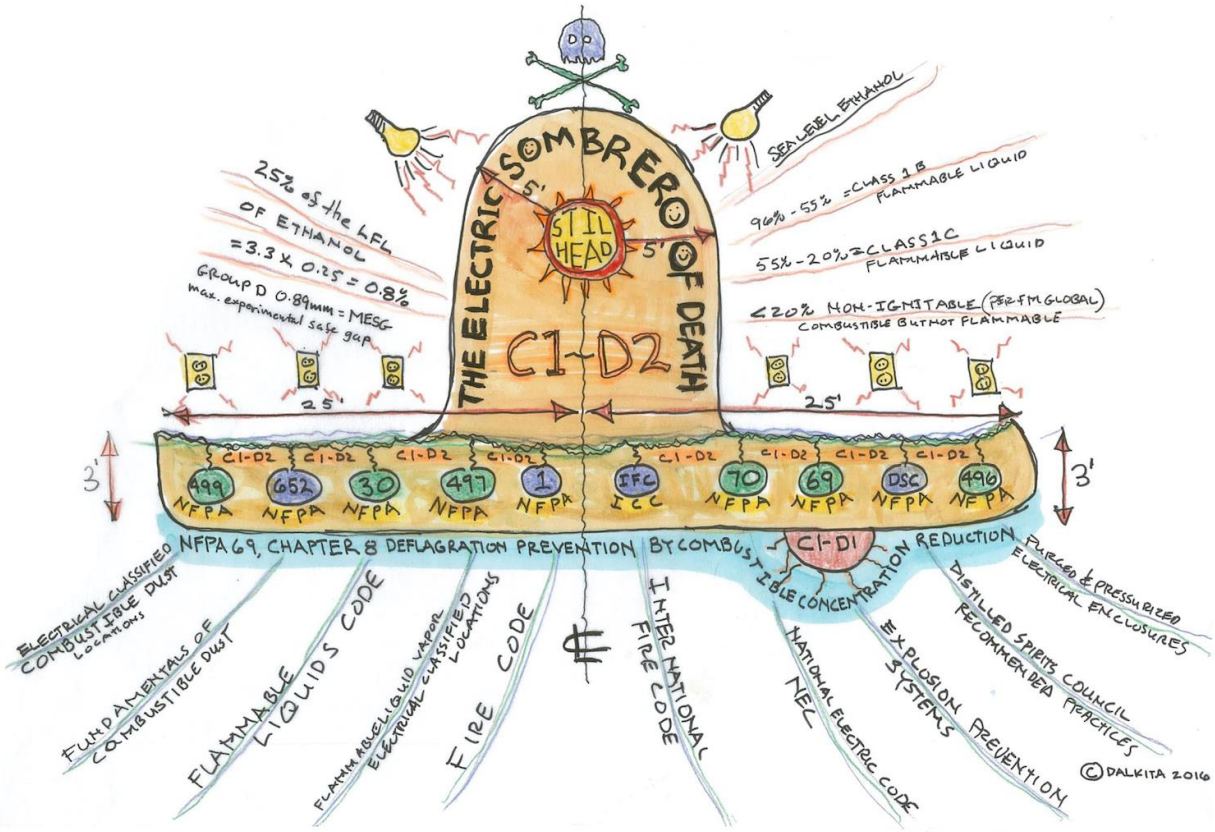

Figure 3: The sombrero of death

Blending/Mixing/Transferring:

As mentioned in the ignition source section, pumping a fluid causes static electricity to build up. Whenever you have an operation of pumping, or mixing, you need to make sure the equipment is hazardous area classified so that they are not potential ignition sources, and that all the containers and pumps are grounded and bonded. Using pneumatic pumps is an exceptional way to keep down costs while not creating any hazards.

Because alcohol and water do not mix readily, and require agitation to fully mix, its exceptionally important to mix these fluids safely.

Storage/Aging:

Any area with wooden barrel storage should be considered a hazardous area (Class I Zone 2) since barrels are porous and alcohol slowly evaporates through the barrels in what is called the “angel’s share”. Sprinklering these areas is really important because not only is the alcohol inside the barrel flammable, but the barrel itself is flammable.

IBC Totes and plastic drums are a contentious issue in the distilling world, because they are very attractive way to store alcohol due to their cost. These however are not acceptable ways to store alcohol. If a fire were to breakout in a distillery, these containers will melt and the fluid inside will further fuel the fire. Most fire jurisdictions will not allow alcohol storage to exist in these totes. These can be used to transport product or store it outside, but inside a distillery it is not a acceptable storage solution. Use only containers rated to store flammable liquids as defined by the Alberta Fire Code.

Figure 4 Plastic Drums and IBC Totes

Bottling:

Bottling is another area with fewer hazards, however any equipment required for pumping should be hazardous area rated or pneumatic in nature. Spill control and rapid inerting procedures should be considered, as well as glass breakage hazards.