Frazier, Barnes & Associates, LLC

White Paper
Biodiesel Plant Safety
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Introduction

Biodiesel is a clean, renewable fuel offering several advantages to petroleum diesel fuel. Many entities have recognized the advantages and potential opportunity inherent in starting a profitable business, while simultaneously benefiting the environment. Safety issues have been a chief concern for the biodiesel industry, evidenced by a long list of fires, explosions, and various equipment failures that have resulted in hazardous conditions for plant employees as well as neighboring residences and businesses. The costs associated with damaged equipment from these hazards is also a concern.

Questions abound as to why biodiesel plants have a much poorer safety record than other chemical and petrochemical operations and what steps can be taken to address this issue before the industry suffers irreversible damage. This document by Frazier, Barnes & Associates (FBA) dives into these issues to examine safety in the biodiesel industry. FBA will assess what improvements can and should be made in the biofuels and bioenergy industries and determine new benchmarks for industry participants. FBA is an independent bioenergy consulting firm specializing in Oilseed Processing, Biodiesel, Ethanol and Biomass processing facilities.

Legal Requirements

The first step in assuring biodiesel safety is implementing a PSM (Process Safety Management) Program. This program includes a HazOp (Hazardous Operations) review. The code of federal regulations 29 under CFR 1910.119 mandates a PSM Program if more than 10,000 pounds, 1,517 gallons, of methanol is present in the production facilities. All but the smallest of plants have more than 1,517 gallons of methanol in the processing area. Even the smallest of plants should implement program mandates for the well being of their employees, protection of investments, and in order to be responsible neighbors to community residences and businesses.

The PSM Program is not a document that can be copied from one site and applied to another site. Each phase of the operation is evaluated for potential hazards and problems that could be encountered during normal operation, start up, shut down, and stand by or down time in the plant. The program must be prepared by a competent, experienced company or individual and must also include the operations staff of the facility. Adequate time should be allowed for a review of each operation and piece of equipment in detail.

As part of the PSM Program, the P & IDs (Piping and Instrument Diagrams) should be complete and ready for review. A set should also be available at all times and location

for the operating personnel. These drawings can be the outline for the review of each phase of the operation.

The PSM Program also requires detailed operating instructions for the plant so that a person not familiar with the plant could read and understand the steps for safe, reliable normal operation, start up, shut down, and maintaining an idle plant.

The PSM Program describes formal safety training that must take place before operations begin. Provision must also be made for the same type of training for new hire employees after initial start up. The training includes OSHA requirements, hot work permit requirements, enclosed space entry permits, required personnel safety protection equipment, and many other areas.

Each step in the process is analyzed by the experienced program provider, the operations management, and the operations staff. The first step in the review is to assure that each piece of equipment is safe during normal operation: the electrical classification, the instrumentation, and the mechanical installation. The next two steps are a similar review for start up and shut down. Following this is a similar review for the plant being idle with or without process fluids being present. An added step is the review of procedures for both mechanical and electrical work in the plant both during operation and during down time.

The review would also include any special precautions for handling hazardous materials. Each hazardous material handled must be reviewed separately. In a biodiesel plant, special attention must be given to methanol during normal containment both in the operating plant and in the down plant. Next, the hazards of methanol for equipment failure, such as a pump seal failure, must be assessed. The question must be asked - what precautions have been taken to assure that flammable conditions are controlled?

The methanol based catalyst requires review in the same manner.

The handling of acids and caustics should also be reviewed thoroughly. This review should include the recommended personal protection equipment required for every instance that acid or caustic may be encountered.

In each stage of the review, the recommendations should be made for steps to be taken in the event of some failure in one of the systems.

Some Common Causes of Plant Problems Due to Safety Issues

Most of the common causes of biodiesel plant problems is the failure to adhere to good manufacturing practices for this type of chemical plant. In the early development of the industry, many small plants were hastily built and the developers did not realize the potential hazards of operating a biodiesel plant. The assumption that a biodiesel facility is not a chemical manufacturing facility sounds good in the press, but in reality chemicals are handled and manufactured at a biodiesel plant. Unfortunately, some of the larger

plants went through the motions of making the plants safe and adhere to the legal requirements without properly evaluating the plant thoroughly and correctly. Study protocol tended towards half-measure approaches based on guides readily available for associated items. A primary caveat being a recommendation that a thorough review of study guides be taken. The review was typically performed hastily or not done at all.

Methanol

The largest safety hazard in biodiesel plants is methanol and the catalyst, which also contains 75% to 80% methanol. Methanol is highly flammable and the vapors are explosive over a fairly wide range of concentrations. Methanol vapors are heavier than air and tend to accumulate in low areas of the plant. Indoor production units should be well ventilated according to the NFPA code for flammable vapors. Many insurance companies and local fire fighting agencies require sprinklers in these areas because the hazard is so great.

The hazard classification should adhere to the National Electric Code so that no spark generating electrical components are allowed in the area. The equipment selection and installation should assure that the components have the highest reliability to reduce mechanical failure.

Frequent causes of methanol escaping into the operating area are pump seal failures, hose failures, instrumentation connection failures, and similar incidents. Personnel should be trained to be observant for any mechanical abnormalities so that remedial action can be taken immediately.

Another potential problem is spill containment. All installations should provide spill containment not only to comply with storm water legislation, but also to control hazardous collections of flammable materials in non-protected areas. Many plants follow the guidelines for most areas and then fail for hose connections that can also create methanol spills.

Equipment Selection and Design

Once a plant is in operation, each piece of equipment should be evaluated that all of the safety precautions are reviewed to minimize the chance for leaks, failure, and design conditions. The temperature and pressure should be well within the limits of operation. The vendor should be questioned to assure that the equipment is the correct application for the biodiesel plant environment.

The design for installation of the equipment and the relevant support systems must also be thoroughly reviewed. Pressure relief instrumentation should be selected based on upset conditions versus normal plant operations alone. Relief should be provided for overheating, over pressure, over temperature, and even upset conditions such as fire. Should a fire occur in the area, precautionary measures should be prepared for the tank, heat exchanger, pump and other affected areas. Control instrumentation is typically

designed for operating within normal limits and appropriate actions should be taken when those limits are exceeded. These systems should include action and/or operations notification for processes going outside normal limits, whether it is a slow upset or a rapid upset.

Each piece of equipment and area should be reviewed to assure that the correct electrical classification is met. This includes proper grounding for the equipment and structures. Access for maintenance is critical for safety since the ability to work on equipment or replace equipment, when under time pressure, often results in bypassing prudent safety practices.

Operator Training

In start up operations, and especially in the smaller installations, operator training is often looked on as an unnecessary cost to be minimized and shortened as much as possible. For a plant to operate safely, the operator needs to have a thorough understanding of the mechanics and chemical reactions associated with the facility. At a minimum, training should include an understanding of how to start up the plant, how to operate the plant, and how to shut down the plant. A proper understanding of each of these functions is essential to the operation of the plant. Each piece of equipment and each area of the plant should have an adequate training protocol so that each person in the plant has a basic understanding of each item and how it relates to other operations in the plant. The control operators, field operators, and maintenance operators should all be included in this training. Area specific training for each staff representative, regardless of individual responsibility expands the field of knowledge such that all the operators understand the operations of each equipment item versus that of their own responsibility alone.

Each operator also needs to understand the basics of the entire process. This knowledge will allow the operator to understand why issues are arising in the plant and how to respond to root problems versus treating specific symptoms. Normal operation will tend to become second nature fairly quickly if the operators work in unison, understanding the entire process and encouraging each other to think through any problems. Upset conditions can cause very severe problems if the operator does not understand the root problem.

Each person in the plant not only needs access to Material Data Safety Sheet information, but needs to know each material in use in the plant. They need to know the proper personal safety equipment required in all areas of the plant and special personal safety equipment required in special areas or when handling certain materials used in biodiesel operations. For example, when unloading a truck of catalyst, caustic, or sulfuric acid, personal safety equipment is required, not recommended. In addition, each employee needs to know the proper response should some event occur that is not normal, such as a spill or equipment failure.

Each operator requires instruction on how to respond to abnormal operations in the plant such as spills, tank overflows, electrical power outages, sudden disruptions in operation,

natural disasters, and fires. The quick and accurate response to problems can sometimes prevent personal injury or death and loss of property.

Mandatory training includes the items required by the federal government in all similar industries. The biodiesel industry, which is young and relatively immature, needs to step up its efforts to improve the efficacy of its safety and training programs to save lives, save money and preserve the reputation of the industry.

History

A few of the adverse events as reported in media sources will be listed as examples of problems that can occur, most of which could be avoided with proper preparation.

American Biofuels, Bakersfield, CA, 02/17/2006

During a methanol transfer, a small spill occurred. The methanol was ignited and the fire spread into the process building.

Apparently, the spill was not contained. Likewise, an ignition source was present around a flammable liquid in an upset condition. A PSM should have identified these two issues so that the spill would be contained and the area would be electrically classified so that no ignition sources should be present. This emphasizes the absolute need for the PSM Program for any size biodiesel plant.

Sun Break Biofuels, Canby, OR, 06/23/2006

A major fire resulted when a small fire melted plastic biodiesel storage tanks. Even though the cause of the initial fire was not listed, the resulting major damage could have been prevented with a PSM Program. The same analysis is that the area should have been electrically classified so that no ignition sources should be present. The area should have containment. Storing biodiesel in plastic tanks is not good manufacturing practice.

Blue Sky Biodiesel. New Plymouth, ID, 07/07/2006

A small fire occurred when a worker was installing a vent tube in an existing tank.

Agri Biofuels Dayton, TX 07/14/2007

A fire resulted from a methanol spill

Better Biodiesel Spanish Fork, UT 7/25/2007

A small fire occurred when there was a mechanical malfunction in a methanol transfer line to the reactor section

Farmers & Truckers Biodiesel Augusta, GA 8/21/2007

A worker was welding a flow meter on the top of a tank and was killed when an explosion occurred

Foothills Biodiesel Lenoir, NC 8/25/2007

Feedstock tanks in the tank farm were destroyed by fire two days after the plant was shut down. The tanks were destroyed. Since the plant was unoccupied, no one was hurt.

American Ag Fuels Defiance, OH 1/3/2008

An explosion occurred when workers left a manhole cover off a glycerin storage tank. A spark ignited methanol vapors.

Green Light Biofuels Princess Ann, MD 5/18/2008

A hot work explosion occurred when a methane line was being added to the plant. A gas line was hit and the resulting explosion killed one worker and injured a second worker.

Biofuels of Tennessee Decaturville, TN 8/15/2008

A fire occurred in the plant after it had been idle for four months. No cause was determined. The company representative stated that nothing was left but smoldering metal.

All American Biodiesel York, ND 8/27/2008

One of four processing buildings and the processing equipment was destroyed by fire. No other details were listed.

Gadsten Fleet Management Facilities Gadsten, AL 9/18/2008

A faulty heating element on the City of Gadsten's biodiesel equipment likely caused the top of the tank to blow off. (Over pressure due to inadequate relief)

Nova Biosource Fuels, Inc. Clinton, IA 9/30/2008

A small fire in the primary biodiesel recovery column was quickly extinguished by the local fire department. The probable cause was a build up of methanol vapors in the column during a ventilation process required as part of the maintenance activity. No injuries were reported for plant personnel. One fireman received minor steam burns.

GreenHunter Biofuels Houston, TX 2/9/2009

A mechanical seal on a circulation pump associated with a process heating unit failed. The resulting excessive heat created caused the fire.

Minnesota Soy Bean Processors Brewster, MN 5/24/2009

A fire and explosion on a Saturday night at10 PM resulted in several tanks being on fire.

Midwest Biorenewables Toledo, OH 6/15/2009

A faulty safety valve was blamed for a fire which destroyed one of two production lines. The vacuum control valve imploded, igniting biodiesel

Columbus Foods Company Chicago, IL 7/19/2009

Two workers were seriously injured in the biodiesel plant while mixing glycerin and sulfuric acid.

New Eden Energy St Cloud FL 9/24/2009

Multiple chemical vessels exploded. At least one building was destroyed and several tanks. The cause has not been determined but one employee said lighting might have started the blaze and multiple explosions.

Xenerga Biodiesel Savannah, GA 10/14/2009

One injury resulted from an explosion in a reactor used to store biodiesel.

Imperium Renewables Hoquiam, WA 12/2/2009

An explosion occurred in a 10,000 gallon glycerin tank as a result of over pressurization. The tank reportedly split open.

Kenneth "Pete" Moss is the managing partner and owner of Frazier, Barnes & Associates, LLC, located in the Agricenter in Memphis, Tennessee. Pete has 20 years of experience in the Agricultural Industry, the last twelve as a consultant with FBA. He has conducted hundreds of bioenergy feasibility studies and oversees FBA's technical services group. FBA also provides business plans, start-up and management services to existing bioenergy firms. FBA has been directly involved with a multitude of oilseed processing, biofuels and bioenergy projects in the U.S. and worldwide.