

TYRIN CPE PILOT PLANT

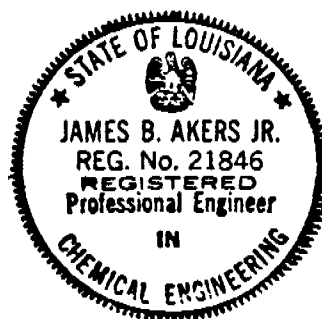
REACTIVE CHEMICAL REVIEW

JULY 18, 1985

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JAMES B. AKERS, PE.

James B. Akers



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OUTLINE

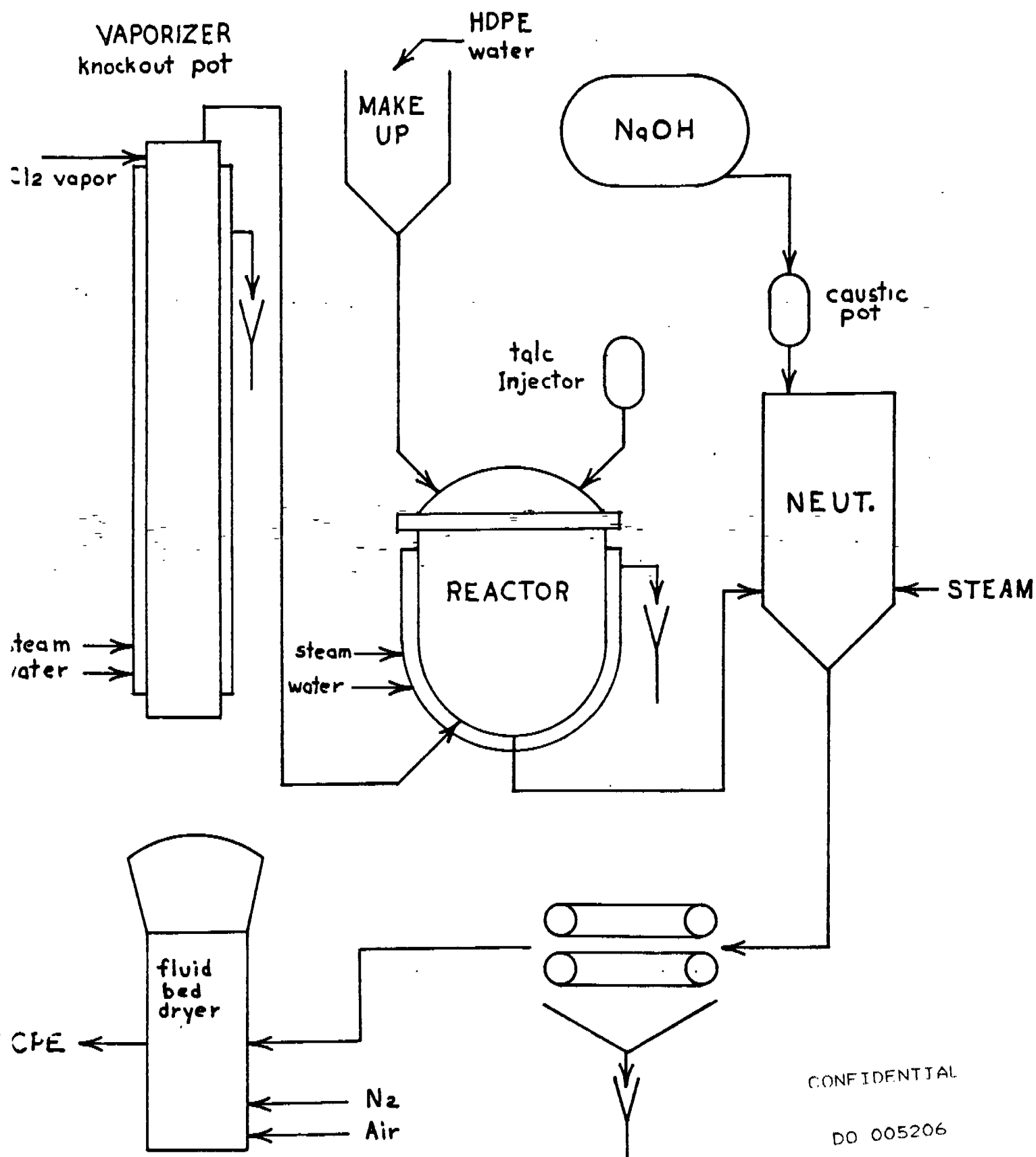
- I. PROCESS FLOWSHEET
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- IV. REACTIONS
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Tyrin[®] CPE Pilot Plant



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CHEMICALS AND MATERIALS USED IN THE TYRIN CPE PILOT PLANT

PROCESS

AIR
CHLORINE
CHLORINATED POLYETHYLENE (CPE)
HYDROCHLORIC ACID
NITROGEN
POLYEHTYLENE (PE)
POLYVINYLPRROLIDONE (PVP)
TALC
T-DET N-9.5 (NONYL PHENOL 9.5 MOLES ETHYLENE OXIDE)
TETRAHYDROFURAN (THF)
SODIUM CHLORIDE
SODIUM HYDROXIDE
WATER

MATERIALS OF CONSTRUCTION

ALLOY 20
CARBON STEEL
DERAKANE 470
DEVOE 244
HASTALLOY C
MONEL 400
NICKEL
POLYESTER
PTFE LINED
PVC
TANTALUM
TITANIUM
TITANIUM PALLADIUM
316 STAINLESS STEEL

APPLICATION

DRY CHLORINE
DRY CHLORINE
NEUTRALIZER SLURRY
50% CAUSTIC
DRY CHLORINE
DRY CHLORINE
STEAM-ACID, ALKALINE
NEUTRALIZER SLURRY
WET-DRY CHLORINE, REACTOR SLURRY
WATER, VENTS
WET-DRY CHLORINE
WET CHLORINE
WET CHLORINE
DRY CHLORINE, NEUTRAL RESIN

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PROPERTIES

SEE APPENDIX A

MATERIAL	PHYSICAL DATA	STABILITY	INCOMPATABILITY
CHLORINE	BP - 34.1°C VAP.P 82 PSIA @ 20°C	HIGHLY REACTIVE HALOGEN	MANY ORGANICS NH3, H2 MOIST OR HOT STEEL, FINELY DIVIDED METALS. TITANIUM WHEN DRY.
CPE	SOLID CRUMB	DECOMPOSES AND EMITS HCL AT HIGH TEMPERATURE.	
HCL	BP - 116.7°C VAP.P-0.5 PSIA@ 20°C	CONTACT WITH METALS MAY LIBERATE H2 GAS.	BASES AND MOST METALS. OXIDIZING MATERIALS
N2	GAS	HIGHLY STABLE. ASPHYXIAN.	
POLYETHYLENE	POWDER	FLAMMABLE. DUST EXPLOSION HAZARD. SEE APPENDIX B	
PVP	POWDER	HYGROSCOPIC. NON-TOXIC. STABLE TO 225°C (DSC)	
TALC	POWDER	INERT TO PROCESS CONDITIONS.	
T-DET	LIQUID FLASH PT. 260°C	STABLE TO 400°C RCL 1079 APPENDIX C	CONCENTRATED OXIDIZING OR REDUCING AGENTS
THF	FLASH PT. 17°C	FORMS EXPLOSIVE PEROXIDES FROM PROLONGED EXPOSURE TO AIR.	STRONG BASES.
CAUSTIC, 50%	BP 145°C		REACTS WITH WATER, ACIDS, SOME ORGANICS, AND AMPHOTERIC METALS SUCH AS ALUMINUM.

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REACTIONS

SEE APPENDIX D

PE + CL2 -----> CPE + HCL

Δ HR = - 1070 BTU
LBCL2

HCL + NAOH -----> NACL + H2O

Δ HR = - 34182 BTU
LBMOLE

T-DET + CL2 -----> NR TO 250°C

RCL 1081

T-DET + 50% NAOH -----> NR TO 200°C

RCL 1082

TALC + CL2 -----> NR TO 250°C

RCL 1070

TALC + 37% HCL -----> NR TO 230°C

RCL 1072

TALC + T-DET -----> NR TO 400°C

RCL 1068

PVP + HCL -----> NR TO 250°C

DTA

PVP + PE -----> NR TO 250°C

DTA

PVP + TALC -----> NR TO 250°C

DTA

PVP + T-DET -----> NR TO 250°C

DTA

PVP + PE + T-DET -----> NR TO 230°C

DTA

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REACTION

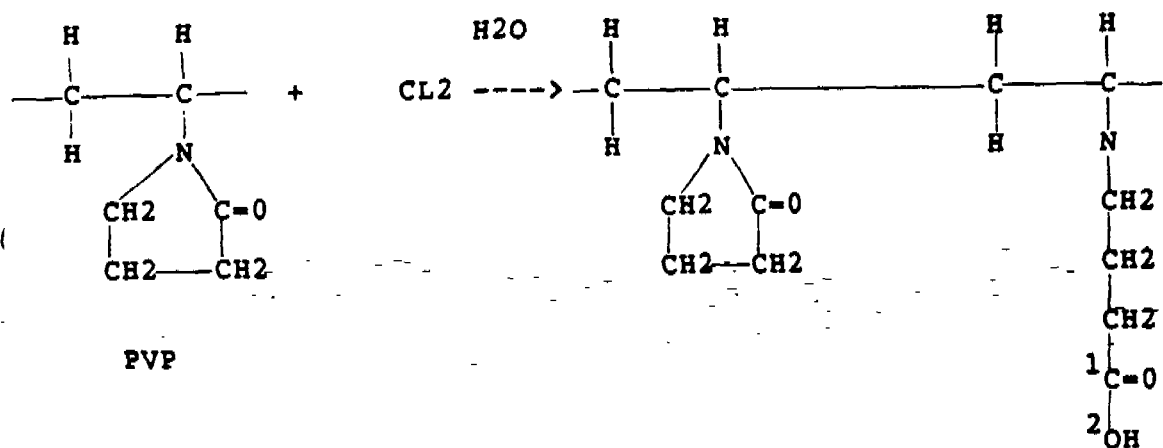
CL₂ + PVP -----> EXOTHERM DTA

BEGINNING 30°C

PEAK 85°C

END 115°C

PRESUMED REACTION



1 PREFERRED CHLORINATION SITE

2 ACID HYDROLYSIS

CHLORINATED PVP IS KNOWN TO BE THE ACTIVE ANTIAGGLOMERATION AGENT.

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MATERIAL COMPATIBILITY - GENERAL PROCEDURE

IT IS STANDARD PROCEDURE TO REPLACE A FITTING OR PIECE WITH ONE OF IDENTICAL MATERIAL UNLESS OTHERWISE INSTRUCTED BY THE ENGINEER IN CHARGE.

A MAJOR CONCERN IS PREVENTING THE CONTACT OF TITANIUM OR TITANIUM PALLADIUM ALLOY WITH DRY CHLORINE. TITANIUM FITTINGS AND PIECES ARE COLOR CODED PURPLE AND KEPT IN A DEDICATED, LOCKED CABINET.

CHLORINE'S REACTIVITY WITH TITANIUM, ORGANICS AND OTHER MATERIALS IS FREQUENTLY STRESSED IN SAFETY MEETINGS.

ALSO, ALL LUBRICANTS, ANTI-SEIZE COMPOUNDS, ETC. THAT MIGHT COME INTO CONTACT WITH CHLORINE MUST BE CLEARED BY THE ENGINEER IN CHARGE (SEE APPENDIX E).

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POLYETHYLENE LOADING

PROBLEM

DUST EXPLOSION

SAFETY MEASURES

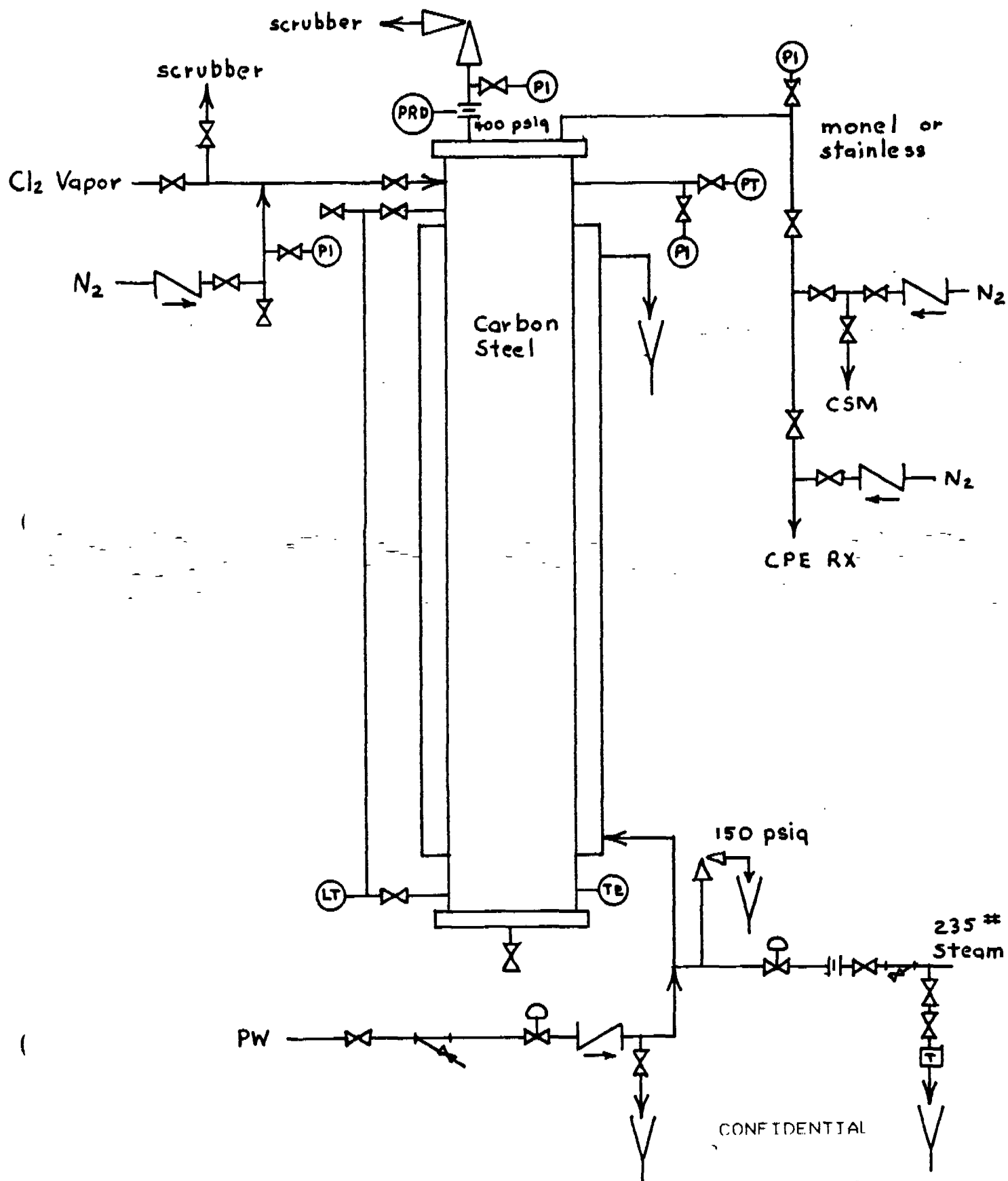
1. SMALL AMOUNTS OF POWDER
(20 LB) ARE USED.
2. STORAGE BOXES HAVE LID ON.
3. STORAGE AREA IS WELL
VENTILATED AND OPEN.
4. GOOD HOUSEKEEPING PRACTICES
ARE FOLLOWED.

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Chlorine Vaporizer / Knockout Pot



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VAPORIZER

<u>POSSIBLE PROBLEM</u>	<u>POSSIBLE CAUSES</u>	<u>SAFETY MEASURES</u>
OVERPRESSURE	HIGH TEMPERATURE WHILE BLOCKED IN WITH LIQUID PRESENT.	1. NORMAL OPERATING MODE IS VAPOR ONLY WITH OPEN VAPOR LINE (120 PSIG) TO CHLORINE PLANT. 2. DOUBLE BLOCK BLEED/PURGE WITH STEAM^{N₂} MANUALLY BLOCKED PROCEDURE FOR SHUTDOWN. 3. FAIL-SAFE TEMPERATURE CONTROL LOOP. AIR, WATER, ELECTRICITY, OPEN CIRCUIT FAILURE PROTECTED. (CRIT. INST., QUARTERLY) 4. LIQUID LEVEL TRANSMITTER. (CRIT. INST., QUARTERLY) 5. THREE PRESSURE INDICATORS. 6. REDUNDANT ULTRASONIC LEVEL DETECTORS, FOUR LEVELS. LIQUID PRESENT ALARM. (BEING INSTALLED) 7. PRESSURE RELIEF TO SCRUBBER. (CRIT. INST., SEMI-ANNUALLY)

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VAPORIZER (CONT.)

LIQUID FULL

1. OPERATING TEMPERATURE IS ABOVE DEWPOINT.
2. VAPORIZER IS ISOLATED BY DOUBLE BLOCK AND BLEED/ PURGE WHEN NOT AT TEMPERATURE.
3. LIQUID LEVEL TRANSMITTER WITH HIGH LEVEL ALARM. (CRIT. INST., QUARTERLY)
4. REDUNDANT ULTRASONIC LEVEL DETECTORS, FOUR LEVELS. LIQUID PRESENT, HIGH LEVEL, AND VERY HIGH LEVEL ALARMS. (BEING INSTALLED.)
5. PRESSURE RELIEF TO SCRUBBER (CRIT. INST., SEMI-ANNUALLY)

NCL3 ACCUMULATION

CHLORINE-AMINE REACTION

1. VAPOR OPERATION MINIMIZES FORMATION.
2. VAPORIZER N2 PURGED QUARTERLY. (CRIT. INST.)
3. VAPORIZER STEAM PURGED ANNUALLY. (CRIT. INST.)

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VAPORIZER (CONTINUED)

REACTOR SLURRY
BACKUP TO
VAPORIZER

REACTOR PRESSURE
HIGHER THAN
VAPORIZER PRESSURE

1. CHLORINE VALVES ARE
BLOCKED WHENEVER
THERE IS NOT A
POSITIVE CHLORINE
FLOW.
2. VAPORIZER OPERATING
PRESSURE IS 120 PSIG.
REACTOR RELIEVES AT
100 PSIG.
3. VAPORIZER LOW PRESSURE
ALARM IS SET AT
105 PSIG.
(CRIT. INST., QUARTERLY)

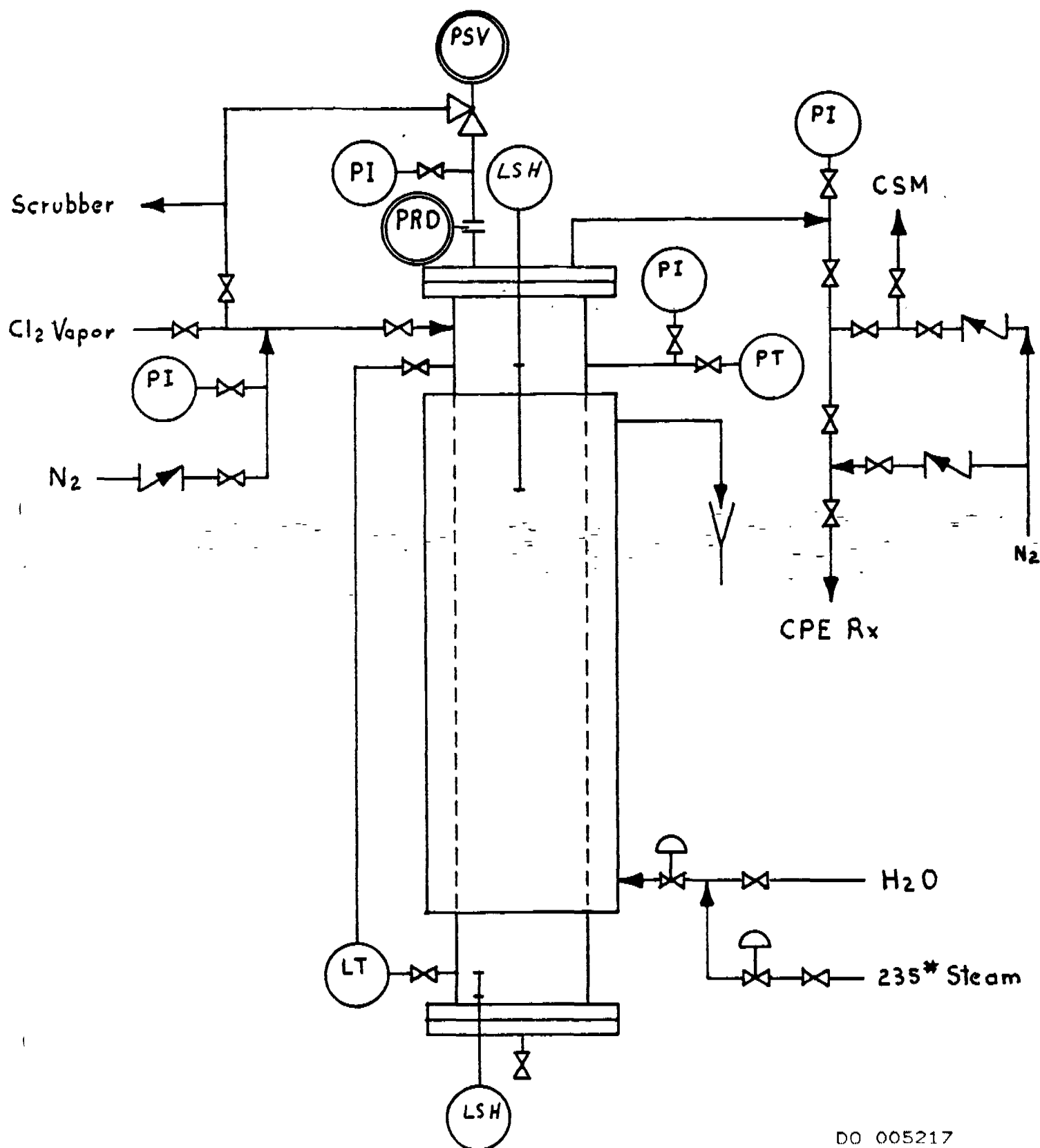
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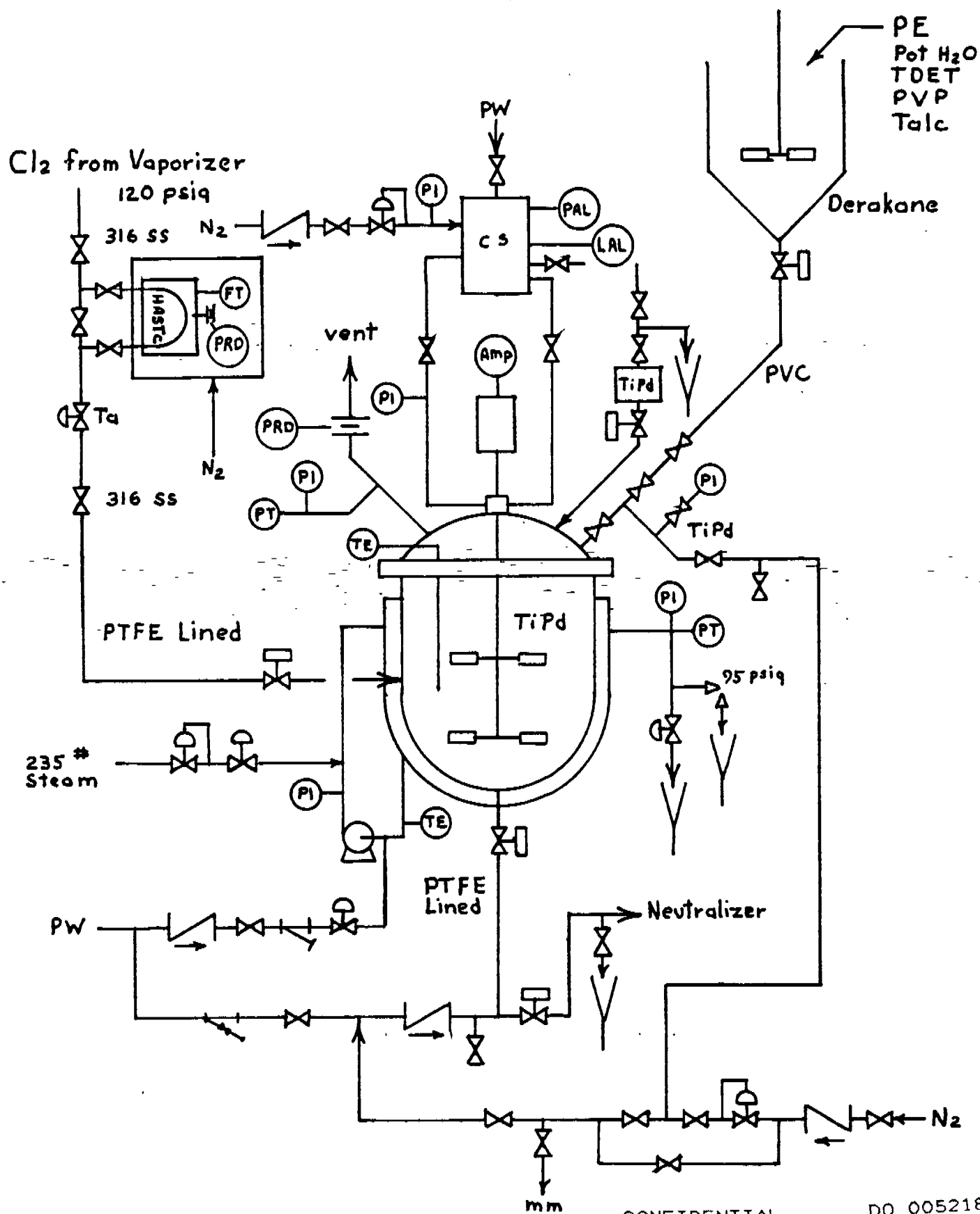
Vaporizer Knockout Pot



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Reactor System



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REACTOR

PROBLEM

OVERPRESSURE

SAFETY MEASURE

1. THE COMPUTER MONITORS PRESSURE AND AT 80 PSIG IT GIVES AN ALARM AND REQUESTS AN EMERGENCY TALC INJECTION.
2. ACCORDING TO PROCEDURE, THE OPERATOR BLOCKS THE CHLORINE VALVE AND STOPS THE PROGRESS OF THE TEMPERATURE PROGRAM AT 80 PSIG.
3. AT 90 PSIG, BOTH A SCAM ALARM AND A COMPUTER HIGH PRESSURE ALARM ARE TRIGGERED.
4. IF NECESSARY, COOLING CAN BE APPLIED TO THE REACTOR.
5. THE REACTOR ITSELF IS RATED TO 300 PSIG. THE 1.5 INCH RUPTURE DISK (0.5 INCH WOULD BE ADEQUATE) WILL OPEN TO THE VENT AT 100 PSIG (CRIT. INST., QUARTERLY).
6. THE REACTOR PRESSURE TRANSMITTER IS INSPECTED ON THE CRITICAL INSTRUMENT PROGRAM QUARTERLY. THERE ARE TWO PRESSURE INDICATORS ON THE REACTOR.

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PROBLEM

HIGH TEMPERATURE

SAFETY MEASURE

1. THE COMPUTER TRIGGERS ALARMS AT FIVE AND TEN DEGREES (CELSIUS) DEVIATION FROM SET POINT.
2. A TEMPERATURE INCREASE MAY BE ARRESTED BY DECREASING CHLORINE FLOW OR BY COOLING WITH THE JACKET.
3. THE COMPUTER AND INSTRUMENTATION USE ONE TYPE K THERMOCOUPLE. A SECOND THERMOCOUPLE IS AVAILABLE FOR MANUAL CHECKING OR SWITCH OVER OF CONTROL IN THE EVENT OF FAILURE OF THE FIRST THERMOCOUPLE.

DRY CHLORINE IN THE
THE REACTOR

1. THE REACTOR IS KEPT FILLED WITH WATER AT ALL TIMES, INCLUDING BETWEEN RUNS.
2. THE CHLORINE FLOW IS ALWAYS BLOCKED WITH AT LEAST TWO VALVES. IF THE CHLORINE FLOW WILL NOT BE RESTARTED WITHIN A FEW HOURS, A NITROGEN PURGE OF THE LINE IS INITIATED.
3. WHEN THE REACTOR WILL BE DOWN FOR A SIGNIFICANT PERIOD OF TIME, THE VAPORIZER AND CHLORINE LINE ARE EMPTIED. THE VAPORIZER IS ISOLATED FROM THE CHLORINE LINE WITH A DOUBLE BLOCK AND BLEED/PURGE, AND THE CHLORINE LINE TO THE REACTOR IS PURGED WITH NITROGEN. THE REACTOR IS STILL KEPT FULL OF WATER.

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PROBLEM

SEAL FAILURE

SAFETY MEASURE

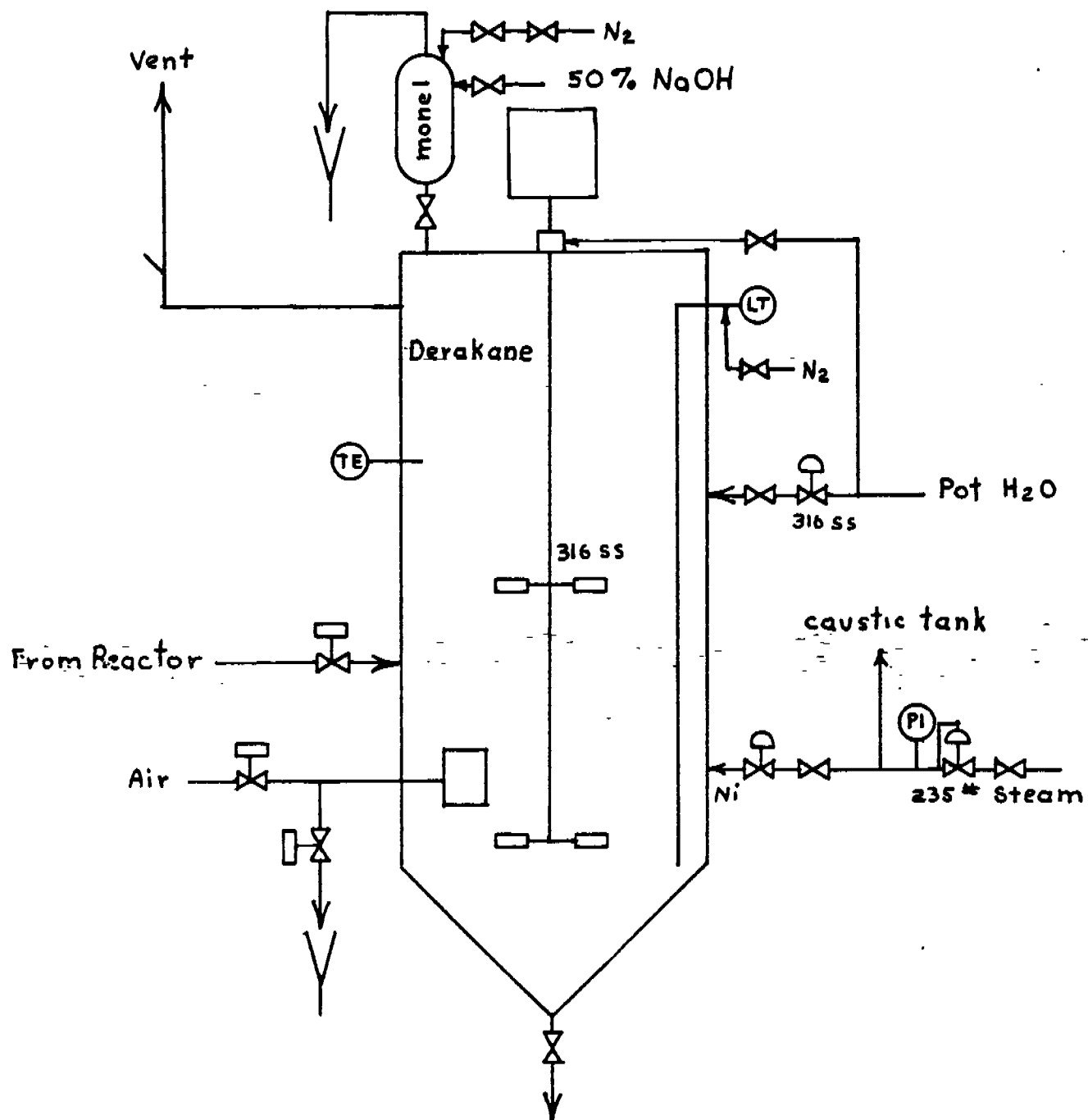
1. DOUBLE MECHANICAL SEAL WITH WATER AS THE INTERMEDIATE FLUID.
2. NORMAL SEAL POT PRESSURE IS 205 PSIG.
3. SEAL POT HAS A LOW LEVEL ALARM AND A LOW PRESSURE ALARM SET AT 145 PSIG (CRIT. INST., QUARTERLY).

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Neutralizer



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NEUTRALIZER

PROBLEM

SAFETY MEASURE

OVERPRESSURE

1. ATMOSPHERIC VESSEL. FOUR INCH VENT TO ATMOSPHERE.

HIGH TEMPERATURE

1. NORMALLY OPERATED AT BOILING POINT OF WATER.
2. TEMPERATURE CONTROLLED.

OVERFLOW

1. LEVEL CONTROLLED WITH POSITIVE PURGE ON LEVEL TRANSMITTER. HIGH LEVEL ALARM.

RESIDUAL NAOH IN
DUMPED RESIN

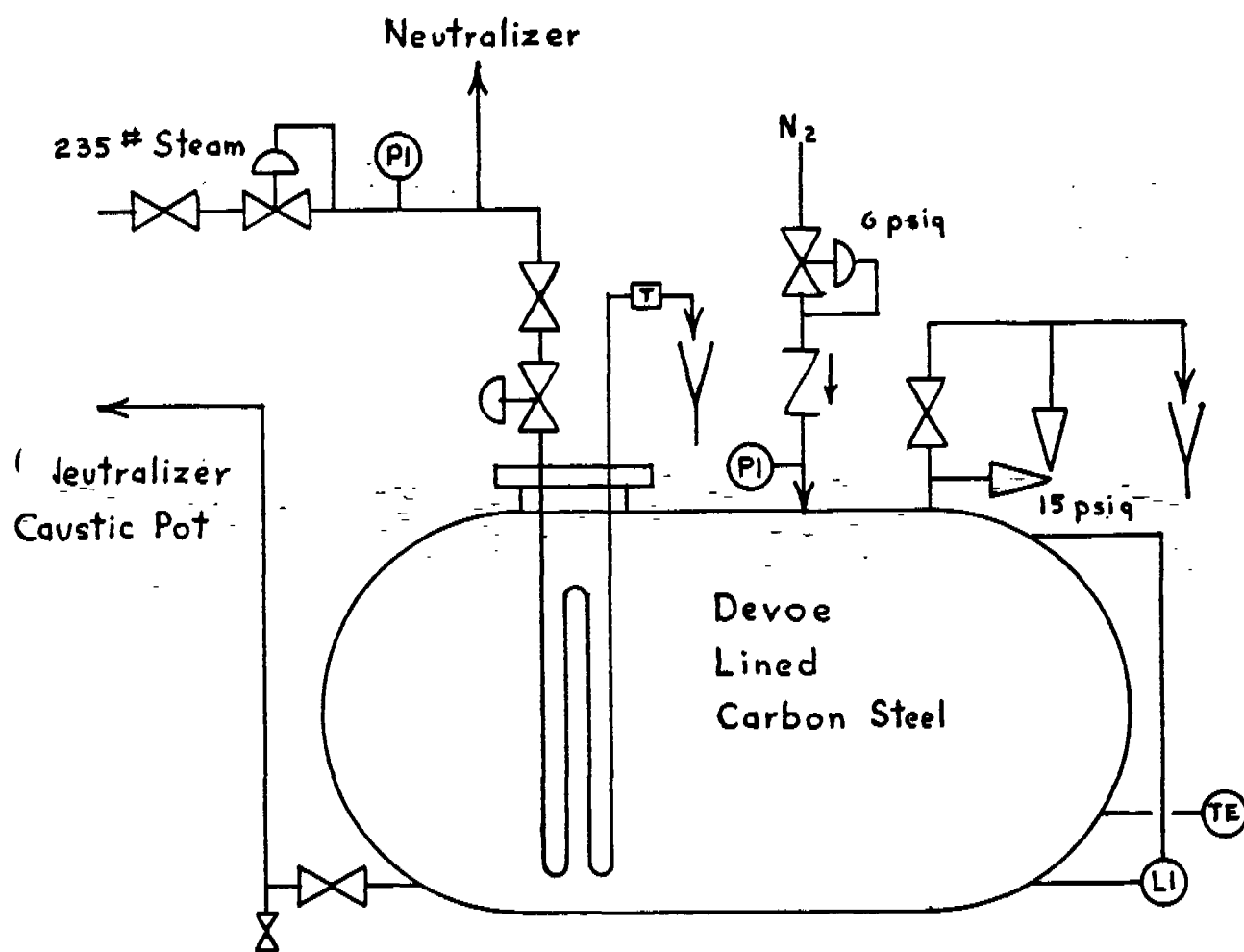
1. AFTER NEUTRALIZATION IS COMPLETE, THE RESIN IS THOROUGHLY WASHED WITH COLD WATER TO COOL IT AND REMOVE ANY RESIDUAL CAUSTIC.

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Caustic Tank



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CAUSTIC TANK

PROBLEMS

HIGH TEMPERATURE

SAFETY MEASURE

1. TEMPERATURE IS CONTROLLED AT 35°C.
2. VESSEL IS RATED TO 110°C.
3. HIGH TEMPERATURE ALARM AT 50°C.

HIGH PRESSURE

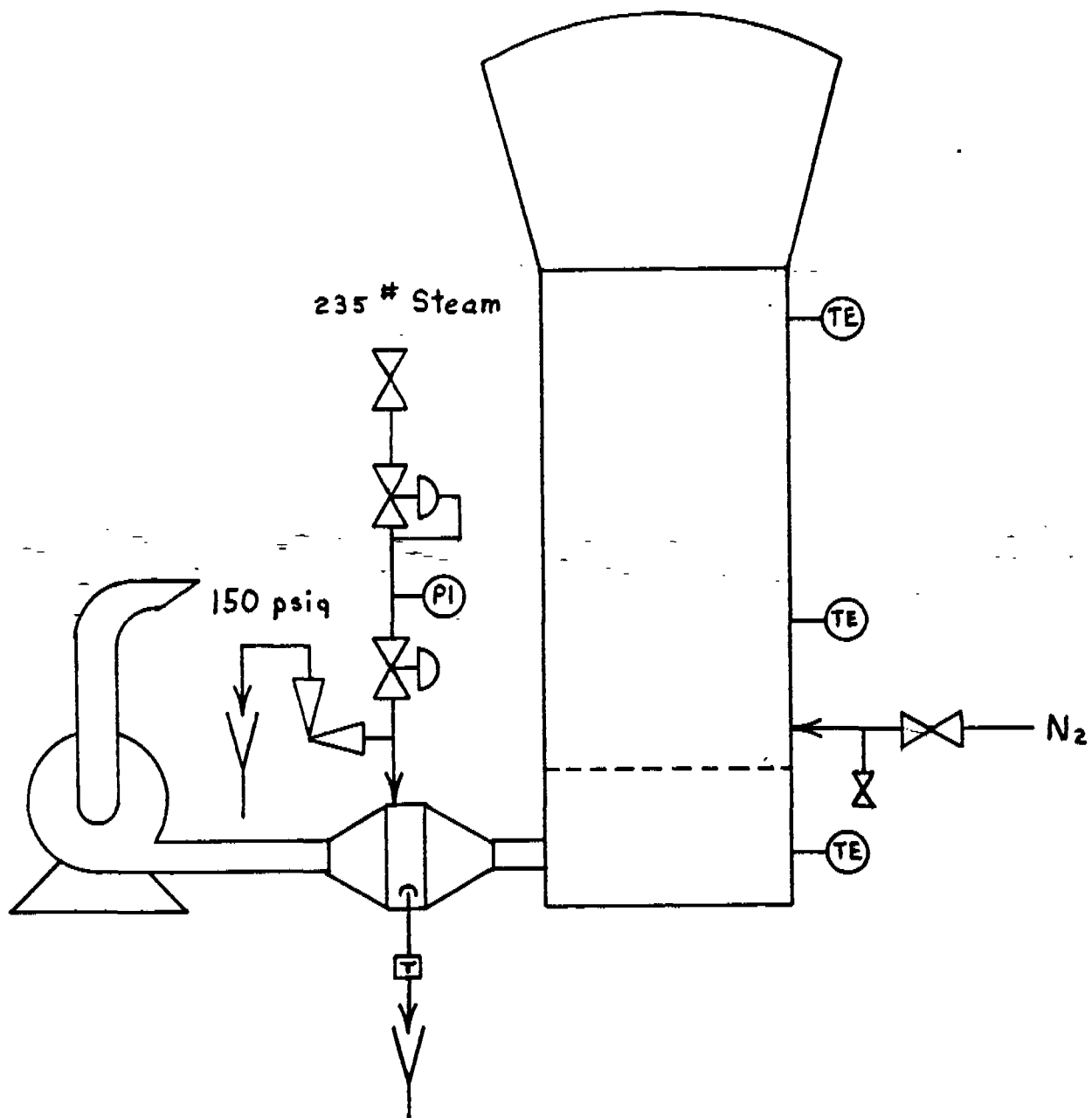
1. THE VESSEL IS PADDED WITH NITROGEN
AT 6 PSIG.
2. THE PSV IS SET FOR 15 PSIG.
3. THE VESSEL'S MAWP IS 20 PSIG.

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Fluid Bed Dryer



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FLUID BED DRYER

PROBLEM

HIGH TEMPERATURE
(CPE FIRE)

SAFETY MEASURE

1. INLET TEMPERATURE CONTROLLED AT 45-60°C.
2. HIGH TEMPERATURE ALARM AT 95°C.
3. TUBE BUNDLE CLEANOUT ON CRITICAL INSTRUMENT LIST SEMI-ANNUALLY.
4. BED PLATE CLEANED REGULARLY AS NECESSARY.

ARC

GASING AND DECOMPOSITION AT 190°C
RUNAWAY AT 251°C AT LOW RATES WHICH
DID NOT CUSTAIN THEMSELVES WHEN TESTED
TO 300°C.

DUST EXPLOSION

1. CPE IS NOT CONSIDERED TO BE A DUST EXPLOSION HAZARD BY ITSELF. THERE HAS BEEN A PROBLEM WITH ADDITIVES SUCH AS CAST. ONLY TALC IS ADDED TO THE CPE IN THE PILOT PLANT DRYER.

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RESIN ANALYSIS - THF TEST

PROBLEM FLAMMABILITY

SAFETY MEASURE

1. ONE GALLON METAL CANS ARE USED AS PER S&LP 405.
2. IT IS HANDLED ONLY IN THE FUME HOOD.

REACTION WITH STRONG BASE

1. DISCUSSED IN SAFETY MEETINGS. OPERATORS ARE AWARE OF THE HAZARD.
2. RESIN IS HAND SQUEEZED TO REMOVE AS MUCH LIQUID AS POSSIBLE PRIOR TO DISSOLUTION IN THF.
3. THE CAUSTIC IS ADDED TO THE NEUTRALIZER FROM A SEPARATE ONE GALLON CAUSTIC POT IN ONE GALLON ALIQUOTS.
4. PROCEDURES PROHIBIT ADDING CAUSTIC DIRECTLY.

PEROXIDE FORMATION

1. WHEN A NEW CAN OF THF IS OPENED, IT IS LABELED WITH THE DATE.
2. ANY OPEN CAN IS USED UP BEFORE ANOTHER CAN MAY BE OPENED.
3. DURING THE PROCEDURE, WATER IS ADDED TO THE THF (PREVENTING PEROXIDE FORMATION).
4. THF, WATER WASTE ARE PLACED IN THE LAST EMPTY CAN OR A SPECIAL PLASTIC CONTAINER AND LABELED THF + WATER.
5. THE WASTE CONTAINERS ARE DISPOSED OF BY THE PRODUCTION PLANT.

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TYPICAL PILOT PLANT RUN CHRONOLOGY

1. 20 POUNDS OF PE, 250 GRAMS OF TALC OR 102 GRAMS OF PVP ARE WEIGHED OUT.
2. 25 ML OF T-DET ARE MEASURED.
3. THE T-DET IS DISSOLVED IN 189 POUNDS OF COLD POTABLE WATER.
4. THE TALC OR PVP, AS REQUIRED, IS ADDED.
5. THE PE IS ADDED AND ALLOWED TO AGITATE FOR A FEW MINUTES.
6. THE CHLORINE SYSTEM IS PRESSURIZED WITH CHLORINE AND PURGED OF NITROGEN.
7. THE WATER IN THE REACTOR IS DRAINED AND THE PE SLURRY IS TRANSFERED TO THE REACTOR.
8. THE REACTOR SLURRY IS HEATED, USING THE JACKET, TO 100°C.
9. THE REACTOR IS VENTED TO THE DITCH.
10. THE REACTOR IS COOLED TO 95°C.
11. THE CHLORINE VALVES ARE OPENED, AND THE CHLORINE IS ALLOWED TO FLOW AT 0 - .4 LB/MIN., AND THE TEMPERATURE IS ALLOWED TO INCREASE AT 0 - .2°C/MIN. AS PER THE PROGRAM.
12. AT 115°C, 250 GRAMS OF TALC ARE ADDED IF THE PROGRAM CALLS FOR IT.
13. WHEN THE TOTAL AMOUNT OF CHLORINE (APPROX. 22.5 LB) HAS BEEN ADDED, AND THE FINAL TEMPERATURE REACHED (APPOX. 130°C), THE CHLORINE FLOW IS SHUT OFF AND THE REACTOR IS COOLED.
14. WHEN THE SLURRY HAS COOLED TO 85°C, THE TRANSFER VALVES ARE OPENED AND THE RUN MAY BE PRESSURED TO THE NEUTRALIZER WITH NITROGEN.

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15. THE REACTOR IS THEN REFILLED WITH WATER.
16. THE NEUTRALIZER INITIALLY HAS A 20 PERCENT LEVEL OF POTABLE WATER.
17. AFTER THE RUN IS IN THE NEUTRALIZER, THE LEVEL IS AGAIN DROPPED TO 20 PERCENT.
18. THE NEUTRALIZER IS THEN REFILLED TO 60 PERCENT ANDD HEATED TO 95 C.
19. THE LEVEL IS THEN DROPPED TO 20 PERCENT.
20. STEPS 16 AND 17 ARE REPEATED FOR 30 MINUTES.
21. WITH THE LEVEL AT 60 PERCENT AND THE LIQUOR HOT, ONE GALLON OF CAUSTIC IS ADDED.
22. AFTER 30 MINUTES, THE RESIN IS SAMPLED AND IT'S PH IS DETERMINED BY USING THE THF TEST.
23. IF THE RESIN IS NOT NEUTRAL AFTER TWO HOURS, AN ADDITIONAL GALLON OF CAUSTIC MAY BE ADDED.
24. WHEN THE RESIN IS NEUTRAL, THE 20-60 PERCENT WASHING CYCLE IS RESUMED FOR 45 MINUTES.
25. THE SLURRY IS THEN COOLED TO LESS THAN 45°C.
26. THE SLURRY IS DUMPED INTO A SIPHON BARREL TO DRAIN.
27. THE RESIN IS THEN EXPRESSED AND LOADED INTO THE DRYER WITH 125 GRAMS OF TALC.
28. COLD AIR AND NITROGEN ARE BLOWN THROUGH THE RESIN UNTIL IT IS DRY ENOUGH TO FLUIDIZE.
29. THEN THE NITROGEN IS SHUT OFF ANDD THE AIR TEMPERATURE IS INCREASED TO 60°C.
30. WHEN THE RESIN APPEARS DRY (THIS IS OBVIOUS WITH EXPERIENCE), THE HEAT IS TURNED OFF AND THE RESIN IS FLUIDIZED WITH COOL AIR FOR A FEW MINUTES.
31. WHEN IT IS COOL, THE RESIN IS DUMPED INTO A BOX AND TAKEN TO THE LAB FOR ANALYSIS.

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APPENDIX A

CHEMICAL SAFETY CHECKSHEETS AND MATERIAL

SAFETY DATA SHEETS

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CHEMICAL SAFETY CHECKSHEET

To Be Completed By Any Users For All Chemicals

CHEMICAL CAUSTIC 50% w/w MELTING POINT _____
 EXPOSURE (ppm) 2 mg/m³ VAPOR PRESSURE 1.5 mm Hg at 20°C
 BOILING POINT 293°F, 145°C CORROSIVENESS HIGH
 EXPLOSIVE LIMITS N/A CHEMICAL REACTIVITY (HIGH) - LOW
 FLASH POINT N/A STABILITY (To pH CHANGE, HEAT, LIGHT) GOOD
 IGNITION TEMP. N/A
 USING SAFETY CONTAINER N/A
 TOXIC PROPERTIES AVOID INGESTION, EYE/SKIN CONTACT, INHALATION

PROTECTIVE EQUIPMENT TO BE USED:

MONOGOGGLES X FUME HOOD _____
 FACE SHIELD X SPECIAL PRECAUTIONS AVOID ALL
 GAS MASK _____ EYE/SKIN CONTACT.
 SLICKER SUIT X WILL REACT WITH ALUMINUM,
 RUBBER BOOTS X TIN, ZINC, BRASS, BRONZE
 RUBBER GLOVES X
 OTHER _____

HAVE YOU READ THE TOXICOLOGY SHEET ON IS THE CHEMICAL OR MIXTURE:

THIS CHEMICAL? (YES) NO SUBJECT TO TSCA? (YES) NO
 GROUP LEADER Dave Alsgaard ON TSCA INVENTORY? (YES) NO [1310-73-2]

USERS SIGNATURE DATE PLEASE CONFIRM WITH SUPPLIER _____

Michael H. Williams 12/11/84

Barbara S. Wilson 12/11/84

Javier Plummer 12/24/84

J. Plummer 1/7/85

C. Delcorral 1/8/85

USED FOR R&D ONLY? YES (NO)

IN COMPLIANCE WITH ALL TSCA RULES & ORDERS YES

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N. M. Long 1/22/85

M A T E R I A L S A F E T Y D A T A S H E E T PAGE: 1
DOW CHEMICAL U.S.A. MIDLAND MICHIGAN 48640 EMERGENCY PHONE: 517-536-4400

EFFECTIVE DATE: 24 AUG 84 DATE PRINTED: 5 SEP 84 PRODUCT CODE: 13216

PRODUCT NAME: CAUSTIC SODA SOLUTION 50X MSD: 0101

INGREDIENTS (TYPICAL VALUES-NOT SPECIFICATIONS) : % :

SODIUM HYDROXIDE : 50 :
WATER : BALANCE:

SECTION 1

PHYSICAL DATA

BOILING POINT: 293F, 145C APPROX. : SOL. IN WATER: WATER SOLUTION
VAP PRESS: 1.5 MMHG, 0.2 KPA @ 20C: SP. GRAVITY: @ 20C (DENS.) 1.52 G/ML
VAP DENSITY (AIR=1): ---- : % VOLATILE BY VOL: LOW (WATER)

(APPEARANCE AND ODOR: COLORLESS TO SLIGHTLY COLORED LIQUID, NO ODOR.

SECTION 2

FIRE AND EXPLOSION HAZARD DATA

FLASH POINT: NONE : FLAMMABLE LIMITS
METHOD USED: NOT APPLICABLE : LFL: NOT APPLIC. UFL: NOT APPLIC.

EXTINGUISHING MEDIA: NON-COMBUSTIBLE.

SPECIAL FIRE FIGHTING EQUIPMENT AND HAZARDS: IN WATER SOLUTION
CAUSTIC CAN REACT WITH AMPHOTERIC METALS (SUCH AS ALUMINUM)
GENERATING HYDROGEN WHICH IS FLAMMABLE AND/OR EXPLOSIVE WHEN IGNITED.

SECTION 3

REACTIVITY DATA

STABILITY: PRODUCT ABSORBS WATER AND CARBON DIOXIDE FROM THE AIR.
KEEP CONTAINERS CLOSED AND SEALED.

INCOMPATIBILITY: WATER AND ACID. PRODUCT IS STRONG CAUSTIC ALKALI. MAY
REACT VIOLENTLY OR EXPLOSIVELY WITH WATER, ACID, AND A NUMBER OF ORGANIC
COMPOUNDS. CAUSTIC REACTS RAPIDLY WITH ALUMINUM, TIN, AND ZINC. IT WILL
ALSO REACT WITH BRONZE AND BRASS.

HAZARDOUS DECOMPOSITION PRODUCTS: NONE.

(HAZARDOUS POLYMERIZATION: WILL NOT OCCUR.

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SECTION 4

SPILL, LEAK, AND DISPOSAL PROCEDURES

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ACTION TO TAKE FOR SPILLS: ONLY TRAINED AND PROPERLY PROTECTED PERSONNEL
SHOULD BE INVOLVED IN SPILL CLEANUP OPERATIONS. ACTING CAUTIOUSLY,
SMALL ACCIDENTAL SPILLS OF CAUSTIC SODA SOLUTION SHOULD BE CAREFULLY

EFFECTIVE DATE: 24 AUG 84 DATE PRINTED: 5 SEP 84 PRODUCT CODE: 15216
PRODUCT (CONT'D): CAUSTIC SODA SOLUTION 50% MSD: 0101

SECTION 4 SPILL, LEAK, AND DISPOSAL PROCEDURES (CONTINUED)

ACTION TO TAKE FOR SPILLS: (CONTINUED)

FLUSHED WITH WATER. DILUTE ACID, PREFERABLY ACETIC ACID, MAY BE USED TO NEUTRALIZE ONLY THE FINAL TRACES OF CAUSTIC AFTER FLUSHING.

DISPOSAL METHOD: DISPOSAL OF CAUSTIC SODA MUST MEET ALL FEDERAL, STATE AND LOCAL REGULATIONS. CONTACT THE DOW CHEMICAL COMPANY FOR ADDITIONAL INFORMATION.

SECTION 5 HEALTH HAZARD DATA

EYES: MAY CAUSE SEVERE IRRITATION WITH CORNEAL INJURY AND RESULT IN PERMANENT IMPAIRMENT OF VISION, EVEN BLINDNESS. DUSTS MAY IRRITATE EYES.

SKIN CONTACT: SHORT SINGLE EXPOSURE MAY CAUSE SEVERE SKIN BURNS.

SKIN ABSORPTION: A SINGLE PROLONGED SKIN EXPOSURE IS NOT LIKELY TO RESULT IN ABSORPTION OF HARMFUL AMOUNTS. THE DERMAL LD50 HAS NOT BEEN DETERMINED.

INGESTION: MAY CAUSE GASTROINTESTINAL IRRITATION OR ULCERATION AND SEVERE BURNS OF THE MOUTH AND THROAT. SINGLE DOSE-ORAL LD50 HAS NOT BEEN DETERMINED.

INHALATION: DUSTS OR MISTS MAY CAUSE SEVERE IRRITATION TO UPPER RESPIRATORY TRACT.

SYSTEMIC & OTHER EFFECTS: ----

SECTION 6 FIRST AID

EYES: WASH EYES IMMEDIATELY AND CONTINUOUSLY UNTIL ASSISTANCE ARRIVES FOR TRANSPORT TO MEDICAL FACILITY; WASH ENROUTE, IF POSSIBLE. IF MEDICAL ASSISTANCE IS NOT IMMEDIATELY AVAILABLE, WASH FOR 30 MINUTES AND SEEK MEDICAL ATTENTION IMMEDIATELY.

SKIN: IMMEDIATE CONTINUED AND THOROUGH WASHING IN FLOWING WATER FOR 30 MINUTES IS IMPERATIVE WHILE REMOVING CONTAMINATED CLOTHING. PROMPT MEDICAL CONSULTATION IS ESSENTIAL. WASH CONTAMINATED CLOTHING BEFORE REUSE. DESTROY CONTAMINATED SHOES.

INGESTION: DO NOT INDUCE VOMITING. GIVE LARGE AMOUNTS OF WATER OR MILK IF AVAILABLE AND TRANSPORT TO MEDICAL FACILITY.

INHALATION: REMOVE TO FRESH AIR IF EFFECTS OCCUR. CONSULT MEDICAL. CONFIDENTIAL

NOTE TO PHYSICIANS: CORROSIVE. MAY CAUSE STRICTURE. IF LAVAGE IS PERFORMED, SUGGEST ENDOTRACHEAL AND/OR ESOPHAGOSCOPIC CONTROL. MATERIAL IS STRONG ALKALI. IF BURN IS PRESENT, TREAT AS ANY THERMAL BURN, AFTER DECONTAMINATION. FOR BURNS OF SKIN ONLY. EYE IRRIGATION MAY BE NECESSARY FOR A TOTAL OF 45 MINUTES TO REMOVE AS MUCH CAUSTIC AS POSSIBLE. DURATION OF IRRIGATION AND TREATMENT IS AT THE

DO 005234

EFFECTIVE DATE: 24 AUG 54 DATE PRINTED: 5 SEP 54 PRODUCT CODE: 15215
PRODUCT (CONT'D): CAUSTIC SODA SOLUTION 50% MSD: 0101

SECTION 6 FIRST AID (CONTINUED)

NOTE TO PHYSICIAN: (CONTINUED)

DISCRETION OF MEDICAL PERSONNEL. NO SPECIFIC ANTIDOTE. SUPPORTIVE CARE. TREATMENT BASED ON JUDGMENT OF THE PHYSICIAN IN RESPONSE TO REACTIONS OF THE PATIENT.

SECTION 7 SPECIAL HANDLING INFORMATION

EXPOSURE GUIDELINE(S): SODIUM HYDROXIDE: ACGIH TLV IS 2 MG/M3 CEILING;
OSHA PEL IS 2 MG/M3 (T44).

VENTILATION: CONTROL AIRBORNE CONCENTRATIONS BELOW THE EXPOSURE GUIDELINE.
GOOD GENERAL VENTILATION SUFFICIENT FOR MOST OPERATIONS.

RESPIRATORY PROTECTION: IN MISTY ATMOSPHERES, USE AN APPROVED MIST RESPIRATOR. IF RESPIRATORY IRRITATION IS EXPERIENCED, USE AN APPROVED AIR-PURIFYING RESPIRATOR.

PROTECTIVE CLOTHING: USE PROTECTIVE CLOTHING IMPERVIOUS TO THIS MATERIAL. SELECTION OF SPECIFIC ITEMS SUCH AS GLOVES, BOOTS, APPROV. FACE-SHIELD OR FULL-BODY SUIT WILL DEPEND ON OPERATION. REMOVE CONTAMINATED CLOTHING IMMEDIATELY, WASH SKIN AREA WITH SOAP AND WATER, AND LAUNDRER CLOTHING BEFORE REUSE.

EYE PROTECTION: USE CHEMICAL-GOGGLES. FULL FACE SHIELD IN ADDITION TO GOGGLES MAY BE DESIRABLE TO PROTECT FACE. MAINTAIN EYE WASH FOUNTAIN AND SAFETY SHOWER AT OR NEAR WORK AREA.

SECTION 8 SPECIAL PRECAUTIONS AND ADDITIONAL INFORMATION

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: PREVENT EYE AND SKIN CONTACT. DO NOT BREATHE DUSTS OR MISTS.

AVOID STORING NEXT TO STRONG ACIDS. CAUSTIC SHOULD BE STORED IN CLEAN, DRY AREAS ABOVE GROUND LEVEL. PRODUCT ABSORBS WATER AND CO2 FROM AIR. KEEP CONTAINERS CLOSED AND SEALED.

ADDING WATER AND OTHER SUBSTANCES MAY GENERATE EXCESSIVE HEAT, SPATTERING AND MISTS. SOLUTIONS OF GREATER THAN 45% ARE VISCOUS AND SLIPPERY.

ADDITIONAL INFORMATION: REVISED SECTIONS 3, 4, 5, 6, 7, AND 8.

LAST PAGE

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THE INFORMATION HEREIN IS GIVEN IN GOOD FAITH, BUT NO WARRANTY, EXPRESSED OR IMPLIED, IS MADE. CONSULT THE DOW CHEMICAL COMPANY FOR FURTHER INFORMATION.

CHEMICAL SAFETY CHECKSHEET

To Be Completed By Any Users For All Chemicals

CHEMICAL CHLORINE MELTING POINT -101°C
 TLV EXPOSURE (ppm) 1.0 VAPOR PRESSURE 53 psia at 0°C
82 psig at 20°C
 BOILING POINT -34°C (-30°F) CORROSIVENESS EXTREME
 EXPLOSIVE LIMITS NONE CHEMICAL REACTIVITY (HIGH) - LOW
 FLASH POINT NONE STABILITY (To pH CHANGE, HEAT, LIGHT) GOOD
 IGNITION TEMP. NONE

USING SAFETY CONTAINER N/A

TOXIC PROPERTIES CAN CAUSE BREATHING DIFFICULTIES, SKIN IRRITATION, DEATH

PROTECTIVE EQUIPMENT TO BE USED:

MONOGOGGLES X FUME HOOD _____
 FACE SHIELD _____ SPECIAL PRECAUTIONS See attached sheet
 GAS MASK X for additional information
 SLICKER SUIT X _____
 RUBBER BOOTS X _____
 RUBBER GLOVES X _____
 OTHER _____

HAVE YOU READ THE TOXICOLOGY SHEET ON IS THE CHEMICAL OR MIXTURE:

THIS CHEMICAL? (YES) NO SUBJECT TO TSCA? (YES) NO
 GROUP LEADER Dave Alsgaard ON TSCA INVENTORY? (YES) NO [7782-50-5]

USERS SIGNATURE DATE PLEASE CONFIRM WITH SUPPLIER _____

Michael H. Williams 12/11/84
Barbara L. Watson 12-11-84
James Flynn 12/26/84
Jim Lohr 1/7/85
W. DeLeon 1/8/85

USED FOR R&D ONLY? YES (NO)

IN COMPLIANCE WITH ALL TSCA RULES & ORDERS YES NO CONFIDENTIAL

W. DeLeon 1/22/85

DO 005236

EFFECTIVE DATE: 09 SEP 81
PRODUCT (CONT'D): CHLORINE, GASEOUS H.P.

PRODUCT CODE: 15276
MSD: 1122

SECTION 4 SPILL, LEAK, AND DISPOSAL PROCEDURES

ACTION TO TAKE FOR SPILLS (USE APPROPRIATE SAFETY EQUIPMENT): MOVE UNPROTECTED PERSONNEL CROSS-WIND. CLOSE NECESSARY VALVES WITH TRAINED PERSONNEL USING PRESCRIBED PROTECTIVE EQUIPMENT.

DISPOSAL METHOD: PRIOR TO DISPOSAL, THE ACTIVE CHLORINE MUST BE REDUCED OR DESTROYED. CHLORINE MAY BE ABSORBED IN DILUTE SOLUTIONS OF CAUSTIC (NAOH), SODA ASH (NA₂CO₃), OR HYDRATED LIME (CA(OH)₂). CAUSTIC AND SODA ASH SOLUTIONS SHOULD CONTAIN APPROXIMATELY 3 POUNDS PER GALLON, LIME 1 POUND PER GALLON, FOR 1 POUND CHLORINE. LOCAL, MUNICIPAL OR STATE AUTHORITIES SHOULD BE CONTACTED FOR DISPOSAL OF RESULTANT PRODUCT.

SECTION 5 HEALTH HAZARD DATA

INGESTION: NOT A PROBLEM, AS CHLORINE IS A GAS AT ROOM TEMPERATURE.

EYE CONTACT: LIQUID AND GAS - CAPABLE OF CAUSING A BURN AND IRRITATION.

SKIN CONTACT: LIQUID AND GAS - CAPABLE OF CAUSING A BURN OR BLISTERS.

SKIN ABSORPTION: NOT LIKELY A PROBLEM BECAUSE OF BURN AND BECAUSE IT IS A GAS.

INHALATION: OSHA CEILING AND ACGIH TLV IS 1 PPM.

EFFECTS OF OVEREXPOSURE: MARKED IRRITATION: EYES, NASAL & THROAT LININGS. LUNG INJURY. SO IRRITATING, IT MAY BE DIFFICULT OR IMPOSSIBLE TO BREATHE.

SECTION 6 FIRST AID--NOTE TO PHYSICIAN

FIRST AID PROCEDURES:

EYES: EXPOSURE TO LIQUID CHLORINE - IMMEDIATE AND CONTINUOUS IRRIGATION WITH FLOWING WATER FOR AT LEAST 15 MINUTES IS IMPERATIVE. PROMPT MEDICAL CONSULTATION ESSENTIAL. EXPOSURE TO CHLORINE GAS - IRRIGATE WITH FLOWING WATER IMMEDIATELY AND CONTINUOUSLY FOR 15 MINUTES. REFER TO MEDICAL PERSONNEL.

SKIN: EXPOSURE TO LIQUID CHLORINE - SKIN BURN LIKELY. IMMEDIATE CONTINUOUS AND THOROUGH WASHING IN FLOWING WATER FOR 15 MINUTES IS INDICATED. REMOVE CLOTHING IMMEDIATELY. DISCARD ALL CONTAMINATED CLOTHING AND ACCESSORIES.

INHALATION: REMOVE TO FRESH AIR IF EFFECTS OCCUR. IF RESPIRATION STOPS GIVE MOUTH TO MOUTH RESUSCITATION. ADMINISTER OXYGEN IF AVAILABLE. CALL PHYSICIAN AND/OR TRANSPORT TO MEDICAL FACILITY.

(CONTINUED ON PAGE 3)

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DO 005238

EFFECTIVE DATE: 09 SEP 81

PRODUCT CODE: 15275

PRODUCT (CONT'D): CHLORINE, GASEOUS H.P.

MSD: 1122

SECTION 6

FIRST AID--NOTE TO PHYSICIAN (CONTINUED)

INGESTION: NOT A PROBLEM AS CHLORINE IS A GAS AT ROOM TEMPERATURE.

NOTE TO PHYSICIAN:

EYES: LIQUID VERY CORROSIVE. MAY CAUSE CORNEAL INJURY OR BURN.
STAIN FOR EVIDENCE OF CORNEAL INJURY. IF CORNEA IS INJURED,
INSTILL ANTIBIOTIC STEROID PREPARATION FREQUENTLY. CONSULT
OPHTHALMOLOGIST. GAS - INJURY IS UNLIKELY.

SKIN: LIQUID VERY CORROSIVE. MAY CAUSE BURN. IF BURN IS PRESENT,
TREAT AS ANY THERMAL BURN.

RESPIRATORY: MAY CAUSE SEVERE IRRITATION. MAY CAUSE PULMONARY EDEMA.
ADMINISTER OXYGEN IF AVAILABLE. BRONCHODILATORS, EXPECTORANTS,
AND ANTITUSSIVES MAY BE OF HELP. MECHANICAL SUPPORT OF RESPIR-
ATION MAY BE NEEDED.

SYSTEMIC: HIGHLY TOXIC. CONSULT STANDARD LITERATURE. TREATMENT BASED
ON SOUND JUDGMENT OF PHYSICIAN AND THE INDIVIDUAL REACTIONS OF
THE PATIENT.

SECTION 7

SPECIAL HANDLING INFORMATION

VENTILATION: RECOMMEND CONTROL OF VAPORS TO SUGGESTED GUIDE.

RESPIRATORY PROTECTION: APPROVED ACID GAS-TYPE RESPIRATOR REQUIRED
IN ABSENCE OF PROPER ENVIRONMENTAL CONTROL. FOR ENTRY INTO
EMERGENCY AREAS, USE ONLY A POSITIVE PRESSURE BREATHING APPARATUS. FOR
ESCAPE FROM EMERGENCY AREA USE AN APPROVED ESCAPE-TYPE MASK.

PROTECTIVE CLOTHING: RUBBER GLOVES, APRON AND BOOTS AND FULL FACE
SHIELD OVER EYE PROTECTION.

EYE PROTECTION: GAS TIGHT GOGGLES OR EQUIVALENT. SUGGEST SEVERAL EYE
FOUNTAINS AND SAFETY SHOWERS READILY AVAILABLE, SO AT LEAST ONE IS
AVAILABLE IN AN EMERGENCY.

SECTION 8

SPECIAL PRECAUTIONS AND ADDITIONAL INFORMATION

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: NO ATTEMPT SHOULD BE
MADE TO HANDLE OR STORE CHLORINE WITHOUT A COMPLETE REVIEW OF THE
CHLORINE MANUAL, AVAILABLE FROM THE CHLORINE INSTITUTE, INC.,
NEW YORK.

ADDITIONAL INFORMATION: 09 SEP 81 REVISED FROM 23 OCT 79 --
INGREDIENT SECTION AND SECTIONS 1,6,7. CONSOLIDATED MSDS 105,
809, 810, AND 1123.

(CONTINUED ON PAGE 4)

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DO 005239

M A T E R I A L S A F E T Y D A T A S H E E T P A G E : 4
DOW CHEMICAL U.S.A. MIDLAND MICHIGAN 48640 EMERGENCY PHONE: 517-636-4400

(EFFECTIVE DATE: 09 SEP 81

PRODUCT CODE: 1527

PRODUCT (CONT'D): CHLORINE, GASEOUS H.P.

MSD: 112

LAST PAGE

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DO 005240

M A T E R I A L S A F E T Y D A T A S H E E T P A G E : 1
DOW CHEMICAL U.S.A. MIDLAND MICHIGAN 48640 EMERGENCY PHONE: 517-636-4400

EFFECTIVE DATE: 09 SEP 81

PRODUCT CODE: 15295

PRODUCT NAME: CHLORINE, LIQUID

MSC: 1122

INGREDIENTS (TYPICAL VALUES-NOT SPECIFICATIONS) : % :

CHLORINE : 99.5 :

SECTION 1

PHYSICAL DATA

BOILING POINT: -29.3F (-34C) : SOL. IN WATER: 0.73G/100G H₂O @ 20C
VAP PRESS: 82 PSIG @ 68F, 20C : SP. GRAVITY: 1.47@32F, 0C; 53.2 PSIA
VAP DENSITY (AIR=1): 2.49 @32F, 0C : % VOLATILE BY VOL: 99.0

APPEARANCE AND ODOR: AMBER COLOR - PUNGENT ODOR; LIQUIFIED GAS
UNDER PRESSURE; VAPORIZES TO GREENISH - YELLOW GAS.

SECTION 2

FIRE AND EXPLOSION HAZARD DATA

FLASH POINT: NONE : FLAMMABLE LIMITS
METHOD USED: NOT APPLICABLE : LFL: NOT APPLIC. UFL: NOT APPLIC.

EXTINGUISHING MEDIA: DO NOT USE WATER DIRECTLY ON A CHLORINE LEAK.
A FOG NOZZLE IN AREA CAN BE USED TO ABSORB GAS.

SPECIAL FIRE FIGHTING EQUIPMENT AND HAZARDS: A POSITIVE-PRESSURE
BREATHING APPARATUS FOR RESPIRATORY PROTECTION AND PROTECTIVE
CLOTHING. MAY REACT TO CAUSE FIRE AND/OR EXPLOSION UPON CONTACT
WITH MANY ORGANIC COMPOUNDS, AMMONIA, HYDROGEN, OR FINELY DIVIDED
METALS, OR WITH STEEL AT ELEVATED TEMPERATURES.

SECTION 3

REACTIVITY DATA

STABILITY: AVOID PROXIMITY TO FLAMMABLE MATERIALS INCLUDING
CHEMICALS.

INCOMPATIBILITY: MANY ORGANIC COMPOUNDS, AMMONIA, HYDROGEN, MOIST
OR HOT STEEL, AND MANY FINELY DIVIDED METALS. MAY REACT EXPLOSIVELY
WITH SOME ORGANICS UNDER CONFINEMENT.

HAZARDOUS DECOMPOSITION PRODUCTS: NONE.

HAZARDOUS POLYMERIZATION: WILL NOT OCCUR.

(CONTINUED ON PAGE 2)

() INDICATES A TRADEMARK OF THE DOW CHEMICAL COMPANY

DO 005241

CONFIDENTIAL

EFFECTIVE DATE: 09 SEP 81
PRODUCT (CONT'D): CHLORINE, LIQUID

PRODUCT CODE: 15295
MSD: 1122

SECTION 4 SPILL, LEAK, AND DISPOSAL PROCEDURES

ACTION TO TAKE FOR SPILLS (USE APPROPRIATE SAFETY EQUIPMENT): MOVE UNPROTECTED PERSONNEL CROSS-WIND. CLOSE NECESSARY VALVES WITH TRAINED PERSONNEL USING PRESCRIBED PROTECTIVE EQUIPMENT.

DISPOSAL METHOD: PRIOR TO DISPOSAL, THE ACTIVE CHLORINE MUST BE REDUCED OR DESTROYED. CHLORINE MAY BE ABSORBED IN DILUTE SOLUTIONS OF CAUSTIC (NAOH), SODA ASH (NA₂CO₃), OR HYDRATED LIME (CA(OH)₂). CAUSTIC AND SODA ASH SOLUTIONS SHOULD CONTAIN APPROXIMATELY 3 POUNDS PER GALLON, LIME 1 POUND PER GALLON, FOR 1 POUND CHLORINE. LOCAL, MUNICIPAL OR STATE AUTHORITIES SHOULD BE CONTACTED FOR DISPOSAL OF RESULTANT PRODUCT.

SECTION 5 HEALTH HAZARD DATA

INGESTION: NOT A PROBLEM, AS CHLORINE IS A GAS AT ROOM TEMPERATURE.

EYE CONTACT: LIQUID AND GAS - CAPABLE OF CAUSING A BURN AND IRRITATION.

SKIN CONTACT: LIQUID AND GAS - CAPABLE OF CAUSING A BURN OR BLISTERS.

SKIN ABSORPTION: NOT LIKELY A PROBLEM BECAUSE OF BURN AND BECAUSE IT IS A GAS.

INHALATION: OSHA CEILING AND ACGIH TLV IS 1 PPM.

EFFECTS OF OVEREXPOSURE: MARKED IRRITATION: EYES, NASAL & THROAT LININGS. LUNG INJURY. SO IRRITATING, IT MAY BE DIFFICULT OR IMPOSSIBLE TO BREATHE.

SECTION 6 FIRST AID--NOTE TO PHYSICIAN

FIRST AID PROCEDURES:

EYES: EXPOSURE TO LIQUID CHLORINE - IMMEDIATE AND CONTINUOUS IRRIGATION WITH FLOWING WATER FOR AT LEAST 15 MINUTES IS IMPERATIVE. PROMPT MEDICAL CONSULTATION ESSENTIAL. EXPOSURE TO CHLORINE GAS - IRRIGATE WITH FLOWING WATER IMMEDIATELY AND CONTINUOUSLY FOR 15 MINUTES. REFER TO MEDICAL PERSONNEL.

SKIN: EXPOSURE TO LIQUID CHLORINE - SKIN BURN LIKELY. IMMEDIATE CONTINUOUS AND THOROUGH WASHING IN FLOWING WATER FOR 15 MINUTES IS INDICATED. REMOVE CLOTHING IMMEDIATELY. DISCARD ALL CONTAMINATED CLOTHING AND ACCESSORIES.

INHALATION: REMOVE TO FRESH AIR IF EFFECTS OCCUR. IF RESPIRATION STOPS GIVE MOUTH TO MOUTH RESUSCITATION. ADMINISTER OXYGEN IF AVAILABLE. CALL PHYSICIAN AND/OR TRANSPORT TO MEDICAL FACILITY.

(CONTINUED ON PAGE 3)

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DO 005242

EFFECTIVE DATE: 09 SEP 81
PRODUCT (CONT'D): CHLORINE, LIQUID

PRODUCT CODE: 16295
MSD: 1122

SECTION 6 FIRST AID--NOTE TO PHYSICIAN (CONTINUED)

INGESTION: NOT A PROBLEM AS CHLORINE IS A GAS AT ROOM TEMPERATURE.

NOTE TO PHYSICIAN:

EYES: LIQUID VERY CORROSIVE. MAY CAUSE CORNEAL INJURY OR BURN.
STAIN FOR EVIDENCE OF CORNEAL INJURY. IF CORNEA IS INJURED,
INSTILL ANTIBIOTIC STEROID PREPARATION FREQUENTLY. CONSULT
OPHTHALMOLOGIST. GAS - INJURY IS UNLIKELY.

SKIN: LIQUID VERY CORROSIVE. MAY CAUSE BURN. IF BURN IS PRESENT,
TREAT AS ANY THERMAL BURN.

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ADMINISTER OXYGEN IF AVAILABLE. BRONCHODILATORS, EXPECTORANTS,
AND ANTITUSSIVES MAY BE OF HELP. MECHANICAL SUPPORT OF RESPIR-
ATION MAY BE NEEDED.

SYSTEMIC: HIGHLY TOXIC. CONSULT STANDARD LITERATURE. TREATMENT BASED
ON SOUND JUDGMENT OF PHYSICIAN AND THE INDIVIDUAL REACTIONS OF
THE PATIENT.

SECTION 7 SPECIAL HANDLING INFORMATION

VENTILATION: RECOMMEND CONTROL OF VAPORS TO SUGGESTED GUIDE.

RESPIRATORY PROTECTION: APPROVED ACID GAS-TYPE RESPIRATOR REQUIRED
IN ABSENCE OF PROPER ENVIRONMENTAL CONTROL. FOR ENTRY INTO
EMERGENCY AREAS, USE ONLY A POSITIVE PRESSURE BREATHING APPARATUS. FOR
ESCAPE FROM EMERGENCY AREA USE AN APPROVED ESCAPE-TYPE MASK.

PROTECTIVE CLOTHING: RUBBER GLOVES, APRON AND BOOTS AND FULL FACE
SHIELD OVER EYE PROTECTION.

EYE PROTECTION: GAS TIGHT GOGGLES OR EQUIVALENT. SUGGEST SEVERAL EYE
FOUNTAINS AND SAFETY SHOWERS READILY AVAILABLE, SO AT LEAST ONE IS
AVAILABLE IN AN EMERGENCY.

SECTION 8 SPECIAL PRECAUTIONS AND ADDITIONAL INFORMATION

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MADE TO HANDLE OR STORE CHLORINE WITHOUT A COMPLETE REVIEW OF THE
CHLORINE MANUAL, AVAILABLE FROM THE CHLORINE INSTITUTE, INC.,
NEW YORK.

ADDITIONAL INFORMATION: 09 SEP 81 REVISED FROM 23 OCT 79 --
INGREDIENT SECTION AND SECTIONS 1,6,7. CONSOLIDATED MSDS 105,
809, 810, AND 1123.

(CONTINUED ON PAGE 4)

(R) INDICATES A TRADEMARK OF THE DOW CHEMICAL COMPANY

CONFIDENTIAL

DO 005243

M A T E R I A L S A F E T Y D A T A S H E E T P A G E : 4
DOW CHEMICAL U.S.A. MIDLAND MICHIGAN 48640 EMERGENCY PHONE: 517-636-4400

(EFFECTIVE DATE: 09 SEP 91
PRODUCT (CONT'D): CHLORINE, LIQUID

PRODUCT CODE: 15295
MSD: 1122

LAST PAGE

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CONSULT THE DOW CHEMICAL COMPANY FOR FURTHER INFORMATION.

THE INFORMATION HEREIN IS GIVEN IN GOOD FAITH, BUT NO WARRANTY,
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(
CONFIDENTIAL

DO 005244

CHEMICAL SAFETY CHECKSHEET

To Be Completed By Any Users For All Chemicals

CHEMICAL CPE - 3615 MELTING POINT 130° c
 EXPOSURE (ppm) _____ VAPOR PRESSURE N/A
 BOILING POINT N/A CORROSIVENESS Low
 EXPLOSIVE LIMITS N/A CHEMICAL REACTIVITY HIGH - (LOW)
 FLASH POINT N/A STABILITY (To pH CHANGE, HEAT, LIGHT) GOOD

IGNITION TEMP. _____

USING SAFETY CONTAINER N/A

TOXIC PROPERTIES CPE IS AN INERT MATERIAL - NON TOXIC

PROTECTIVE EQUIPMENT TO BE USED:

MONOGOGGLES _____ FUME HOOD _____

FACE SHIELD _____ SPECIAL PRECAUTIONS _____

GAS MASK _____

SLICKER SUIT _____

RUBBER BOOTS _____

RUBBER GLOVES _____

OTHER JUST SAFETY GLASSES

CONFIDENTIAL

HAVE YOU READ THE TOXICOLOGY SHEET ON _____ IS THE CHEMICAL OR MIXTURE:

DO 005245

THIS CHEMICAL? ☒ YES ☐ NO

SUBJECT TO TSCA? ☒ YES ☐ NO

GROUP LEADER Dave Alsopord

ON TSCA INVENTORY? ☒ YES ☐ NO [64754-90-1]

USERS SIGNATURE DATE
Thomas R. Butt 11/17/85
Michael H. Williams 12/11/84

PLEASE CONFIRM WITH SUPPLIER _____

Barbara L. Watson 12-11-84

USED FOR R&D ONLY? YES ☒ NO

John H. Hays 12/26/84

IN COMPLIANCE WITH ALL TSCA RULES & ORDERS YES ☐ NO

John Hays 1/5/85

Michael Williams 1/8/85

D. Williams 1/24/85

M A T E R I A L S A F E T Y D A T A S H E E T P A G E : 1
DOW CHEMICAL U.S.A. MIDLAND MICHIGAN 48640 EMERGENCY PHONE: 517-636-4400
EFFECTIVE DATE: 19 JUN 79 PRODUCT CODE: 13652
PRODUCT NAME: CPE 3615 MSD: 1038

INGREDIENTS (TYPICAL VALUES-NOT SPECIFICATIONS) : X :

HD POLYETHYLENE, CHLORINATED : :
CHLORINE CONTENT OF POLYMER : 36 :
CRYSTALLINITY : <2 :

SECTION 1

PHYSICAL DATA

BOILING POINT: ---- : SOL. IN WATER: NIL
VAP PRESS: ---- : SP. GRAVITY: 1.17
VAP DENSITY (AIR=1): ---- : % VOLATILE BY VOL: 0.2
APPEARANCE AND ODOR: COLOR - OFF WHITE. PHYSICAL STATE - CRUMBS.
ODOR - NONE.

SECTION 2

FIRE AND EXPLOSION HAZARD DATA

FLASH POINT: ---- : FLAMMABLE LIMITS (STP IN AIR)
METHOD USED: NOT APPLICABLE : LFL: NOT APPLIC. UFL: NOT APPLIC.
EXTINGUISHING MEDIA: WATER FOG, FOAM, ALCOHOL FOAM, CO2, DRY CHEMICAL.
SPECIAL FIRE FIGHTING EQUIPMENT AND HAZARDS: SELF-CONTAINED BREATHING
APPARATUS.

SECTION 3

REACTIVITY DATA

STABILITY: AVOID HIGH TEMPERATURES - HCL GAS
EVOLVED.
INCOMPATIBILITY: ----
HAZARDOUS DECOMPOSITION PRODUCTS: HCL GAS.
HAZARDOUS POLYMERIZATION: WILL NOT OCCUR.

SECTION 4

SPILL, LEAK, AND DISPOSAL PROCEDURES

ACTION TO TAKE FOR SPILLS (USE APPROPRIATE SAFETY EQUIPMENT): SWEEP
UP AND DISCARD.
DISPOSAL METHOD: BURN IN ADEQUATE INCINERATOR OR BURY IN LANDFILL.

SECTION 5

HEALTH HAZARD DATA

INGESTION: VERY LOW IN SINGLE DOSE ORAL TOXICITY. NO LD50 VALUE
AVAILABLE.

(CONTINUED ON PAGE 2)

(R) INDICATES A REGISTERED OR TRADEMARK NAME OF THE DOW CHEMICAL COMPANY

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DO 005246

EFFECTIVE DATE: 19 JUN 79
PRODUCT (CONT'D): CPE 3615

PRODUCT CODE: 13652
MSD: 1038

SECTION 5

HEALTH HAZARD DATA (CONTINUED)

EYE CONTACT: MINOR IRRITATION ONLY.
SKIN CONTACT: MINOR IRRITATION ONLY.
SKIN ABSORPTION: NOT LIKELY TO BE ABSORBED IN ACUTELY TOXIC AMOUNTS.
INHALATION: NO GUIDE FOR CONTROL KNOWN. NO PROBLEM LIKELY.
EFFECTS OF OVEREXPOSURE: ----

SECTION 6

FIRST AID--NOTE TO PHYSICIAN

FIRST AID PROCEDURES:

EYES: IRRIGATION OF THE EYE IMMEDIATELY WITH WATER FOR FIVE MINUTES
IS GOOD SAFETY PRACTICE.
SKIN: WASH OFF IN FLOWING WATER.
INHALATION: REMOVE TO FRESH AIR IF EFFECTS OCCUR. CONSULT MEDICAL
PERSONNEL.
INGESTION: LOW IN TOXICITY. INDUCE VOMITING IF LARGE AMOUNTS ARE
INGESTED.

NOTE TO PHYSICIAN:

EYES: MAY CAUSE MILD IRRITATION. STAIN FOR EVIDENCE OF CORNEAL
INJURY.
SKIN: MAY CAUSE MILD IRRITATION WITH REPEATED CONTACT. TREAT AS
ANY CONTACT DERMATITIS.
RESPIRATORY: NO EFFECT EXPECTED
ORAL: LOW IN TOXICITY.
GENERAL: HUMAN EFFECTS NOT ESTABLISHED. NO SPECIFIC ANTIDOTE.
TREATMENT BASED ON THE SOUND JUDGMENT OF THE PHYSICIAN
AND THE INDIVIDUAL REACTIONS OF THE PATIENT.

SECTION 7

SPECIAL HANDLING INFORMATION

VENTILATION: GOOD ROOM VENTILATION USUALLY ADEQUATE FOR MOST OPERATIONS.
RESPIRATORY PROTECTION: NONE NORMALLY NEEDED. IF REQUIRED USE AN
APPROVED DUST RESPIRATOR.
PROTECTIVE CLOTHING: NONE REQUIRED.
EYE PROTECTION: NOT NORMALLY NECESSARY.

SECTION 8 SPECIAL PRECAUTIONS AND ADDITIONAL INFORMATION

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: PRACTICE REASONABLE
CARE AND CAUTION.

(CONTINUED ON PAGE 3)

(R) INDICATES A REGISTERED OR TRADEMARK NAME OF THE DOW CHEMICAL COMPANY

CONFIDENTIAL

DO 005247

M A T E R I A L S A F E T Y D A T A S H E E T P A G E : 3
DOW CHEMICAL U.S.A. MIDLAND MICHIGAN 48640 EMERGENCY PHONE: 517-636-4400

EFFECTIVE DATE: 19 JUN 79
PRODUCT (CONT'D): CPE 3615

PRODUCT CODE: 13652
MSD: 1038

SECTION 8 SPECIAL PRECAUTIONS AND ADDITIONAL INFORMATION (CONTINUED)

ADDITIONAL INFORMATION: REVISIONS 6/19/79 -- SPECIAL FIRE FIGHTING
EQUIPMENT AND HAZARDS.

LAST PAGE

(R) INDICATES A REGISTERED OR TRADEMARK NAME OF THE DOW CHEMICAL COMPANY

THE INFORMATION HEREIN IS GIVEN IN GOOD FAITH, BUT NO WARRANTY,
EXPRESSED OR IMPLIED, IS MADE.

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DO 005248

CHEMICAL SAFETY CHECKSHEET

To Be Completed By Any Users For All Chemicals

CHEMICAL HCl aqueous 7% w/w MELTING POINT _____
 EXPOSURE (ppm) _____ VAPOR PRESSURE _____
 BOILING POINT _____ CORROSIVENESS HIGH
 EXPLOSIVE LIMITS NONE CHEMICAL REACTIVITY HIGH - LOW
 FLASH POINT NONE STABILITY (To pH CHANGE, HEAT, LIGHT) GOOD
 IGNITION TEMP. N/A
 USING SAFETY CONTAINER N/A
 TOXIC PROPERTIES AVOID SKIN/EYE CONTACT

PROTECTIVE EQUIPMENT TO BE USED:

MONOGOGGLES X FUME HOOD _____
 FACE SHIELD _____ SPECIAL PRECAUTIONS _____
 GAS MASK _____
 SLICKER SUIT _____
 RUBBER BOOTS _____
 RUBBER GLOVES X
 OTHER _____

HAVE YOU READ THE TOXICOLOGY SHEET ON IS THE CHEMICAL OR MIXTURE:

THIS CHEMICAL? YES NO SUBJECT TO TSCA? YES NO
 GROUP LEADER Dave Alsgaard ON TSCA INVENTORY? YES NO [7647-01-0]

USERS SIGNATURE DATE PLEASE CONFIRM WITH SUPPLIER _____

Michael H. Williams 12/11/84
Barbara J. Waters 12-11-84
James D. Lipson 12/26/84
John P. ... 1/2/85
PC Delacourte 1/8/85

USED FOR R&D ONLY? YES NO

IN COMPLIANCE WITH ALL TSCA RULES & ORDERS YES NO

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DO 005249

David ... 1/22/85

CHEMICAL SAFETY CHECKSHEET

To Be Completed By Any Users For All Chemicals

CHEMICAL POLYETHYLENE - HDPE MELTING POINT 125-130°C
EXPLOSURE (ppm) NONE VAPOR PRESSURE N/A
BOILING POINT N/A CORROSIVENESS LOW
EXPLOSIVE LIMITS N/A CHEMICAL REACTIVITY HIGH - (LOW)
FLASH POINT N/A STABILITY (To pH CHANGE, HEAT, LIGHT) GOOD
IGNITION TEMP. 300°C
USING SAFETY CONTAINER N/A
TOXIC PROPERTIES N/A

PROTECTIVE EQUIPMENT TO BE USED:

MONOGOGGLES _____ FUME HOOD _____
FACE SHIELD _____ SPECIAL PRECAUTIONS AIRBORNE DUST
GAS MASK _____ MAY PRESENT AN EXPLOSION
SLICKER SUIT _____ HAZARD.
RUBBER BOOTS _____
RUBBER GLOVES _____
OTHER DUST MASK, SAFETY GLASSES

HAVE YOU READ THE TOXICOLOGY SHEET ON _____ IS THE CHEMICAL OR MIXTURE:

THIS CHEMICAL? ☒ YES ☐ NOSUBJECT TO TSCA? ☒ YES ☐ NOGROUP LEADER Dave AbgaardON TSCA INVENTORY? ☒ YES ☐ NO [9002-88-4]

USERS SIGNATURE _____ DATE _____

PLEASE CONFIRM WITH SUPPLIER _____

Michael Hildbrand 12/11/84USED FOR R&D ONLY? YES ☒ NOBarbara L. Watson 12-11-84IN COMPLIANCE WITH ALL TSCA RULES & ORDERS YES ☐ NO ☐ CONFIDENTIALJavier Flynn 12/26/84Jim Allen 1/7/85CC DeSantis 1/8/85DM Lerner 1/22/85
1 0 . . 1 . . . ✓

DO 005250

CHEMICAL SAFETY CHECKSHEET

To Be Completed By Any Users For All Chemicals

CHEMICAL T-DET N-9.5 MELTING POINT _____
 EXPOSURE (ppm) _____ VAPOR PRESSURE _____
 BOILING POINT _____ CORROSIVENESS _____
 EXPLOSIVE LIMITS _____ CHEMICAL REACTIVITY HIGH - LOW
 FLASH POINT 7500 STABILITY (To pH CHANGE, HEAT, LIGHT) _____
 IGNITION TEMP. _____
 USING SAFETY CONTAINER _____
 TOXIC PROPERTIES _____

PROTECTIVE EQUIPMENT TO BE USED:

MONOGOGGLES X FUME HOOD _____
 FACE SHIELD _____ SPECIAL PRECAUTIONS _____
 GAS MASK _____
 SLICKER SUIT _____
 RUBBER BOOTS _____
 RUBBER GLOVES X _____
 OTHER _____

CONFIDENTIAL

HAVE YOU READ THE TOXICOLOGY SHEET ON IS THE CHEMICAL OR MIXTURE:

DO 005251

THIS CHEMICAL? YES NO SUBJECT TO TSCA? YES NO

GROUP LEADER _____ ON TSCA INVENTORY? YES NO

USERS SIGNATURE DATE PLEASE CONFIRM WITH SUPPLIER _____

Nickolas H. Williams 12/14/84
Bethune L. Watson 12-11-84
James H. Hines 12/26/84
Jim Allen 1/2/85
DC DeSantis 1/8/85

USED FOR R&D ONLY? YES ☒ NO

IN COMPLIANCE WITH ALL TSCA RULES & ORDERS YES NO

Donna M. 1/2/85
1 1

CHEMICAL SAFETY CHECKSHEET

To Be Completed By Any Users For All Chemicals

CHEMICAL TETRAHYDROFURAN - THF MELTING POINT -108.5°C
 TLV EXPOSURE (ppm) 200 VAPOR PRESSURE 114 mm at 15°C
 BOILING POINT 65.4°C CORROSIVENESS LOW
 EXPLOSIVE LIMITS LEL 1.8%, UEL 11.8% CHEMICAL REACTIVITY HIGH - LOW MODERATE
 FLASH POINT 1.4°F STABILITY (To pH CHANGE, HEAT, LIGHT)

IGNITION TEMP. 610°F

USING SAFETY CONTAINER USE METAL SAFETY CAN

TOXIC PROPERTIES AVOID INHALING VAPORS, AVOID SKIN CONTACT W/ LIQUID

PROTECTIVE EQUIPMENT TO BE USED:

MONOGOGGLES X FLAME HOOD X
 FACE SHIELD --- SPECIAL PRECAUTIONS MAY FORM
 GAS MASK --- THERMALLY EXPLOSIVE PEROXIDES
 SLICKER SUIT --- AFTER PROLONGED CONTACT WITH
 RUBBER BOOTS --- AIR. REACTS VIOLENTLY WITH
 RUBBER GLOVES X KOH, NaOH.

OTHER ---

CONFIDENTIAL

DO 005252

HAVE YOU READ THE TOXICOLOGY SHEET ON IS THE CHEMICAL OR MIXTURE:

THIS CHEMICAL? (YES) NO

SUBJECT TO TSCA? (YES) NO

GROUP LEADER Dave Alsgaard

ON TSCA INVENTORY? (YES) NO [109-99-9]

USERS SIGNATURE DATE

PLEASE CONFIRM WITH SUPPLIER ---

Barbara L. Watson 12-11-84

USED FOR R&D ONLY? YES (NO)

Michael Williams 12/1/84

IN COMPLIANCE WITH ALL TSCA RULES & ORDERS YES NO

J. Lynn Slyn 12/26/84

J. B. B. 1/3/85

D. DeGard 1/8/85

L. M. M. 1/22/85

CHEMICAL SAFETY CHECKSHEET

To Be Completed By Any Users For All Chemicals

CHEMICAL Polyvinylpyrrolidone (PVP) MELTING POINT _____
 EXPOSURE (ppm) None - Non-toxic VAPOR PRESSURE _____
 BOILING POINT — CORROSIVENESS very low
 EXPLOSIVE LIMITS _____ CHEMICAL REACTIVITY HIGH - LOW
 FLASH POINT — STABILITY (To pH CHANGE, HEAT, LIGHT) Good

IGNITION TEMP. _____
 USING SAFETY CONTAINER N/R
 TOXIC PROPERTIES None

PROTECTIVE EQUIPMENT TO BE USED:

MONOGOGGLES ✓ FUME HOOD _____
 FACE SHIELD _____ SPECIAL PRECAUTIONS _____
 GAS MASK _____
 SLICKER SUIT _____
 RUBBER BOOTS _____
 RUBBER GLOVES _____
 OTHER _____

HAVE YOU READ THE TOXICOLOGY SHEET ON IS THE CHEMICAL OR MIXTURE:

THIS CHEMICAL? YES NO SUBJECT TO TSCA? YES NO
 GROUP LEADER Jim Akers ON TSCA INVENTORY? YES NO

USERS SIGNATURE [Signature] DATE 7/12/85
 PLEASE CONFIRM WITH SUPPLIER _____
 USED FOR R&D ONLY? YES NO
 IN COMPLIANCE WITH ALL TSCA RULES & ORDERS YES NO

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 DO 005253

APPENDIX B

POLYETHYLENE DUST EXPLOSION DATA

JBA: 7/85
OH19

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DO 005254



Linear Polyethylene and Derivatives
TECHNOLOGY CENTER

December 18, 1980

Building 807
Plaquemine, Louisiana 70764
504 389-8564 or 504 389-8231

D. Andrews - Sarnia
C. W. Brannan - Plaquemine
K. Burmeister - Tesserlo
D. G. Flood - Sarnia
G. C. Kools - Plaquemine
A. J. Seidule - Plaquemine
B. G. Shamburger - Plaquemine

DUST EXPLOSIONS SUMMARY

Over the past fifteen years, extensive data has been generated on the explosive tendency of high density polyethylene powder. This data has been generated both internally from the Dow slurry process and externally for polyethylene dust. Additional data has been obtained correlating the effects of hexane in the parts per million range and the effect of particle size on the explosive tendencies of the "dust". This information is included in the attached report.

Some of the data previously generated is included in Appendix I. The data compares several variables in the process and analytical techniques in the development of explosive tendencies of polyethylene dust. During the last few years, the use of a Dust Material Constant, Kst, originally developed by Donat and Bartnecht (units of Kst are Bars-meters/sec) has been used to calculate the area required for explosion vents. The calculated values of this constant Kst is given with much of the data. It is important to remember that the presence of low concentrations (0-1000 ppm) hexane will greatly influence the rate of pressure rise in a polyethylene "dust" explosion and must be considered in the sizing of the explosion vents.

Variables reviewed in the data in the appendix include:

A. Effect of Test Apparatus Size and Geometry on the Dust Explosion Tendencies

<u>Container Geometry</u>	<u>Volume of Container-l</u>	<u>Maximum Rate of Pressure psi/sec</u>
Cylinder-Hartmann	1.2	1290
Sphere	1.2	1841
Sphere	20	1610
Sphere	1000	972

The U.S. Bureau of Mines has used the Hartmann test apparatus with a strong ignition source - a wire at 1700°F with an energy input of 0.125 to 0.4 joules.

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DO 005255

RDA - do you have a
copy of method used
to calculate vent size

File Dust Explosion
General HOPE

December 12, 1980

B. Effect of Air/Dust Mixture Temperature

<u>Temperature of Dust/Air</u>	<u>Rate of Pressure Rise, psi/sec</u>	<u>Maximum Pressure, psi</u>
Ambient 20°C	1610	84.1
90°C	2074	53.2

C. Effect of Hexane Content vs. Minimum Ignition Energy

<u>Hexane Content, ppm</u>	<u>Ignition Energy, joules</u>
0	0.101
2500	0.096
5000	0.080
12000	0.080

The effect of hexane content on the rate of pressure rise and the effect of particle size are discussed in the attached report.

Please review this data as it applies to our current operations.

Bob

Robert D. Armstrong
Linear Polyethylene and Derivatives
Technology Center - Slurry Process
Building 807
Plaquemine, Louisiana

Attachments

1tb

DO 005256

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COMPARISON OF DUST EXPLOSION DATA

	CONCENTRATION AT MAXIMUM EXPLOSION COND.	MINIMUM IGNITION ENERGY/joules	MAXIMUM PRESSURE PSI	MAXIMUM RATE OF PRESSURE	KST (Bars) M/Sec	TEST
Skimmer Tank Powder from	oz/ft ³					
T ssenderlo - regular plant						
catalyst						
	0.5		68.2	1290	24	Hartmann
	1.0		69.2	1841	34	1.2 L SPHERE - ROOM TEMPERATURE
	2.0		53.2	2074	39	20 L SPHERE - 90°C
essenderlo Powder			84.1	1610	30	20 L SPHERE e TERNEUZEN
			108.8	972	67	1000 L Sphere Westfalische Berggewerk- SchaftsKasse
Plaquemine						
CPE LP 51.1	0.33	0.045	69	2044	15	Hartmann
Start-up Powder 2/77						
B.D. = 12-14 $\frac{1}{ft^3}$	0.40	0.045	58	2633	19	Hartmann
Start-up Powder with 300 ppm	0.40	0.020	64	4428	32	Hartmann
Irganox 1010 and Weston 618						
69065 B.D. = 18	0.67	0.061	60	1733	13	Hartmann
Avg. particle size = 62 micron						
69065 with 2000 ppm CaSt	0.27	0.061	59	2750	20	Hartmann
B.D. = 21 Avg. part.						
siz = 60 microns						

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DO 005257

END

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DO 005258

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[illegible]

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~~DOW CONFIDENTIAL~~

DUST EXPLOSION POTENTIAL OF HDPE POWDERS
LINEAR POLYETHYLENE TECHNOLOGY CENTER REPORT

Following an explosion in the powder drying system of Train III, Plaquemine, March 28, 1980; tests were run to

1. Evaluation of the effect of hexane on the explosive tendencies of HDPE powder.
2. Effect of powder particle size on the explosive tendencies.
3. Explosive characteristics of powder made with Type II B alkoxide catalyst.

All tests were made using the Standard Hartmann testing unit by the Instrument Methods Group in Midland.

Discussion of Results

A. Effect of Hexane on the Explosive Characteristics

Samples of Type I Alkoxide powder produced on Train IV, April 8, 1980 were used in these tests. The particle size distribution of the powder was broad ranging from 10 microns to 600 microns with a volume median diameter of 148 microns. Particle size distribution is included in Appendix II. The hexane concentration in the air was varied using 0, 100, 500, and 1000 ppm in the tests. Data from these tests are given in Table I and Figure 1.

Based upon this data the conclusions are:

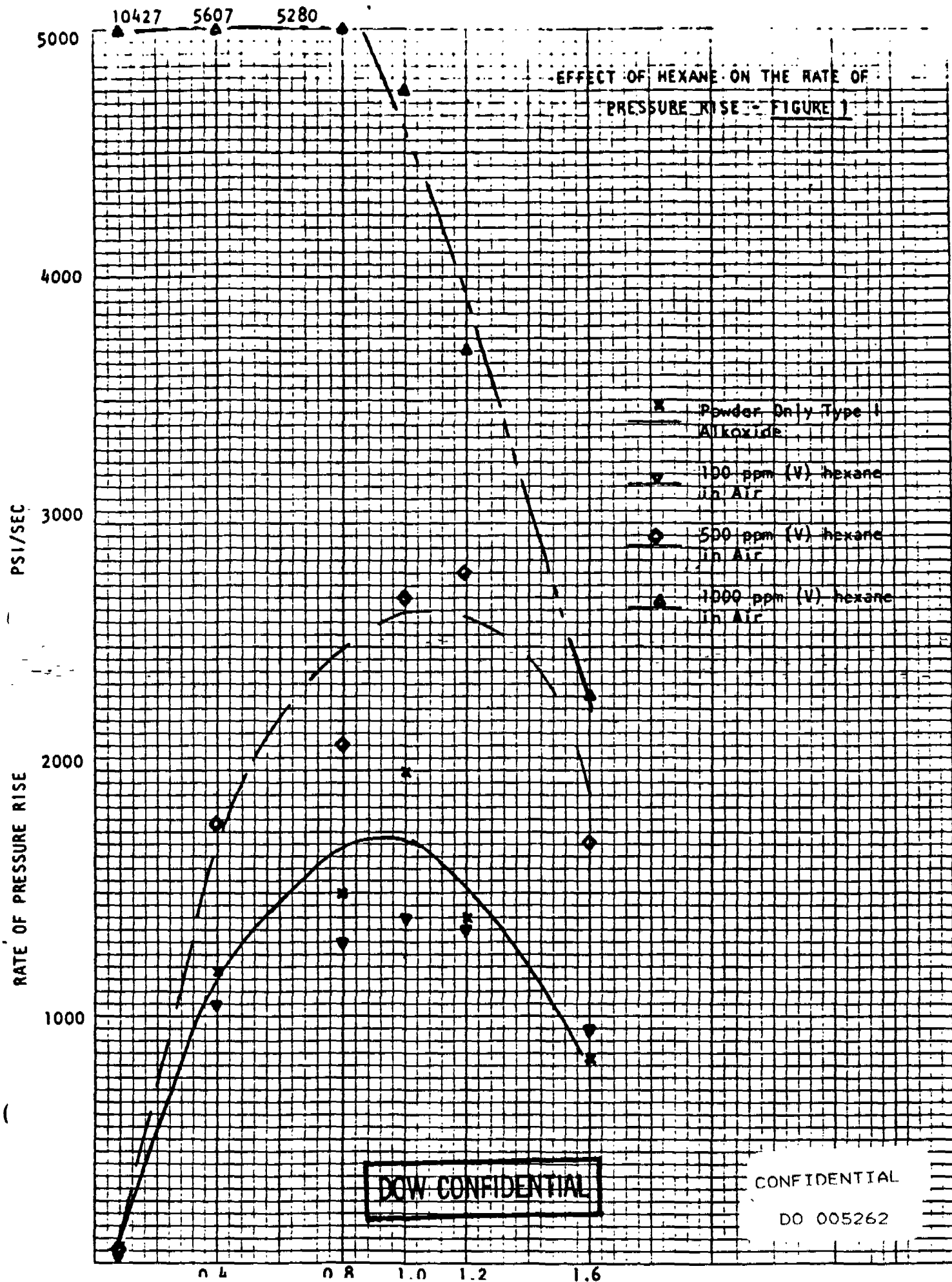
1. The addition of hexane over the range studied does not change the explosive limits of the powder which varies between 0.08 and 2.40 oz/ft³.
2. The higher hexane content in the powder will increase the rate of pressure rise especially at the lower powder concentration - 0.08 to 1.0 oz/ft³. Therefore a relief system must function faster when hexane is present. This will linearly effect the Kst used for sizing explosion vents.
3. The maximum pressure released from an explosion is not effected by the presence of hexane at the concentrations studied. The amount of fuel present remains approximately constant.
4. The reduction of explosion intensity by the higher levels of hexane at loading of 2.4 oz/ft³ cannot be explained but is reproducible.
5. These tests also showed that using this procedure a gas mixture containing 1000 ppm will burn if a hot source of ignition is available. The flame from this ignition will not propagate through the vessel nor will it continue to burn when the heat source is removed. (Explosive limits of hydrocarbon are defined as the range over which a flame will propagate).

This data was reviewed with Reid Tait - 438 Bldg. - Midland. He indicated this was common for hydrocarbon mixtures to ignite well below the Lower Explosive Limit in a Hartman test instrument when a high energy source is used. He also emphasized there would not be ignition of the mixture when a spark was used as the source of the ignition. Similar data for hydrogen and ethylene were requested.

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DO 005261

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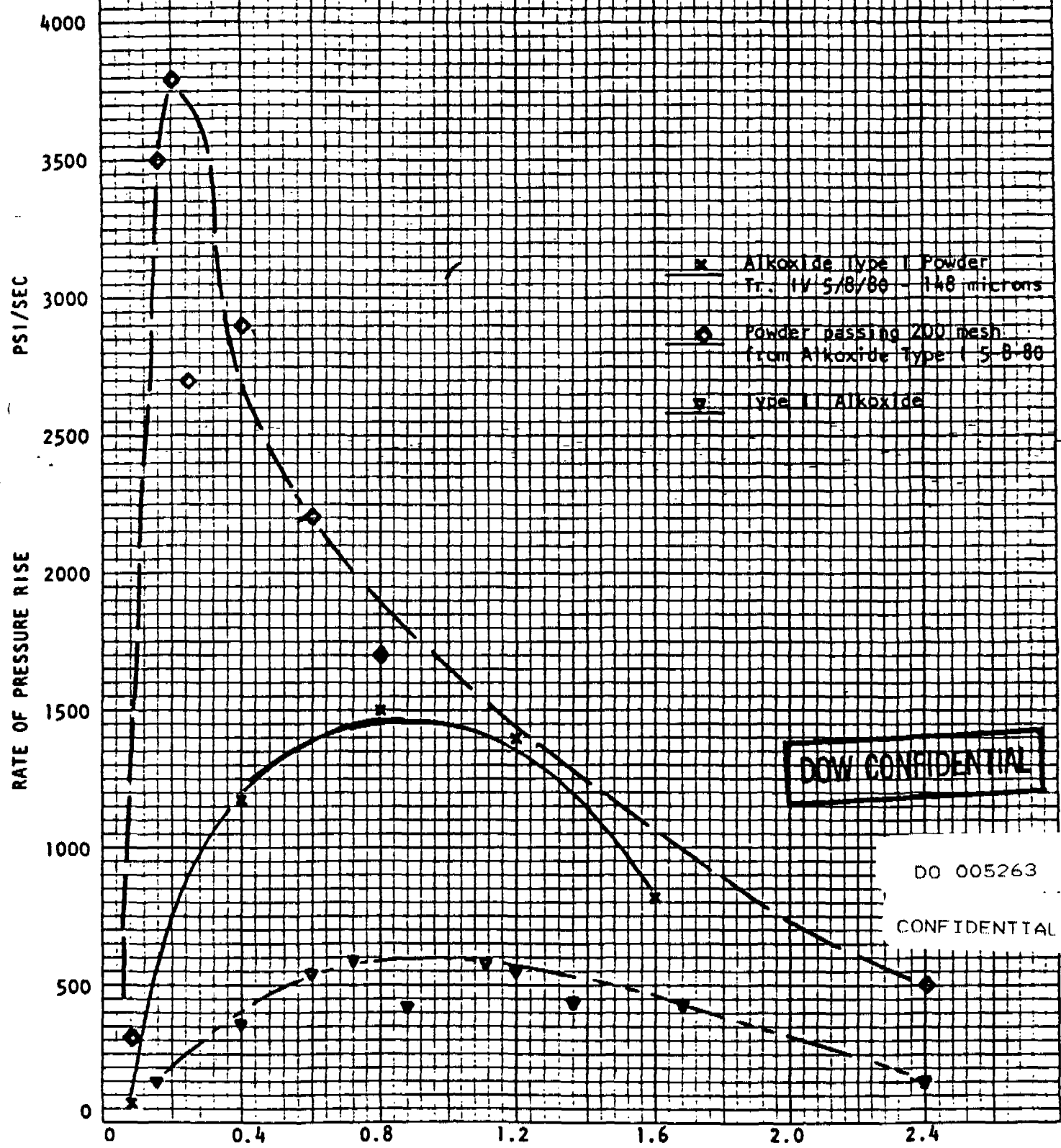


EFFECT OF POWDER PARTICLE SIZE

ON RATE OF PRESSURE RISE

ALKOXIDE TYPE I POWDER

FIGURE 2



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DO 005263

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B. Effect of Particle Size

Powder made with Alkoxide Type I catalyst used in the tests determining the effect of hexane was screened with the material passing a 200 mesh screen tested to determine the particle size on the explosive tendencies.

As expected, the finer particle size increases the rate of pressure rise to double or triple the previous values but again does not effect the maximum pressure. Data is given in Table I and II and shown in Figure B.

C. Type II Alkoxide Powder

Powder made with Type II B Alkoxide from the pilot plant April 2, 1980 was used in this test. Again the particle size distribution was broad ranging from 10 microns to 430 microns and the volume median diameter was 163 microns.

As expected, because of the larger particle size, the pressure rise was 1/3 to 1/2 of rate of rise of alkoxide Type I powder. Data is given in Table III.

RDA/ltb
12-18-80

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DO 005264

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DUST EXPLOSION DATA EFFECT OF HEXANE

DO 005265

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TABLE II

[illegible]

HIRC ANALYSIS

SAMPLE: RCM 11250 PE

DATE:

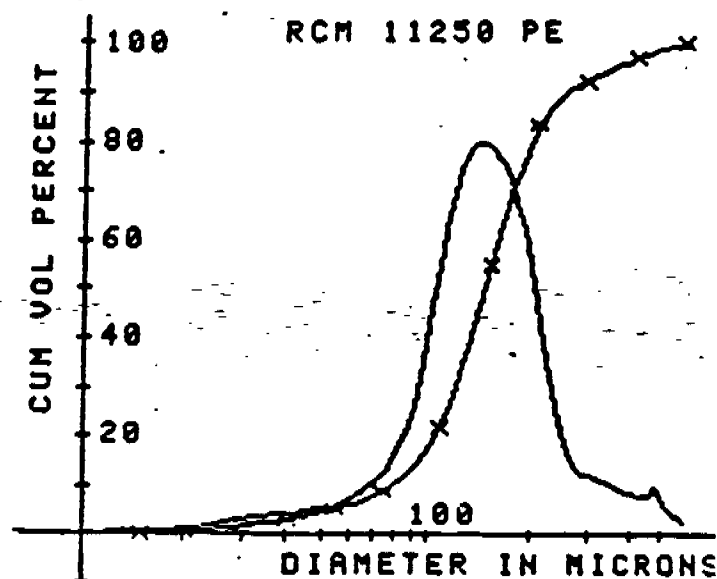
DATA SET # 1

CHANNEL	COUNTS
1	34834
2	21349
3	16120
4	9442
5	6262
6	4433
7	3256
8	1767
9	470
10	57
11	11
12	2

AVERAGE DIAMETER	(microns)
NUMBER=	31.7
AREA=	121.1
VOLUME=	168.2
MEDIAN=	147.8

DIA RANGE		VOLUME %
(microns)		
min - max		
10.0	15.0	0.3
15.0	20.0	0.3
20.0	30.0	1.1
30.0	40.0	1.5
40.0	55.0	2.1
55.0	75.0	3.5
75.0	110.0	12.9
110.0	155.0	33.1
155.0	215.0	28.7
215.0	300.0	8.6
300.0	430.0	4.8
430.0	600.0	3.0

TOTAL PARTICLE VOLUME=4.78E-003
PRESSURE FACTOR= 2.06E+004



DO 005268

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HIAC ANALYSIS

SAMPLE: RCM 11251 PE

DATE:

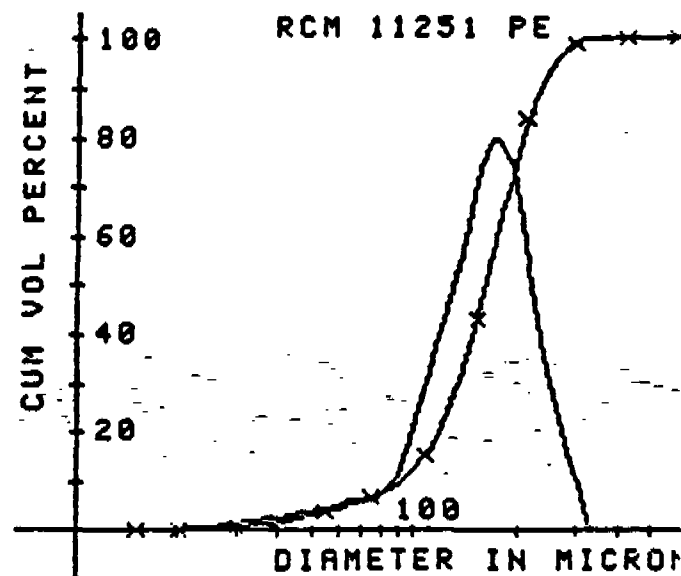
DATA SET # 2

CHANNEL	COUNTS
1	42060
2	31408
3	26425
4	17893
5	12638
6	8782
7	6375
8	4116
9	1575
10	192
11	4
12	0

AVERAGE DIAMETER	(microns)
NUMBER=	43.0
AREA=	135.0
VOLUME=	165.9
MEDIAN=	163.4

DIA RANGE (microns)		VOLUME %
min	max	
10.0	15.0	0.1
15.0	20.0	0.1
20.0	30.0	0.6
30.0	40.0	1.1
40.0	55.0	1.9
55.0	75.0	3.1
75.0	110.0	8.4
110.0	155.0	27.7
155.0	215.0	41.0
215.0	300.0	15.0
300.0	430.0	0.9
430.0	600.0	0.0

TOTAL PARTICLE VOLUME=1.12E+002
 PRESSURE FACTOR= 1.44E+004



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DO 005269

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APPENDIX C

T-DET STABILITY DTA

JBA: 7/85
OH20

DO 005270

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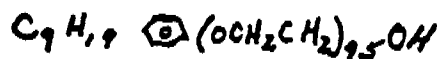


DOW CONFIDENTIAL
REACTIVE CHEMICAL HAZARD DATA
PROPERTIES AND PRECAUTIONS

RC61079

12-28-78

T-det 9.5



liquid

THERMOCHEMICAL INFORMATION

HEAT OF FORMATION FROM THE ELEMENTS
HEAT OF SELF DECOMPOSITION IN OXYGEN
HEAT OF SELF DECOMPOSITION

FLAME TEMPERATURE	DECOMPOSITION TEMP
°C	°C
REPORT NUMBER	

LABORATORY SCREENING TESTS

WARNING: Data shown on laboratory test reports are for information only and are not intended for use in extending to different environments.

DIFFERENTIAL THERMAL ANALYSIS

NAME OF TEMP. INCREASE	PC MIN.	PC MAX.
20	400	

DROP-WEIGHT SHOCK SENSITIVITY

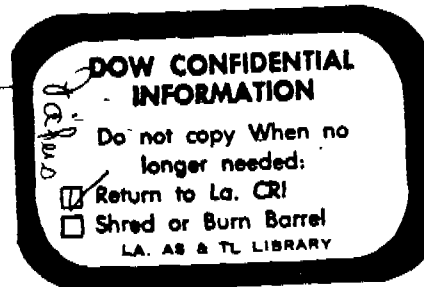
TEST METHOD	TEST TEMP.	HEIGHT	WEIGHT	NUMBER OF TESTS
PC	PC	CM	KG	POSITIVE NEGATIVE

none

COMMENTS

No thermal activity indicated at 0.5 sensitivity

COMMENTS



TEST RUN BY	TEST DATE	TEST REFERENCE
F. Tims	12-27-78	

FLAMMABILITY PROPERTIES
(in air at ambient pressure unless otherwise noted)

FLASH POINT	°C	°F

TEST RUN BY	TEST DATE	TEST REFERENCE
-------------	-----------	----------------

AUTOIGNITION TEMPERATURE

TEST RUN BY	TEST DATE	TEST REFERENCE
-------------	-----------	----------------

FLAMMABLE LIMITS

LIMITS - VOL. %		PRESSURE	TEMP.	IGNITION
LOWER	UPPER	PSIA or mmHg	°C	SOURCE

TEST RUN BY	TEST DATE	TEST REFERENCE
-------------	-----------	----------------

COMMENTS AND SPECIAL PRECAUTIONS

CONSIDER

ENERGY POTENTIAL
TEMPERATURE
PRESSURE
SELF-REACTION
POLYMERIZATION
MOISTURE
LIGHT SENSITIVITY
PEROXIDES
AGING
FREEZE-THAW
ACIDS
BASES
OXIDIZERS
REDUCERS
INHIBITORS
CATALYSTS
IMPURITIES
CONTAINERS
PACKAGING
STATIC GENERATION
DUST EXPLOSION

DO 005271

NAME OF ORIGINATOR OR OWNER OF CHEMICAL MATERIAL

T. C. R. R. R.

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4A

1901

8476

APPENDIX D

REACTION DTAs

JBA: 7/85
OH21

DO 005272

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DOW CONFIDENTIAL
REACTIVE CHEMICAL HAZARD DATA
PROPERTIES AND PRECAUTIONS

REFERENCE NUMBER
REL 1082
DATE OF ISSUE
1-8-79
LATEST REVISION DATE

SYNOPSIS NAME AND CHEMICAL NAME OF MATERIAL

T-det 9.5: 50% Sodium Hydroxide 1:1

MOLECULAR FORMULA

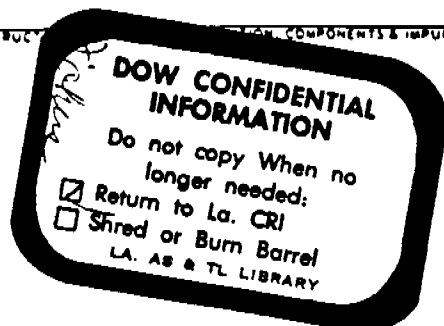
MOLECULAR WEIGHT

PHYSICAL STATE

SAMPLE PURITY

liquid

STRUCTURE AND COMPONENTS & IMPURITIES



Thermochemical Information

HEAT OF FORMATION
FROM THE ELEMENTS
K cal. Gram Mole

HEAT OF SELF DECOM-
POSITION IN OXYGEN
K cal. 100 Grams

HEAT OF SELF
DECOMPOSITION
K cal. 100 Grams

$\Delta H_f =$

$\Delta H_o =$

$\Delta H_d =$

S L G

S L G

S L G

FLAME TEMPERATURE

DECOMPOSITION TEMP.

REPORTED BY

REPORT NUMBER

LABORATORY SCREENING TESTS

WARNING: Data based on laboratory test conditions; use caution in extending to different environments.

DIFFERENTIAL THERMAL ANALYSIS							
RATE OF TEMP. INCREASE				MAXIMUM TEST TEMP.			
20 °C MIN				2.00 °C			
EXO	TYPE	ENDO	START °C	PEAK °C	END °C	SIZE	
none							

DROP-WEIGHT SHOCK SENSITIVITY					NUMBER OF TESTS	
TEST METHOD	TEST TEMP. °C	HEIGHT cm	WEIGHT Kg		POSITIVE	NEGATIVE
Solid - Liquid						

COMMENTS:

No thermal activity indicated at 0.5 sensitivity. Capillary ruptured from pressure in all tests.

COMMENTS (H30, E30):

TEST RUN BY	TEST DATE	TEST REFERENCE
F. Tims	1-5-8-79	

TEST RUN BY	TEST DATE	TEST REFERENCE

FLAMMABILITY PROPERTIES (In air at ambient pressure unless otherwise noted)			
FLASH POINT	°C	°F	METHOD
TEST RUN BY	TEST DATE	TEST REFERENCE	
AUTOIGNITION TEMPERATURE	°C	°F	
TEST RUN BY	TEST DATE	TEST REFERENCE	

COMMENTS AND SPECIAL PRECAUTIONS

• CONSIDER -

ENERGY POTENTIAL
TEMPERATURE
PRESSURE
SELF-REACTION
POLYMERIZATION
MOISTURE
LIGHT SENSITIVITY
PEROXIDES
AGING
FREEZE-THAW
ACIDS
BASES
OXIDIZERS
REDUCERS
INHIBITORS
CATALYSTS
IMPURITIES
CONTAINERS
PACKAGING
STATIC GENERATION
DUST EXPLOSION

FLAMMABLE LIMITS			
LIMITS - VOL. %		PRESSURE	TEMP.
LOWER	UPPER	PSIA or mmHg	°C
TEST RUN BY	TEST DATE	TEST REFERENCE	

NAME OF ORIGINATOR OR OWNER OF CHEMICAL MATERIAL

J. Granier

DIVISION

LA

CONFIDENTIAL

BUILDING

1901

PHONE

B470

DO 005273



LOW CONFIDENTIAL
REACTIVE CHEMICAL HAZARD DATA
PROPERTIES AND PRECAUTIONS

RECEIVED
RCL 1970
1-12-79

Mistron Vapor Talc: Chlorine

MOLECULAR FORMULA: MOLECULAR WEIGHT: PHYSICAL STATE: SAMPLE PURITY:

Solid-liquid

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INFORMATION

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THERMOCHEMICAL INFORMATION

HEAT OF FORMATION
FROM THE ELEMENTS
K cal. Gm Mo P

HEAT OF SELF DECOM-
POSITION IN OXYGEN
K cal. 100 Grams

HEAT OF SELF
DECOMPOSITION
K cal. 100 Grams

$\Delta H_f =$

$\Delta H_o =$

$\Delta H_d =$

S

L

G

S

L

G

S

L

G

FLAME TEMPERATURE

DECOMPOSITION TEMP

REPORTED BY

REPORT NUMBER

LABORATORY SCREENING TESTS

WARNING: Data based on laboratory test conditions. Use caution in extending to different environments.

DIFFERENTIAL THERMAL ANALYSIS

RATE OF TEMP INCREASE: MAXIMUM TEST TEMP

20

PC MIN.

250

PC

END TYPE: END: START: PEAK: END: SIZE:

none

DROP-WEIGHT SHOCK SENSITIVITY

TEST METHOD: TEST TEMP: WEIGHT: WEIGHT: NUMBER OF TESTS: POSITIVE: NEGATIVE:

Solid-Liquid

PC

cm

kg

POSITIVE

NEGATIVE

COMMENTS:

No thermal activity indicated
at 0.5 sensitivity.

COMMENTS: HX, Etc

TEST RUN BY: TEST DATE: TEST REFERENCE:

E. Tims

1-11-79

FLAMMABILITY PROPERTIES

In air at ambient pressure unless otherwise noted

FLASH POINT: METHOD: °C: °F: METHOD: °C: °F:

TEST RUN BY: TEST DATE: TEST REFERENCE:

AUTOIGNITION TEMPERATURE

TEST RUN BY: TEST DATE: TEST REFERENCE:

FLAMMABLE LIMITS

LIMITS - VOL. %: PRESSURE: TEMP.: IGNITION: LOWER: UPPER: PSIA or mmHg: °C: SOURCE:

TEST RUN BY: TEST REFERENCE:

NAME OF ORIGINATOR OR OWNER OF CHEMICAL MATERIAL

J. Granier

DATE

LA

CONFIDENTIAL

DO 005274

SOURCE

1901

8476

STATIC GENERATION
DUST EXPLOSION

DOW

DOW CONFIDENTIAL
REACTIVE CHEMICAL HAZARD DATA
PROPERTIES AND PRECAUTIONS

REFERENCE NUMBER

RCL 1071

DATE OF ISSUE

1-8-79

LATEST REVISION DATE

MATERIAL NAME (Use C.R.I. name if available):

Mistron Vapor Talc: 50% Sodium Hydroxide

MOLECULAR FORMULA

MOLECULAR WEIGHT

PHYSICAL STATE

SAMPLE PURITY

Solid-Liquid

STRUCTURAL FORMULA, COMPOSITION, ETC.

THERMOCHEMICAL INFORMATION

HEAT OF FORMATION
FROM THE ELEMENTS
K cal. Gram MoleHEAT OF SELF DECOM-
POSITION IN OXYGEN
K cal. 100 GramsHEAT OF SELF
DECOMPOSITION
K cal. 100 Grams $\Delta H_f =$ $\Delta H_d =$ $\Delta H_d =$

S L G

S L G

S L G

FLAME TEMPERATURE

DECOMPOSITION TEMP.

°C

°C

REPORTED BY

REPORT NUMBER

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LABORATORY SCREENING TESTS

WARNING: Data based on laboratory test conditions, use caution in extending to different environments.

DIFFERENTIAL THERMAL ANALYSIS

RATE OF TEMP. INCREASE

MAXIMUM TEST TEMP.

20

°C MIN.

250

°C

EXO TYPE ENDO START °C PEAK °C END °C SIZE

none

DROP-WEIGHT SHOCK SENSITIVITY

TEST METHOD

TEST TEMP.

HEIGHT

WEIGHT

NUMBER OF TESTS

Solid-Liquid

°C

cm

Kg

POSITIVE

NEGATIVE

COMMENTS:

No thermal activity indicated
at 0.5 sensitivity.

COMMENTS (H30, E30):

TEST RUN BY

TEST DATE

TEST REFERENCE

F. Tims

1-8-79

FLAMMABILITY PROPERTIES
(In air or ambient pressure unless otherwise noted)FLASH
POINT

°C

°F

METHOD

METHOD

°C

°F

TEST RUN BY

TEST DATE

TEST REFERENCE

AUTOIGNITION
TEMPERATURE

°C

°F

TEST RUN BY

TEST DATE

TEST REFERENCE

FLAMMABLE LIMITS

LIMITS - VOL. %

PRESSURE

TEMP.

IGNITION

LOWER

UPPER

PSIA or mmHg

°C

SOURCE

TEST RUN BY

TEST DATE

TEST REFERENCE

NAME OF ORIGINATOR OR OWNER OF CHEMICAL MATERIAL

DIVISION

CONFIDENTIAL

BUILDING

PHONE

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DO 005275

• CONSIDER •

ENERGY POTENTIAL
TEMPERATURE
PRESSURE
SELF-REACTION
POLYMERIZATION
MOISTURE
LIGHT SENSITIVITY
PEROXIDES
AGING
FREEZE-THAW
ACIDS
BASES
OXIDIZERS
REDUCERS
INHIBITORS
CATALYSTS
IMPURITIES
CONTAINERS
PACKAGING
STATIC GENERATION
DUST EXPLOSION



DOW CONFIDENTIAL
REACTIVE CHEMICAL HAZARD DATA
PROPERTIES AND PRECAUTIONS

RCL 106B

12-28-78

Mistron Vapor Talc: T-det 9.5 1/1

solid-liquid

THERMOCHEMICAL INFORMATION

HEAT OF FORMATION FROM THE ELEMENTS
HEAT OF SELF DECOMPOSITION
HEAT OF OXIDATION

5 5 5 5 5 5 5 5 5 5

5 5 5 5 5 5 5 5 5 5

5 5 5 5 5 5 5 5 5 5

5 5 5 5 5 5 5 5 5 5

LABORATORY SCREENING TESTS

WARNING: Data listed on laboratory test reports are for information only and are not to be used for regulatory purposes.

DIFFERENTIAL THERMAL ANALYSIS

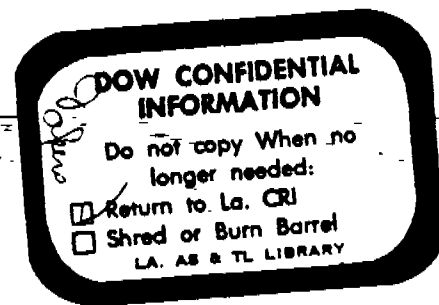
20 400

none

DROP-WEIGHT SHOCK SENSITIVITY

TEST METHOD TEST TEMP HEIGHT WEIGHT NUMBER OF TESTS
POSITIVE NEGATIVE

No thermal activity indicated at 0.5 sensitivity.



F. Tims 12-27-78

FLAMMABILITY PROPERTIES

FLASH POINT

AUTOIGNITION TEMPERATURE

TEST RUN BY TEST DATE TEST REFERENCE

FLAMMABLE LIMITS

LIMITS VOL% PRESSURE TEMP. GPM SOURCE
LOWER UPPER PSIA or mmHg °C

TEST RUN BY TEST DATE TEST REFERENCE

COMMENTS AND SPECIAL PRECAUTIONS

CONSIDER

ENERGY POTENTIAL
TEMPERATURE
PRESSURE
SELF-REACTION
POLYMERIZATION
MOISTURE
LIGHT SENSITIVITY
PEROXIDES
ACIDS
BASES
OXIDIZERS
REDUCERS
INHIBITORS
CATALYSTS
IMPURITIES
CONTAINERS
PACKAGING
STATIC GENERATION
DUST EXPLOSION

DO 005276

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REACTIVE CHEMICAL HAZARD DATA
PROPERTIES AND PRECAUTIONS

REFERENCE NUMBER

RCL 1072

DATE OF ISSUE

1-15-79

LATEST REVISION DATE

Mistron Vapor Talc: 37% Hydrochloric Acid

MOLECULAR FORMULA

MOLECULAR WEIGHT

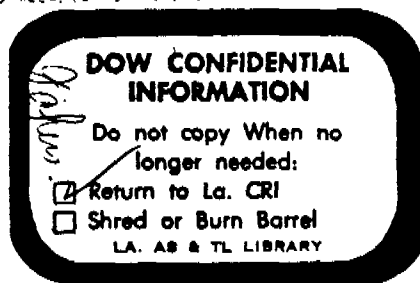
PHYSICAL STATE

SAMPLE PURITY

solid-liquid

SPECIAL FORMULA, COMPOSITION, COMPONENTS & WEIGHTS

THERMOCHEMICAL INFORMATION



HEAT OF FORMATION
FROM THE ELEMENTS
K cal. Gram Mole

HEAT OF SELF DECOM-
POSITION IN OXYGEN
K cal. 100 Grams

HEAT OF SELF
DECOMPOSITION
K cal. 100 Grams

$\Delta H_f =$

$\Delta H_d =$

$\Delta H_d =$

S L G

S L G

S L G

FLAME TEMPERATURE

DECOMPOSITION TEMP

°C

°C

REPORTED BY

REPORT NUMBER

LABORATORY SCREENING TESTS

WARNING: Data based on laboratory test conditions. Use caution in extending to different environments.

DIFFERENTIAL THERMAL ANALYSIS

RATE OF TEMP. INCREASE MAXIMUM TEST TEMP
20 °C MIN. 230 °C

DROP-WEIGHT SHOCK SENSITIVITY

TEST METHOD TEST TEMP. HEIGHT HEIGHT NUMBER OF TESTS
°C cm Kg POSITIVE NEGATIVE

none

COMMENTS

No thermal activity indicated
at 0.5 sensitivity.
Capillary ruptured from pressure
in all tests.

COMMENTS AND SPECIAL PRECAUTIONS

TEST RUN BY TEST DATE TEST REFERENCE
E. Tims 1-8-79

TEST RUN BY TEST DATE TEST REFERENCE

FLAMMABILITY PROPERTIES

(In air at ambient pressure unless otherwise noted)

FLASH POINT °C METHOD
°C METHOD

TEST RUN BY TEST DATE TEST REFERENCE

AUTOIGNITION TEMPERATURE °C °F

TEST RUN BY TEST DATE TEST REFERENCE

FLAMMABLE LIMITS

LIMITS - VOL. % PRESSURE TEMP. IGNITION
LOWER UPPER PSIA or mmHg °C SOURCE

TEST RUN BY TEST DATE TEST REFERENCE

CONSIDER

ENERGY POTENTIAL
TEMPERATURE
PRESSURE
SELF-REACTION
POLYMERIZATION
MOISTURE
LIGHT SENSITIVITY
PEROXIDES
AGING
FREEZE-THAW
ACIDS
BASES
OXIDIZERS
REDUCERS
INHIBITORS
CATALYSTS
IMPURITIES
CONTAINERS
PACKAGING
STATIC GENERATION
DUST EXPLOSION

DO 005277

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NAME OF ORIGINATOR OR OWNER OF CHEMICAL MATERIAL

ISSUED

SUCCESSOR

PHONE

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DOW CONFIDENTIAL
REACTIVE CHEMICAL HAZARD DATA
PROPERTIES AND PRECAUTIONS

REFERENCE NUMBER

RCL 1081

1-12-79

LATEST REVISION DATE

T-det 9.5 : Chlorine

MOLECULAR FORMULA

MOLECULAR WEIGHT

PHYSICAL STATE

SAMPLE PURITY

liquid

STRUCTURAL FORMULA, IUPAC NAME, COMPONENTS, IMPURITIES

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INFORMATION**

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THERMOCHEMICAL INFORMATION

HEAT OF FORMATION
FROM THE ELEMENTS
K cal. Gram-Mole

HEAT OF SELF DECOM-
POSITION IN OXYGEN
K cal. 100 Grams

HEAT OF SELF
DECOMPOSITION
K cal. 100 Grams

$\Delta H_f =$

$\Delta H_o =$

$\Delta H_d =$

S L G

S L G

S L G

FLAME TEMPERATURE

DECOMPOSITION TEMP.

REPORTED BY

REPORT NUMBER

LABORATORY SCREENING TESTS

WARNING: Data based on laboratory test conditions. Use caution in extending to different environments.

DIFFERENTIAL THERMAL ANALYSIS

NAME OF TEMP. INCREASE

MAXIMUM TEST TEMP

20

PC MIN

250

°C

END

TYPE

END

START

PC PEAK

PC END

°C

SIZE

none

DROP-WEIGHT SHOCK SENSITIVITY

TEST METHOD

TEST TEMP.

HEIGHT

WEIGHT

NUMBER OF TESTS

Solid-Liquid

°C

cm

Kg

POSITIVE

NEGATIVE

COMMENTS

*No thermal activity indicated
at 0.5 g/1 sensitivity.*

COMMENTS -550, 550

TEST RUN BY

TEST DATE

TEST REFERENCE

E. Tims

1-12-79

FLAMMABILITY PROPERTIES
(in air at ambient pressure unless otherwise noted)

FLASH POINT

°C

°F

METHOD

METHOD

°C

°F

TEST RUN BY

TEST DATE

TEST REFERENCE

AUTOIGNITION TEMPERATURE

°C

°F

TEST RUN BY

TEST DATE

TEST REFERENCE

FLAMMABLE LIMITS

LIMITS - VOL. %

PRESSURE

TEMP.

IGNITION SOURCE

LOWER

UPPER

PSIA or mmHg

°C

SOURCE

TEST RUN BY

TEST DATE

TEST REFERENCE

NAME OF ORIGINATOR OR OWNER OF CHEMICAL MATERIAL

J. Granier

LOCATION

LA

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CONTROL NUMBER

1901

PLATE

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DO 005278

- CONSIDER •
- ENERGY POTENTIAL
 - TEMPERATURE
 - PRESSURE
 - SELF-REACTION
 - POLYMERIZATION
 - MOISTURE
 - LIGHT SENSITIVITY
 - PEROXIDES
 - AGING
 - FREEZE-THAW
 - ACIDS
 - BASES
 - OXIDIZERS
 - REDUCERS
 - INHIBITORS
 - CATALYSTS
 - IMPURITIES
 - CONTAINERS
 - PACKAGING
 - STATIC GENERATION
 - DUST EXPLOSION

DOW CONFIDENTIAL		REACTIVE CHEMICAL HAZARD DATA PROPERTIES AND PRECAUTIONS				REPORT NO. 85122A			
		DATE OF TEST 7-15-85		DOW DATA BOOK ENTRY 4039-34B					
TEST NAME HDPE : WATER : FDET SURFACTANT : POLYVINYL PYRROLIDONE : CHLORINE									
MOLECULAR FORMULA				REPORT NO. 85122		PHYSICAL STATE LIQUID/SOLID			
STRUCTURAL FORMULA, COMPOSITION, COMPONENTS & DILUTANTS				RELATED TO TEST PROCESS OR PRODUCT					
				SOURCE OF SAMPLE (Location, Building, Reactor, Etc.)					
				STAGE OF DEVELOPMENT (Lab/Pilot Plant)					
				OWNER OR ORIGINATOR OF REQUEST NAME J. AKERS CHARGE NO. 1210 BLDG. 2513 PHONE NO. 6259 LOCATION LA-DIVISION					
				LABORATORY SCREENING TESTS					
WARNING: Data based on laboratory test conditions; use caution when extending to different environments.									
DSC (DTR) THERMAL ANALYSIS				DROP-HEIGHT, IMPACT SENSITIVITY (DH)					
RATE OF TEMP INCREASE 20 (C)/MIN.		MODERN TEST TEMP 250 (C)		TEST METHOD DSC-Liq	TEST TEMP. (C)	HEIGHT cm	HEIGHT Kg	NO. OF TESTS	
END TYPE END	START (C)	PEAK (C)	END (C)					SIZE	POSITIVE
95	133	140							
TEST HEIGHT		SAMPLE ATMOSPHERE NITROGEN OXYGEN AIR OTHER		COMMENTS					
COMMENTS Critical temp of Cl₂ = 144°C									
TEST RUN BY M. ERWIN		TEST DATE 7-10-85		TEST REFERENCE A1203		TEST RUN BY		TEST DATE	
FLASH POINT (FP)		(F) METHOD		TEST DATE		FLAMMABLE LIMITS (FL)			
		(C) METHOD		TEST RUN BY		LIMITS-VOL% LOWER UPPER		PRESSURE PSIA or mmHg	TEMP (C)
COMMENTS, FOLLOW-UP, SPECIAL PRECAUTION									
TEST RUN BY						TEST DATE		TEST REFERENCE	
AUTOIGNITION TEMPERATURE (AIT)						(C)		(F)	
TEST RUN BY						TEST DATE		TEST REFERENCE	
ACCELERATING RATE CALORIMETRY (ARC)									
REPORT NUMBER						DATE			
WALKER ADIABATIC RUNAWAY DEVICE (ARD)									
REPORT NUMBER						DATE			

CONFIDENTIAL

DO 005279

DOW						REACTIVE CHEMICAL HAZARD DATA								REPORT NO. 85127A	
CONFIDENTIAL						PROPERTIES AND PRECAUTIONS								DATE OF ISSUE 7-15-85	
FEDERAL NAME POLYVINYL PYRROLIDONE : CHLORINE										NON DATA BOOK ENTRY 4039-34A					
MOLECULAR FORMULA						REQUEST NO. 85127		ANALOG STATE SOLID/LIQUID		NON REACTIVITY NO.					
STRUCTURAL FORMULA, COMPOSITION, COMPONENTS & DERIVATIVES						RELATED TO WHAT PROCESS OR PRODUCT?									
						SOURCE OF SAMPLE (Location, Building, Reactor, Etc.)									
						STAGE OF DEVELOPMENT (Lab/Pilot Plants)									
						OWNER OR ORIGINATOR OF REQUEST									
						NAME J. AKERS				CHARGE NO. 1210					
						BLDG. 2513				PHONE NO. 6259					
						LOCATION LA. DIVISION									
LABORATORY SCREENING TESTS															
WARNING: Data based on laboratory test conditions; use caution when extending to different environments.															
DSC (DTA) THERMAL ANALYSIS							DROP-WEIGHT IMPACT SENSITIVITY (DW)								
RATE OF TEMP INCREASE			MODERN TEST TEMP				TEST METHOD Sol-Liq	TEST TEMP. (C)	HEIGHT mm	HEIGHT kg	NO. OF TESTS				
20 (C)/MIN.			250 (C)								POSITIVE	NEGATIVE			
TYPE EXO ENDO	START (C)	PEAK (C)	END (C)	SIZE											
Exo	30°C	85°C	115°C												
TEST HEIGHT		SAMPLE ATMOSPHERE NITROGEN OXYGEN AIR OTHER		COMMENTS											
COMMENTS ΔT-AXIS SENSITIVITY = 1°/INCH															
TEST RUN BY M. ERWIN		TEST DATE 7-12-85		TEST REFERENCE Al ₂ O ₃		TEST RUN BY		TEST DATE		TEST REFERENCE					
FLASH POINT (FP)	(F)	METHOD	TEST DATE		FLAMMABLE LIMITS (FL)										
	(C)	METHOD	TEST RUN BY		LIMITS-VOL%		PRESSURE PSIA or mmHg	TEMP (C)	IGNITION SOURCE						
LOWER	UPPER														
COMMENTS, FOLLOW-UP, SPECIAL PRECAUTION					TEST RUN BY		TEST DATE		TEST REFERENCE						
					AUTOIGNITION TEMPERATURE (AIT)		(C)		(F)						
					TEST RUN BY		TEST DATE		TEST REFERENCE						
					ACCELERATING RATE CALORIMETRY (ARC)		REPORT NUMBER		DATE						
DO 005280					WALKER ADIABATIC RUNAWAY DEVICE (ARD)										
					REPORT NUMBER		DATE								
CONFIDENTIAL															

DO		REACTIVE CHEMICAL HAZARD DATA				85127R	
CONFIDENTIAL		PROPERTIES AND PRECAUTIONS				DATE OF DATA 7-15-85	
FEDERAL NAME		POLYVINYLPIRROLIDONE : HYDROCHLORIC ACID (aqueous)				DOH DATA BOOK ENTRY 4039-34A	
MOLECULAR FORMULA		REQUEST NO. 85127		PHYSICAL STATE LIQUID/SOLID		DOH REACTIVITY NO.	
STRUCTURAL FORMULA, COMPOSITION, COMPONENTS & DEGRADATES		RELATED TO HMT PROCESS OR PRODUCT					
		SOURCE OF SAMPLE (Location, Building, Reactor, Etc.)					
		STAGE OF DEVELOPMENT (Lab/Pilot Plant)					
		OWNER OR ORIGINATOR OF REQUEST					
		NAME J. AKERS BLDG. 2513 LOCATION LA. DIVISION				CHARGE NO. 1210 PHONE NO. 6259	
LABORATORY SCREENING TESTS							
WARNING: Data based on laboratory test conditions; use caution when extending to different environments.							
DSC (DTA) THERMAL ANALYSIS				DROP-WEIGHT IMPACT SENSITIVITY (DW)			
RATE OF TEMP INCREASE		MAXIMUM TEST TEMP		TEST METHOD Bal-Liq	TEST TEMP. (C)	HEIGHT mm	HEIGHT kg
20 (C)/MIN.		250 (C)					
TYPE END	START (C)	PEAK (C)	END (C)				
SIZE							
NONE							
TEST HEIGHT		SAMPLE ATMOSPHERE NITROGEN OXYGEN AIR OTHER		COMMENTS			
COMMENTS NO THERMAL ACTIVITY DETECTED USING A AT-Axis SENSITIVITY OF 1/4 INCH							
TEST RUN BY M. ERWIN		TEST DATE 7-12-85		TEST REFERENCE A2O3		TEST RUN BY	
FLASH POINT (FP)		METHOD (F)		TEST DATE		TEST DATE	
FLASH POINT (FP)		METHOD (C)		TEST RUN BY		TEST REFERENCE	
COMMENTS, FOLLOW-UP, SPECIAL PRECAUTION				FLAMMABLE LIMITS (FL)			
				LIMITS-VOL%		PRESSURE PSIA or mmHg	TEMP (C)
				LOWER	UPPER		
				TEST RUN BY		TEST DATE	TEST REFERENCE
				AUTOIGNITION TEMPERATURE (AIT)		(C)	(F)
				TEST RUN BY		TEST DATE	TEST REFERENCE
				ACCELERATING RATE CALORIMETRY (ARC)			
				REPORT NUMBER			
				WALKER ADIABATIC RUNAWAY DEVICE (ARD)			
				REPORT NUMBER			

DOH		REACTIVE CHEMICAL HAZARD DATA				85127C	
CONFIDENTIAL		PROPERTIES AND PRECAUTIONS				7-15-85	
OTHER NAME POLYVINYL PYRROLIDONE : TALC						DON DATA BOOK ENTRY 1039-34A	
MOLECULAR FORMULA		REQUEST NO. 85127		ANALYST STATE SOLID		DON REGISTRY NO.	
STRUCTURAL FORMULA, COMPOSITION, COMPONENTS & DERIVATIVES		RELATES TO HEAT PROCESS OR PROPERTY					
		SOURCE OF SAMPLE (Location, Building, Reactor, Etc.)					
		STAGE OF DEVELOPMENT (Lab./Pilot Plant)					
		OWNER OR ORIGINATOR OF REQUEST NAME T. AKERS CHARGE NO. 1210 BLDG. 2513 PHONE NO. 6259 LOCATION LA. DIVISION					
LABORATORY SCREENING TESTS							
WARNING: Data based on laboratory test conditions; use caution when extending to different environments.							
DSC (DIA) THERMAL ANALYSIS				DROP-HEIGHT IMPACT SENSITIVITY (DH)			
RATE OF TEMP INCREASE		MAXIMUM TEST TEMP		TEST METHOD	TEST TEMP. (C)	HEIGHT cm	HEIGHT kg
20 (C)/MIN.		250 (C)					
END	START (C)	PEAK (C)	END (C)	END	SIZE	POSITIVE	NEGATIVE
NONE							
TEST HEIGHT		SAMPLE ATMOSPHERE NITROGEN OXYGEN AIR OTHER		COMMENTS			
COMMENTS							
NO THERMAL ACTIVITY DETECTED USING A AT-AXIS SENSITIVITY OF 1°/MIN.							
TEST RUN BY M. EDWIN		TEST DATE 7-12-85		TEST REFERENCE Al₂O₃		TEST RUN BY	
TEST DATE		TEST REFERENCE		TEST RUN BY		TEST REFERENCE	
FLASH POINT (FP)		(F)		METHOD		TEST DATE	
		(C)		METHOD		TEST RUN BY	
FLAMMABLE LIMITS (FL)							
LIMITS-VOL%		PRESSURE PSIA or mmHg		TEMP (C)		IGNITION SOURCE	
LOWER		UPPER					
TEST RUN BY		TEST DATE		TEST REFERENCE			
AUTOIGNITION TEMPERATURE (AIT)		(C)		(F)			
TEST RUN BY		TEST DATE		TEST REFERENCE			
ACCELERATING RATE CALORIMETRY (ARC)							
REPORT NUMBER				DATE			
WALKER ADIABATIC RUNAWAY DEVICE (ARD)							
REPORT NUMBER				DATE			

DOH CONFIDENTIAL		REACTIVE CHEMICAL HAZARD DATA PROPERTIES AND PRECAUTIONS				REPORT NO. 85127D DATE OF ISSUE 7-15-85 DOH DATA BOOK ENTRY 4039-34A										
SPECIAL NAME POLYVINYLPIRROLIDONE : POLYETHYLENE						REQUEST NO. 85127										
MOLECULAR FORMULA						PHYSICAL STATE SOLID										
STRUCTURAL FORMULA, COMPOSITION, COMPONENTS & ISOMERISM						RELATED TO HAZARD PROPERTIES OR PRODUCT										
						SOURCE OF SAMPLE (Location, Building, Reactor, Etc.)										
						STAGE OF DEVELOPMENT (Lab/Pilot Plant)										
						OWNER OR ORIGINATOR OF REQUEST NAME J. AKERS CHARGE NO. 1210 BLDG. 2513 PHONE NO. 6269 LOCATION LA. DIVISION										
LABORATORY SCREENING TESTS																
WARNING: Data based on laboratory test conditions; use caution when extending to different environments.																
DSC (DTA) THERMAL ANALYSIS					DROP-WEIGHT IMPACT SENSITIVITY (DW)											
DATE OF TEST DETERMINED		MAXIMUM TEST TEMP			TEST METHOD Bul-Liq	TEST TEMP. (C)	HEIGHT mm	HEIGHT kg	NO. OF TESTS							
20 (C)/MIN.		250 (C)							POSITIVE	NEGATIVE						
ENDOTHERM	START (C)	PEAK (C)	END (C)	SIZE												
ENDO	125	132	145													
TEST METHOD		SAMPLE ATMOSPHERE NITROGEN OXYGEN		OTHER	COMMENTS											
COMMENTS																
AT-AXIS SENSITIVITY = 1°C/INCH																
TEST RUN BY		TEST DATE		TEST REFERENCE		TEST RUN BY		TEST DATE		TEST REFERENCE						
M. EDWIN		7-12-85		Al₂O₃												
FLASH POINT (FP)	(F)	METHOD		TEST DATE		FLAMMABLE LIMITS (FL)										
	(C)	METHOD		TEST RUN BY												
COMMENTS, FOLLOW-UP, SPECIAL PRECAUTION						LIMITS-VOL%		PRESSURE PSIA OR mmHg	TEMP (C)	IGNITION SOURCE						
						LOWER	UPPER									
						TEST RUN BY		TEST DATE		TEST REFERENCE						
						AUTOIGNITION TEMPERATURE (AIT)		(C)		(F)						
						TEST RUN BY		TEST DATE		TEST REFERENCE						
						ACCELERATING RATE CALORIMETRY (ARC)										
						REPORT NUMBER		DATE								
						WALKER ADIABATIC RUNAWAY DEVICE (ARD)										
						REPORT NUMBER		DATE								

DO 005283

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DOW CONFIDENTIAL		REACTIVE CHEMICAL HAZARD DATA PROPERTIES AND PRECAUTIONS				REFERENCE NO. 85127 E DATE OF ISSUE 7-15-85 DON DATA BOOK ENTRY 4039-34A					
FEDERAL NAME POLYVINYLPYRROLIDONE : T-DET SURFACTANT						REGISTER NO. 85127					
MOLECULAR FORMULA 						PHYSICAL STATE SOLID / LIQUID					
STRUCTURAL FORMULA, COMPOSITION, COMPONENTS & PURITIES						RELATED TO TEST PROCEDURE OR PROPERTY					
						SOURCE OF SAMPLE (Location, Building, Master, Etc.)					
						STAGE OF DEVELOPMENT (Lab/Pilot Plant)					
						OWNER OR ORIGINATOR OF REQUEST NAME J. AKERS BLDG. 2513 LOCATION LA. DIVISION					
						CHARGE NO. 1210 PHONE NO. 6259					
LABORATORY SCREENING TESTS											
WARNING: Data based on laboratory test conditions; use caution when extending to different environments.											
DSC (DTG) THERMAL ANALYSIS				DROP-WEIGHT IMPACT SENSITIVITY (DW)							
DATE OF TEST DETERMINED		MAXIMUM TEST TEMP		TEST METHOD	TEST TEMP. (C)	HEIGHT cm	HEIGHT kg	NO. OF TESTS			
20 (C)/MIN.		250 (C)						POSITIVE	NEGATIVE		
TYPE OF DSC	START (C)	PEAK (C)	END (C)	SIZE							
NONE											
TEST HEIGHT		SAMPLE ATMOSPHERE NITROGEN OXYGEN		COMMENTS							
		FOR OTHER									
COMMENTS											
NO THERMAL ACTIVITY DETECTED USING A AT-Axis SENSITIVITY OF 1°C/INCH.											
TEST RUN BY		TEST DATE		TEST REFERENCE		TEST RUN BY		TEST REFERENCE			
M. ERWIN		7-12-85		A1203							
FLASH POINT (FP)		(F)	METHOD	TEST DATE		FLAMMABLE LIMITS (FL)					
		(C)	METHOD	TEST RUN BY							
COMMENTS, FOLLOW-UP, SPECIAL PRECAUTION						LIMITS-VOL%		PRESSURE PSIA or mmHg	TEMP (C)	IGNITION SOURCE	
						LOWER	UPPER				
						TEST RUN BY		TEST DATE		TEST REFERENCE	
						AUTOIGNITION TEMPERATURE (AIT)		(C)		(F)	
						TEST RUN BY		TEST DATE		TEST REFERENCE	
						ACCELERATING RATE CALORIMETRY (ARC)					
						REPORT NUMBER				DATE	
						WALKER ADIABATIC RUNAWAY DEVICE (ARD)					
						REPORT NUMBER				DATE	

APPENDIX E

CHLORINE COMPATIBILITY GUIDELINES

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7/26/81 JBA
RCM-151

CHLORINE

Manufacturing Chemists' Association, Inc.

Manual
Sheet
SD-88

Chemical Safety Data Sheet

CHLORINE

ADOPTED MAY 1960

1. NAMES

Chemical Name: Chlorine
Common Name: Chlorine
Formula: Cl_2

2. PROPERTIES

2.1 GRADE

Commercial (liquid)

2.2 PROPERTIES AND CHARACTERISTICS

Physical State _____ Gas at atmospheric temperatures and pressures. Chlorine in commerce is a liquefied gas under pressure; the chlorine in containers has both a liquid and a gas phase.

Boiling Point _____ $-34.05^\circ\text{C. } (-29.29^\circ\text{F.})$

Color _____ Gas—greenish yellow
Liquid—clear amber

Critical Density _____ $35.77 \text{ lb./ft.}^3 (573 \text{ g./L.})$

Critical Pressure _____ $1118.4 \text{ psia. } (76.1 \text{ atmos.})$

Critical Temperature _____ $144^\circ\text{C. } (291^\circ\text{F.})$

Critical Volume _____ $0.02796 \text{ ft.}^3/\text{lb. } (0.001745 \text{ L./g.})$

Density _____ Dry gas— $0.2003 \text{ lb./ft.}^3 (3.209 \text{ g./L.})$
at $0^\circ\text{C. } (32^\circ\text{F.})$ and 1 atmos.

Saturated gas— $0.7537 \text{ lb./ft.}^3 (12.07 \text{ g./L.})$ at $0^\circ\text{C. } (32^\circ\text{F.})$

Liquid— $91.67 \text{ lb./ft.}^3 (1468 \text{ g./L.})$ at $0^\circ\text{C. } (32^\circ\text{F.})$

— $88.79 \text{ lb./ft.}^3 (11.87 \text{ lb./gal.})$ at $15.6^\circ\text{C. } (60^\circ\text{F.})$
(See Figure 1)

Flammability _____ Chlorine, gas or liquid, is non-explosive and nonflammable; however, like oxygen it is capable of supporting the combustion of certain substances. Many organic chemicals react readily with chlorine, in some cases with explosive violence.

Latent Heat of Vaporization _____ $123.7 \text{ BTU/lb. } (68.7 \text{ g. cal./g.})$ at $-34.05^\circ\text{C. } (-29.29^\circ\text{F.})$

Liquid-Gas Volume Relationship _____ The weight of one volume of liquid chlorine equals the weight of 457.6 volumes of chlorine gas at $0^\circ\text{C. } (32^\circ\text{F.})$ and 1 atmos. (14.696 psia.).

Melting Point _____ $-100.98^\circ\text{C. } (-149.76^\circ\text{F.})$

Odor _____ Characteristic penetrating and irritating odor.

Reactivity

With Water

Chlorine is only slightly soluble in water. When it reacts with pure water, weak solutions of hypochlorous and hydrochloric acids are formed. Chlorine hydrate ($\text{Cl}_2 \cdot 8\text{H}_2\text{O}$), may crystallize below 49.3°F.

With Metals

Temperatures encountered in normal uses of chlorine do not exceed 230°F. Below this temperature, copper, iron, lead, nickel, platinum, silver, steel and tantalum are chemically resistant to dry chlorine, gas or liquid. Certain copper and ferrous alloys, including Hastelloy "C", Monel, and

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Types 304 and 316 stainless steel also are resistant. The reaction rate of chlorine with most metals increases with extreme rapidity above certain temperatures, beyond which construction materials must be selected with great care; these temperatures are considerably lower if the metal or alloy is in finely-divided, powdered, sponge, or wire form.

Dry chlorine reacts with aluminum, arsenic, gold, mercury, selenium, tellurium, tin and titanium. Aluminum ignites in chlorine at minus 4°F. At certain temperatures, potassium and sodium burn in chlorine gas. Carbon steel ignites at 483°F. Antimony, arsenic, bismuth, boron, copper, iron, phosphorus, and certain of their alloys, in finely-divided, powdered, sponge or wire form ignite spontaneously in chlorine.

Moist chlorine, primarily because of the hydrochloric and hypochlorous acids formed through hydrolysis, is very corrosive to all common metals. Gold, platinum, silver and titanium are resistant. At temperatures below 300°F., tantalum is totally inert to wet (and dry) chlorine. Moist chlorine reacts readily with mercury.

With Other Elements

Chlorine unites, under specific conditions, with most of the elements; these reactions may be extremely rapid. At the boiling point of chlorine it reacts with sulfur. It does not react directly with oxygen or nitrogen; the oxides and nitrogen compounds are well known, but can only be prepared by indirect methods. Mixtures of chlorine and hydrogen composed of more than 5 percent of either component can react with explosive violence, forming hydrogen chloride.

With Inorganic Compounds

The preparation of soda and lime bleaches (sodium and calcium hypochlorite) are typical reactions of chlorine with the alkalies and alkaline earth metal hydroxides; the hypochlorites formed are powerful oxidizing agents. Because of its great affinity for hydrogen, chlorine removes hydrogen from some of its compounds, such as the reaction with hydrogen sulfide to form hydrochloric acid and sulfur. Chlorine reacts with ammonia or ammonium compounds to form various mixtures of chloramines depending on the conditions. One of these, under proper conditions, might be the explosive nitrogen trichloride.

With Organic Compounds

Chlorine reacts with organic compounds much the same as with inorganics to form chlorinated derivatives and hydrogen chloride. Some of these reactions can be explosive, including those with hydrocarbons, alcohols and ethers, and proper methods must be applied in operations in which they are involved.

Solubility in Water

See Figure 2.

Below 9.6°C. (49.3°F.) chlorine hydrate, $\text{Cl}_2 \cdot 8\text{H}_2\text{O}$, may crystallize.

Specific Gravity

Dry gas—2.482 at 0°C. and 1 atmos.

Liquid—1.468 at $\frac{0^\circ}{4^\circ}$ C. and 53.15 psia. (3.617 atmos.)

Specific Heat

Dry gas—0.113 BTU/lb./°F. (0.113 g. cal./g./°C.) at constant pressure for chlorine gas at 100 psia. or less between -1.1°C. and 26.7°C. (30°F. and 80°F.)

Dry gas—0.0832 Btu/lb./°F. (0.0832 g. cal./g./°C.) at constant volume for chlorine gas at 100 psia. or less between -1.1°C. and 26.7°C. (30°F. and 80°F.)

Liquid—0.236 Btu/lb./°F. (0.236 g. cal./g./°C.) for liquid

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at equilibrium between -1.1°C. and 26.7°C. (30°F. and 80°F.)

C_p/C_v —1.355—Ratio of gas specific heat at constant pressure to specific heat at constant volume.

Specific Volume—Dry gas—4.992 ft.³/lb. at 0°C. (32°F.) and 14.696 psia. (1 atmos.)

Saturated gas—1.327 ft.³/lb. at 0°C. (32°F.)

Liquid—0.01091 ft.³/lb. at 0°C. (32°F.)

Vapor Pressure—See Figure 3.

At 0°C. (32°F.) the vapor pressure is 53.155 psia. (3.617 atmos.)

Viscosity—Gas—About the same as that of saturated steam between 1 atmos. and 10 atmos.

Liquid—About one-third that of water at the same temperature from 0°C. to 65.6°C. (32°F. to 150°F.).

Volume Temperature Relationship—The volume of liquid chlorine increases rapidly as its temperature increases (See Figure 4.)

3. HAZARDS

1. HEALTH HAZARDS

Liquid chlorine is a skin irritant; prolonged contact will produce "burns." Liquid chlorine in the eyes will cause severe damage. When exposed to normal atmospheric pressure and temperature it vaporizes to gas.

Chlorine gas is primarily a respiratory irritant. At concentrations exceeding 15 ppm it will irritate the mucous membranes, the respiratory system and the skin. In extreme cases, the difficulty of breathing may increase to the point where death can occur from suffocation. For more details see Sect. 10.

3.1.1 Warning Properties

The characteristic penetrating odor of chlorine gas gives warning of its presence in the air. Its greenish yellow color makes it visible when high concentrations are present.

2. OTHER HAZARDS

3.2.1 Fire Hazards

Chlorine is neither explosive nor flammable; however, chlorine will support combustion.

3.2.2 Chemical Action

Chlorine has a very strong chemical affinity for

many substances. It will react with almost all the elements and with many inorganic and organic compounds, usually with the evolution of heat. At elevated temperatures it reacts vigorously with most metals (See Sect. 2.2)

3.2.3 Volumetric Expansion

The volume of liquid chlorine increases considerably with increasing temperature. Precautions must be taken to avoid hydrostatic rupture of containers or other equipment filled with liquid chlorine.

3.2.4 Corrosive Action

At ordinary temperatures, dry chlorine, either liquid or gas, does not corrode steel. (For other materials used in piping systems see Sect. 4.3 and 2.2. In the presence of moisture, however, highly corrosive conditions exist as a result of the formation of hydrochloric and hypochlorous acids. Every precaution must be taken to keep chlorine and chlorine equipment free from moisture. Pipe lines, valves, and containers must be tightly closed when not in use to keep out moisture from the air. Never use water on a chlorine leak because resulting corrosive conditions always make the leak worse.

4. ENGINEERING CONTROL OF HAZARDS

4.1 BUILDING DESIGN

4.1.1 General

Shipping containers and equipment containing chlorine preferably should be located indoors, in a suitable fire-resistant building. If a separate building is not provided, the chlorine containers and

equipment should be located in an isolated room having floors and walls of fire-resistant construction. Standard fire walls may be needed to separate chlorine equipment from flammable materials. Subsurface locations should be avoided; if impossible, an adequate exhaust system should be provided. (See Sect. 4.4)

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CHLORINE HANDLING PRINCIPLES

Extracted from Texas Division Safety Reference No. 49

1. Chlorine will react violently with many things such as oils, greases, paints, some solvents, etc. It will also react with steel wool, oily filings or pipe cuttings. It is therefore essential that all foreign material be removed from chlorine lines and containers before putting chlorine in them.
2. Hot water and/or steam can be used safely to clean chlorine equipment and is strongly recommended over any solvent. Though carbon tetrachloride is not reactive with chlorine, it is highly toxic. No solvent, soap or detergent-type material should be used without the approval of a Unit Manager.

Under no circumstances should the following materials be used with chlorine prior to further testing and consultation with the Reactive Chemicals Committee. In general, hydrocarbons and silicones should not be used in chlorine service without prior testing. Reactive Chemical hazard Data Reference Numbers are given if available:

Acetone (RCD 32)

Activated Alumina

Activated Charcoal

Alcohol

Ammonia

Ander 1 495 Syn. Lube Oil (RCT 2217)

Anderol 500 Syn. Lube Oil (RCT 2216)

Chemola Lubricant (TFE #8155-2) (RCL 187)

Climax 400 (RCT 2135)

Climax 400 & Iron Powder (RCT 2136)

Climax 400 & Ferric Oxide Powder (RCT 2137)

Climax 600 (RCT 2131)

Climax 650 (RCT 2138)

Climax 750 (RCT 2139)

Climax 800 (RCT 2140)

Climax FS (RCT 2222)

Chl rothene (RCD 30)

Chlorothene NU (RCT 1448 & 1449) (1,1,1 - Trichloroethane plus inhibitors - is more reactive with chlorine or "chlorine gunk" than chlorothene.)

C p-Graf Anti-Seize Compound (La. Div. LAD-323)

Desco 400 (RCT 2141)

Desco 600 (RCT 2142)

1,2 - Dichloroethane (RCT-32)

Dibutylphthalate

Dimethyl Polysiloxane

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CHLORINE HANDLING PRINCIPLES - cont'd

Dow Corning Fluorosilicone 1-3907 (RCT 2132)
Dow Corning FS 1265 (RCT 2134)
Dow Corning Molykote 1-3912 (RCT 2133)
Dow Corning FS 1281 (RCT 2144)
Dow Corning Stopcock Grease (RCT 2145)
Dow Corning Valve Seal (RCT 2143 & 2220)
Dow Corning Valve Lubricant FS-3452 (RCT 2218)
Dowtherm G (RCT-1520) & other Dowtherms
Drawing Wax
Ethers
Ethylene Glycol (RCT 451)
Fel-Pro C5-A Anti-Seize Compound (La. Div. LAD 323)
Freon 13 (RCT 3706)
Freon 22 (RCL 0080 & RCT 1451)
Glycerine
Humbletherm 500 (RCT 0512)
Hydrocarbon Oil
Kerosene
Linseed Oil
Marfax #1 (RCT 2547)
Methyl Trifluoropropyl Siloxane
Mineral Oil
Molykote Br-2 (RCT 2219)
Molykote Z Powder (RCT 2221)
Neversees - colloidal copper grease (RCT 2548)
Perchloroethylene (RCD 43)
Permatex Form A - Gasket #2 (RCT 539)
Polychlorinated Biphenyl
Polyethylene (RCL 0075)
Polypropylene with zinc oxide powder (RCD 32)
Silica Gel
Silicone Oil
Sisco 300 (RCT 2146)
Solox Cleaner
Super Jet Detergent (La. Div. LAD 323) - water solution of potassium hydroxide
Turpentine
Unirex N2
Varsol
Vitrea 33 (1:1 vol. RCS 1086)

Some of these materials are used regularly and even routinely in chlorine plants for other than chlorine service. In some cases, there may be contact with chlorine - this is not recommended. Using the materials in the plant may be acceptable, but extra care and caution must be used to remove the materials prior to chlorine exposure.

It should not be assumed a material is safe to use with chlorine just because it is not on the list.

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CHLORINE HANDLING PRINCIPLES - cont'd

3. Lubricants For Chlorine Service

Only completely halogenated fluorocarbon lubricants are chemically inert in liquid and gaseous chlorine. See section on Lubricants for detail.

4. Chlorine and moisture form hydrochloric and hypochlorous acids that will attack all common metals including steel if brought in contact with it. It also forms hydrates of iron chloride, which will cause plugging.
5. Wet chlorine gas may be handled in titanium equipment at normal temperatures. The gas must be kept wet as dry chlorine reacts violently with titanium. Note: All liquid chlorine should be considered as dry chlorine.
6. Chlorine that has been dried does not react with steel at normal temperatures and is handled and stored in steel equipment.

At ordinary temperatures, dry chlorine reacts with aluminum, arsenic, gold, mercury, selenium, tellurium, tin, and titanium.

Antimony, arsenic, bismuth, boron, copper, iron, phosphorus, and certain of their alloys, in finely divided, powdered, sponge or wire form ignite spontaneously in chlorine.

7. Dry chlorine will react violently with hot steel. For this reason, welding must not be done on chlorine lines that have not been isolated and depressured. Also welding cables must not be attached to such lines.
8. Chlorine and hydrogen mixtures may react violently anywhere such a mixture occurs. Ultra-violet light such as sunlight can start this reaction.
9. The acid formed by chlorine gas coming in contact with wet skin is corrosive and should be thoroughly washed off promptly.
10. Liquid chlorine is also dangerous to the skin and in addition can cause tissue damage due to freezing.
11. Take-offs should be on the top or side of a chlorine line, not on the bottom. "Chlorine Gunk" will tend to accumulate and cause plugging problems.
12. All chlorine lines should be supported on shoes and not in contact with other lines. This prevents corrosion and makes the entire line accessible for painting. Lines containing corrosive material, such as acid, should not be installed above chlorine lines.

CHLORINE HANDLING PRINCIPLES - cont'd

13. Chlorine systems should be purged with dry air or dry nitrogen after depressuring to minimize pick up of moisture (and corrosion) in the system.
14. Any vessel that has contained chlorine must be depressured, purged, blinded off and washed before it is safe to enter. (See Safety Standard 13.)
15. Chlorine equipment that has been washed should be dried with air or nitrogen until a dew point of -60°F is reached.
16. Valves that come in contact with water during washing must be dismantled and dried before they are returned to chlorine service.
17. Do not use water on chlorine leaks. Small chlorine leaks can be located with the use of ammonia water in a plastic squeeze bottle. "Chlorine Gunk" will expel chlorine gas continuously for long periods. Heat will increase the degassing rate.
18. The volume of liquid chlorine increases considerably with increasing temperatures. Precautions must be taken to avoid hydrostatic rupture of lines and vessels. Valves that may contain condensed chlorine that may be trapped in the valve should not be heated with steam.

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3. Metals

a. Chlorine and Iron/Carbon Steel

Carbon steel piping and equipment are suitable for service in dry chlorine - less than 5 ppm by weight of water in chlorine - at temperatures below 155°C (311°F).

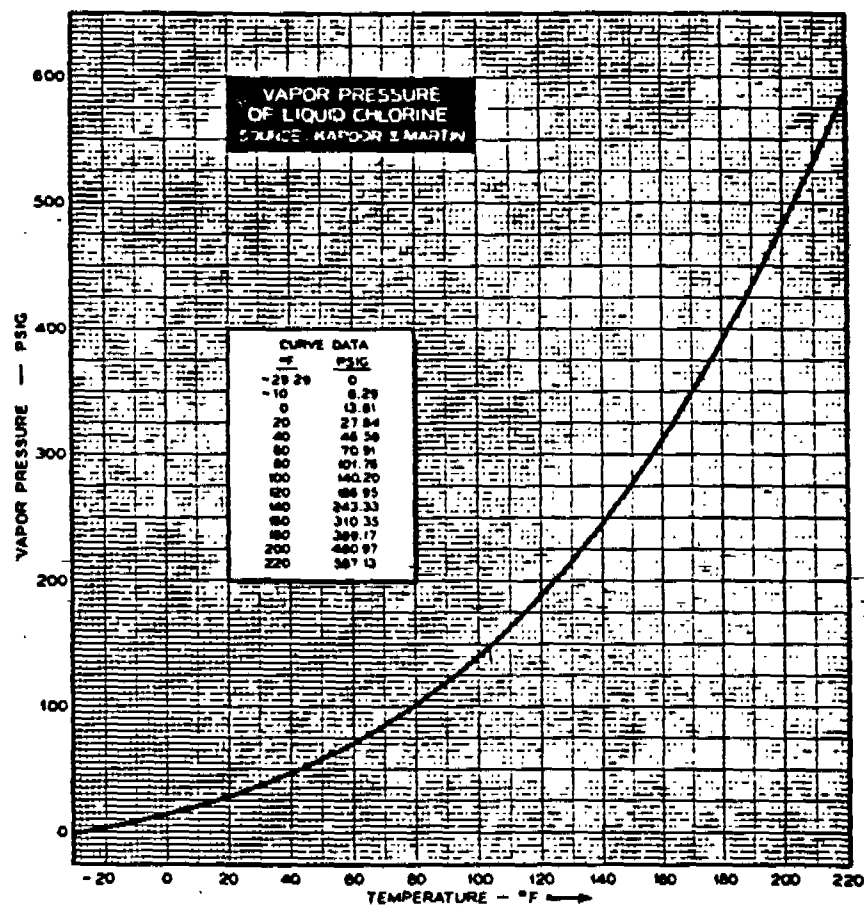
Although laboratory data shows that ignition of iron in chlorine occurs at 204-260°C (400-500°F) (483°F in "Safety Data"), a more realistic ignition temperature under compressor operating conditions is 175°C (347°F). See summary of LAD-420 on next page.

In the past, chlorine-iron reactions were serious problems. Present alarm and trip systems plus temperature recording devices have greatly reduced this problem, but the potential remains. Although the reaction is not explosive it is very vigorous and destroys steel in a very short time. Large quantities of chlorine can be released.

To prevent ignition of iron in chlorine service, the iron must be kept below its auto-ignition temperature. Using a 20° safety factor, a MAXIMUM ACCEPTABLE OPERATING TEMPERATURE is 155°C.

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