Safety Data Sheet

Total Reduced Sulfur (TRS) Gases

1. Identification

TRADE NAME (AS LABELED):	Total Reduced Sulfur (TRS) Gases.
SYNONYMS:	Stripper Off-Gases, Non-Condensable Gases (NCG).
PRODUCT USES:	By-product of the pulping process.
CHEMICAL NAME/CLASS:	Gaseous chemical by-product mixture.
MANUFACTURER'S NAME:	WestRock
ADDRESS:	504 Thrasher Street Norcross, GA 30071
EMERGENCY PHONE:	(800) 424-9300 (CHEMTREC)
BUSINESS PHONE:	770-448-2193

2. Hazard(s) Identification

Signal Word: DANGER
TRS Gases

Product Classification (GHS)	Hazard Statement(s)	Pictogram
PHYSICAL Flammable- Category 1	Extremely Flammable Gas	
HEALTH Acute Toxicity Inhalation Gases –Category 2	May Be Fatal If Inhaled	

2. Hazard(s) Identification (cont'd.)

Product Classification (GHS)	Hazard Statement(s)	Pictogram
Specific Target Organ Toxicity (STOT) –Single Exposure Category 1	Causes Damage to Respiratory and Central Nervous System	
Eye Damage/Irritation- Category 2B	Causes eye irritation	

[1] Total Reduced Sulfur Gases (TRS) are formed as off-gases in the Kraft pulping and recovery process. The gaseous mixture consists mainly of hydrogen sulfide (H_2S), methyl mercaptan (MM), dimethyl sulfide (DMS) and dimethyl disulfide (DMDS) gases. TRS gas emissions are generated in the process of Kraft pulping or acidification of liquors and vary in their concentrations and relative percentages greatly, depending on where in the process the emissions are generated. Gases are generated in multiple stages in the process and can be in higher concentrations in areas such as the digester and stripper off gas streams and in lower concentrations in areas such as tank air spaces and smelt dissolving tanks. There are many other processes, vessels and process streams which generate TRS gas emissions in the mills (e.g. Black Liquor). TRS gases can exist in liquid phase depending on pressure and temperature.

Precautionary Statements:

PREVENTION STATEMENTS**:** Wear protective gloves/clothing/eye/face and respiratory protection. Avoid release to the environment. Avoid breathing vapors and gases.

RESPONSE STATEMENTS: If in eyes rinse immediately with water for at least 15 minutes. Remove contact lenses if present and easy to do. Continue rinsing. If exposed or concerned get medical attention. If inhaled, remove victim to fresh air and keep at rest in a position comfortable for breathing. Immediately call a POISON CENTER or doctor/physician. Eliminate all ignition sources if safe to do so.

CAUTION: If pulping liquors containing these gases are reacted with acids, or if the liquor enters an acid sewer the TRS gases are released in potentially lethal concentrations. Hydrogen sulfide and methyl mercaptan have central nervous system (CNS) effects. Hydrogen sulfide interferes with oxygen use in the body as well. A very dangerous aspect of hydrogen sulfide exposure results from olfactory accommodation and/or olfactory paralysis when exposed to concentrations >150 ppm. This means that the individual can accommodate to the odor and is not able to detect the presence of the chemical after a short period of time.

Ingredients of Unknown Acute Toxicity (>1%): Not applicable.

3. Composition/Information on Ingredients

Component	CAS#	EC#	Wt %
Hydrogen sulfide (H_2S)	7783-06-4	231-977-3	Variable
Methyl mercaptan-MM (CH_4S)	74-93-1	200-822-1	Variable
Dimethyl sulfide- DMS (C_2H_6S)	75-18-3	200-846-2	Variable
Dimethyl disulfide -DMDS ($C_2H_6S_2$)	624-92-0	210-871-0	Variable

4. First-Aid Measures

Ingestion: Not likely to occur under normal circumstances.

Eye Contact: Exposure to the liquids that generate TRS gases and the gases themselves can cause eye irritation or damage. Immediately flush with running water for 15 minutes including under eyelids. Get immediate medical help.

Skin Contact: Contact with the liquids that generate TRS gases can cause skin irritation including dermatitis. Remove contaminated clothes and launder prior to reuse. Immediately wash affected area with water. Get medical help if irritation or burns are present after washing.

Skin Absorption: Some gases may be readily absorbed through the intact skin, especially if skin is moist.

Inhalation: Remove to fresh air immediately using appropriate precautions for rescuers. Get medical help.

Signs and Symptoms of Exposure:

Acute Symptoms/Effects – The primary health hazards posed by TRS gases are due to inhaling the gases or vapors, which can cause eye, nose, throat, and respiratory tract irritation. Hydrogen sulfide and methyl mercaptan have central nervous system (CNS) effects. Hydrogen sulfide interferes with oxygen use in the body as well. Exposure to high concentrations can cause nausea, headache, dizziness, difficulty breathing, and/or sudden collapse and in extreme cases (>500 ppm H_2S) death.

Delayed Symptoms/Effects – Unique delayed effects are not anticipated after exposure. See Section 11 for additional information on chronic effects.

5. Fire-fighting Measures

Flash Point (Method Used): Tag Closed Cup -55 F^o to 59 F^o (-48 C^o to 15 C^o)

Flammable Limits:	**LFL =**	H_2S:	4.3%	**UFL =**	H_2S: 45%
		MM:	3.8%		MM: 21.8%
		DMS:	2.2%		DMS: 9.7%
		DMDS:	1.1%		DMDS: 16%

Extinguishing Media: Foam, dry chemical, or carbon dioxide.

Autoignition Temperature: 500°F (262°C) for H_2S. 572ºF (300ºC) for DMDS.

Special Firefighting Procedures: Evacuate area. Stop gas flow. Use water to keep fire exposed containers cool and to protect persons affecting the shut off. Isolate hazard area and deny entry. Ventilate enclosed spaces before entering them. Wear positive-pressure breathing apparatus and special protective clothing.

Hazardous Combustion Products: Irritating gases of incomplete combustion such as carbon monoxide, carbon dioxide and sulfur dioxide may be produced.

Unusual Fire and Explosion Hazards: TRS gases are flammable and may be ignited by heat or flames. Vapors may travel to ignition sources and flash back. Explosion hazard exists when gases concentrate indoors or in enclosed spaces such as sewers.

NFPA Rating (Scale 0-4): **Health =** 4 **Fire =** 4 **Reactivity =** 0

6. Accidental Release Measures

Steps to be Taken In Case Material Is Released or Spilled: Immediately notify safety and environmental personnel. Evacuate persons not wearing protective equipment. Avoid inhalation of gases or vapors. Prevent contact of the skin and eyes with liquid that generates TRS gases. Remove all ignition sources. Ventilate area. Stop gas flow while wearing the appropriate personal protective equipment.

7. Handling and Storage

Precautions to be Taken In Handling and Storage: Do not enter a chest tank, digester, evaporator, or other equipment or confined space that has contained pulping liquors such as white, green, black liquor, or other residual liquors until it has been tested for the presence of reduced sulfur compounds and follow confined spaces procedures closely. Carefully follow line- break safety measures for piping systems that may contain or transport TRS gas components.

8. Exposure Control Measures/ Personal Protection

Exposure Limits/Guidelines:

Name	CAS#	Percent	Agency	Exposure Limits	Comments
Hydrogen Sulfide (H_2S)	7783-06-4	Variable	OSHA ACGIH ACGIH	PEL- Ceiling (C) 20ppm[1] TLV-TWA 1 ppm TLV-STEL 5 ppm	Peak 50ppm/10 minutes
Methyl mercaptan-MM (CH_4S)	74-93-1	Variable	OSHA ACGIH	Ceiling (C) 10 ppm TLV-TWA 0.5 ppm	Current PEL
Dimethyl sulfide-DMS (C_2H_6S)	75-18-3	Variable	OSHA ACGIH	None TLV-TWA 10 ppm	None
Dimethyl disulfide - DMDS ($C_2H_6S_2$)	624-92-0	Variable	OSHA ACGIH	None TLV –TWA 0.5 ppm	None (Skin)[2]

[1] If instantaneous monitoring is not feasible, then the ceiling shall be assessed as a 15-minute time weighted average exposure which shall not be exceeded at any time during the working day.

[2] Potential significant contribution to overall exposure by the cutaneous route.

Personal Protective Equipment:

RESPIRATORY PROTECTION – Use NIOSH approved full face piece respirator with cartridges appropriate for use with TRS gas exposures. Higher levels of respiratory protection will be required if there is a potential to exceed the exposure limits or for exposure to unknown concentrations. Use and select respiratory protection in accordance with regulatory and respirator selection requirements such as the OSHA respiratory protection standard 29 CFR 1910.134 following a determination of potential exposure risks. Eye irritation may become a serious issue at elevated levels.

PROTECTIVE GLOVES – Rubber or chemically resistant gloves are recommended if in the liquid phase.

EYE PROTECTION – Chemical goggles are recommended.

OTHER PROTECTIVE CLOTHING OR EQUIPMENT – For entry or escape from unknown concentrations, a self-contained breathing apparatus (SCBA) with full-face piece operated in pressure-demand or other positive-pressure mode in combination with separate escape supply is recommended.

WORK/HYGIENE PRACTICES – Follow good hygienic and housekeeping practices.

Ventilation:

LOCAL EXHAUST – Provide local exhaust as needed so that exposure limits are met.

MECHANICAL (GENERAL) – Not applicable.

SPECIAL – TRS gases may form explosive mixtures in air streams depending on concentration. Ensure ventilation system design considers explosivity potential.

9. Physical/Chemical Properties

Physical Description/Odor: TRS is a generic term used to describe a mixture of primarily hydrogen sulfide (H_2S), methyl mercaptan (MM or MESH), dimethyl sulfide (DMS), and dimethyl disulfide (DMDS) and other minor reduced sulfur gases. TRS gases can exist in liquid phase depending on pressure and temperature. The gases have a characteristic "rotten egg" odor.

Auto-ignition temperature:	Not available
Boiling Point (@ 760 mm Hg):	Not available
Decomposition temperature:	Not available
Evaporation Rate (Butyl Acetate = 1):	Not available
Freezing Point:	Not available
Flash Point:	55 F^o to 59 F^o (-48 C^o to 15 C^o)
Flammability:	Variable (see section 5)
Melting Point:	Not available
Partition Coefficient (n-octonal/water):	Not available
Odor Threshold:	Very low odor threshold for MM, DMS and DMDS typically at ppb or ppt levels
pH:	Not applicable
Solubility in Water (% by weight):	Not available
Specific Gravity (H_2O = 1):	Not available
Upper/Lower Explosive Limits:	Variable (see section 5)
Vapor Density (air = 1; 1 atm):	Not available
Relative Density:	Not available
Vapor Pressure (mm Hg):	Not available
Viscosity:	Not applicable
% Volatile by Volume [@ 70°F (21°C)]:	Not available

10. Stability and Reactivity

Stability: ☐ Unstable ☒ Stable

Conditions to Avoid: Avoid heat and flames.

Incompatibility (Materials to Avoid): Oxidizing materials, metal oxides, metal salts and bases.

Hazardous Decomposition or By-Products: Toxic and irritating oxides of sulfur and carbon are produced on combustion.

Hazardous Polymerization: ☐ May occur ☒ Will not occur

Sensitivity to Mechanical Impact: Not applicable

Sensitivity to Static Discharge: Yes, if in explosive concentration ranges.

11. Toxicological Information

Acute toxicity: No information available for TRS gases combined. Individual component information is listed below.

Components:

H_2S: LC_{50} (rat, inhalation) = 444 ppm/4 hours; LC_{50} (mouse, inhalation) = 673 ppm/1 hour; LC_{50} (rat and mouse) = 1,000 ppm/15-30 minutes.

MM: LC_{50} (rat, inhalation) = 675 ppm/4 hours; LC_{50} (mouse, inhalation) = 1,664 ppm/unknown exposure duration; acute (rat, inhalation) = 500 ppm/30-35 minutes produced no effect; 700 ppm/30-35 minutes produced inactivity with instant recovery after exposure ended; 1,500 ppm/unknown exposure

11. Toxicological Information (cont'd.)

duration resulted in reflex loss and damage to lungs and airways; 10,000 ppm/1 minute produced convulsions, paralysis, and death occurred within 14 minutes.

DMS: LC_{50} (rat, inhalation) = 40,250 ppm/unknown exposure duration; LC_{50} (mouse, inhalation) = 31,620 ug/m^3/unknown exposure duration; Irritation, 250µg 24 Hours (eye-rabbit) – Severe

DMDS: LC_{50} (rat, inhalation) = 805 ppm/4 hours; LC_{50} (rat, inhalation) = 15.85 mg/m^3/2 hours LC_{50} (mouse, inhalation) = 12.3 mg/m^3/2 hours; sub chronic (rat, inhalation): 100 ppm/6 hours/day/5 days/week/4 weeks resulted in no toxicity.

Target Organs: Eyes, skin and respiratory system.

Primary Route(s) of Exposure: Eyes and respiratory system.

Carcinogenicity:

IARC: Listed by IARC - No
NTP: Listed by NTP - No
OSHA: Listed by OSHA – No

Aspiration Hazard: Not applicable in gaseous form.

Reproductive effects: No information available.

Teratogenic effects: No information available.

Mutagenic effects: No information available.

Effects:

Acute Health Hazards: Can cause eye, nose, throat, and lung irritation. Exposure to high concentrations can cause nausea, headache, disorientation, pain in extremeties, dizziness, difficult breathing, and/or sudden collapse and in extreme cases (>500 ppm H_2S) death.

Chronic Health Hazards: Irritation and respiratory system effects. Loss of appetite, weight loss, irregular heartbeat, headache, sleep disturbances, lung congestion, nerve damage, paralysis, effects on the brain.

12. Ecological Information

Ecotoxicity:

Hydrogen sulfide: Very toxic to aquatic life- category 1, based on 96-hour LC_{50}=0.0071mg/L of fishes (Fathead minnows).

Methyl mercaptan: 500µg/L 5 hours (mortality) spotfin shiner. Di methyl sulfide; 48 hour EC_{50} Daphnia pulex: 23 mg/L.

Dimethyl sulfide: No information available.

Dimethyl disulfate: No information available.

Biopersistance and Degradability: No information available.

Bioaccumulation: No information available.

Soil Mobility: No information available.

13. Disposal Considerations

Waste Disposal Method: Preferred method is approved incineration and if necessary, vent gases to outside air. Always do so in accordance with federal, state, and local regulations.

14. Transport Information

Mode: (Air, Land, water) TRS gases are a by-product of pulp production and is not a product that is shipped in commerce:

14. Transport Information (cont'd.)

Proper Shipping Name:	NA
Hazard Class:	NA
UN/NA ID Number:	NA
Hazard Zone:	NA
Packing Group:	NA
Label/Placard Required:	NA

15. Regulatory Information

TSCA: All TRS gas components are on the TSCA inventory.
CERCLA: Hydrogen sulfide (RQ 100 lbs.), Methyl mercaptan (RQ 100 lbs.).
DSL: All TRS gas components are on the Canadian Domestic Substance List Inventory.
OSHA: Regulated under the federal OSHA Hazard Communication Standard 29 CFR 1910.1200.
STATE RIGHT-TO-KNOW:
California – This product does not contain substances identified on the Proposition 65 list.
New Jersey – Hydrogen sulfide, methyl mercaptan, dimethyl sulfide, and dimethyl disulfide are on the New Jersey Hazardous Substance List.
Pennsylvania – Hydrogen sulfide, methyl mercaptan, dimethyl sulfide, and dimethyl disulfide are on the Pennsylvania Hazardous Substance List.
SARA 313 Information: TRS gases contain hydrogen sulfide and methyl mercaptan at levels that may exceed the threshold reporting levels established by SARA Title III, section 313 and 40 CFR section 372.
SARA 311/312 Hazard Category: This product has been reviewed according the EPA "Hazard Categories: promulgated under SARA Title III, Sections 311 and 312 and is considered, under applicable definitions, to meet the following categories:

An immediate (acute) health hazard	H_2S: Yes	MM:Yes	DMS: Yes	DMDS:Yes
A delayed (chronic) health hazard	H_2S:	MM:	DMS:	DMDS:
A fire hazard	H_2S: Yes	MM:Yes	DMS: Yes	DMDS:Yes
A reactivity hazard	H_2S:	MM:	DMS:	DMDS:
A sudden release hazard	H_2S: Yes	MM: Yes	DMS:	DMDS:

WHMIS Classification: Controlled product: Class D1A, Acute lethality-very toxic-immediate (hydrogen sulfide, methyl mercaptan and dimethyl disulfide). All identified components are Class B1 Flammable and combustible materials- flammable gas.

16. Additional Information

Date Prepared: 02/06/2012
Date Revised: 07/02/2015
Prepared By: WestRock Safety and Health Department.
WestRock SDS available on: www.westrock.com
Disclaimer:

The information and data herein are believed to be accurate and have been compiled by WestRock Safety and Occupational Health professionals from external sources believed to be reliable. WestRock provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person using this product. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose and use in

16. Additional Information (cont'd.)

compliance with all applicable laws and standards. WestRock will not be liable for claims relating to any party's use of or reliance on information and data contained herein.

Definition of Common Terms:

ACGIH = American Conference of Governmental Industrial Hygienists
C = Ceiling Limit
CAS# = Chemical Abstracts System Number
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
DOT = U. S. Department of Transportation
DSL = Canada-Domestic Substance List
EC50 = Effective concentration that inhibits the endpoint to 50% of control population
EC# = European Commission Number
ENCS = Japanese Existing and New Chemical Substances List
EPA = U.S. Environmental Protection Agency
IARC = International Agency for Research on Cancer
IATA = International Air Transport Association
IMDG = International Maritime Dangerous Goods
LC50 = Concentration in air resulting in death to 50% of experimental animals
LCLo = Lowest concentration in air resulting in death
LD50 = Administered dose resulting in death to 50% of experimental animals
LDLo = Lowest dose resulting in death
LEL = Lower Explosive Limit
LFL = Lower Flammable Limit
MSHA = Mine Safety and Health Administration
NA = Not Applicable
NIOSH = National Institute for Occupational Safety and Health
NFPA = National Fire Protection Association
NPRI = Canadian National Pollution Release Inventory
NTP = National Toxicology Program
OSHA = Occupational Safety and Health Administration
PEL = Permissible Exposure Limit
PNOR = Particulate Not Otherwise Regulated
PNOS = Particulate Not Otherwise Stated
RCRA = Resource Conservation and Recovery Act
REACH = Registration, Evaluation, Authorisation and Restriction of Chemicals
STEL = Short-Term Exposure Limit (15 minutes)
STP = Standard Temperature and Pressure
TCLo = Lowest concentration in air resulting in a toxic effect
TDG = Canada- Transportation of Dangerous Goods
TDLo = Lowest dose resulting in a toxic effect
TLV = Threshold Limit Value
TSCA = Toxic Substance Control Act
TWA = Time-Weighted Average (8 hours)
UFL = Upper Flammable Limit
WHMIS = Canada-Workplace Hazardous Materials Information System