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UNION CARBIDE CORPORATION
CHEMICALS AND PLASTICS
ENGINEERING
SOUTH CHARLESTON, WEST VIRGINIA

TRANSMITTAL MEMORANDUM

July 21, 1972

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TO: Mr. A. W. Byer
Mr. L. J. Couvaras
Mr. J. M. Gaston
Mr. E. F. Moryl
Mr. G. E. Rutzen

COPY TO: Mr. W. D. Bradbury, Jr.
Mr. G. J. Hanks, Jr./Mr. F. D. Bess
Mr. R. A. Payne
Mr. D. T. Watters

FROM: G. R. Hattiangadi
J. B. Ledbetter

SUBJECT: Waste Disposal for India SEVIN Unit

Attached for your information is a revised version of the subject memorandum originally issued on July 17, 1972. Significant revisions are as follows:

1. On page 3 an error in the solids disposal requirement has been corrected. The estimated volume for ultimate solids disposal is 143 to 286 acre-feet per year.

2. Figures 1 and 2 have been reorganized and redrafted for improved clarity and ease of understanding.

J. B. Ledbetter
G R Hattiangadi

GRH/JBL/jh
Attach.

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SUBJECT: Waste Disposal for India SEVIN Unit

A preliminary evaluation has been made of the waste disposal problems for the proposed SEVIN Unit to be located in Bhopal, India. This study was undertaken to (a) provide a basis for estimating investment and operating cost, (b) recommend further development, and (c) serve as a basis for negotiations with the Indian Government.

The Bhopal location presents an unusual challenge in that there is no nearby waterway into which treated effluent can be discharged. This waste disposal evaluation has been based on very preliminary and incomplete information and further study is recommended as the project develops. One alternative that should definitely be studied is the potential for either recycling the acid wastestreams or converting them to some saleable product. Disposing of the acid-bearing wastestreams in this manner would significantly reduce the magnitude of the waste disposal problem.

Wastestreams

Origin and proposed disposal of major wastestreams - solid, liquid, and gaseous - are presented schematically in Figure 1. Quantities and compositions of all process wastestreams were taken from material balance diagrams. The 82 gallons per minute of wastewater originating from utilities consists of blowdown from the closed-cycle cooling water system plus steam condensate loss. Blowdown of cooling water is necessary to purge the closed system of algal growth, dissolved solids, process fluids from heat exchanger leaks, and other impurities. This blowdown was estimated as one percent of the total cooling water cycle. A steam condensate loss of 20 gallons per minute was estimated from process considerations. These estimates are considered to be reasonably accurate in the absence of more detailed information.

Waste Disposal Processes

This study was focussed primarily on the acid-bearing process wastes which are clearly the major disposal problem for the proposed unit. The combustion of concentrated organics and gaseous wastes in properly designed incinerator and flare systems, as indicated on the process material balance diagrams, is an appropriate method of disposal and should cause no serious environmental problems. A proposed system for neutralizing and disposing of the acid-bearing process wastes is presented in Figure 2.

Reagent Selection

This study was conducted with very incomplete information concerning the availability and relative cost of various neutralizing agents at the Bhopal location. The proposed treatment system is based on a choice of reagents that would normally be most economical in the United States.

The use of limestone chips with 100 percent passing a one-inch screen was chosen for the neutralization of hydrochloric acid waste. If limestone of this size is not economically available, equipment should be provided for crushing larger stones, or the limestone pit should be made proportionately larger to compensate for the smaller surface area of the larger stones. Excessive fines would be considered undesirable. The limestone requirement is about 14.4MM pounds per year.

The facilities shown in Figure 2 for neutralizing waste sulfuric acid are based on purchasing calcium oxide (pebble quicklime) and slaking to calcium hydroxide. Calcium oxide requirements are approximately 21.2MM pounds per year. Limestone is generally unsuitable for sulfuric acid neutralization because of a very slow reaction rate and the tendency of precipitated calcium sulfate to coat reagent particles rendering them inert. It is theoretically possible to utilize limestone pulverized to at least 100 mesh for this neutralization. However, the neutralization basin should be increased in volume by a factor of 60, and reagent utilization 40 percent in excess of stoichemetric quantities would be expected. This inefficient utilization of reagent would result in a significantly increased solids load to the evaporation pond. Other reagents that would be suitable include ammonia, sodium hydroxide, and sodium carbonate. The availability and relative economics of these reagents should be evaluated.

Water Requirements

The proposed waste treatment system requires the use of water for both slaking calcium oxide and controlling the temperature of the exothermic neutralization reactions. In addition to the relatively clean wastewater streams available from the process and utility blowdowns, approximately 50 gallons per minute will be required for these purposes.

Criteria for Equipment Sizing

A 20-foot by 70-foot lime silo will store approximately 700,000 pounds of calcium oxide or about one week's requirement. Adjustment of this size may be necessary based on shipping schedules and reliability of supply. The 18,000-gallon slurry tank will provide eight hours retention and serve as surge capacity, allowing for some variation in instantaneous wastestream flows and acidity. This surge capacity is required because the dynamic response of the solids feeding and slaking system would be too slow for direct automatic pH control. The 9 by 9 by 10-foot deep neutralization basin was chosen to provide ten minutes retention to a peak flow of three times the average. The use of an automatically adjustable slurry feeder is recommended for feeding the lime slurry to the neutralization basin. The abrasive and plugging characteristics of lime slurry make throttling by conventional control valves difficult and troublesome.

The limestone pits for neutralizing hydrochloric acid have been scaled from pits in similar service at Institute, West Virginia. Influent hydrochloric acid and dilution water should be sparged evenly over the bottom of the pit with the neutralized effluent overflowing near the top. Gases emitted from the pit should be collected by a blower and discharged at a height of at least 12 feet. Polyester-Fiberglas pipe, or equivalent, should be used for streams containing HCl including the blower suction and discharge piping. Two pits have been shown to allow one to be out of service for cleaning while operating the other. If the available limestone is of sufficient quality to allow infrequent cleaning and if cleaning can be scheduled during normal down time, one pit may be adequate.

The 22-acre, 15-foot deep evaporation pond represents the minimum size suitable for both evaporating the 180 gallons per minute of wastewater and providing ultimate disposal of dissolved and suspended solids. To avoid danger of polluting subsurface water supplies in the Bhopal area, this pond should be lined with clay suitable for rendering the pond bottom and dikes impervious to water. The 22-acre surface area is based on a total evaporation rate of 10.4 gallons per minute per acre of which 2.4 is required to balance rainfall and 8.0 is required to evaporate wastewater influent. The evaporation rate was estimated by the use of data from portions of the United States felt to be possibly similar to the climatic conditions at Bhopal. The true value should be checked on-site, using actual weather data for the Bhopal area. The 15-foot depth was selected to provide one to two years of solids disposal capacity based on a requirement of 143 to 286 acre-feet per year. This preliminary geometry for the evaporation pond should be optimized with consideration to terrain and soil conditions. However, the chosen design must conform to the restraints of adequate surface area for evaporation plus adequate volume for solids disposal. It should be further recognized that if the proposed pond geometry is selected, new ponds will have to be constructed at one to two-year intervals throughout the life of the project.

Potential Problems

One potential problem for which no provision has been made in the proposed design is the possibility of floating oils decreasing the estimated rate of evaporation from the pond. In addition to the free oils such as toluene contained in the aqueous wastes, some of the organic salts that are dissolved in the acid wastes may be liberated by neutralization. This problem should be studied in further detail. It may be necessary to include either a skimming or steam distillation step between the neutralization basin and evaporation pond. A skimming operation at this point would be complicated by the high level of suspended and settleable solids.

J. B. Ledbetter
G R Hattiangadi

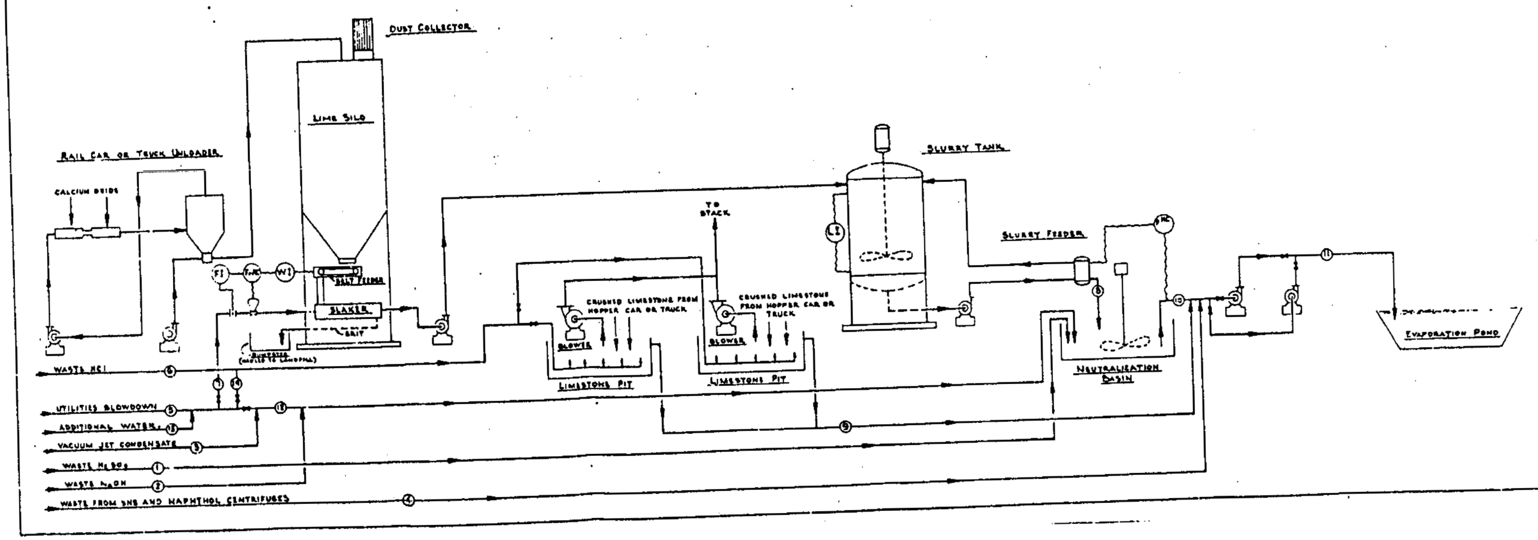
GRH/JBL/jh
Attach.

938-2938

COMPONENT	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	STREAM (POUNDS PER HOUR)													
SULFURIC ACID	3500													
1 - NSA	60									68	68			
2 - NSA	900									300	300			
WATER	600	2550	6500		41800	10700	17000	16000	17500	71000	86300	60000	23600	6500
RESIDUE		40	5			100				45	3	3		
SODIUM HYDROXIDE		315												
TOLUENE			1							5	5	5		
TRIETHYL AMINE			1							1	1	1		
SNS				300							300			
SODIUM SULFATE				4300						880	2340			
SODIUM SULFITE				2200							2180			
NAPHTHOLS, TARS, OILS				620							620			
HYDROCHLORIC ACID						3820								
CALCIUM HYDROXIDE								4000		350	760			
CALCIUM CHLORIDE									2860		2280			
CALCIUM SULFATE										6600	6200			

MAJOR EQUIPMENT LIST

1. ONE PACKAGE HOPPER CAR UNLOADING SYSTEM WITH BLOWER - CAPACITY 30,000 LB/HR CALCIUM OXIDE.
2. ONE CONCRETE SILO WITH HIGH AND LOW LEVEL ALARMS AND BAG HOUSE FOR VENT DUST COLLECTION - 30' DIAMETER BY 70' HIGH.
3. ONE PASTE SLAKER WITH GRAVIMETRIC BELT FEEDER - CAPACITY 6,000 LB/HR.
4. ONE STEEL SLURRY TANK - 10' DIAMETER BY 12' HIGH.
5. ONE SLURRY TANK AGITATOR - STEEL, TOP-ENTERING, 7-1/2 HP.
6. ONE VARIABLE-SPEED SLURRY FEEDER - STEEL, AUTOMATICALLY ADJUSTABLE.
7. ONE NEUTRALIZATION BASIN - 9' x 9' x 10' DEEP, ACID-PROOF BRICK OVER CONCRETE.
8. ONE NEUTRALIZATION BASIN AGITATOR - OVERHUNG TYPE, 5 HP, HASTELLOY C IMPELLER AND SHAFT.
9. TWO LIMESTONE PITS - 12' x 15' x 10' DEEP, ACID-PROOF BRICK OVER CONCRETE, BRICK CONSTRUCTED SPARGERS, COATED-STEEL GRATING.
10. TWO LIMESTONE PIT BLOWERS - 3,000 CFM, 10 HP, FIBERGLAS REINFORCED POLYESTER HOUSING AND WHEEL.
11. TWO 40 GPM CAST IRON OR STEEL PUMPS.
12. TWO 200 GPM HASTELLOY C PUMPS.
13. ONE EVAPORATION POND - 22 ACRES, 1½-FT. TOTAL DEPTH, CLAY-LINED TO BE IMPERVIOUS TO WATER, DIKED TO PREVENT ENTRANCE OF SURFACE RUN-OFF.



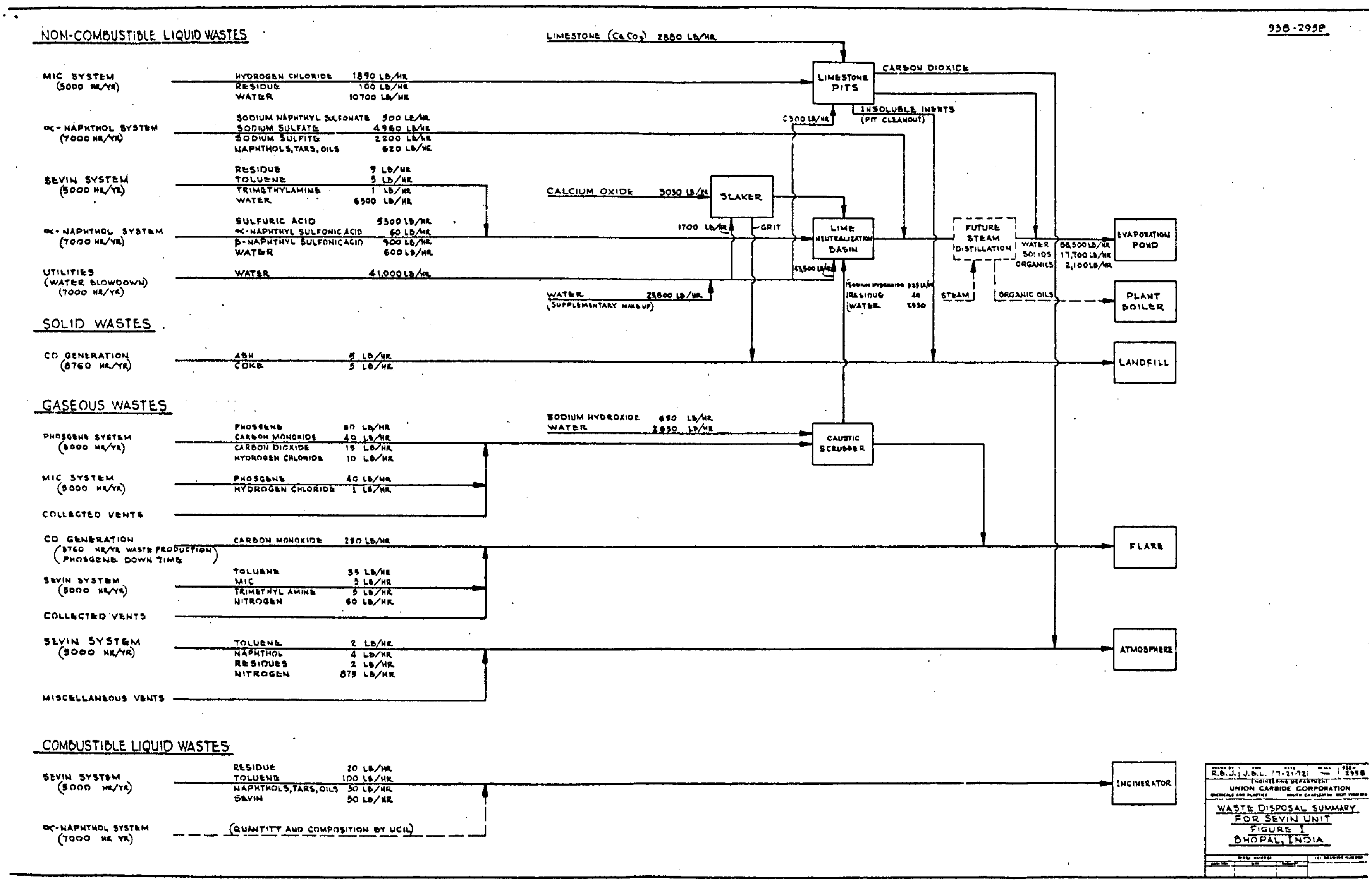
ALL ITEMS ON THIS FLOW DIAGRAM HAVE THE PREFIX

PROCESS ENGINEER:
CONTROL SYSTEMS:
REVIEWED:
ENGR. ASSISTANT:
GROUP LEADER:
SAFETY REVIEWER:

NOT TO BE REPRODUCED WITHOUT AUTHORIZATION OF THE ENGINEERING DEPARTMENT

UNION CARBIDE CORPORATION
FLOW DIAGRAM
PROPOSED WASTE DISPOSAL SYSTEM FOR SEVIN UNIT
BHOPAL, INDIA

UCC 04130



938-295P
NON-COMBUSTIBLE LIQUID WASTES
MIC SYSTEM (5000 HR/YR)
HYDROGEN CHLORIDE 1890 LB/HR
RESIDUE 100 LB/HR
WATER 10700 LB/HR
α-NAPHTHOL SYSTEM (7000 HR/YR)
SODIUM NAPHTHYL SULFONATE 500 LB/HR
SODIUM SULFATE 4960 LB/HR
SODIUM SULFITE 2200 LB/HR
NAPHTHOLS, TARS, OILS 620 LB/HR
SEVIN SYSTEM (5000 HR/YR)
RESIDUE 9 LB/HR
TOLUENE 5 LB/HR
TRIMETHYLAMINE 1 LB/HR
WATER 6500 LB/HR
α-NAPHTHOL SYSTEM (7000 HR/YR)
SULFURIC ACID 5300 LB/HR
α-NAPHTHYL SULFONIC ACID 60 LB/HR
β-NAPHTHYL SULFONIC ACID 900 LB/HR
WATER 600 LB/HR
UTILITIES (WATER BLOWDOWN) (7000 HR/YR)
WATER 41,000 LB/HR
SOLID WASTES
CO GENERATION (8760 HR/YR)
ASH 5 LB/HR
COKE 5 LB/HR
GASEOUS WASTES
PHOSGENE SYSTEM (5000 HR/YR)
PHOSGENE 80 LB/HR
CARBON MONOXIDE 40 LB/HR
CARBON DIOXIDE 15 LB/HR
HYDROGEN CHLORIDE 10 LB/HR
MIC SYSTEM (5000 HR/YR)
PHOSGENE 40 LB/HR
HYDROGEN CHLORIDE 1 LB/HR
COLLECTED VENTS
CO GENERATION (8760 HR/YR WASTE PRODUCTION) (PHOSGENE DOWN TIME)
CARBON MONOXIDE 280 LB/HR
SEVIN SYSTEM (5000 HR/YR)
TOLUENE 35 LB/HR
MIC 5 LB/HR
TRIMETHYL AMINE 5 LB/HR
NITROGEN 60 LB/HR
COLLECTED VENTS
SEVIN SYSTEM (5000 HR/YR)
TOLUENE 2 LB/HR
NAPHTHOL 4 LB/HR
RESIDUES 2 LB/HR
NITROGEN 875 LB/HR
MISCELLANEOUS VENTS
COMBUSTIBLE LIQUID WASTES
SEVIN SYSTEM (5000 HR/YR)
RESIDUE 20 LB/HR
TOLUENE 100 LB/HR
NAPHTHOLS, TARS, OILS 30 LB/HR
SEVIN 50 LB/HR
α-NAPHTHOL SYSTEM (7000 HR YR)
(QUANTITY AND COMPOSITION BY UCIL)
LIMESTONE (CaCo3) 2880 LB/HR
LIMESTONE PITS
CARBON DIOXIDE
INSOLUBLE INERTS (PIT CLEANOUT)
5300 LB/HR
CALCIUM OXIDE 5050 LB/HR
SLAKER
1700 LB/HR
GRIT
LIME NEUTRALIZATION BASIN
43,500 LB/HR
WATER 25800 LB/HR (SUPPLEMENTARY MAKE UP)
SODIUM HYDROXIDE 325 LB/HR
RESIDUE 40
WATER 2550
FUTURE STEAM DISTILLATION
STEAM
ORGANIC OILS
WATER 68,500 LB/HR
SOLIDS 17,700 LB/HR
ORGANICS 2,100 LB/HR
EVAPORATION POND
PLANT BOILER
LANDFILL
SODIUM HYDROXIDE 650 LB/HR
WATER 2650 LB/HR
CAUSTIC SCRUBBER
FLARE
ATMOSPHERE
INCINERATOR
R.B.J. J.B.L. 7-21-72 938-2958
ENGINEERING DEPARTMENT
UNION CARBIDE CORPORATION
WASTE DISPOSAL SUMMARY
FOR SEVIN UNIT
FIGURE I
BHOPAL, INDIA