DISTILLERIES

INTRODUCTION

Spirituous liquor distilleries make whiskey, gin, rum, vodka, brandy and similar beverages. Whiskey is made from rye, corn, wheat or barley; gin from rye and juniper berries; rum from sugar cane or molasses; vodka from rye or potatoes and brandy from wine or fruit. Sake is made from rice. Specialty liquors are made from a wide variety of fruits and vegetables.

Manufacturing spirituous liquor involves many hazards, including grain storage and handling, pressure vessels for fermentation, fuel fired equipment for distilling, and alcohol storage and handling. Many measures can be taken to prevent and control losses from these hazards.

PROCESSES AND HAZARDS

The simplified process flow chart in Figure 1 shows the major steps for distilling spirits. These steps are described in the following sections.

Grain Storage And Handling

Distilleries store and handle large amounts of cereal grains. Grains are stored in silos and transferred by various types of conveyors or elevators.

Grain storage and handling presents a major dust explosion potential. Deep seated fires are also possible. Common ignition sources include improper or poorly maintained electrical equipment, transfer machinery malfunction, and spontaneous heating.

"Beer" Manufacturing

Grain from storage is weighed and mixed with water in mash tubs or steam heated pressure cookers. The mixture (mash) is cooked then transferred to the fermenters. Yeast, water and thin stillage from the "beer" stills are added (see Distilling), and the mixture is allowed to ferment. The resulting liquid is called "beer" (not drinking beer) and has an alcohol content of 7% – 13%. The "beer" is transferred to holding tanks before distilling.

Pressure cookers and fermenters are subject to vessel rupture from fatigue or overpressurization. Fermenting produces carbon dioxide, which some distillers recover for sale. Mashing and fermenting operations present very little chance of fire or explosion.

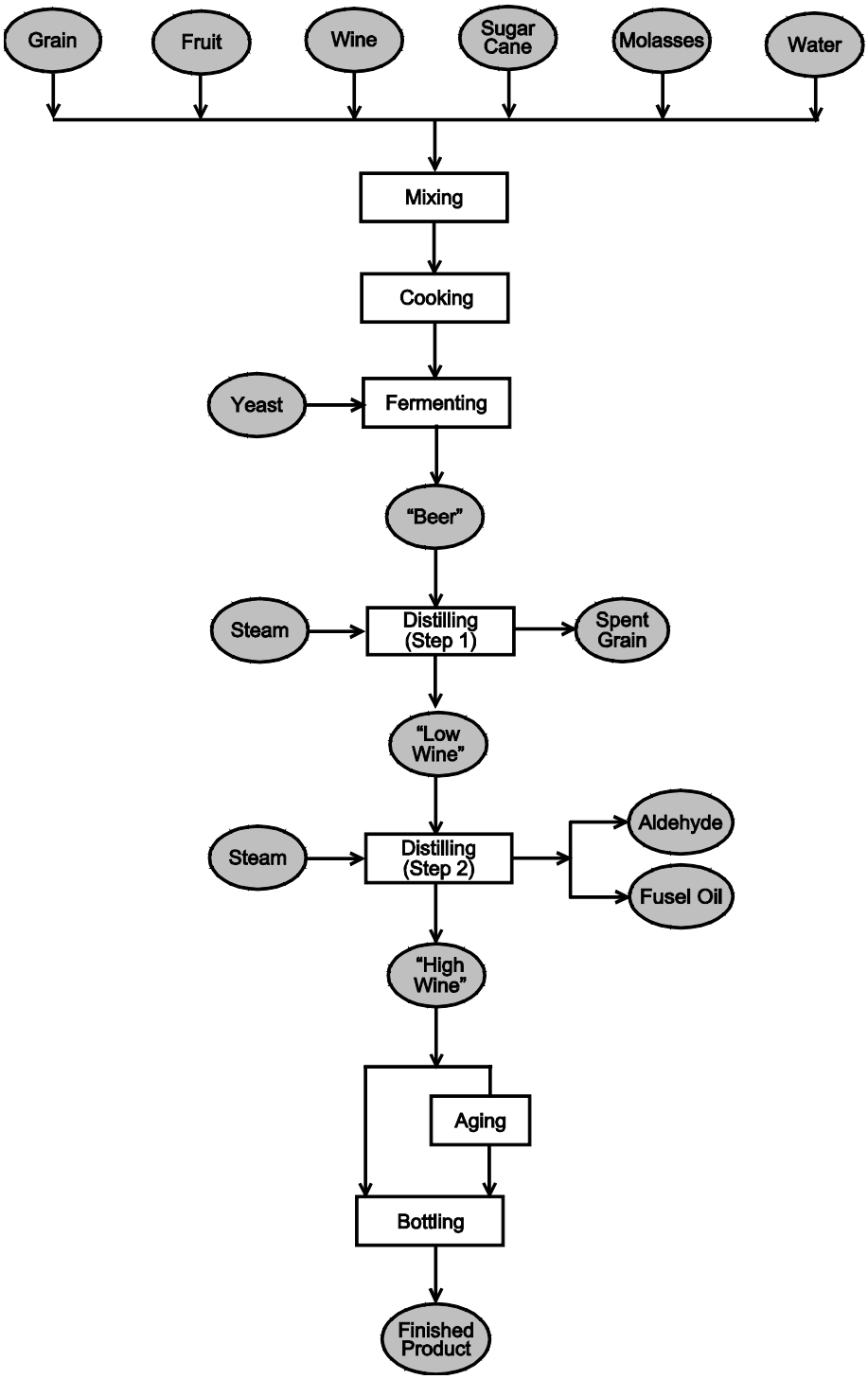

Figure 1. Simplified Flow Chart For Distilling Spirits.

Distilling

Distilling is done in two steps. The first step produces "low wine," the second "high wine." The stills in both steps are steam heated.

"Beer" is pumped through preheaters to the top of the beer still. The "beer" flows down over baffles while alcohol-rich vapors rise from below. The vapors are collected, condensed and pumped to a storage tank. This liquid is called "low wine," and it has an alcohol content of 40% – 70%.

The “low wine” is pumped to stills called rectifying columns, or doublers. The liquid condensed from the vapors is called “high wine,” and it has an alcohol content of 55% – 75%. Commercial grade high wine can have an alcohol content up to 95%.

Byproducts of distillation include aldehydes and fusel oil from the high wines. Residue from the beer still is spent grain, which is dried and sold as animal feed.

The hazards of distilling include combustion explosions in the fireboxes of fuel fired equipment, rupture of steam piping and process pressure vessels, fire in alcohol spills, and explosions in alcohol-containing vessels.

Distilled Liquor Handling

“High wine” (distilled liquor) is sent from distilling to storage tanks. The tanks are usually in a separate building or fire area, in accordance with government regulations concerning alcohol that has not yet been taxed. At this point, the “high wine” is tested for quality and proof. (The proof number is twice the alcohol percentage.)

“High wine” is transferred to the blending or cistern room, where the proof is adjusted by adding distilled water. The final product is then pumped into special wooden barrels and moved to aging warehouses, where it remains for several years. Once aged, the product is ready for bottling. Some liquor, such as vodka, is bottled without aging.

Due to its high alcohol content, distilled liquor presents serious fire and explosion hazards.

Barrel Storage Warehousing

Barrels of newly distilled liquor are stored in warehouses under the close supervision of government agents, because the alcohol has still not been taxed. These warehouses are kept locked.

Barrel warehouses are of several designs, the most common being the one story, open rack type. In these warehouses, barrels are stored on side in racks 4 to 45 barrels high. Racks may be single, double or multi-row. The racks are made of either wood or steel, and in some cases, they support the roof.

Barrels are moved vertically by elevator and then moved to their storage location. Limited walkways are provided to allow employees to check for leaking barrels. Less often, false floors are provided at 6-barrel intervals.

Some barrel warehouses are multi-story. In these warehouses, barrels are stored on side 6 to 9 barrels high in each story. In other warehouses, barrels are stored on end on pallets to 6 pallets high.

One loss exposure in barrel warehouses is liquids damage from leaking barrels. Most leaks are small, but dropping a barrel can result in a significant spill. Racks can collapse from improper weight distribution, creating a major spill.

Because distilled liquor is flammable, spills also present a serious fire exposure. Flammable liquids fires develop rapidly and can be very difficult to extinguish. Large losses commonly result.

Blending And Bottling

After aging, the barrels are brought to a blending and bottling operation. The liquor is emptied into tanks and tested for proof. The proof is adjusted with distilled water, and the liquor is bottled.

At this point, the tax must be paid and the product shipped or stored in open warehouses. If the tax is not paid, the liquor is stored in bonded warehouses until needed, at which time the tax will be paid.

The major loss exposure with blending and bottling is flammable liquids fires. Sources of liquid spills include leaking barrels, improper procedures for transferring the liquor, loose fittings, broken piping, overfilling of tanks and leaking tanks.

LOSS PREVENTION AND CONTROL

Management Programs

Implement management programs in the areas discussed in *OVERVIEW*, AXA XL Risk Consulting's total management program for loss prevention and control. Tailor these programs to distillery processes, paying particular attention to the following areas.

Hazard Evaluation

Identify locations for and estimate sizes of possible flammable liquids spills throughout the facility. Analyze the effects of spills and ensuing fire on operations. Design and lay out operations to minimize damage and down time from spills, and to minimize the chance of igniting spills.

Estimate the potential for contamination of product in all parts of the facility. Design and protect the facility to minimize overall exposure to contamination.

Evaluate the importance of heating and refrigeration systems. Either install duplicate systems, design systems with extra capacity, or keep spare components of these systems so that loss of one system will not spoil a large amount of product. Also consider providing diesel-driven refrigeration compressors.

Evaluate the importance of electrical equipment. Provide emergency power supplied to minimize spoilage in the event of a power loss.

Maintenance

Implement preventive maintenance programs for the following equipment:

- Boilers, in accordance with PRC.7.1.0.5 and PRC.7.1.0.6.
- Conveyors, in accordance with PRC.9.3.1.
- Motors, in accordance with PRC.1.3.1.
- Emergency generators, in accordance with PRC.6.2.1.1.
- Electrical equipment, in accordance with NFPA 70B.

In addition, conduct regular inspections and nondestructive testing of process pressure vessels, including fermenting tanks and pumping systems.

Housekeeping

Control accumulation of grain dust with well designed ventilation and dust control systems. Immediately clean spills in both process and storage areas. Keep combustible materials throughout the facility, including packaging materials, to a minimum.

Construction

Cut off storage areas with freestanding 4 h rated fire walls. Protect wall openings with double 3 h rated, automatic closing fire doors.

Provide 3 h rated fire barrier walls to isolate office areas, utilities buildings, grain handling areas, fermenting operations and distilling operations. Protect wall openings with single 3 h rated, automatic closing fire doors.

Install electrical equipment suitable for the occupancy in accordance with NFPA 70. Use Class II, Group G equipment in areas containing grain. Use either Class I, Group D equipment or Class I, Group IIA equipment in distillation areas.

Building Protection

Protect process occupancies in accordance with Table 1. Protect storage occupancies other than barrel warehouses in accordance with Table 2. The sprinkler designs in these tables are from *Recommended Fire Protection Practices For Distilled Spirits Beverage Facilities* published by the

Distilled Spirits Council. The tables refer to NFPA 13. When using this standard, also refer to PRC.12.1.1.0.

TABLE 1
Process Occupancies

Occupancy	Type Of Sprinkler System[1]	Density gpm/ft^2	Area Of Demand ft^2	Hose Stream Demand gpm
Grain Handling (including Drying)	Protect in accordance with NFPA 13, for an Ordinary Hazard Group 2 occupancy.			
Mashing and Fermenting[2]	Wet	0.20	2000	250
	Dry	0.20	2600	250
Still House	Wet or Dry	0.20	5000 first level 2000 intermediate and ceiling levels	500
Barrel Fill and Drain Areas	Wet or Dry	0.25	5000	500
Barrel Warehousing	See PRC.8.1.0.1			
Tanker Loading, Unloading Station	Deluge	0.25	Simultaneous operation of all heads (see NFPA 15)	500
Tank Rooms[3]	Wet or Dry 165°F	0.30	5000	500
	Wet or Dry 286°F	0.30	4000	500
Bottling Areas	Wet	0.20	3000	500
	Dry	0.20	5000	500
Cooperage	Protect in accordance with NFPA 13.			

SI Units: 1 gpm/ft^2 = 40.7/L/min/m^2; ft^2 = 0.093 m^2; 1 gpm = 3.79 L/min; 1 psi = 0.687 bar; 1 ft = 0.305 m; °F = (°C × 1.8) + 32

NOTES

[1] For use with sprinkler heads temperature rated between 165°F and 286°F, unless otherwise noted.

[2] Minimum of 600 gpm sprinkler demand at base of riser in accordance with NFPA 13 requirements for Ordinary Hazard Group.

[3] Sprinklers should be provided beneath all tanks with a horizontal dimension greater than 4 ft. Design should be based on an end head pressure of 15 psi. Sprinklers under solid or grated catwalks should be designed to provide a density of 0.15 gpm/ft.^{2} The overall tank room design should consider the simultaneous operation of ceiling, undertank, and under-catwalk heads within the area of demand specified above.

The sprinkler designs in Table 2 are based on fire testing of 100 proof (50%) alcohol. Protection of higher proof alcohol requires a sprinkler design based on an analysis of the storage arrangement.

Protect barrel warehouses in accordance with PRC.8.1.0.1. Always keep bungs in used empty barrels.

Provide sprinkler protection beneath tanks on legs. Ramp or dike tank areas to contain spills from the tanks. Install fusible links on discharge piping from the tanks. Locate the links as close to the tank shell as possible.

Grain Storage And Handling

Design and protect grain handling equipment and buildings in accordance with NFPA 61. Design and install pneumatic conveying systems in accordance with NFPA 650. In silos, bins, hoppers and bucket elevators, either install deflagration venting in accordance with NFPA 68 or provide explosion suppression systems in accordance with NFPA 69.

TABLE 2
Storage Occupancies

Occupancy	Type Of Sprinkler System[1]	Density gpm/ft^2	Area Of Demand ft^2	Hose Stream Demand gpm
Finished Case Goods				
1. Solid Pile (PET Plastic and Glass Bottles)				
Under 20 ft	Wet	0.30	3000	500
	Dry	0.30	4000	500
20-25 ft	Wet	0.40	3000	500
	Dry	0.40	4000	500
2. Racked and Palletized in corrugated cartons				
a) Glass	Protect in accordance with NFPA 13 for a Class III Commodity.			
b) PET Plastic	Protect in accordance with NFPA 13 for a Class IV Commodity.			
Empty Bottles[2]				
1. Glass	Protect in accordance with NFPA 13 for a Class I Commodity.			
2. PET Plastic				
a) Solid Pile				
Under 15 ft	Wet	0.30	3000	500
	Dry	0.30	4000	500
15-20 ft	Wet	0.40	3000	500
	Dry	0.40	4000	500
b) Racked	Protect in accordance with NFPA 13 for a Class IV Commodity..			
Dry Goods[2,3]	Protect in accordance with NFPA 13 as appropriate.			
Empty Barrel and Idle Pallet Storage				
1. Interior	Protect in accordance with NFPA 13. Treat empty barrels as a Class IV commodity.			500
2. Exterior		--		1000

SI Units: 1 gpm/ft^2 = 40.7/L/min/m^2; ft^2 = 0.093 m^2; 1 gpm = 3.79 L/min; °F = (°C × 1.8) + 32

NOTES

[1] For use with sprinkler heads temperature rated between 165°F and 286°F, unless otherwise noted.

[2] Plastic closures and 50 ml or smaller PET Plastic Bottles should be considered as granular plastic, and protected in accordance with NFPA 13 as Ordinary Hazard Group 2.

[3] Where applicable, ESFR sprinkler systems may be installed in accordance with NFPA 13.

Fuel Fired Equipment

Provide combustion safeguards for boilers in accordance with NFPA 85 and PRC.4.0.1. Provide combustion safeguards for kiln dryers in accordance with NFPA 86 and PRC.4.0.1.

Cooling Towers

Use cooling towers of totally noncombustible construction. Protect cooling towers with combustible shell or fill in accordance with NFPA 214.

Refrigeration Systems

Arrange refrigeration systems in accordance with ANSI/ASHRAE 15. Design and install ammonia refrigeration systems in accordance with ANSI/IIAR 2. For more information, see the NFPA *Fire Protection Handbook*.

Locate ammonia refrigeration systems in separate areas cut off by 3-h rated fire barrier walls. Install isolation valves on ammonia piping to limit the amount of leakage in the event of line ruptures. Provide sprinkler protection wherever combustible insulation is used.

Conveyors

Protect combustible conveyor belts in accordance with PRC.9.3.1