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U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

Form Approved
OMB No. 44-R1387

MATERIAL SAFETY DATA SHEET

Required under USDL Safety and Health Regulations for Ship Repairing, Shipbuilding, and Shipbreaking (29 CFR 1915, 1916, 1917)

SECTION I

MANUFACTURER'S NAME	EMERGENCY TELEPHONE NO.
MATHESON GAS PRODUCTS	

ADDRESS (Number, Street, City, State, and ZIP Code)
P.O. Box 85 East Rutherford NJ 07073

CHEMICAL NAME AND SYNONYMS	TRADE NAME AND SYNONYMS
CARBONYL SULFIDE	CARBON OXYSULFIDE
CHEMICAL FAMILY INORGANIC CORROSIVE	**FORMULA** COS

SECTION II - HAZARDOUS INGREDIENTS

PAINTS, PRESERVATIVES, & SOLVENTS	%	TLV (Units)	ALLOYS AND METALLIC COATINGS	%	TLV (Units)
PIGMENTS			BASE METAL		
CATALYST			ALLOYS		
VEHICLE			METALLIC COATINGS		
SOLVENTS			FILLER METAL PLUS COATING OR CORE FLUX		
ADDITIVES			OTHERS		
OTHERS					

HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES	%	TLV (Units)
N/A		

SECTION III - PHYSICAL DATA

BOILING POINT (°F.) @ 1atm (-50.2°C)	-58.4°F	SPECIFIC GRAVITY (H2O=1)	2.1
VAPOR PRESSURE (mm Hg.) PSIG@70°F	160	PERCENT, VOLATILE BY VOLUME (%)	100%
VAPOR DENSITY (AIR=1)	2.1	EVAPORATION RATE (_____ =1)	N/A
SOLUBILITY IN WATER	N/A		
APPEARANCE AND ODOR	Colorless, Odor of rotton eggs		

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used)	FLAMMABLE LIMITS	Lel	Uel
-50°F		11.9	28.5

EXTINGUISHING MEDIA: Stop flow of gas, inert gas

SPECIAL FIRE FIGHTING PROCEDURES: N/A

UNUSUAL FIRE AND EXPLOSION HAZARDS: N/A

(Continued on reverse side)

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SECTION V - HEALTH HAZARD DATA

[redacted] 10 PPM

[redacted] Acts on nervous system, death from respiratory paralysis.

EMERGENCY AND FIRST AID PROCEDURES
Remove from area. Keep warm, give oxygen or artificial respiration.

SECTION VI - REACTIVITY DATA

STABILITY	UNSTABLE		CONDITIONS TO AVOID
	STABLE	X	

INCOMPATABILITY (Materials to avoid)
Copper, Al-Si Br, Brass, Butyl, Neoprene

HAZARDOUS DECOMPOSITION PRODUCTS
N/A

HAZARDOUS POLYMERIZATION	MAY OCCUR		CONDITIONS TO AVOID Store at temperatures not
	WILL NOT OCCUR	X	exceeding 125°F.

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED
Eliminate all sources of ignition. For all spills wash site of spill with strong soap solution to which has been added some hypochlorite.

WASTE DISPOSAL METHOD

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION *(Specify type)* SELF-CONTAINED BREATHING APPARATUS

VENTILATION	LOCAL EXHAUST		SPECIAL
	MECHANICAL *(General)*	X	OTHER

PROTECTIVE GLOVES	X	EYE PROTECTION	X

OTHER PROTECTIVE EQUIPMENT

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING
Store in well ventilated area preferably a hood away from heat, open flame or sparks. Do not store with oxidizing or flammable materials.

OTHER PRECAUTIONS
Use check valve or trap valve to prevent suckback of materials into the cylinder.

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CARBONYL SULFIDE

(Synonym: Carbon Oxysulfide)
(Formula: COS)

PHYSICAL PROPERTIES (1)

Molar Mass	
Molecular Weight	0.060 070 kg
One Mole of COS	0.060 070 kg
Specific Volume @ 21.1 °C, 101.325 kPa	402.0 dm^3/kg; 6.44 ft^3/lb
Vapor Pressure @ 21.1 °C	1 204.5 kPa; 12.05 bar; 174.7 psia; 11.89 atm
Boiling Point @ 101.325 kPa	223.0 °K; 50.2 °C; -58.0 °F
Triple Point	
Temperature	134.30 °K; -138.8 °C; -217.9 °F
Pressure	0.101 325 kPa; 1.013 25 mbar; 0.760 mmHg
Absolute Density, Gas @ 101.325 kPa @ 20 °C	2.527 kg/m^3
Relative Density, Gas @ 101.325 kPa (Air = 1) @ 20 °C	2.10
Density, Liquid @ Saturation Pressure @ -80 °C	1.238 kg/l
Critical Temperature	375.15 °K; 102.0 °C; 215.6 °F
Critical Pressure	5 877 kPa; 58.77 bar; 58.0 atm; 852.4 psia
Critical Volume	2.331 dm^3/kg
Critical Density	0.44 kg/dm^3
Critical Compressibility Factor	0.264
Latent Heat of Fusion @ -138.8 °C	78 660 J/kg; 78.66 kJ/kg; 18.80 kcal/kg
Flammable Limits in Air	12–29% (by volume)
Dipole Moment	2.385 × 10^{-30} C·m; 0.715 D
Molar Specific Heat, Gas @ 101.325 kPa @ 25 °C	
@ Constant Pressure	42.752 kJ/(kmol·°K); 42.752 J/(mol·°K); 10.218 cal/(mol·°C)
@ Constant Volume	34.438 kJ/(kmol·°K); 34.438 J/(mol·°K); 8.209 cal/(mol·°C)
Specific Heat Ratio, Gas @ 101.325 kPa, Cp/Cv @ 25 °C	1.241
Viscosity, Gas @ 101.325 kPa @ 0 °C	0.011 66 mPa; 0.011 66 mN·s/m^2; 0.011 66 cP
Thermal Conductivity, Gas @ 101.325 kPa @ 25 °C	0.010 88 W/(m·°K); 26 × 10^{-6} cal/(s·cm^2·°C)
Surface Tension @ -69.5 °C	24.06 mN/m; 24.06 dyn/cm
Solubility in Water @ 101.325 kPa @ 0 °C	1.333 cm^3/1 cm^3 water

Description

Carbonyl sulfide is a colorless, flammable, toxic gas, having an unpleasant odor similar to rotten eggs. It is shipped as a liquefied gas under its own vapor pressure of 1103 kPa (160 psig) at 21.1 °C.

Specifications

Matheson carbonyl sulfide has a minimum purity of 97.5 mole %.

Uses

Carbonyl sulfide is particularly useful in the synthesis of thioacids, S-trisubstituted carbinols, substituted thiazoles and substituted thiocarbamic acids (salts). High yields are obtained in the synthesis of substituted thiazoles.

Effects in Man (2)

Carbonyl sulfide is only slightly irritating to the lungs. It acts principally on the central nervous system, with death resulting

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mainly from respiratory paralysis. Rabbits showed some ill effects after ½ hour exposure to 1 300 ppm, convulsions and death following an exposure of 1 hour to 3 200 ppm, 90 seconds to 2 900 ppm and 35 minutes to 1 200 ppm. Sixteen minutes exposure to 900 ppm caused no perceptible effects.

Experience with exposure of human beings has not been recorded. It is probable that the effects can be assigned to the action of hydrogen sulfide resulting from partial decomposition in the lungs and after absorption into the blood stream.

Toxicity

Toxic exposures are indicated in the above section. Carbonyl sulfide is considered to be a general poison in that it shows both mild irritant effects and systemic poisoning. Symptoms such as headache, giddiness, vertigo, and confusion should be taken as a warning that a dangerous concentration is being inhaled. The disagreeable odor of carbonyl sulfide is not considered to be a reliable warning property because of the likelihood of olfactory fatigue.

First Aid Treatment

Inhalation

Remove the victim to an uncontaminated atmosphere. Keep him warm and at rest. If he is breathing and conscious, recovery is expected to be rapid. If breathing is weak or has ceased, give artificial respiration and oxygen at once. Give oxygen until completely recovered. Otherwise treatment is symptomatic and supportive.

Contact with Eyes

Irrigate eyes with water for at least 15 minutes. Conjunctivitis may be relieved by instilling 1 drop of olive oil in each eye and sometimes by 3 or 4 drops of epinephrine sulfate (1:1 000) at frequent intervals (e.g., 5 minutes). Occasionally local anesthetics and hot and cold compresses are necessary to control the pain. Take victim promptly to an eye specialist for definite treatment.

Contact with Mucous Membranes of Nose

Flush with water for at least 15 minutes.

Precautions in Handling and Storage

Since carbonyl sulfide does not adequately warn the user of its presence, it should be stored and used in a well-ventilated area (preferably a hood) away from any sources of heat, sparks or open flames. Never use flames to detect flammable gas leaks; use soap water solution. Do not use carbonyl sulfide around sparking motors or other non-explosive-proof equipment. Do not store reserve stocks of carbonyl sulfide cylinders with cylinders containing oxygen, chlorine or other highly oxidizing or flammable materials. A check valve or trap of adequate size to take the total volume of the liquid should be used to prevent suckback of materials into the cylinder.

In addition, the general rules listed in Appendix I should be observed.

Leak Detection

Never use a flame to detect carbonyl sulfide leaks; use soap water solution. Leaks will be evident by the formation of bubbles. If a leak appears around the cylinder valve stem, the valve packing nut should be tightened. If leaks persist, do not attempt to fix them without first contacting the supplier. Remove the cylinder to an isolated area (preferably a hood) or out-of-doors where the gas can be safely bled off.

Analytical Detection

Methods for the quantitative determination of carbonyl sulfide have been described (see Reference 3).

Disposal of Leaking Cylinders

Put on appropriate gas mask and transport the leaking cylinder to a safe out-of-doors area. Post warnings to prevent persons from approaching the cylinder with lit cigarettes or open flames or sparks. Proceed with disposal of the gas as described in Appendix II-D, using alcoholic potassium hydroxide or alkaline hypobromite as the absorbing solution.

Carbonyl sulfide can also be disposed of by burning.

Materials of Construction

Since carbonyl sulfide is noncorrosive no special materials of construction are required, provided the system is dry. Moisture will slowly decompose carbonyl sulfide into carbon dioxide and hydrogen sulfide which will create corrosion problems, requiring the use of stainless steel or aluminum. Piping or vessels should be adequately designed to withstand the pressures to be encountered.

Cylinder and Valve Description

Carbonyl sulfide is shipped in DOT approved cylinders. Matheson uses the standard hydrogen sulfide valve outlet for carbonyl sulfide service. It is designated as Compressed Gas Association (CGA) No. 330, and is 0.825 inches in diameter, with left-hand external threads, with a flat seat and washer. Figure 1 illustrates the valve outlet and mating connection.

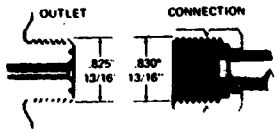

Fig. 1. CONNECTION 330 .825"-14 LH EXT. used with Flat Seat and Washer

Lecture bottles are equipped with a 5/16"-32 threads per inch female valve outlet.

Safety Devices

Cylinders of carbonyl sulfide have a safety device of fusible metal, melting at approximately 73.9 °C (165 °F). Cylinders over 76.2 cm (30 inches) long require this device in both ends of the cylinder.

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Recommended Controls

Automatic Pressure Regulator

Single stage regulator Model 11-330 is recommended for use with carbonyl sulfide cylinders. The regulator is constructed of an anodized aluminum body with type 316 stainless steel internal parts, plus a diaphragm of FEP Teflon on Viton and a Kel-F seat. No cylinder pressure gauge is necessary since it would not indicate cylinder content but only vapor pressure, which will remain constant as long as any liquid remains in the cylinder. Cylinder content should be determined by weighing. The delivery pressure range of this regulator is 28-550 kPa (4-80 psig).

Sensitive, and accurate control at low pressures can be obtained with Model 71 low pressure regulators. These regulators have oversized pancake bodies of aluminum with type 303 stainless steel internal parts, and Teflon seats. The Model 71 and Model 71A have Teflon coated Butyl rubber diaphragms. The delivery pressure range of Models 71 and 71A are 3.4–55 kPa (0.5-8 psig) and 34.5–83 kPa (5-12 psig), respectively.

To prevent suckback of foreign materials into a regulator, a stainless steel check valve is recommended for use with either of the above regulators.

Manual Controls

Series 61-330 stainless steel needle valves are recommended for use with carbonyl sulfide. This type of valve may be equipped with a variety of outlets, such as a hose connection, ¼" tube fitting or ¼" NPT male or female pipe. This type of valve is suitable for intermittent flow control but does not control pressure. Thus, it will not prevent pressure from building up if the system becomes clogged or if the system itself is closed.

Stainless steel needle valve Model 32S or Model 59 is recommended for use with lecture bottles.

Flowmeters

Matheson Series 7600 laboratory stainless steel flowmeter units with 150 mm tubes and floats or Matheson 7200 laboratory stainless steel flowmeter units with 65 mm tubes with a single float are recommended for use where definite flow rates must be known.

Electronic Mass Flow Controllers

The Matheson Series 8240 of type 316 stainless steel and Series 8260 of type 316 stainless steel or monel are designed to control the flow of gas regardless of pressure and temperature changes. These mass flow controllers consist of a transducer, a control valve, a blind controller/power supply, a potentiometer and a digital indicator. The transducer senses the gas flow and sends a signal to the power supply. This signal and one from the potentiometer are compared. If there is an imbalance, the power supply generates a signal for the control valve to reduce or increase the flow to correct the imbalance. The accuracy is ± 1.2%.

Shipping Regulations

Carbonyl sulfide is shipped in low pressure steel cylinders as a flammable, compressed gas, taking a DOT "Red Gas Label".

Chemical Preparation

Carbonyl sulfide may be obtained by direct reaction of carbon monoxide with sulfur at the boiling point of the latter, by reaction of water vapor with carbon disulfide below 400 °C, by hydrolysis of ammonium or potassium thiocyanate with dilute sulfuric acid at 50–75 °C, or by decomposition of certain thiocarbonates and thiocarbamates with acid.

Chemical Properties

Carbonyl sulfide burns readily and forms an explosive mixture with oxygen. On oxidation with bromine water or acid permanganate, carbonyl sulfide gives carbon dioxide and sulfuric acid. Carbonyl sulfide is reduced by hydrogen giving carbon monoxide and hydrogen sulfide. Carbonyl sulfide and water react slowly giving carbon dioxide and hydrogen sulfide. Carbonyl sulfide undergoes thermal decomposition by either of 2 reactions:

$$2\,COS \rightarrow 2CO + 2S$$

$$2\,COS \rightarrow CO_2 + CS_2$$

Dissociation by the first reaction is rapid and reaches a maximum of 64% at 900 °C; dissociation by the second reaction is slow and reaches a maximum at 600 °C. Carbonyl sulfide is decomposed to an appreciable extent by alkalis to the alkali sulfide and carbonate. Carbonyl sulfide is used in the synthesis of thioacids and of S-trisubstituted carbinols by means of Grignard compounds (2).

For a review of the chemistry of carbonyl sulfide see Reference 3.

Thermodynamic and Detailed Physical Data

Molecular Structure

The COS molecule is linear, with bond distances of 1.16×10^{-10} m and 1.56×10^{-10} m for C=O and C=S, respectively. These interatomic distances are in agreement with the distances calculated from the following three resonance structure:

$$\ddot{O}::C::\ddot{S} \leftrightarrow :\overset{+}{O}:::C:\ddot{S}:^{-} \leftrightarrow :^{-}\ddot{O}:C:::\overset{+}{S}:$$

The COS molecule has $C_{\infty v}$ symmetry and has a symmetry number of one.

Infrared Spectrum

See Figure 2 for the infrared spectrum of gaseous carbonyl sulfide.

Figure 2. Infrared spectrum of gaseous COS in the frequency range 3 800–450 cm^{-1}; 10 cm path length cell, with KBr windows; pressure: curve A: 4.0 kPa (30 mmHg), curve B (partial scan): 0.0667 kPa (0.5 mmHg) (7).

Vapor Pressure

The vapor pressure of liquid COS in the temperature of 111.0 °C to −49.0 °C is represented by the following equation (4):

$$\log_{10} p = 10.153\,09 - \frac{1\,318.260}{T} - 0.014\,778\,4T + 0.000\,018\,838T^2$$

In which p = cmHg and T = °K.

Some calculated vapor pressure values are listed below:

Temperature, °C	Vapor Pressure kPa	mbar	mmHg = torr
−111.0	1.769	17.7	13.27
−101.0	4.254	42.5	.91
−91.0	[illegible]	93.1	69.83
−281.0	[illegible]572	185.7	139.30
−71.0	34.290	342.9	257.20
−61.0	59.302	593.0	444.80
−50.0	101.538	1 015.4	761.60

Vapor pressure from −40 to 60 °C are shown below (5).

Temperature, °C	Vapor Pressure kPa	bar
−40	151.99	1.52
−20	314.11	3.14
0	618.08	6.18
20	1 155.1	11.6
40	1 824	18.2
60	2 736	27.4

See Figure 3 for vapor pressure curve.

Latent Heat of Vaporization, ΔHv

Temperature, °C	ΔHv, kJ/kg
−70.0	321.58
−60.0	314.34
−50.2	308.07
−40.0	302.08
−30.0	293.38
−20.0	284.93

Thermodynamic Properties of Carbonyl Sulfide as Ideal Gas @ 25 °C (8)

Heat Capacity, C_p°	41.497 J/(mol·°K)
	0.691 kJ/(kg·°K)
Entropy, S°	231.471 J/(mol·°K)
	3.853 kJ/(kg·°K)
Free Energy Function, $(F_{298}^\circ - H_{298}^\circ)/T$	−231.471 J/(mol·°K)
	−3.853 kJ/(kg·°K)
Enthalpy, H°	9.927 kJ/mol
	165.257 kJ/kg
Enthalpy of Formation, ΔH_f°	−138.407 kJ/mol
	−2 304.095 kJ/kg
Free Energy of Formation, ΔF_f°	−165.640 kJ/mol
	−2 757.450 kJ/kg

REFERENCES

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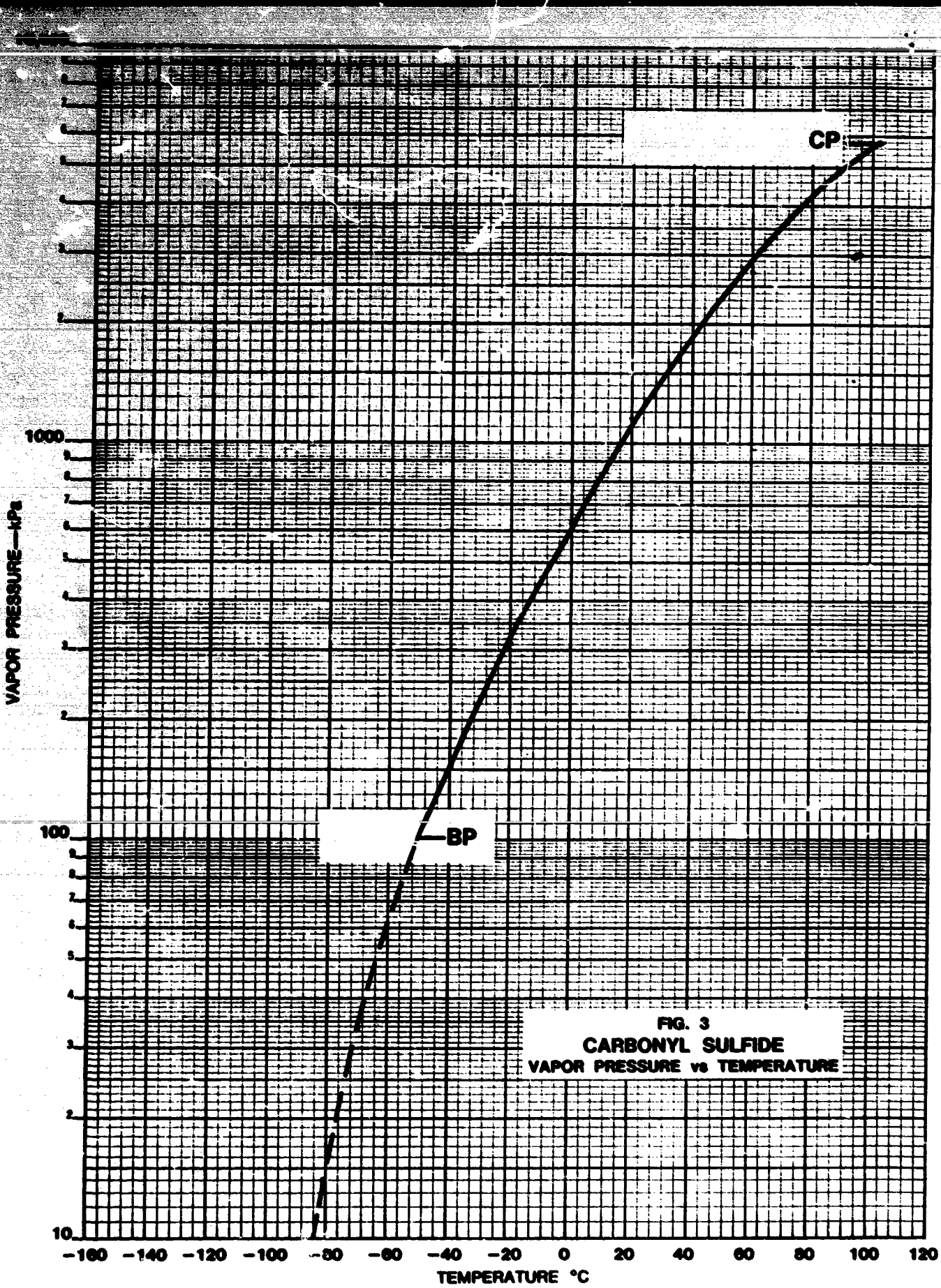

FIG. 3
CARBONYL SULFIDE
VAPOR PRESSURE vs TEMPERATURE

AMTEK CORP.

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