






SAFETY DATA SHEET (SDS)

According to WHMIS 2015

VANADIUM ELECTROLYTE SOLUTION (VANALYTE™)

1. PRODUCT AND COMPANY IDENTIFICATION			
Trade name:	VANADIUM ELECTROLYTE SOLUTION (VANALYTE™)		
Application and commercial uses of substance/mixture:	Scientific research and development, electrolyte equimolar solution used for vanadium redox flow batteries (VRFB)		
Manufacturer/Supplier	ELECTROCHEM TECHNOLOGIES & MATERIALS INC.		
Address	<p><u>HEAD OFFICE</u> Street: 2037 AIRD AVENUE, SUITE 201 City: MONTREAL Province/State: QUEBEC Postal/Zip Code: H1V 2V9 Country: CANADA Telephone: +1 (514) 251-9909 (9:00pm to 5:00pm)(Monday-Friday) Email: contact@electrochem-technologies.com</p> <p><u>MANUFACTURING SITE</u> Street: 75 BOULEVARD DE MORTAGNE C.P. 112 City: BOUCHERVILLE Province/State: QUEBEC Postal/Zip Code: J4B 6Y4 Country: CANADA</p>		
Emergency numbers FOR TRANSPORT ONLY (24 hours/7 days)	CANADA:	CANUTEC	+1-613-996-6666
2. HAZARD(S) IDENTIFICATION			
GHS Classification of the substance or mixture		Met. Corr.1	H290 May be corrosive to metals.
		Skin Corr. 1C	H314 Causes severe skin burns and eye damage.
		Eye Dam . 1	H318 Causes serious eye damage.
		Carc. 1A	H350 May cause cancer.
		Repr. 2	H361 Suspected of damaging fertility or the unborn child. Route of exposure: Oral
		STOT RE 1	H372 Causes damage to the respiratory system through prolonged or repeated exposure. Route of exposure: Inhalation.
		Aquatic Acute 3	H402 Harmful to aquatic life.
		Aquatic Chronic	H412 Harmful to aquatic life with long lasting effects

Hazard pictogram(s)	  GHS05 GHS08
Signal Word (s):	DANGER
Hazard Statements:	<p>H290 May be corrosive to metals</p> <p>H302 Harmful if swallowed</p> <p>H314 Causes severe skin burns and eye damage.</p> <p>H318 Causes serious eyes damage</p> <p>H335 May cause respiratory track irritation</p> <p>H350 May cause cancer.</p> <p>H361 Suspected of damaging fertility or the unborn child. Route of exposure: Oral</p> <p>H372 Causes damage to the respiratory system through prolonged or repeated exposure. Route of exposure: Inhalation.</p> <p>H412 Harmful to aquatic life with long lasting effects.</p>
Precautionary Statements:	<p>P201 Obtain special instructions before use.</p> <p>P202 Do not handle until all safety precautions have been read and understood.</p> <p>P234 Keep only in original container.</p> <p>P260 Do not breathe fumes, dusts or mists or sprays.</p> <p>P264 Wash thoroughly after handling.</p> <p>P270 Do not eat, drink or smoke when using this product.</p> <p>P273 Avoid release to the environment.</p> <p>P280 Wear protective gloves/protective clothing/eye protection/face protection.</p> <p>P301+P312+P330+P331 if swallowed, rinse mouth, do not induce vomiting: call a poison center or doctor/physician if you feel unwell. Rinse the mouth. Do not induce vomiting.</p> <p>P302+P352+P353 if on skin: Wash with plenty of soap and water. Take off immediately all contaminated clothing.</p> <p>P304+P340 if inhaled: remove victim to fresh air and keep at rest in a position comfortable for breathing.</p> <p>P305+P351+P338 if in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.</p> <p>P308+P313 IF exposed or concerned: get medical advice/ attention if you feel unwell.</p> <p>P314 Get medical advice/ attention if you feel unwell</p> <p>P361 Remove immediately contaminated clothing</p> <p>P363 Wash contaminated clothing before reuse.</p> <p>P390 Absorb spillage to prevent material damage and corrosion of surrounding metals..</p> <p>P405 Store locked up.</p> <p>P406 Store in corrosive resistant container with a resistant inner liner.</p> <p>P501 Dispose of contents/container in accordance with local / regional / national / international regulations.</p>

3. COMPOSITION

Chemical family:	Vanadium compounds				
Synonyms, generic names, acronyms:	Vanadium equimolar electrolyte solution				
	NAME	CAS number	Mass percentage (wt.%)	EINECS number	
	SULFURIC ACID	[7664-93-9]	10%-20%	231-639-5	
	VANADIUM OXIDE SULFATE	[27774-13-6]	10%-15%	248-652-7	
	DIVANADIUM (TRIS)SULFATE	[13701-70-7]	10%-15%	237-226-6	
	PHOSPHORIC ACID	[7664-38-2]	≤1%	231-633-2	
	WATER	[7732-18-5]	50%-70%	616-646-7	

4. FIRST AID PROCEDURES

General Treatment:	Immediately remove any clothing contaminated with the product. Symptoms of poisoning may be delayed and occur several hours after exposure; medical observation for at least 48 hours after accidental exposure.
Important Symptoms:	Breathing difficulty. Fever. Coughing. Gastric or intestinal disorders. Danger of pulmonary oedema and pneumonia.
After inhalation:	Remove victim to fresh air. If required provide artificial respiration. Supply oxygen if breathing is difficult. Seek immediate medical advice. Keep patient warm. In case of unconsciousness move the patient body into a stable side position for transportation.
Ingestion:	Clean mouth with water. Seek immediate medical attention.
Skin contact:	Wash affected area with mild soap and water rinse thoroughly. Remove any contaminated clothing. Seek immediate medical advice if required.
Eye contact:	Flush eyes with water, blinking often for several minutes. Remove contact lenses if present and easy to do. Continue rinsing. Then consult a physician if required.

5. FIREFIGHTING MEASURES

Flammability:	Product is not flammable
Extinguishing Media:	No special restrictions – use suitable extinguishing agent for surrounding material and type of fire.
Special Fire Fighting Procedure:	Use full-face, self-contained breathing apparatus with full protective impervious clothing to prevent contact with skin and eyes. Do not inhale gases or combustion gases. Dispose of fire debris and contaminated firefighting water in accordance with enforced regulations.
Special hazards resulting from the mixture:	In case of fire the following substances can be released: sulfur dioxide, vanadium (V) oxide particle, sulfuric acid mists, phosphoric acid.

6. ACCIDENTAL RELEASE MEASURES

If Material Is Released/Spilled:	Wear appropriate respiratory and protective equipment specified in special protection information. Isolate spill area and provide adequate ventilation. Vacuum up spill using a high efficiency particulate absolute (HEPA) air filter and place in a closed container for disposal. Take care not to produce fumes, mists, and aerosol or raise dust. Avoid spillage into the environment.				
Methods for spill containment	Use neutralizing agent. Absorb with liquid-binding material (sand, Kieselguhr, diatomite, spent lime, acid binders, universal binders, sawdust). Send for recovery or disposal in suitable containers.				
Environmental Precautions:	Isolate runoff to prevent environmental pollution and do not allow product to reach sewage systems or any water course. Inform respective authorities in case of seepage into water course or sewage system.				
7. HANDLING AND STORAGE					
Handling Conditions:	Ensure good ventilation and maintain good housekeeping procedures to prevent generation of mists, accumulation of dust and the generation of airborne particles. Wear protective clothing when handling. Avoid inhalation and skin and eye contact. Wash equipment thoroughly after handling.				
Storage Conditions:	Store in a cool, dry place inside a tightly sealed container, away from incompatible materials and direct sunlight. Store apart from materials and conditions listed in section 10 if any.				
Sensitivities:	Do not store together with alkalis and caustic solutions				
Work/Hygienic Maintenance:	Do not use tobacco or food in work area. Wash thoroughly before eating and smoking. Do not blow dust off clothing or skin with compressed air.				
Ventilation:	Provide sufficient ventilation to maintain concentration at or below threshold limit.				
8. EXPOSURE CONTROLS AND PERSONAL PROTECTION					
Permissible Exposure Limits:	CHEMICAL	NIOSH - OSHA		ACGIH TLV [USA]	
		NIOSH REL	OSHA PEL	TWA	STEL
	SULFURIC ACID [7664-93-9]	1 mg/m ³	1 mg/m ³	0.2 mg/m ³	3 mg/m ³
	VANADIUM OXIDE SULFATE [27774-13-6]	N.A.	N.A.	N.A.	N.A.
	VANADIUM (III) SULFATE [13701-70-7]	N.A.	N.A.	N.A.	N.A.
	ORTHOPHOSPHORIC ACID [7664-38-2]	1 mg/m ³	1 mg/m ³	1 mg/m ³	3 mg/m ³
General safety measures:	Keep away from foodstuffs, beverages and feed. Immediately remove all soiled and contaminated clothing. Wash hands before breaks and at the end of work. Store protective clothing separately.				
Special Equipment:	Properly operating fume hood designed for hazardous chemicals and				

	having an average face velocity of at least 100 feet per minute (0.508 m/s).
Respiratory Protection:	In case of brief exposure or low pollution use respiratory filter device such as a Dust Respirator N95 (USA, Canada) or PE (EN 143). In case of intensive or longer exposure or when high concentrations are present use respiratory protective device that is independent of circulating air.
Protective Gloves:	The glove material has to be impervious and chemically resistant to the product/ the substance/ the preparation. Nitrile Rubber (NBR) gloves with minimum thickness 4 mils (0.11 mm) are deemed satisfactory when used for a duration below the recommended time suggested by the manufacturer.
Eye Protection:	Safety glasses and tightly sealed goggles, face shield.
Body Protection:	Acid-proof protective work clothing. Wear close-toed shoes and long sleeves/pants. Wash hands before breaks and at the end of the work shift. Safety shoes or boots with steel toes and sole.
9. PHYSICAL AND CHEMICAL PROPERTIES	
Form:	Liquid
Color:	Dark blue to bluish green
Odor:	Faint metallic odor
Melting point/Freezing point:	-16°C to -10°C (3.3°F to 14°F)
Boiling point:	Not determined
Solubility in/Miscibility with water:	Fully miscible
pH (20°C):	below 1.0
Flammability:	Not applicable
Lower and upper explosion limits:	Not applicable
Flash point:	Not applicable
Auto ignition temperature:	Not applicable
Decomposition temperature:	Not determined
Viscosity (Kinematic):	1.10 to 1.75 mm ² /s
Solubility in/Miscibility with water:	Fully miscible
Partition coefficient n-octanol/water:	Not applicable
Vapor pressure at 20°C (68°F):	23 hPa (17.3 mmHg)
Density at 20°C:	1,250 to 1,450 kg/m ³ (10.43 to 12.10 lb. per gallon)
Relative vapor density:	Not applicable
Particle characteristics:	Not applicable
10. STABILITY AND REACTIVITY	
Stability:	Stable under recommended storage conditions
Reacts With:	Strong bases, lye's, iron metal, zinc metal, aluminum metal, magnesium metal
Incompatibility:	Strong bases, lye's, iron metal, zinc metal, aluminum metal, magnesium metal

Conditions to avoid: No further information

Hazardous Decomposition Products: No further information

11. TOXICOLOGICAL INFORMATION

Information on toxicological effects:

Acute toxicity: Toxicological data

SUBSTANCE	ORAL	DERMAL	INHALATION
VANDIUM OXIDE SULFATE [27774-13-6]	LD50 288 mg/kg (rat) [OECD 401]	LD50 4450 mg/kg (rabbit) [OECD 402]	LC50 0.125 mg/L (mice) [EC No 1272/2008]
VANADIUM (III) SULFATE [13701-70-7]	Not available	Not available	Not available
SULFURIC ACID [7664-93-9]	2140 mg/kg (rat)	Not listed	85-103 mg/m ³ (rat)

Target Organs: Not Available

Potential Health Effects:

Eyes: Irritating to the eyes
Skin: Irritant to the skin and mucous membrane
Ingestion: Toxic by ingestion
Inhalation: May cause respiratory track irritation
Sensitization: No sensitizing effects known

Chronic: No data available

Signs and Symptoms: No effects known.

Aggravated Medical Conditions: No effects known.

Median Lethal Dose: No effects known.

Carcinogenicity: Sulfuric acid contained in the product exhibits carcinogenic properties according to ECHA, EPA, IARC, OSHA or ACGIH

12. ECOLOGICAL INFORMATION

Aquatic Toxicity: No further relevant information available.
Persistent Bioaccumulation Toxicity: No further relevant information available.
Very Persistent, Very Bioaccumulative: No further relevant information available.
Notes: N/A
Toxicity: No further relevant information available.
Persistence and degradability: No further relevant information available.
Bioaccumulative potential: No further relevant information available.
Ecotoxicological effects: Harmful to fish and aquatic life
Mobility in soil: No further relevant information available.
PBT and vPvB assessment: Not Applicable.
Other adverse effects: No further relevant information available.

13. DISPOSAL CONSIDERATIONS

Product, as supplied, should be disposed of in accordance with the regulations issued by the appropriate federal, state and local authorities. Same consideration should be given to containers and packaging. Contact a licensed

professional waste disposal service. Dispose of in accordance with federal, state, provincial, local, national, and international enforced environmental regulations.

14. TRANSPORTATION DATA

Hazardous: Hazardous material for transportation.
 Hazard Class: Class 8 Corrosive substances
 Packing Group: II
 UN Number: UN3264
 Proper Shipping Name: Corrosive liquid, acidic, inorganic, n.o.s.
 (Vanadyl sulfate, sulfuric acid)



Label: 8

DOT

UN/ID No UN3264
 Proper Shipping Name: Corrosive liquid, acidic, inorganic, n.o.s.
 (Vanadyl sulfate, sulfuric acid)
 Hazard Class: Class 8 Corrosive substances
 Packing Group: II



Label: 8

IATA

UN/ID No UN3264
 Proper Shipping Name: CORROSIVE LIQUID, ACIDIC, INORGANIC, N.O.S.
 (VANADYL SULPHATE, SULPHURIC ACID)
 Hazard Class: Class 8 Corrosive substances
 Packing Group: II



Label: 8

TDG

UN/ID No UN3264
 Proper Shipping Name: CORROSIVE LIQUID, ACIDIC, INORGANIC, N.O.S.
 (VANADYL SULPHATE, SULPHURIC ACID)
 Hazard Class: Class 8 Corrosive substances
 Packing Group: II

IMDG

UN/ID No UN3264
 Proper Shipping Name: CORROSIVE LIQUID, ACIDIC, INORGANIC, N.O.S.
 (VANADYL SULPHATE, SULPHURIC ACID)
 Hazard Class: Class 8 Corrosive substances
 Packing Group: II



Label: 8

ICAO(Air)

UN/ID No UN3264
 Proper Shipping Name: CORROSIVE LIQUID, ACIDIC, INORGANIC, N.O.S.
 (VANADYL SULPHATE, SULPHURIC ACID)
 Hazard Class: Class 8 Corrosive substances
 Packing Group: II



Label: 8

Additional information for the transport (TMD, IMDG, IATA):

Excepted quantity (EQ): Code E4
 Limited quantity (LQ): 0.5 Litre
 Excepted quantity (EQ): Maximum net quantity per inner packaging: 10 mL
 Maximum net quantity by outer packaging: 0.5 Litre

15. REGULATORY INFORMATION**United States (USA):**

Toxic Substance Control Act (TSCA): All ingredients are Listed

Superfund Amendments and Reauthorization Act (SARA 355 Extremely Hazardous): Sulfuric acid

Superfund Amendments and Reauthorization Act (SARA 313 Toxic Chemicals): Sulfuric acid,
 vanadium oxide sulfate, phosphoric acid

European Union (EU):

European Inventory of Existing Chemical Substances (EINECS): All ingredients are Listed

Substance of Very High Concern (SVHC) [REACH Regulations (EC) No. 1907/2006]: Not listed

Canada:

Canadian Domestic Substances List (DSL): All ingredients are Listed

Canadian Non-Domestic Substances List (NDSL): Not listed

16. Other Information**Disclaimer**

The information set forth is based on information that Electrochem Technologies & Materials Inc. believes to be accurate. No warranty, expressed or implied, is intended. The information is provided solely for your information

and consideration and Electrochem Technologies & Materials Inc. assumes no legal responsibility for use or reliance thereon. This safety data sheet should be used in conjunction with technical sheets. It does not replace them. The information given is based on our knowledge of this product, at the time of publication. It is given in good faith. The attention of the user is drawn to the possible risks incurred by using the product for any other purpose other than that for which it was intended. This does not in any way excuse the user from knowing and applying all the regulations governing his activity. It is the sole responsibility of the user to take all precautions required in handling the product. The aim of the mandatory regulations mentioned is to help the user to fulfill his obligations regarding the use of hazardous products.

Abbreviations and acronyms:

ADR: European Agreement concerning the International Carriage of Dangerous Goods by Road

IMDG: International Maritime Code for Dangerous Goods

IATA: International Air Transport Association

GHS: Globally Harmonised System of Classification and Labelling of Chemicals

EINECS: European Inventory of Existing Commercial Chemical Substances

CAS: Chemical Abstracts Service (division of the American Chemical Society)

LC50: Lethal concentration, 50 percent

LD50: Lethal dose, 50 percent

PST: Persistent, Bioaccumulative and Toxic

vPvB: very Persistent and very Bioaccumulative

TLV: Threshold Limit Value

PEL: Permissible Exposure Limit

REL: Recommended Exposure Limit

Met. Corr.1: Corrosive to metals - Category 1

Acute Tax. 3: Acute toxicity- Category 3

Skin Corr. 1A: Skin corrosion/irritation - Category 1A

Skin Corr. 1 B: Skin corrosion/irritation - Category 1 B

Skin Carr. 1 C: Skin corrosion/Irritation - Category 1 C

Skin Irrit. 2: Skin corrosion/irritation - Category 2

Eye Dam. 1: Serious eye damage/eye irritation- Category 1

Eye Irrit. 2A: Serious eye damage/eye irritation - Category 2A

Carc. 1A: Carcinogenicity- Category 1A

Repr. 2: Reproductive toxicity - Category 2

STOT RE 1: Specific target organ toxicity (repeated exposure) - Category 1

Aquatic Acute 2: Hazardous to the aquatic environment- acute aquatic hazard -Category 2

Aquatic Acute 3: Hazardous to the aquatic environment- acute aquatic hazard - Category 3

Aquatic Chronic 2: Hazardous to the aquatic environment- long-term aquatic hazard - Category 2

Aquatic Chronic 3: Hazardous to the aquatic environment - long-term aquatic hazard -Category 3

-----oo0 END OF SAFETY DATA SHEET 0oo-----