Hazardous Waste Reduction Through Process Change At OxyChem's Pasadena, Texas Plant

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INTRODUCTION

In 1987, Occidental Chemical Corporation instituted a program called OxyMin, whose objective was the systematic reduction in hazardous waste, toxic air emissions and water pollutants in each of its chemical manufacturing plants. At OxyChem's Pasadena, Texas PVC plant, an inventory of these releases from the process revealed that the best opportunity for a major impact under the OxyMin program was the elimination of the toluene used with the reaction initiator in the PVC process, which exited the plant as the major component of a significant hazardous waste stream requiring commercial incineration.

THE TOLUENE ELIMINATION PROJECT

PVC Process Description

The OxyChem Pasadena PVC plant is located on the Houston Ship Channel east of Houston and operates on an around-the-clock basis. The plant produces in excess of one billion pounds of PVC homopolymer resin per year for both rigid and flexible applications. The Pasadena plant utilized modern large-reactor suspension process technology that takes place in twelve 35,000 gallon batch reactors. Being one of the largest and most efficient PVC resin manufacturing facilities in the country, it uses a full-time process control computer to run the reaction part of the process. Each reactor produces several batches of PVC resin daily. The main ingredi nts that go into each batch are: (1) Water, (2) Vinyl chloride monomer (VCM), (3) Reaction initiator (organic peroxides), (4) Modifiers, (5) Suspending agents.

A simplified flow diagram is provided in Figure 1. After each batch is completed, the unreacted VCM is recovered for purification and re-use. The resulting slurry of PVC particles in water (with some organics) is fed to stripping columns which operate on a continuous basis, as does the rest of the process. After stripping to remove residual VCM, the slurry is fed to centrifuges with the separated water being routed to the plant biological waste treatment unit. The separated wet solids are fed to fluidized-bed dryers with the final dry PVC resin being transported by conveying air to large product silos. PVC resin is gravity-fed into rail hopper cars, trucks or is bagged for shipment.

Role of Toluene

Since the plant started operation in 1975, toluene had been used in two ways in the process: (1) The solvent for the organic peroxide chemicals used as the PVC reaction initiator, (2) The flush medium for the initiator charge lines to each PVC reactor.

During these years, the suppliers of the reaction initiators supplied the organic peroxides in 70-75% concentration solutions of toluene. The solutions were typically delivered in five gallon (or less) plastic jugs in refrigerated trucks. The jugs were stored on-site in refrigerated vaults equipped with sophisticated temperature control and alarm systems. Earthen blast walls surround these buildings. In the Pasadena plant, the reaction initiator was further diluted to less than a 50% concentration with pure

toluene just prior to its computer-controlled introduction to each PVC batch. The transfer of initiator solution is made through insulated and refrigerated piping which runs from the solution prep building to each PVC reactor. All of these precautions are necessary because these peroxide chemicals are highly reactive and temperature sensitive, and must be handled carefully from a safety standpoint.

Because of the safety considerations with such a potent chemical, it has always been the practice in Pasadena to flush each of these lines from start to finish with pure toluene after each use. This ensures that no residual peroxides are left stagnant in each line when not in use. The toluene used to accomplish this was flushed into each reactor prior to initiating the batch.

As a result of these two operational functions, each batch recipe contained a significant amount of toluene.

Fate of the Toluene

In theory, the toluene did not participate in the polymerization reaction but was simply the carrier for an active ingredient. The toluene was still present in the batch at the end of the reaction, along with unreacted VCM, the newly-formed PVC particles and the water in which they are suspended.

There are three places that the toluene could end up from here: (1) In the recovered VCM stream, which is purified in a distillation column. Here the toluene was removed as a heavy end and constituted the bulk of the column bottoms stream, (2) As an air emission from the PVC dryers stacks where drying air exits the process, (3) In the process waste water leaving the PVC plant that is treated in the Pasadena facility's biological waste treatment unit.

In 1987, the last full calendar year that toluene was used, the distribution of toluene in the process was such that about 1.5 million pounds of the heavy ends stream from the VCM distillation column was generated. As a RCRA hazardous waste, this material was shipped to a nearby commercial facility for incineration.

Steps in the Project

A comprehensive evaluation for potential substitutes for toluene was begun in 1987. This program consisted of: (1) Research and development studies in the laboratory, (2) Pilot plant studies, (3) Negotiations with reaction initiator suppliers, (4) Controlled field tests in the Pasadena PVC plant.

Several consequences of the substitution of toluene with other solvents were of concern: (1) Continued safety in the handling of the organic peroxides, (2) The ultimate fate of the substitute chemicals within the process, including the product PVC resin, (3) The impact, if any, on the quality of the various PVC resins produced at the Pasadena plant by having no toluene present, (4) The effectiveness of the substitute flush medium in the initiator charge lines from a safety standpoint.

In early 1988, these questions were answered to OxyChem's satisfaction and a step-wise substitution for toluene by a chemical as the new solvent/carrier for the organic peroxides was started. During the second quarter, another chemical was substituted for toluene as the new initiator charge line flush medium. In December 1988, the Pasadena PVC plant was totally shut down for a scheduled turn-around. During this outage, any residual toluene still present in the process equipment was removed. After startup, the PVC plant was considered to be completely toluene-free.

In 1989, the first full calendar year that the toluene was not present in the plant, the only heavy end produced from the distillation of recovered VCM turned out to be a water stream. The new substitute chemicals that were recovered from the PVC reactors along with the unreacted VCM from each batch, functioned as light ends in the VCM distillation process. At the end of 1989, no pounds of the heavy ends stream had been generated during the year, compared with the 1.5 million pounds generated in 1987.

Fate of the Substitute Chemicals

Since the new chemicals did not end up as components of the bottoms stream in the VCM distillation column, they had to be distributed elsewhere in the process. Some of these two chemicals was emitted as VOC air emissions from the PVC dryer stacks. However, on a production-weighted basis, a reduction in total VOC air emissions from the PVC plant of over 40% was realized from 1987 to 1989.

The bulk of these new chemicals exited the PVC progress in the waste water streams going to the facility's biological waste treatment unit. Here, biological treatment is accomplished prior to discharge of the plant effluent to the Houston Ship Channel.

Benefits of This Process Change

The most important benefit of this basic process change in obvious - the dramatic significant reduction in the volume of hazardous waste and VOC air emissions from the OxyChem Pasadena PVC plant. However, other benefits have also been realized.

Significant cost savings resulted from this process modification: (1) The cost of commercial incineration of the 1.5 million pounds/year of hazardous waste has been eliminated. This savings is in the mid-six figure range, (2) The cost of the substitute chemicals is less than the cost of the toluene.

CONCLUSIONS

By any standard, the Toluene Elimination Project must be considered a major success within the OxyMin Program. This project demonstrates that significant reduction in hazardous waste generation and in toxic air emissions can be accomplished in well-established chemical manufacturing operations through basic process changes.

The key to success is recognizing the opportunity when it is present and then pursue it in a determined, organized and systematic manner.

When all of the pieces fit together, they can lead to an accomplishment like the one in "pollution prevention" at OxyChem's Pasadena PVC plant.

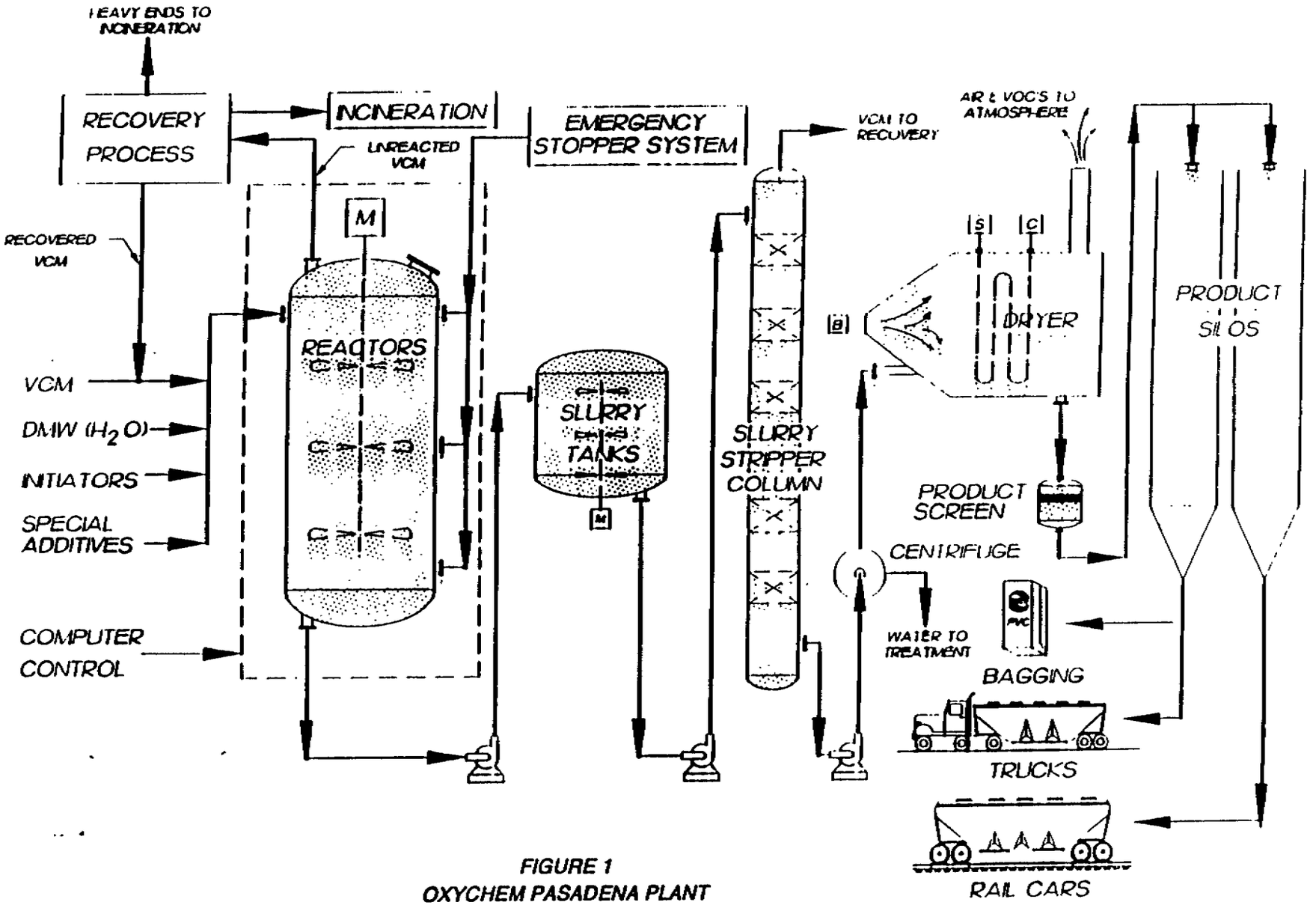

FIGURE 1
OXYCHEM PASADENA PLANT
SIMPLIFIED PVC PROCESS FLOW DIAGRAM

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