ABSTRACT

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WASTE MINIMIZATION EFFORTS AT A MAJOR SILICONE MANUFACTURING PLANT

The Union Carbide Corporation Plant located at Sistersville, WV, along the Ohio River, is dedicated entirely to the manufacture of silicones. The process of making some silicone products can generate from one to three pounds of wastes per pound of product. Many of the wastes generated are , RCRA hazardous wastes due reactivity, ignitability or corrosivity.

In 1984 a Long Range Environmental Planning Team was developed to examine the future capital needs (through 1990) for the Sistersville Plant. Pending environmental regulations were considered and various waste treatment and disposal scenarios were evaluated. Following the issuance of the 1984 RCRA Amendments and as a result of the potential capital investment to meet RCRA and NPDES regulatory requirements (up to $20 MM), a multifunctional Environmental Steering Committee was formed. Its objective was to minimize the expenditures of capital for treatment and disposal of wastes while maintaining full compliance with all State and Federal Regulations and continuing to meet production demands. It was quickly recognized that the key to meeting this objective was waste minimization, and a waste characterization and minimization progam was initiated.

In order to properly evaluate the needs and requirements of each phase of this program a detailed study of over 40 generic processes involving over 700 products was conducted to determine all waste streams derived from each product. Nearly 700 waste streams were identified and quantified. This paper evaluation was then compared to actual waste disposal records kept by the Environmental Protection Department and a mass balance determined.

Based on this evaluation, specific project teams were formed to examine the potential long term needs. These teams addressed solvent recovery, waste minimization, incineration, sludge reduction, filtration, hydraulic reduction, and land disposal. The principal outputs of this work were the development of product/waste ratios for each product, actual waste disposal costs per product, and identification of over 15 MMLBS/year of hazardous waste reduction, chiefly through solvent recovery, improved incinerator operation and sludge/process reduction.

An overall description of this Long Range Environmental Strategy with an indepth review of the waste minimization program will be presented.

The Union Carbide Sistersville Plant, located on the Ohio River in West Virginia, is dedicated entirely to the manufacture of silicone and silane products. The chemistry is unique, involving the silicon atom instead of carbon which is familiar to most of the chemical industry. The majority of the processes are batch operations that produce over 700 products. Some silicone processes are inherently inefficient and can generate up to three pounds of waste per pound of product. Many of these wastes are RCRA characteristic hazardous wastes (i.e. ignitable, corrosive, reactive). Very few RCRA listed hazardous materials are used in the manufacture of silicones. The major listed hazardous wastes generated are the spent solvents toluene and methanol. The Sistersville plant has generated up to 30 million pounds of wastes per year.

In 1984 a Long Range Environmental Planning Team was formed to examine the future capital needs (through 1990) for the Sistersville Plant. The team considered pending environmental regulations and evaluated various waste treatment and disposal scenarios. Following the passage of the 1984 RCRA Amendments and considering the potential capital investment to meet RCRA and NPDES needs (up to 20 million dollars), a multifunctional Environmental Steering Committee was formed. This committee included the Long Range Environmental Planning team, plant management, Silicones R&D and technology managers and was sponsored by the Union Carbide Specialty Chemicals Division management. Its objective was to assure that capital expenditures for waste treatment and disposal facilities were minimized while maintaining full compliance with all state and federal regulations and continuing to meet production demands. The team quickly recognized that the key to meeting this objective was waste minimization and at-source reduction. A five year Long Range Strategic Waste Management Plan was developed to accomplish this task.

Waste Identification

The first phase of the strategic plan was to develop a total understanding of all wastes being generated. The Environmental Protection Department led a detailed study of over 40 generic processes (i.e. emulsions, oils, organofunctional silanes, etc.) involving over 700 products to determine all waste streams derived from each product. Waste characterization sheets were developed for each product and data generated were compiled in a data management system. Nearly 700 waste streams were identified and quantified. The effort required over 4 man months (engineers and chemists) to complete.

The data generated by the production units were then compared to actual waste disposal records kept by the Environmental Protection Department. Waste streams were compared by category -- air emissions, wastewater discharges, residues, solvents, and solids. An overall plant waste balance of $\pm$ 10% was achieved.

The waste stream database has provided four major benefits:

Waste Cost Accounting

Costs of waste treatment and disposal can be rationally assigned to those products which generate the wastes. Previously, costs were assigned in a simple, but inexact fashion. This new procedure has allowed the standard cost of each product to include both variable (materials) and period (people) costs. Union Carbide's business managers are now able to see the true cost and profit margin of their products. The database also allows more accurately predicting the impact of changing production demands on Environmental Protection facilities.

Accurate Feedback to Production Units

The Production departments now have more immediate feedback on the plant's changing waste loads, in the form of monthly cost variances in the environmental protection accounts.

Improve Information Management and Reporting

The Environmental Protection Department can respond more quickly and accurately to the regulating agencies' ever-increasing requests for information on our waste handling activities.

Establish Resource Priorities

And most importantly, it allowed the Envrionmental Steering Committee to appoint project teams to evaluate key waste generation areas. Project teams have addressed:

- Waste solvent generation and recovery
- Alcohol recovery and reuse
- Sludge reduction
- Sludge dewatering
- Hydraulic reduction
- Land disposal
- Incineration capacity

Waste Solvent Generation and Recovery

The Sistersville Plant utilizes several million pounds of toluene per year. The waste identification effort demonstrated that significant amounts of toluene were disposed that potentially could be recovered and resued. Key segments of this effort included:

1) Developing spent toluene specifications for distillation
2) Developing recovered toluene specifications for reuse.
3) Developing a recovery network (tankage) to reduce bottlenecks.
4) Improving distillation recovery efficiency by 25 percent via distillation system evaluation and modifications.
5) Developing procedures to insure proper execution of the recovery system across plant units.
6) Maximizing batch campaign length to minimize cleanups.

As a result of these efforts the quality of recovered toluene improved dramatically. Also, recoverable toluene was increased from 900,000 pounds to 3,000,000 pounds annually. This translates into annual cost savings of $350,000. Other benefits include reduced potential for spills, less distillation downtime and maintenance, and reduced production downtime. In addition, optimizing campaign lengths reduces toluene usage and saves over $200,000 per year.

Alcohol Recovery

Another major waste is acid alcohols (methanol and ethanol plus hydrogen chloride). This waste contributes the major portion of the organic load to

the wastewater treatment system. Studies showed that between 0.5 and 0.75 lbs. of biological sludge is generated per pound of alcohol treated. Reducing alcohol flow to the sewer would reduce this sludge waste.

In most cases, the waste alcohol streams are collected in tanks prior to discharge to the wastewater treatment system. To improve the collection of these alcohol streams, projects to provide additional tanks and piping were implemented. This would allow longer storage of these waste streams and not impact production. These streams could then be diverted to incineration thus eliminating the generation of secondary sludge.

In order to be able to incinerate these alcohol streams either the load to the existing incinerator had to be decreased, or the capacity of the incinerator had to be increased. As a result of efforts by the toluene recovery and incinerator teams, both goals were accomplished. Alcohols replaced toluene as the major fuel source for the incinerator. Over 2 million pounds of alcohols will be burned as a fuel in 1987 with up to 4 million pounds to be burned by 1988. This translates into an annual savings of over $200,000.

Sludge Reduction

In 1985, over five million pounds of solids were generated from primary clarification of wastewater. Slaked lime was being used for neutralization of the highly acidic wastewater stream at that time. Laboratory tests, followed by full scale tests of the use of caustic (aqueous sodium hydroxide) for neutralization, were conducted in late 1986. It was determined that the plant

could reduce primary sludge generation by up to 75 percent by switching from lime to caustic. This sludge reduction not only minimized landfill volume requirements, but also reduced state hazardous waste fees (primary clarifier sludges at Sistersville are RCRA hazardous wastes by definition) and equipment maintenance costs on the lime slaker.

Biological sludges were generated at a rate of over four million pounds per year during 1986. This high generation rate was due to high BOD (Biological Oxygen Demand) loadings to the wastewater treatment unit and calcium carbonate precipitation. This precipitate is formed from residual calcium (from lime) reacting with carbon dioxide evolved during the biodegradation of waste. At-source reduction of biodegradable materials (primarily alcohols), in addition to reduction of solids not removed by primary clarification (due to the use of caustic), will allow secondary sludge generation to be reduced by about 50%.

Sludge Dewatering

A sludge dewatering team was also formed at the plant to address the needs of the plant to meet the 1984 RCRA amendments for land disposal of sludge. The team was responsible for conducting both laboratory and full scale pilot testing of dewatering units. The team determined that belt filters were needed to effectively dewater these sludges. Filter cakes being generated during the pilot tests were subjected to the paint filter test to insure that no free liquids were present. The filter cake contained 18 to 35% solids and all cakes passed the paint filter test. Dewatering facilities are currently being constructed to allow the plant to begin dewatering sludges in

early 1988. Dewatered filter cake will utilize less landfill space and provide a sludge that can be incinerated. Incineration of the biological sludge is being considered. This would reduce its volume by 50-60% and produce a drier material for landfill.

Hydraulic Reduction

In October, 1986, the rotary kiln flue gas scrubber make-up water was changed from recycled process sewer wastewater to recycled noncontact storm sewer water. The additional 800-1000 gallon per minute of kiln scrubber flow created a hydraulic demand on the Unox secondary biological treatment system equal to 130% of design capacity. A high potential for NPDES permit violations resulted in the implementating of a hydraulic reduction program.

This process sewer flow reduction was achieved by recycling primary clarifier effluent wastewater back to process area vent scrubbers. Nine production unit vent gas scrubbers were tied into the recycled wastewater system. A total of 400 gallons per minute decrease in process sewer flow was attributed to this project. Further hydraulic reduction projects are planned to reduce the process sewer flow to 30% below 1986 levels.

No. 3 Surface Impoundment

As a result of the minimum technology requirements (MTR) mandated in the 1984 RCRA amendments, it appeared that the Sistersville facility's existing land disposal unit (single liner) may not be allowed to operate past November, 1988. To utilize the remaining capacity of this unit (projected life, 1993)

an exemption to the MTR was unsuccessfully pursued and a delisting petition is currently being evaluated by the U.S. EPA. Since the plant's wastewater treatment unit (WWTU) sludges are classified as hazardous wastes (by definition) under RCRA, and due to the large quantity generated, it was apparent that if the existing land disposal unit could not continue to operate, a new unit would be required.

A team was formed to work on the location, design, permitting, and, if necessary, the installation of this new unit. The members consisted of civil, environmental, maintenance, safety, and research and development personnel. A geotechnical consulting engineering firm was contracted to assist with this project.

After a site was located on plant property, a double lined, 50 million gallon surface impoundment was designed. Although this unit is designed and will be permitted as a surface impoundment, it is intended to be operated as a dry landfill, receiving dewatered WWTU sludges. Permitting as a surface impoundment as opposed to a landfill allows for increased operating flexibility if sludges or wastes are generated that contain some free liquids. This unit is designed with a composite bottom liner composed of three feet of compacted clay overlaid with a 100 mil high density polyethylene (HDPE) synthetic liner. A leachate collection system is installed next, overlaid by a second 100 mil HDPE synthetic liner. Cement mats (fabriform) will protect the side walls and sand will be placed, as necessary, to protect the floor liner from accidental damage during its operating life..

Incineration Capacity

One of the major objectives of the plant's Environmental Steering Committee was to minimize land disposal by reducing solids generation and maximizing incineration use and capacity. In 1985 the capacity of the incinerator was 7,500,000 lbs/year. Several projects were developed and implemented to increase the particulate removal efficiency which was the limiting factor for capacity. In addition, a project was developed to computerize the control system and help maximize waste throughput while meeting all RCRA Part B permit conditions. Projects to improve particulate removal efficiency increased capacity to 10,000,000 lbs/year. Also, the improved feed control system is expected to reduce downtime and help achieve a rate up to 12,000,000 lbs/year.

Finally, a RCRA trial burn was conducted which demonstrated that the incinerator could operate at rates up to 12 MMLBS/year while meeting all required conditions for a Part B permit and having little capacity impact. The trial burn was conducted nearly five years after the original trial burn plan was submitted to the Regulatory Agencies. The test was conducted over a two week period and the total cost to date has been over $500,000.

Results

The waste reductions gained and the overall program efforts are presented in the following table. The data presented utilizes 1986 as the base year and provides projected 1987 and 1990 waste loads. These results reflect the long range envrionmental strategy of waste recycle, minimization

of land disposal via reduced sludge generation and dewatering, and maximizing waste incineration. This program is on track and will achieve a 30% reduction in hazardous waste generated in 1987 and 40% reduction in hazardous waste generation in 1990 as compared to the 1986 base year.

The total capital expenditures for the Sistersville Long Range Environmental Program is approximately $12,000,000. Upon completion of this program the following will have been achieved:

1) Capital avoidance of $10MM for additional incinerator and wastewater treatment capacity;
2) Primary sludge reduced by 75 percent;
3) Secondary sludge reduced by 50 percent;
4) Organic load to the wastewater treatment unit reduced by 65 percent;
5) Environmental costs traceable to products;
6) Incineration capacity increased by 60 percent;
7) An annual savings of nearly 1.4 million dollars
8) All RCRA requirements are met
   - Five interim status impoundments/landfills are closed
   - One impoundment meets minimum technology requirements
   - Sludges are dewatered and meet the paint filter test
   - New land disposal facility will meet minimum technology requirements when built
   - All incinerator permit requirements are complied with and incineration is not affected.

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WASTE LOAD BALANCE

Union Carbide Corporation
Sistersville, W.V.

Thousands Pounds/Year

	BASELINE 1986	PROJECTED 1987	REDUCTION	PLAN 1990	REDUCTION	$ SAVED/YR 1990
Waste Improvement						
Toluene Recovery	900	3000	2100	4000	3100	400,000
Alcohol Recovery	0	2000	2000	4200	4200	
Primary Sludge (Dry Basis)	5270	1315	3955	1315	3955	]-- 500,000
Secondary Sludge (Dry Basis)	4020	2814	1206	2010	2010	
Total			9251		13265	
Other Improvements						
Wastewater Organics Load	6225	4225	2000	2025	4200	150,000
Solvent Disposal Outside of Plant	2000	0	2000	0	2000	300,000
Incineration Capacity	7500	10000	-	12000	-	

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