



Explosion at the Dupont Buffalo Facility

An Online Continuing Education Course for Engineers

Course Number: H-1004

Credit: 1 Hour / 1 PDH / 1 CPD

Explosion at the DuPont Buffalo Facility

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PROLOGUE

The scheduled maintenance on November 9, 2010 was a routine procedure. Tank 1 had been cleaned and inspected and remained empty in anticipation of the scheduled maintenance. Lockouts were performed and the DuPont construction field engineer and the contractor supervisor completed and signed the work permit. The welder mounted the top of the tank to begin the grinding and welding involved in repairing the agitator support assembly. The foreman stood nearby on the catwalk to supervise and provide fire watch.

Work began on the 10,000-gallon tank around 9:00 a.m. and progressed normally for two hours. A few minutes after 11:00 a.m. fire erupted in the tank and the resulting explosion blew the steel cover from the tank. The welder died instantly from blunt force trauma and the foreman suffered first-degree burns and minor injuries.

Residents about a mile away felt the blast. Concerned about the potential for toxic fumes, police later instructed those living nearby to close their windows. (It was later determined that there was no threat to human health posed by escaped gases.)

INTRODUCTION

The incident at the DuPont Yerkes plant in Tonawanda, NY, a suburb of Buffalo, resulted in a U.S. Chemical Safety and Hazard Investigation Board (CSB) investigation and Occupational Health and Safety Administration (OSHA) citations and fines against both DuPont and Mollenberg-Betz, the contractor.

CSB concluded that DuPont overlooked hazards and that the probable cause of the accident was the sparks or heat from welding that ignited highly flammable vinyl fluoride (VF) vapor in the tank. VF from process tanks flowed undetected through the connections between in-service process tanks and was ignited by the hot work. The inside of the tank was never tested for the presence of flammable gasses prior to the hot work.

The CSB investigation called the incident “another example of improperly monitored hot work activities involving flammable conditions inside a container”¹ and its lead investigator concluded, “Had technicians tested tank one for flammable atmosphere, they would have known that any hot work presented a serious hazard.”²

DuPont's plant manager told a local reporter "It had not been part of the work practice, and that was viewed as a general purpose area and for 50 years, we thought it was only a slurry basically made up of water."³

The Buffalo plant is referred to as both "the Yerkes plant" and "the Buffalo plant" in various news reports and government documents. As the DuPont website refers to it as the Buffalo plant, this course study will adopt the name used by the company.

COURSE OBJECTIVES

This course will examine the events that lead to the deadly incident at the Buffalo plant, and the decisions and assumptions made by the DuPont engineers and other employees. It relies heavily on CSB's report on the investigation.

Readers are encouraged to consider the following issues as they relate to the course material.

1. How did design factors contribute to the incident? What modifications to the design might have improved safety?
2. How can designs minimize potential safety risks during the maintenance procedures that will be required? What kind of insights can operations and management personnel add to the design process?
3. How did operational decisions contribute to the incident?
4. What shortcomings were there in the plant's procedures and the work permit process? How could human errors been avoided?

BACKGROUND

E.I. DuPont de Nemours and Co., Inc.⁴

E.I. DuPont de Nemours and Co., Inc. is a Fortune 100 company. The company was founded in the United States and has grown to be one of the world's largest chemical companies, conducting business in more than 90 countries.

The company provides materials and products for industry and consumers and has wide-ranging products and services. The company website explains "Our market-driven innovation introduces thousands of new products and patent applications every year, serving markets as diverse as agriculture, nutrition, electronics and communications, safety and protection, home and construction, transportation and apparel."

In 2012, Fortune Magazine included DuPont in its list of the 50 Most Admired Companies and it received 2012 recognition from the Patent Board as Best in Industry.

DuPont Buffalo Plant

As noted, the plant is located in Tonawanda, NY, outside of Buffalo.

The plant produces Corian countertops and Tedlar films, resins and adhesives for release films or surface protectants. Tedlar is commonly used in solar panels and aircraft passenger areas.

The facility received a 2002 award for pollution prevention from the NY governor's office.⁵ A November 2006 corporate process safety management (PSM) audit of the facility awarded DuPont Buffalo a 99% score, the highest ever awarded and a 2009 DuPont audit lauded Buffalo's process hazard analyses (PHA's), finding them to be of high quality.

Mollenberg-Betz

Mollenberg- Betz is a Buffalo, NY mechanical contractor. The company specializes in refrigeration, plumbing, heating, ventilation, air conditioning, industrial piping, custom metal fabrication and service.

The company was hired by DuPont to repair the agitator support base on the tank. The incident was the company's first on the job fatality in its 100-year history.⁶

Vinyl Fluoride

The Buffalo facility uses VF to produce the polyvinyl fluoride (PVF) used in the production of Corian and Tedlar.

VF's chemical name is fluorethylene. It is an organic halide (formula C_2H_3F) and the monomeric precursor to PVF.

VF is heavier than air and will accumulate in low areas. It is highly flammable at ambient temperatures and carries *NFPA 704*® Fire Hazard Rating 4: "Will rapidly or completely vaporize at normal atmospheric pressure and temperature, or is readily dispersed in air and will burn readily (e.g., acetylene, diethylzinc). Includes pyrophoric substances. Flash point below 23°C (73°F)"

It has *NFPA 704*® Reactivity Hazard Rating 2: "Undergoes violent chemical change at elevated temperatures and pressures, reacts violently with water, or may form explosive mixtures with water (e.g., white phosphorus, potassium, and sodium)"

Its explosive limits are 2.6- 21.7%.

Its OSHA Chemical Sampling Information describes VF⁷:

- Colorless gas
- Faint ethereal odor
- May be carcinogenic
- Effects central nervous system
- Exposure produces "Headache, Dizziness, Confusion, Incoordination; Narcosis, Nausea, Vomiting; liquid – frostbite"

Polyvinyl Fluoride

PVF is a polymer with the chemical formula $(\text{CH}_2\text{CHF})_n$.

It is used by DuPont to make solar panels and the interior of planes. It is resistant to weathering, lowers flammability and is non-combustible.

It has *NFPA 704*® Fire Hazard Rating 1 (Combustible if heated) and its *NFPA 704*® Reactivity Hazard Rating is 0 (Stable; Not reactive when mixed with water.)

Hot Work

Hot work is “[w]ork involving burning, welding, or a similar operation that is capable of initiating fires or explosions.” Hot work also includes other activities with the potential to create a source of ignition such as cutting, brazing, grinding, and soldering.⁸

A 2004 Welding Journal article cites insurer FM Global’s research on the risk inherent in hot work.⁹

- Hot work is one of leading causes of multi-million dollar industrial fires and explosions.
- As of 2004, the losses averaged \$2 million per incident.
- Cutting or welding torches causes three out of four incidents.
- The risk nearly doubles when procedures are performed by outside contractors working without supervision.
 - In FM Global’s study, outside contractors accounted for 75% of FM Global losses caused by hot work.

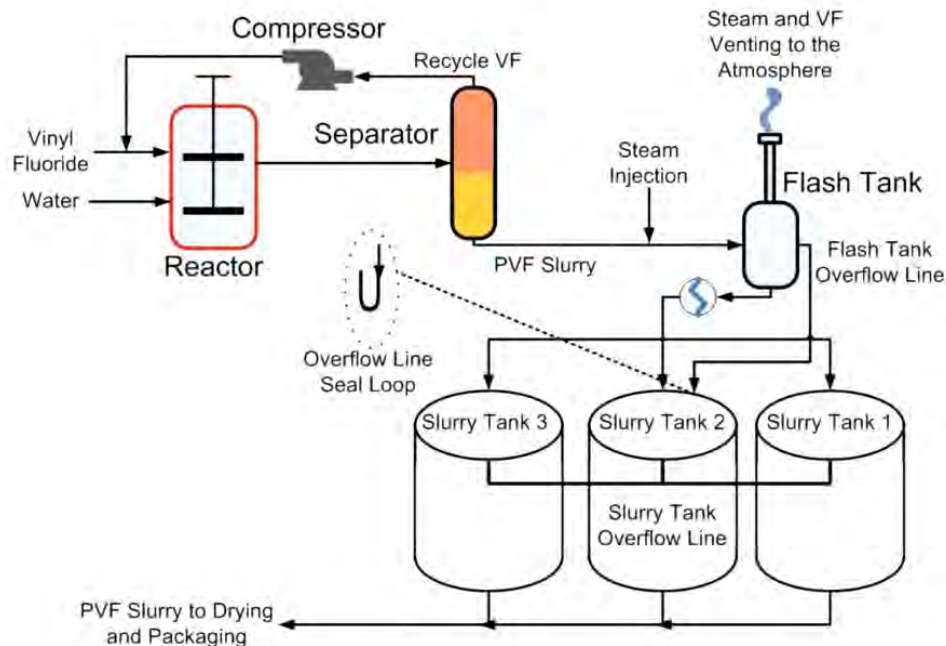
American Welding Society Standards

E6.4 All containers should be considered unsafe for welding or cutting unless they have been rendered safe, or declared safe by a qualified person. When welding or cutting containers, there is the possibility of explosions, fires, and the release of toxic vapors or fumes. Containers include jacketed vessels, tanks, drums, covered parts or other equivalent situations. Seemingly empty containers might have materials hidden in cracks and crevices, which will release hazardous fumes when heated by welding or cutting. By-products of corrosion can result in explosive atmospheres (hydrogen) in a container. Even a water tank should be considered hazardous unless a qualified person has declared it safe to weld or cut.¹⁰



Depiction of hot work from the CSB's 2008 safety video "Death in the Oilfield." (Source: CSB.)

Production Process



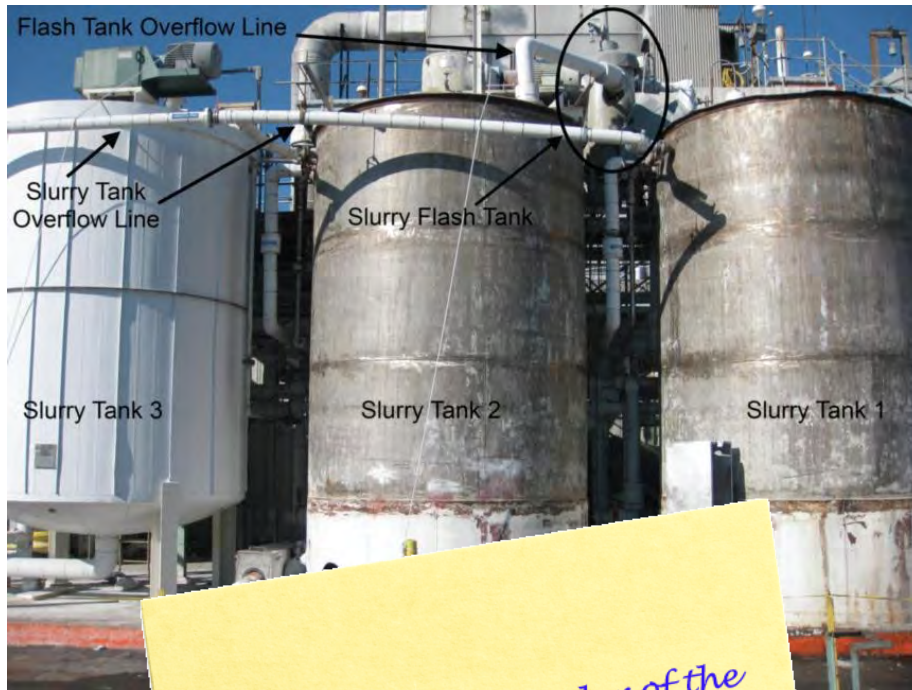
PVF process flow diagram. (Source: CSB.)

DuPont produces VF at a different facility and transports it to the Buffalo plant for storage. There, the VF gas is mixed with water and pumped from storage tanks to a reactor. In the reactor, VF undergoes a process to produce a mix of polymer and water PVF slurry and unreacted VF. The mix is sent to separators to remove the unreacted VF, which is pumped back to the reactor.

Any remaining VF is removed from the PVF by a steam injection process that vaporizes the residual VF. The heated PVF slurry is moved through a flash tank, where the steam and vaporized VF is released, and on to one of the three storage tanks. The slurry stores in the tank to settle before being pumped out of the bottom of the tank and sent to another reactor to be transformed into a polymer powder. The dried powder is transported to a mixing area to produce Tedlar.

PVF Slurry Tank Farm

The flash tank and three slurry storage tanks are housed in an area next to the Tedlar manufacturing building.



The slurry tanks are 11 feet high and hold around 10,800 gallons. The shell and top are made of stainless steel.

The slurry tank feed and discharge lines are located at the tops of the tanks and bleed off to a common equalizer line near one tank from another when the third is used. Each tank has an agitator and covers cover the top.

The flash tank vents small amounts of vapor. A gas detector device alerts workers when a leak is detected on the catwalk near slurry tanks. A gas detector is also installed in the Tedlar control room if hazardous vapors are detected in the vapor form.

To view the remainder of the course material and to take the quiz for PDH credit, you must purchase the course.
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