OILSEED EXTRACTION

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1.0 SCOPE

This data sheet provides loss prevention recommendations for oilseed manufacturing facilities and the hazards associated with operations in the solvent extraction area of an oilseed plant.

This data sheet does not cover the hazards associated with grain or bean storage and handling.

For additional guidance refer to Data Sheets 7-11, *Conveyors*; and 7-76, *Combustible Dusts*.

1.1 Hazards

The main hazards present at this occupancy are combustible dust and ignitable liquid (hexane and processing of the seed oil). The loss drivers in the occupancy are fire and explosion, mechanical breakdown, and natural hazards.

1.2 Changes

January 2023. Interim revision. Minor editorial changes were made.

2.0 LOSS PREVENTION RECOMMENDATIONS

2.1 Construction and Location

2.1.1 Provide damage-limiting construction (DLC) designed in accordance with Data Sheet 1-44, *Damage-Limiting Construction*, for buildings where hexane is handled.

2.1.2 To the extent possible, locate solvent work tanks, solvent/water separators, and solvent/miscella pumps at ground level to prevent elevated floor spills.

2.1.3 Provide adequate drainage and containment for extraction buildings in accordance with Data Sheet 7-83, *Drainage Systems for Ignitable Liquids*.

2.2 Process Hazards/Safety

2.2.1 Establish a process safety program in accordance with Data Sheet 7-43, *Process Safety*.

2.3 Protection

2.3.1 Extraction Building

2.3.1.1 Install automatic sprinkler protection in accordance with Data Sheet 7-14, *Fire Protection for Chemical Plants*. Ensure protection provides effective coverage on elevated flanges, sight glasses, and in the shielded area between the upper and lower levels of horizontal loop extractors.

2.3.1.2 Provide passive or active structural protection in accordance with Data Sheet 7-14, *Fire Protection for Chemical Plants*.

2.3.1.3 Protect external hexane storage tanks in accordance with Data Sheet 7-88, *External Ignitable Liquids Storage Tanks*, and internal tanks in accordance with Data Sheet 7-32, *Ignitable Liquid Operations*.

2.3.1.4 If there is a separate preparation building, provide protection per Data Sheet 7-32, *Ignitable Liquid Operations*, over the entire preparation building, including below steel-grated floors.

2.3.1.5 When steam snuffing is used as protection, provide a reliable supply independent from the process/purging steam with a delivery rate of 4 to 8 lb/min per 100 ft^3 (0.64 to 1.3 kg/min/m^3) of enclosure volume. For additional information see Data Sheet 7-99, *Heat Transfer Fluid Systems*.

2.4 Equipment and Processes

2.4.1 Provide all vessels containing ignitable liquids with normal and emergency venting in accordance with Data Sheet 7-88, *Ignitable Liquids Storage Tanks*, and Data Sheet 7-49, *Emergency Venting of Vessels*.

2.4.2 In the extraction building, provide a reliable vapor/LEL detection system designed to alarm to a constantly attended location.

2.4.3 Install noncombustible gaskets for solvent/miscella-carrying pipe connections.

2.4.4 Provide temperature-sensing devices in the desolventizer toaster (DT) and the water outlet from the waste water evaporator (so as to guard against solvent carry-over) to alarm when the temperature drops to within 25°F (14°C) of the boiling point of the solvent. An alarm should also operate when the temperature rises more than 25°F (14°C) above the normal operating temperature to detect overheating of the metal. Continuously record the temperature in the desolventizer toaster (DT).

2.4.5 Provide interlocks to shut down all ignitable liquid flow upon activation of the fire protection system in accordance with A through D below. Also provide a manual emergency stop capability from the control room and/or a safe remote location.

A. Area of solvent holdup. This is not required for the hoppers on crown-style extractors (handled by shutting off hopper pumps).

B. Automatic isolation valves (fail-to-close) on all vessels containing hexane or miscella.

C. All solvent pumps containing hexane or miscella.

D. Consider other key utilities (e.g., steam) in the shutdown scheme.

2.5 Operation and Maintenance

2.5.1 Provide detailed procedures to safely shut down and start up the extraction process.

2.5.2 Purging operations for a solvent extractor may be performed with steam or air. Air-only purges are acceptable when the plant needs to go offline for minor repairs or if there is a minor process upset. For major maintenance outages, or if hot work is required, a full steam purge is needed. A full steam purge is also needed to liberate solvent from agglomerated miscella. For additional information see Data Sheet 7-59, *Inerting and Purging Vessels and Equipment*.

2.5.3 Ensure the testing/calibration activities of the vapor/LEL detectors in the solvent extraction building do not exceed manufacturer's recommendations. For additional information refer to Data Sheet 5-49, *Gas and Vapor Detectors and Analysis Systems*.

2.5.4 Establish an asset integrity monitoring program in accordance with Data Sheet 9-0, *Asset Integrity*. Pay special attention to corrosion of carbon steel vessels, including the extractor, the top of the desolventizer toaster (DT), and steam supplies (process, purging, and snuffing).

2.6 Electrical

2.6.1 For hazardous areas in which ignitable liquids are handled or stored, provide electrical classification in accordance with Data Sheet 7-32, *Ignitable Liquid Operations*. This includes the entire extractor building.

2.6.2 For MCC rooms located inside the extraction building, provide purge and pressurization to the enclosure in accordance with Data Sheet 5-1, *Electrical Equipment in Hazardous (Classified) Locations*.

3.0 SUPPORT FOR RECOMMENDATIONS

3.1 Loss History

The most frequent causes of loss in this type of occupancy are fires and explosions. Figure 1 provides a summary of all losses between 2006 and 2016.

An explosion and fire in a canola crushing processing plant was caused by an overheated bearing on a bucket elevator in the meal-handing area. Sparks travelled down the empty side of the elevator to the base where dust loading was the highest, causing the initial small explosion in the below-grade portion of the bucket elevator. Two more explosions occurred, damaging the seed tower area and the pellet storage building.

A fire (caused by vandalism) in a soybean processing plant damaged the quality control equipment, electronic equipment, warehouse, surveillance, and medical area.

Other losses included the mechanical breakdown of a 10 MW steam turbine due to overspeed, and a fire at a control room that caused damage to equipment.

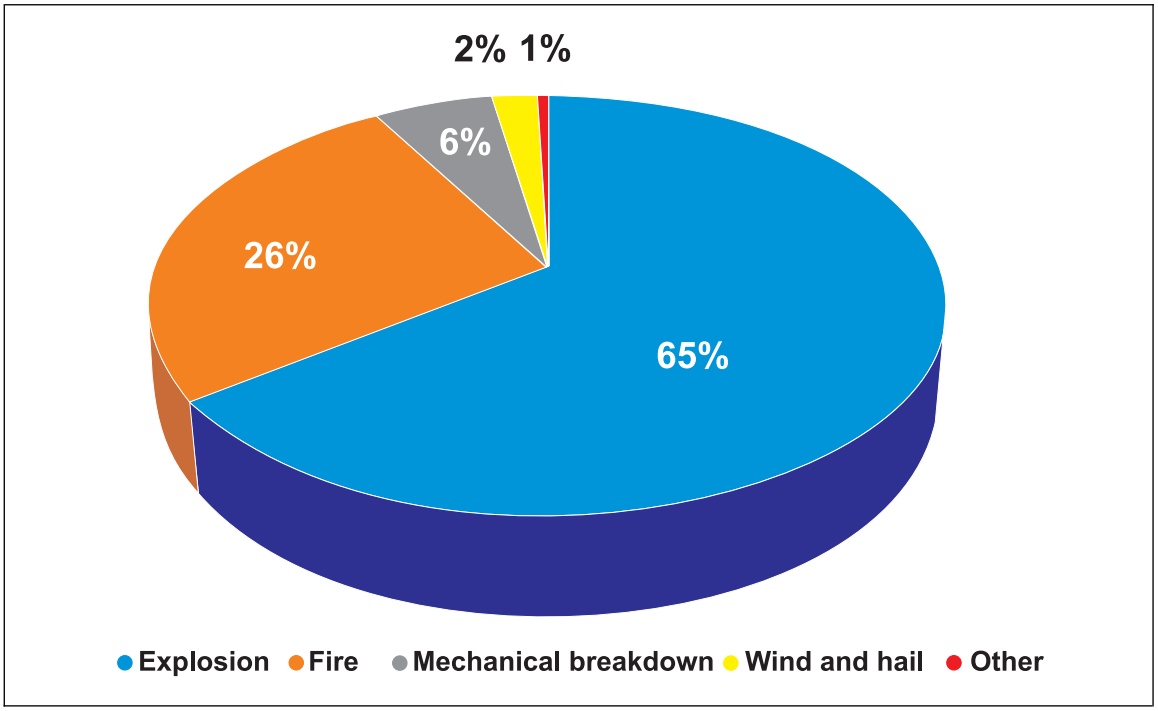

Fig. 1. Losses by peril, 2006-2016 (based on frequency)

3.2 Process Overview

Oil is typically extracted via a solvent such as hexane. Soy beans are a common feedstock, but other materials (such as corn germ) are also used.

The typical soy bean extraction process (see Figure 2) involves cleaning the bean, then removing the seed hull. Beans are then flaked before contacting the hexane solvent in a counterflow extraction system. The extractor (see Figure 3), is a totally enclosed chamber with a very slow-moving band conveyor inside. Several washing points using miscella (hexane/oil mix) of different concentrations are used, with a final fresh solvent point to ensure a maximum oil extraction.

The miscella is evaporated and then distilled to separate the oil from the hexane solvent. The recovered hexane is returned to the extraction process and the oil is further purified to make an edible product.

The leftover flake passes through a desolventizer and is then steam-treated to remove any traces of residual hexane before becoming either soy flake protein or food for livestock.

4.0 REFERENCES

4.1 FM

Data Sheet 1-44, *Damage-Limiting Construction*
Data Sheet 5-1, *Electrical Equipment in Hazardous (Classified) Locations*
Data Sheet 5-49, *Gas and Vapor Detectors and Analysis Systems*
Data Sheet 7-14, *Fire Protection for Chemical Plants*
Data Sheet 7-32, *Ignitable Liquids Operations*
Data Sheet 7-43, *Process Safety*
Data Sheet 7-49, *Emergency Venting of Vessels*
Data Sheet 7-59, *Inerting and Purging Vessels and Equipment*
Data Sheet 7-83, *Drainage Systems for Ignitable Liquids*
Data Sheet 7-88, *Ignitable Liquid Storage Tanks*
Data Sheet 7-99, *Heat Transfer Fluid Systems*
Data Sheet 9-0, *Asset Integrity*

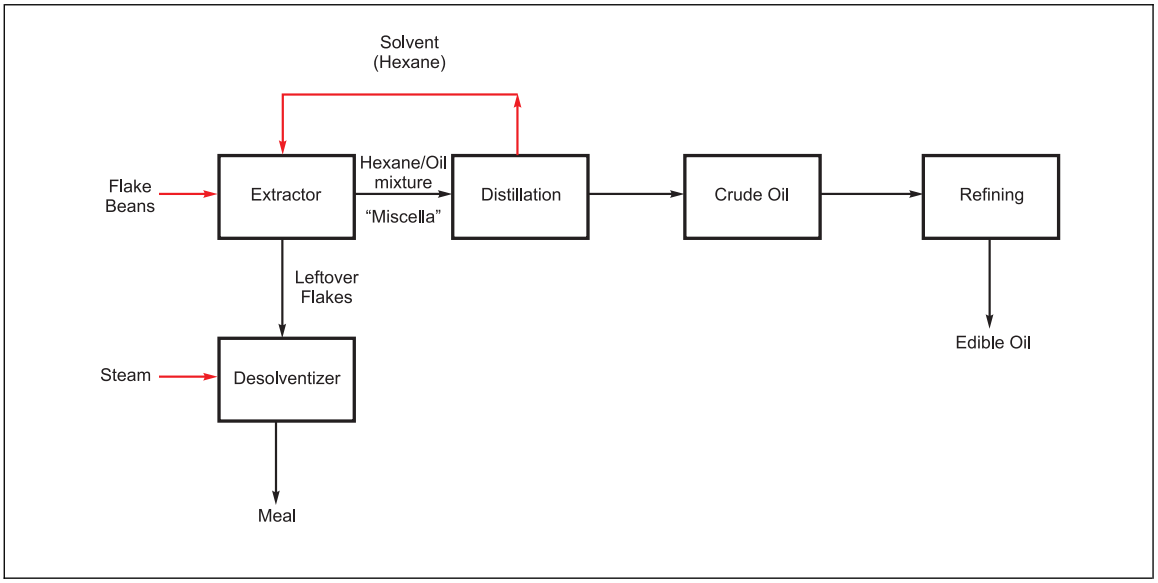

Fig. 2. Oilseed process flowchart

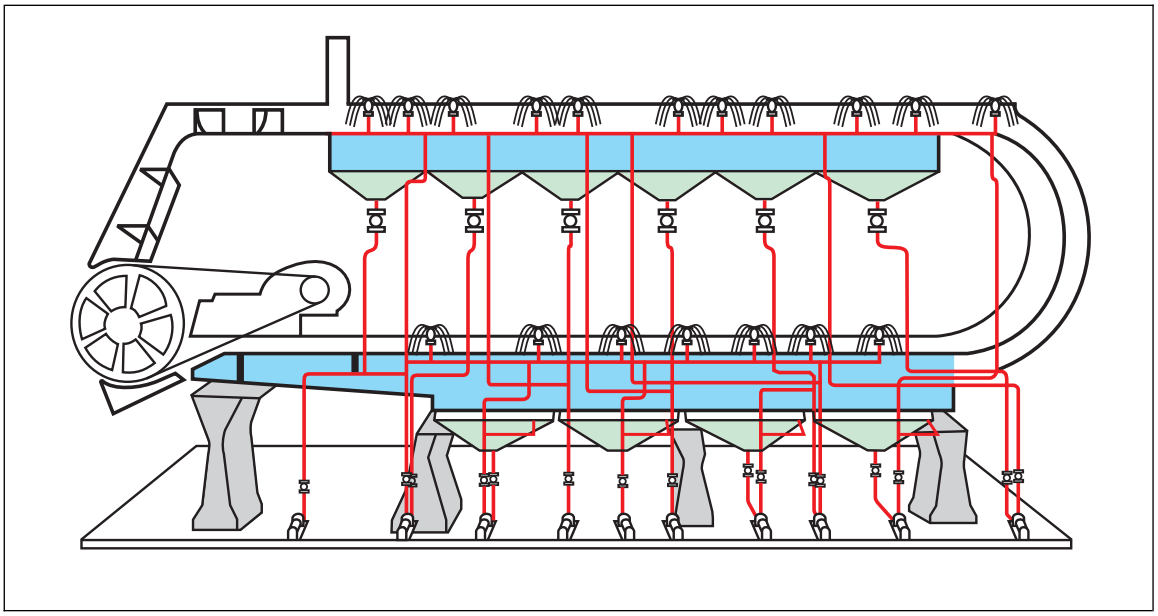

Fig. 3. Extractor diagram

4.2 Other

National Fire Protection Association (NFPA). NFPA 36, *Standard for Solvent Extraction Plants*. 2017.

APPENDIX A GLOSSARY OF TERMS

See also Data Sheet 7-111.

Flammable limits: Minimum and maximum concentration of flammable vapor or gas/air mixture that will propagate a flame (flash) when ignited. The currently accepted test method for determining flammability limits is ASTM E 681. Note: Lower flammability limit (LFL)and upper flammability limit (UFL) are often used interchangeably with lower explosive limit (LEL) and upper explosive limit (UEL).

Miscella: Hexane/oil mixture.

APPENDIX B DOCUMENT REVISION HISTORY

The purpose of this appendix is to capture the changes that were made to this document each time it was published. Please note that section numbers refer specifically to those in the version published on the date shown (i.e., the section numbers are not always the same from version to version).

January 2023. Interim revision. Minor editorial changes were made.

January 2022. Interim revision. Minor editorial changes were made.

July 2019. This is the first publication of this document. This document replaces Data Sheet 7-30N, *Solvent Extraction Plants*.