Emissions to Air Management Plan

Report Ref: ITM - EP001 - 010

Submitted to:

Environment Agency

In Support of Permit Application Ref:

EPR/HP3640QD/A001 & EPR/AP3225SE/P001

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Contents

1. Emissions to Air Management Plan

1.1 Introduction

This document is the Emissions to Air Management Plan for the Environmental Permit application for ITM Power (Trading) Ltd, located in Sheffield, England. The National Grid Reference for the centre of the site is SK 39894 90515. ITM Power (Trading) Ltd operates a hydrogen electrolyser manufacturing facility which is located off Shepcote Lane in Sheffield. The main activity undertaken at the facility is the manufacture of hydrogen electrolysers.

The facility is required to apply for an Environmental Permit (EP) in order to ensure compliance with the Environmental Permitting (England and Wales) Regulations 2016, SI 2016/1154, as amended.

Table 1.1 below details the Regulated Activities that take place within the Installation boundary:

Table 1.1 – EPR Regulated Activities		
EPR Schedule 1 Ref	**Description**	**ITM Process**
S4.2 A(1)(c)	Unless falling within any other Section, any manufacturing activity (other than the application of a glaze or vitreous enamel) involving the use of, or the use or recovery of, any compound of any of the following elements— (i)antimony, (ii)arsenic, (iii)beryllium, (iv)gallium, (v)indium, (vi)lead, (vii)palladium, (viii)platinum, (ix)selenium, (x)tellurium,	The process using platinum-based electroplating solution for coating metal sinters.
S4.2 A(1)(c)	As above	Production of the catalyst coated membrane (CCM) using in-house formulated precious metal-based ink powders to print onto a non-metal substrate.
S4.2 A(1)(b)	Unless falling within any other Section, any manufacturing activity which is likely to result in the release into the air of any hydrogen halide (other than the manufacture of glass or the coating, plating or surface treatment of metal) or which is likely to result in the release into the air or water of any halogen or any of the compounds mentioned in paragraph (a)(vi) (other than the treatment of water).	The hydrochloric acid chemical milling process for removal of the metal oxide layer from titanium components.

2. Emissions to Air Inventory & limits

2.1 Emissions Inventory

Two of the Regulated Activities that take place within the Installation boundary generate emissions to air that have associated permittable limits.

Table 2.1 below provides details of the point source releases to air from these activities.

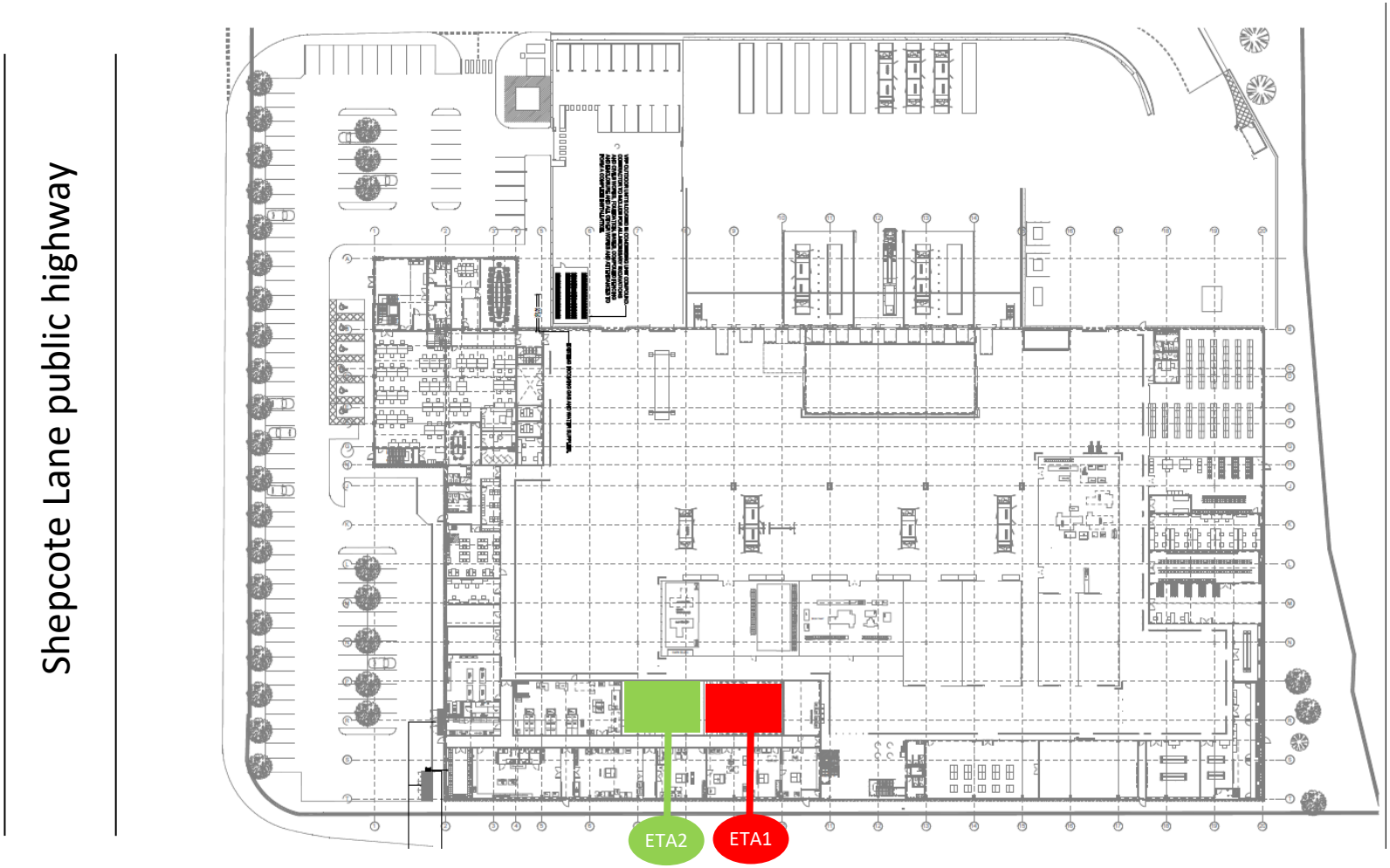
Table 2.1 – Point Source Emissions to Air				
Emission Point Reference (See image 1)	**Regulated Activity**	**Source**	**Nature of Release**	**EA Limits**
ETA1	The hydrochloric acid chemical milling process for removal of the metal oxide layer from titanium	Acid etch machine	Hydrochloric acid vapour and mist.	10mg/m3 if mass emission is above 30g/hr. [2]
			Sulphuric acid vapour and mist.	150 mg/m3 where emissions over 500g/hr. [3]
ETA1	The hydrochloric acid chemical milling process for removal of the metal oxide layer from Titanium.	Acid rinse tanks	Sulphuric acid vapour & mist.	150 mg/m3 where emissions over 500g/hr. [3]
ETA2	Production of the catalyst coated membrane (CCM) using in-house formulated precious metal-based ink powders to print onto a non-metal substrate	Tunnel Oven	Volatile Organic Compounds (VOC's) from solvents: Nafion, Dipropylene Glycol and Propylene Glycol.[1]	75mg/m3. [4]

1. Safety Data Sheets for solvents provided in Appendix 1,2,3
2. Limits for HCL and sulphuric acid gases emissions are found in the document 'Common Wastewater and waste gas treatment/management systems in the chemical sector'
3. Limit for Sulphuric Acid gases emissions are found in the document 'Common Wastewater and waste gas treatment/management systems in the chemical sector'
4. Limit for VOC's are found in the document titled 'Inorganic Chemicals Sector (EPR 4.03) guidance

The two emission points in Table 2.1 are shown on a map of the facility in Section 2.2 below.

2.2 Emissions to Air Map

Image 1 below shows the location of the point source emissions listed in Table 2.1 and the route to atmosphere that the emissions take.



ETA1 is the lab where the etching and plating of titanium sinters takes place, and the hydrochloric and sulphuric acid emissions are generated.

ETA2 is the print lab where the printing and drying of the CCM is completed, and where the VOC emissions are generated from the Natgraph Tunnel Oven.

Image 1: Location of point source emissions and route to atmosphere

3. Emissions Testing & Results

A program of works was undertaken to understand emissions to air from the processes associated with the regulated activities listed in Table 1.1.

This program of works is described below:

- Quantify emissions to air from the regulated activities
- Verify emission levels against limits specified by the Environment Agency
- Design and install abatement systems to bring emission levels under the acceptable limits (if required)

Emissions from the regulated activities (listed in Table 2.1) have been tested as per the request of Environment Agency Area Regulator Officer Ralph Bolton.

Emissions test results can be found in Table 3.1 below and more detail can be found in the reports referenced in the table, all reports are included in the document submission pack for the permit application.

All emissions tests were performed by Envirocare Technical Consultancy Ltd, who are MCERTS approved and MCERTS numbers and qualifications for the monitoring operatives are available within the reports listed in Table 3.1 below.

All standards used throughout the emissions tests are listed in the reports shown in Table 3.1 below.

Table 3.1 Emissions Testing Results

Report Ref	Substance	Mass Emission (g/hr)	Concentration (mg/m3)
ES-1429 EP1 – Acid Rinse LEV 06	Sulphuric Acid gases	2.3	1.0
ES-1429 EP2 – Master Etch LEV 07	Hydrochloric Acid gases	51.7	22.6
ES-1429 EP2 – Master Etch LEV 07	Sulphuric Acid gases	0.77	0.34
ES-1429 EP3 – Natgraph Tunnel Oven	Total VOC's	3.8	2.6

These results and any abatement required is discussed in Section 4.

4. Emissions Abatement Systems

4.1 Abatement for VOC's

As shown by the emissions testing results for the tunnel oven, the VOC emissions are below the limit of 75mg/m3, which means that no abatement measures are required, and no ongoing monitoring is required.

This conclusion has been confirmed by the Regulator Officer for South Yorkshire Ralph Bolton, see email extract below. This email was in response to the first set of emissions testing results from the tunnel oven (Ref: 17233 – Emissions Tests 21st Dec 2023).

RE: ITM Power - Emissions Testing Results

BR Bolton, Ralph <ralph.bolton@enviro

Reply | Reply All | Forward

To Tegan Pringle

Tue 17/01/2023 11:27

Cc Shane Hurley; Rachel Smith; Eoin Hughes; Lee Hamilton

You replied to this message on 17/01/2023 13:58.

Caution: This email comes from outside the ITM email system. Please take care when clicking links or opening attachments. If in doubt, contact IT support

Morning Tegan
The VOC results are very low, as are the acid gas results (although the low flow meant the test did not meet the required standard, it still demonstrates minimal emissions under the operating conditions at the time of monitoring).
I am therefore satisfied that emissions were insignificant and agree to ITM Power continuing chemical activities pending permit application and issue. If the results are representative of normal operations, it is unlikely we would require ongoing monitoring, however this will be decided during the permit determination. It may be that an improvement condition will be used in the permit to require further monitoring to demonstrate emissions are routinely low and provide a report with an updated risk assessment to show that ongoing periodic monitoring is not needed, ultimately this will be decided by the permitting officer assigned to your application.
Regards

Ralph Bolton
Regulatory Officer – South Yorkshire Installations Team
Environment Agency | Bowbridge Close, Bradmarsh Business Park, Templeborough, Rotherham S60 1BY
Tel 02030253993
If an urgent response is required, call my team's number 02030254014, or 0800807060 to report pollution incidents
ralph.bolton@environment-agency.gov.uk

4.2 Abatement for acid gas emissions

Acid gas emissions are generated from the etching process which is one of the regulated activities as shown in Table 1.1.

Emissions test results show that the without any abatement, the acid gas emissions from this process would be above the limit for HCL acid gases to air.

This system therefore requires abatement to treat the emissions and bring the HCL acid gas emissions under the specified limit.

An abatement system has been commissioned and will be fully installed before the permit application is determined. The process has only been operated for the purposes of emissions testing.

The process will not be operated until the abatement system is in place, the emissions have been retested and an agreement with the regulatory officer has been reached for its safe operation.

Details of the abatement system are provided in Appendix 2.

Appendix 1: Safety Data Sheets

This appendix contains details of the Safety Data Sheets for the following solvents used within the production of the Catalyst Coated Membrane (CCM).

Solvent Name	**Manufacturer**	**SDS Date**
Dipropylene Glycol	Thermofisher Scientific	15-Jan-2021
Propylene Glycol	Thermofisher Scientific	24-Dec-2021
Nafion PFSA 20% Dispersions – D2021CS	Chemours	15-Nov-2019

ThermoFisher SCIENTIFIC

SAFETY DATA SHEET

Creation Date 03-May-2010 **Revision Date** 15-Jan-2021 **Revision Number** 2

SECTION 1: IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

1.1. Product identifier

Product Description:	Dipropylene glycol
Cat No. :	**A18716**
Synonyms	1,1'-Oxydi-2-Propanol
CAS No	25265-71-8
EC No	246-770-3
Molecular Formula	C6 H14 O3
REACH registration number	-

1.2. Relevant identified uses of the substance or mixture and uses advised against

Recommended Use	Laboratory chemicals.
Sector of use	SU3 - Industrial uses: Uses of substances as such or in preparations at industrial sites
Product category	PC21 - Laboratory chemicals
Process categories	PROC15 - Use as a laboratory reagent
Environmental release category	ERC6a - Industrial use resulting in manufacture of another substance (use of intermediates)
Uses advised against	No Information available

1.3. Details of the supplier of the safety data sheet

Company

Thermo Fisher (Kandel) GmbH
Erlenbachweg 2, 76870 Kandel, Germany
Tel: +49 (0) 721 84007 280
Fax: +49 (0) 721 84007 300

Swiss distributor - Fisher Scientific AG
Neuhofstrasse 11, CH 4153 Reinach
Tel: +41 (0) 56 618 41 11
e-mail - infoch@thermofisher.com

E-mail address

tech@alfa.com
www.alfa.com
Product safety Tel + +049 (0) 7275 988687-0

1.4. Emergency telephone number

Carechem 24: **+44 (0) 1235 239 670** (Multi-language emergency number)
Poison Information Center Mainz
www.giftinfo.uni-mainz.de
Telephone: +49(0)6131/19240

Exclusively for customers in Austria:
Poison Information Center (VIZ)
Emergency call 0-24 clock: **+43 1 406 43 43**
Office hours: Monday to Friday, 8am to 4pm, tel: +43 1 406 68 98

For customers in Switzerland:
Tox Info Suisse Emergency Number: **145 (24hr)**
Tox Info Suisse: +41-44 251 51 51 (Emergency number from abroad)
Chemtrec (24h) Toll-Free: 0800 564 402

SECTION 2: HAZARDS IDENTIFICATION

2.1. Classification of the substance or mixture

CLP Classification - Regulation (EC) No 1272/2008

Physical hazards

Based on available data, the classification criteria are not met

Health hazards
Based on available data, the classification criteria are not met

Environmental hazards
Based on available data, the classification criteria are not met

Full text of Hazard Statements: see section 16

2.2. Label elements
None required

2.3. Other hazards

Substance is not considered persistent, bioaccumulative and toxic (PBT) / very persistent and very bioaccumulative (vPvB)

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

3.1. Substances

Component	CAS No	EC No	Weight %	CLP Classification - Regulation (EC) No 1272/2008
Dipropylene glycol	25265-71-8	EEC No. 246-770-3	>95	-

REACH registration number	-

Full text of Hazard Statements: see section 16

SECTION 4: FIRST AID MEASURES

4.1. Description of first aid measures

Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Get medical attention.
Skin Contact	Wash off immediately with plenty of water for at least 15 minutes. Get medical attention immediately if symptoms occur.
Ingestion	Do NOT induce vomiting. Get medical attention.
Inhalation	Remove to fresh air. Get medical attention immediately if symptoms occur. If not breathing, give artificial respiration.
Self-Protection of the First Aider	No special precautions required.

4.2. Most important symptoms and effects, both acute and delayed

No information available.

4.3. Indication of any immediate medical attention and special treatment needed

Notes to Physician Treat symptomatically.

SECTION 5: FIREFIGHTING MEASURES

5.1. Extinguishing media

Suitable Extinguishing Media
Water spray, carbon dioxide (CO2), dry chemical, alcohol-resistant foam.

Extinguishing media which must not be used for safety reasons
No information available.

5.2. Special hazards arising from the substance or mixture

Thermal decomposition can lead to release of irritating gases and vapors.

Hazardous Combustion Products
Carbon monoxide (CO), Carbon dioxide (CO_2).

5.3. Advice for firefighters

As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

SECTION 6: ACCIDENTAL RELEASE MEASURES

6.1. Personal precautions, protective equipment and emergency procedures

Ensure adequate ventilation. Use personal protective equipment as required.

6.2. Environmental precautions

Should not be released into the environment. See Section 12 for additional Ecological Information.

6.3. Methods and material for containment and cleaning up

Soak up with inert absorbent material. Keep in suitable, closed containers for disposal.

6.4. Reference to other sections

Refer to protective measures listed in Sections 8 and 13.

SECTION 7: HANDLING AND STORAGE

7.1. Precautions for safe handling

Wear personal protective equipment/face protection. Ensure adequate ventilation. Avoid contact with skin, eyes or clothing. Avoid ingestion and inhalation.

Hygiene Measures
Handle in accordance with good industrial hygiene and safety practice. Keep away from food, drink and animal feeding stuffs. Do not eat, drink or smoke when using this product. Remove and wash contaminated clothing and gloves, including the inside, before re-use. Wash hands before breaks and after work.

7.2. Conditions for safe storage, including any incompatibilities

Keep containers tightly closed in a dry, cool and well-ventilated place.

Technical Rules for Hazardous Substances (TRGS) 510 Storage Class (LGK) (Germany)	Storage Class/LGK 10
Switzerland - Storage of hazardous substances	Storage class - SC 10/12 https://www.kvu.ch/de/themen/stoffe-und-produkte https://www.kvu.ch/fr/themes/substances-et-produits https://www.kvu.ch/it/temi/sostanze-e-prodotti

7.3. Specific end use(s)

Use in laboratories

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1. Control parameters

Exposure limits
List source(s): **CH** - The Government of Switzerland has set a directive on limit values for working materials (Grenzwerte am arbeitplatz) which is based on the Swiss Federal Regulation "Verordnung über die Verhütung von Unfällen und Berufskrankheiten". This directive is administered, periodically revised and enforced by SUVA (Swiss National Accident Insurance Fund).

Component	Italy	Germany	Portugal	The Netherlands	Finland
Dipropylene glycol		TWA: 100 mg/m³ (8 Stunden). AGW - exposure factor 2 TWA: 100 mg/m³ (8 Stunden). MAK can occur as vapor and aerosol at the same time Höhepunkt: 200 mg/m³			

Component	Austria	Denmark	Switzerland	Poland	Norway
Dipropylene glycol			STEL: 280 mg/m³ 15 Minuten TWA: 140 mg/m³ 8 Stunden		

Component	Russia	Slovak Republic	Slovenia	Sweden	Turkey
Dipropylene glycol			TWA: 100 mg/m³ 8 urah inhalable fraction STEL: 200 mg/m³ 15 minutah inhalable fraction		

Biological limit values
This product, as supplied, does not contain any hazardous materials with biological limits established by the region specific regulatory bodies

Monitoring methods
BS EN 14042:2003 Title Identifier: Workplace atmospheres. Guide for the application and use of procedures for the assessment of exposure to chemical and biological agents.

Derived No Effect Level (DNEL) / Derived Minimum Effect Level (DMEL)
See table for values

Component	Acute effects local (Dermal)	Acute effects systemic (Dermal)	Chronic effects local (Dermal)	Chronic effects systemic (Dermal)
Dipropylene glycol 25265-71-8 (>95)				DNEL = 84mg/kg bw/day

Component	Acute effects local (Inhalation)	Acute effects systemic (Inhalation)	Chronic effects local (Inhalation)	Chronic effects systemic (Inhalation)
Dipropylene glycol 25265-71-8 (>95)				DNEL = 238mg/m³

Predicted No Effect Concentration (PNEC)
See values below.

Component	Fresh water	Fresh water sediment	Water Intermittent	Microorganisms in sewage treatment	Soil (Agriculture)
Dipropylene glycol 25265-71-8 (>95)	PNEC = 0.1mg/L	PNEC = 0.238mg/kg sediment dw	PNEC = 1mg/L	PNEC = 1000mg/L	PNEC = 0.0253mg/kg soil dw

Component	Marine water	Marine water sediment	Marine water Intermittent	Food chain	Air
Dipropylene glycol 25265-71-8 (>95)	PNEC = 0.01mg/L	PNEC = 0.0238mg/kg sediment dw		PNEC = 313mg/kg food	

8.2. Exposure controls

Engineering Measures
None under normal use conditions.

Personal protective equipment

Eye Protection Wear safety glasses with side shields (or goggles) (European standard - EN 166)

Hand Protection Protective gloves

Glove material	Breakthrough time	Glove thickness	EU standard	Glove comments
Natural rubber Nitrile rubber Neoprene PVC	See manufacturers recommendations	-	EN 374	(minimum requirement)

Skin and body protection Wear appropriate protective gloves and clothing to prevent skin exposure.

Inspect gloves before use. observe the instructions regarding permeability and breakthrough time which are provided by the supplier of the gloves. (Refer to manufacturer/supplier for information) gloves are suitable for the task: Chemical compatability, Dexterity, Operational conditions, User susceptibility, e.g. sensitisation effects, also take into consideration the specific local conditions under which the product is used, such as the danger of cuts, abrasion. gloves with care avoiding skin contamination.

Respiratory Protection No protective equipment is needed under normal use conditions.

Large scale/emergency use Use a NIOSH/MSHA or European Standard EN 136 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced
Recommended Filter type: Particle filter

Small scale/Laboratory use Maintain adequate ventilation
Recommended half mask:- Valve filtering: EN405; or; Half mask: EN140; plus filter, EN 141

Environmental exposure controls No information available.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

9.1. Information on basic physical and chemical properties

Physical State	Liquid	
Appearance	Colorless	
Odor	Odorless	
Odor Threshold	No data available	
Melting Point/Range	No data available	
Softening Point	No data available	
Boiling Point/Range	229 - 232 °C / 444.2 - 449.6 °F	@ 760 mmHg
Flammability (liquid)	No data available	
Flammability (solid,gas)	Not applicable	Liquid
Explosion Limits	**Lower** 2.9 vol% **Upper** 12.6 vol%	
Flash Point	138 °C / 280.4 °F	**Method** - No information available
Autoignition Temperature	310 °C / 590 °F	
Decomposition Temperature	No data available	
pH	No information available	
Viscosity	No data available	
Water Solubility	Miscible	
Solubility in other solvents	No information available	
Partition Coefficient (n-octanol/water)		
Component	**log Pow**	
Dipropylene glycol	-1.07	
Vapor Pressure	0.03 mmHg @ 25 °C	
Density / Specific Gravity	1.020	
Bulk Density	Not applicable	Liquid

Vapor Density	4.63	(Air = 1.0)
Particle characteristics	Not applicable (liquid)	

9.2. Other information

Molecular Formula	C6 H14 O3
Molecular Weight	134.18

SECTION 10: STABILITY AND REACTIVITY

10.1. Reactivity

None known, based on information available

10.2. Chemical stability

Hygroscopic.

10.3. Possibility of hazardous reactions

Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions	None under normal processing.

10.4. Conditions to avoid

Incompatible products. Excess heat. Exposure to moist air or water.

10.5. Incompatible materials

Strong oxidizing agents.

10.6. Hazardous decomposition products

Carbon monoxide (CO). Carbon dioxide (CO_2).

SECTION 11: TOXICOLOGICAL INFORMATION

11.1. Information on hazard classes as defined in Regulation (EC) No 1272/2008

Product Information

(a) acute toxicity;

Oral	Based on available data, the classification criteria are not met
Dermal	Based on available data, the classification criteria are not met
Inhalation	Based on available data, the classification criteria are not met

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Dipropylene glycol	LD50 = 14850 mg/kg (Rat)	LD50 > 5010 mg/kg (Rabbit)	LC50 > 2.34 mg/L (Rat) 4 h

(b) skin corrosion/irritation; Based on available data, the classification criteria are not met

(c) serious eye damage/irritation; Based on available data, the classification criteria are not met

(d) respiratory or skin sensitization;

Respiratory	Based on available data, the classification criteria are not met
Skin	Based on available data, the classification criteria are not met

(e) germ cell mutagenicity; Based on available data, the classification criteria are not met

	Not mutagenic in AMES Test
(f) carcinogenicity;	Based on available data, the classification criteria are not met There are no known carcinogenic chemicals in this product
(g) reproductive toxicity;	Based on available data, the classification criteria are not met
(h) STOT-single exposure;	Based on available data, the classification criteria are not met
(i) STOT-repeated exposure;	Based on available data, the classification criteria are not met
Target Organs	None known.
(j) aspiration hazard;	Based on available data, the classification criteria are not met
Other Adverse Effects	The toxicological properties have not been fully investigated.
Symptoms / effects,both acute and delayed	No information available.

11.2. Information on other hazards

Endocrine Disrupting Properties	Assess endocrine disrupting properties for human health. This product does not contain any known or suspected endocrine disruptors.

SECTION 12: ECOLOGICAL INFORMATION

12.1. Toxicity
Ecotoxicity effects .

Component	Microtox	M-Factor
Dipropylene glycol	EC50 = 10000 mg/L 16 h	

12.2. Persistence and degradability
Persistence Persistence is unlikely.

12.3. Bioaccumulative potential Bioaccumulation is unlikely

Component	log Pow	Bioconcentration factor (BCF)
Dipropylene glycol	-1.07	0.3 - 1.4

12.4. Mobility in soil The product is water soluble, and may spread in water systems . Will likely be mobile in the environment due to its water solubility. Highly mobile in soils

12.5. Results of PBT and vPvB assessment Substance is not considered persistent, bioaccumulative and toxic (PBT) / very persistent and very bioaccumulative (vPvB).

12.6. Endocrine disrupting properties

Endocrine Disruptor Information	This product does not contain any known or suspected endocrine disruptors

12.7. Other adverse effects

Persistent Organic Pollutant	This product does not contain any known or suspected substance
Ozone Depletion Potential	This product does not contain any known or suspected substance

SECTION 13: DISPOSAL CONSIDERATIONS

13.1. Waste treatment methods

Waste from Residues/Unused Products	Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.
Contaminated Packaging	Empty remaining contents. Dispose of in accordance with local regulations. Do not re-use empty containers.
European Waste Catalogue (EWC)	According to the European Waste Catalog, Waste Codes are not product specific, but application specific.
Other Information	Waste codes should be assigned by the user based on the application for which the product was used.
Switzerland - Waste Ordinance	Disposal should be in accordance with applicable regional, national and local laws and regulations. Ordinance on the Avoidance and the Disposal of Waste (Waste Ordinance, ADWO) SR 814.600 https://www.fedlex.admin.ch/eli/cc/2015/891/en

SECTION 14: TRANSPORT INFORMATION

IMDG/IMO	Not regulated
14.1. UN number	
14.2. UN proper shipping name	
14.3. Transport hazard class(es)	
14.4. Packing group	
ADR	Not regulated
14.1. UN number	
14.2. UN proper shipping name	
14.3. Transport hazard class(es)	
14.4. Packing group	
IATA	Not regulated
14.1. UN number	
14.2. UN proper shipping name	
14.3. Transport hazard class(es)	
14.4. Packing group	
14.5. Environmental hazards	No hazards identified
14.6. Special precautions for user	No special precautions required
14.7. Maritime transport in bulk	Not applicable, packaged goods

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Dipropylene glycol **Revision Date** 15-Jan-2021

according to IMO instruments

SECTION 15: REGULATORY INFORMATION

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

International Inventories
X = listed, Europe (EINECS/ELINCS/NLP), U.S.A. (TSCA), Canada (DSL/NDSL), Philippines (PICCS), China (IECSC), Japan (ENCS), Japan (ISHL), Australia (AICS), Korea (KECL).

Component	EINECS	ELINCS	NLP	TSCA	DSL	NDSL	PICCS	IECSC	ENCS	ISHL	AICS	KECL
Dipropylene glycol	246-770-3	-		X	X	-	X	X	X	X	X	KE-12226

Component	CAS No	Seveso III Directive (2012/18/EC) - Qualifying Quantities for Major Accident Notification	Seveso III Directive (2012/18/EC) - Qualifying Quantities for Safety Report Requirements
Dipropylene glycol	25265-71-8	Not applicable	Not applicable

Regulation (EC) No 649/2012 of the European Parliament and of the Council of 4 July 2012 concerning the export and import of dangerous chemicals
Not applicable

Take note of Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work .

National Regulations

UK - Take note of Control of Substances Hazardous to Health Regulations (COSHH) 2002 and 2005 Amendment

WGK Classification See table for values

Component	Germany - Water Classification (VwVwS)	Germany - TA-Luft Class
Dipropylene glycol	WGK1	

Swiss Regulations
Article 4 para. 4 of the Ordinance on the protection of young people in the workplace (SR 822.115) and Article 1 lit. f of the EAER regulation on hazardous work and young people (SR 822.115.2).
Take note on Article 13 Maternity Ordinance (SR 822.111.52) with regards expectant and nursing mothers.

15.2. Chemical safety assessment

A Chemical Safety Assessment/Report (CSA/CSR) has not been conducted

SECTION 16: OTHER INFORMATION

Full text of H-Statements referred to under sections 2 and 3

Legend

CAS - Chemical Abstracts Service

EINECS/ELINCS - European Inventory of Existing Commercial Chemical Substances/EU List of Notified Chemical Substances

PICCS - Philippines Inventory of Chemicals and Chemical Substances

TSCA - United States Toxic Substances Control Act Section 8(b) Inventory

DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List

ENCS - Japanese Existing and New Chemical Substances

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IECSC - Chinese Inventory of Existing Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances
AICS - Australian Inventory of Chemical Substances
NZIoC - New Zealand Inventory of Chemicals

WEL - Workplace Exposure Limit
ACGIH - American Conference of Governmental Industrial Hygienists
DNEL - Derived No Effect Level
RPE - Respiratory Protective Equipment
LC50 - Lethal Concentration 50%
NOEC - No Observed Effect Concentration
PBT - Persistent, Bioaccumulative, Toxic
TWA - Time Weighted Average
IARC - International Agency for Research on Cancer
Predicted No Effect Concentration (PNEC)
LD50 - Lethal Dose 50%
EC50 - Effective Concentration 50%
POW - Partition coefficient Octanol:Water
vPvB - very Persistent, very Bioaccumulative

ADR - European Agreement Concerning the International Carriage of Dangerous Goods by Road
IMO/IMDG - International Maritime Organization/International Maritime Dangerous Goods Code
OECD - Organisation for Economic Co-operation and Development
BCF - Bioconcentration factor
ICAO/IATA - International Civil Aviation Organization/International Air Transport Association
MARPOL - International Convention for the Prevention of Pollution from Ships
ATE - Acute Toxicity Estimate
VOC - (volatile organic compound)

Key literature references and sources for data
https://echa.europa.eu/information-on-chemicals
Suppliers safety data sheet, Chemadvisor - LOLI, Merck index, RTECS

Training Advice
Chemical hazard awareness training, incorporating labelling, Safety Data Sheets (SDS), Personal Protective Equipment (PPE) and hygiene.

Prepared By	Health, Safety and Environmental Department
Creation Date	03-May-2010
Revision Date	15-Jan-2021
Revision Summary	Not applicable.

This safety data sheet complies with the requirements of Regulation (EC) No. 1907/2006. COMMISSION REGULATION (EU) 2020/878 amending Annex II to Regulation (EC) No 1907/2006 .

For Switzerland - Compiled in accordance with the technical provisions referred to in Annex 2, Number 3, ChemO (SR 813.11 - Ordinance on Protection against Dangerous Substances and Preparations).

Disclaimer
The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of Safety Data Sheet

ALFAAA18716

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ThermoFisher SCIENTIFIC

SAFETY DATA SHEET

Creation Date 19-Nov-2009 **Revision Date** 24-Dec-2021 **Revision Number** 8

1. Identification

Product Name Propylene Glycol

Cat No. : P355-1; P355-4; P355-20; P355-200; S801501; XXBA147

CAS No 57-55-6
Synonyms 1,2-Propanediol; 1,2-Dihydroxypropane; Methyl Glycol (USP/FCC)

Recommended Use Laboratory chemicals.
Uses advised against Food, drug, pesticide or biocidal product use.

Details of the supplier of the safety data sheet

Company
Fisher Scientific Company
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Emergency Telephone Number CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

2. Hazard(s) identification

Classification
This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Label Elements
None required

Hazards not otherwise classified (HNOC)

None identified

3. Composition/Information on Ingredients

Component	CAS No	Weight %
1,2-Propylene glycol	57-55-6	>95

4. First-aid measures

Eye Contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. If symptoms persist, call a physician.

Skin Contact Wash off immediately with plenty of water for at least 15 minutes. Get medical attention if symptoms occur.

Inhalation Remove to fresh air. Get medical attention immediately if symptoms occur. If not breathing, give artificial respiration.

Ingestion Do NOT induce vomiting. Get medical attention immediately if symptoms occur.

Most important symptoms and effects No information available.

Notes to Physician Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media Water spray, carbon dioxide (CO2), dry chemical, alcohol-resistant foam.

Unsuitable Extinguishing Media No information available

Flash Point 99 °C / 210.2 °F

Method - No information available

Autoignition Temperature 400 °C / 752 °F

Explosion Limits
Upper 12.6 vol %
Lower 2.6 vol %
Sensitivity to Mechanical Impact No information available
Sensitivity to Static Discharge No information available

Specific Hazards Arising from the Chemical
Keep product and empty container away from heat and sources of ignition. Thermal decomposition can lead to release of irritating gases and vapors.

Hazardous Combustion Products
Carbon monoxide (CO). Carbon dioxide (CO_2).
Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA

Health	Flammability	Instability	Physical hazards
2	1	1	N/A

6. Accidental release measures

Personal Precautions	Use personal protective equipment as required. Ensure adequate ventilation.
Environmental Precautions	Should not be released into the environment. See Section 12 for additional Ecological Information.
Methods for Containment and Clean Up	Soak up with inert absorbent material. Keep in suitable, closed containers for disposal.

7. Handling and storage

Handling	Ensure adequate ventilation. Wear personal protective equipment/face protection.
Storage.	Keep containers tightly closed in a dry, cool and well-ventilated place. Keep away from heat, sparks and flame. Incompatible Materials. Strong oxidizing agents. Acids.

8. Exposure controls / personal protection

Exposure Guidelines

Engineering Measures	Ensure adequate ventilation, especially in confined areas. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal Protective Equipment

Eye/face Protection	Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin and body protection	Wear appropriate protective gloves and clothing to prevent skin exposure.
Respiratory Protection	Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.
Hygiene Measures	Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Viscous liquid Liquid
Appearance	Clear Colourless
Odor	Odorless
Odor Threshold	No information available
pH	6.5-7.5 100g/l aq. sol
Melting Point/Range	-60 °C / -76 °F
Boiling Point/Range	187 °C / 368.6 °F
Flash Point	99 °C / 210.2 °F
Evaporation Rate	No information available
Flammability (solid,gas)	Not applicable
Flammability or explosive limits	
Upper	12.6 vol %
Lower	2.6 vol %
Vapor Pressure	0.13 mbar @ 20 °C
Vapor Density	2.62 (Air = 1.0)
Specific Gravity	1.03 - 1.04
Solubility	Soluble in water
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	400 °C / 752 °F
Decomposition Temperature	No information available

Viscosity	45 mPa.s at 20 °C
Molecular Formula	C3 H8 O2
Molecular Weight	76.10

10. Stability and reactivity

Reactive Hazard None known, based on information available

Stability Hygroscopic.

Conditions to Avoid Incompatible products. Excess heat. Exposure to moist air or water.

Incompatible Materials Strong oxidizing agents, Acids

Hazardous Decomposition Products Carbon monoxide (CO), Carbon dioxide (CO_2)

Hazardous Polymerization Hazardous polymerization does not occur.

Hazardous Reactions None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information
Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
1,2-Propylene glycol	LD50 = 20 g/kg (Rat)	LD50 = 20800 mg/kg (Rabbit)	Not listed

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation No information available

Sensitization No information available

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS No	IARC	NTP	ACGIH	OSHA	Mexico
1,2-Propylene glycol	57-55-6	Not listed	Not listed	Not listed	Not listed	Not listed

Mutagenic Effects No information available

Reproductive Effects No information available.

Developmental Effects No information available.

Teratogenicity No information available.

STOT - single exposure None known
STOT - repeated exposure None known

Aspiration hazard No information available

Symptoms / effects,both acute and delayed No information available

Endocrine Disruptor Information No information available

Other Adverse Effects The toxicological properties have not been fully investigated.

U.S. Federal Regulations

SARA 313 Not applicable

SARA 311/312 Hazard Categories See section 2 for more information

CWA (Clean Water Act) Not applicable

Clean Air Act Not applicable

OSHA - Occupational Safety and Health Administration Not applicable

CERCLA Not applicable

California Proposition 65 This product does not contain any Proposition 65 chemicals.

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
1,2-Propylene glycol	-	X	X	-	X

U.S. Department of Transportation
Reportable Quantity (RQ): N
DOT Marine Pollutant N
DOT Severe Marine Pollutant N

U.S. Department of Homeland Security This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade Slight risk, Grade 1

Authorisation/Restrictions according to EU REACH

Safety, health and environmental regulations/legislation specific for the substance or mixture

Component	CAS No	OECD HPV	Persistent Organic Pollutant	Ozone Depletion Potential	Restriction of Hazardous Substances (RoHS)
1,2-Propylene glycol	57-55-6	Listed	Not applicable	Not applicable	Not applicable

Component	CAS No	Seveso III Directive (2012/18/EC) - Qualifying Quantities for Major Accident Notification	Seveso III Directive (2012/18/EC) - Qualifying Quantities for Safety Report Requirements	Rotterdam Convention (PIC)	Basel Convention (Hazardous Waste)
1,2-Propylene glycol	57-55-6	Not applicable	Not applicable	Not applicable	Not applicable

16. Other information

Prepared By Regulatory Affairs
Thermo Fisher Scientific
Email: EMSDS.RA@thermofisher.com

12. Ecological information

Ecotoxicity

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
1,2-Propylene glycol	EC50: = 19000 mg/L, 96h (Pseudokirchneriella subcapitata)	LC50: 41 - 47 mL/L, 96h static (Oncorhynchus mykiss) LC50: = 51400 mg/L, 96h static (Pimephales promelas) LC50: = 51600 mg/L, 96h static (Oncorhynchus mykiss) LC50: = 710 mg/L, 96h (Pimephales promelas)	= 710 mg/L EC50 Photobacterium phosphoreum 30 min	EC50: > 1000 mg/L, 48h Static (Daphnia magna)

Persistence and Degradability Miscible with water Persistence is unlikely based on information available.

Bioaccumulation/ Accumulation No information available.

Mobility Will likely be mobile in the environment due to its water solubility.

Component	log Pow
1,2-Propylene glycol	-0.9

13. Disposal considerations

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT Not regulated
TDG Not regulated
IATA Not regulated
IMDG/IMO Not regulated

15. Regulatory information

United States of America Inventory

Component	CAS No	TSCA	TSCA Inventory notification - Active-Inactive	TSCA - EPA Regulatory Flags
1,2-Propylene glycol	57-55-6	X	ACTIVE	-

Legend:
TSCA US EPA (TSCA) - Toxic Substances Control Act, (40 CFR Part 710)
X - Listed
'-' - Not Listed

TSCA 12(b) - Notices of Export Not applicable

International Inventories
Canada (DSL/NDSL), Europe (EINECS/ELINCS/NLP), Philippines (PICCS), Japan (ENCS), Japan (ISHL), Australia (AICS), China (IECSC), Korea (KECL).

Component	CAS No	DSL	NDSL	EINECS	PICCS	ENCS	ISHL	AICS	IECSC	KECL
1,2-Propylene glycol	57-55-6	X	-	200-338-0	X	X	X	X	X	KE-29267

KECL - NIER number or KE number (http://ncis.nier.go.kr/en/main.do)

Creation Date	19-Nov-2009
Revision Date	24-Dec-2021
Print Date	24-Dec-2021
Revision Summary	This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

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End of SDS

SAFETY DATA SHEET

Nafion™ PFSA 20% Dispersions - D2021CS

Version	Revision Date:	SDS Number:	Date of last issue: 11/15/2019
4.6	03/09/2020	1334128-00037	Date of first issue: 02/27/2017

SECTION 1. IDENTIFICATION

Product name : Nafion™ PFSA 20% Dispersions - D2021CS

Other means of identification : Nafion™ PFSA 20% Dispersions - D2021

SDS-Identcode : 130000034156

Manufacturer or supplier's details

Company name of supplier : Fuel Cell Store

Address : 1902 Pinon Drive, Unit B
College Station, TX 77845

Telephone : 1-979-703-1925

Emergency telephone : INFOTRAC 1-800-535-5053 (USA Only) +1-352-323-3500 (Outside USA)

Recommended use of the chemical and restrictions on use

Recommended use : Intermediate

Restrictions on use : For industrial use only.
Do not use or resell Chemours™ materials in medical applications involving implantation in the human body or contact with internal body fluids or tissues unless agreed to by Seller in a written agreement covering such use. For further information, please contact your Chemours representative.

SECTION 2. HAZARDS IDENTIFICATION

GHS classification in accordance with the Hazardous Products Regulations

Flammable liquids : Category 2

Serious eye damage : Category 1

Specific target organ toxicity - single exposure : Category 3

GHS label elements

Hazard pictograms :

Signal Word : Danger

Hazard Statements : H225 Highly flammable liquid and vapor.
H318 Causes serious eye damage.

H336 May cause drowsiness or dizziness.

Precautionary Statements :

Prevention:

P210 Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
P261 Avoid breathing mist or vapors.
P271 Use only outdoors or in a well-ventilated area.
P280 Wear protective gloves/ protective clothing/ eye protection/ face protection.

Response:

P303 + P361 + P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water.
P304 + P340 + P312 IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER/ doctor if you feel unwell.
P305 + P351 + P338 + P310 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER/ doctor.

Storage:

P405 Store locked up.

Disposal:

P501 Dispose of contents/ container to an approved waste disposal plant.

Other hazards

The thermal decomposition vapors of fluorinated plastics may cause polymer fume fever with flu-like symptoms in humans, especially when smoking contaminated tobacco.
Vapors may form explosive mixture with air.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance / Mixture : Mixture

Components

Chemical name	CAS-No.	Concentration (% w/w)
Propan-1-ol	71-23-8	>= 30 - < 60
Ethanol	64-17-5	>= 1 - < 5

Actual concentration or concentration range is withheld as a trade secret

SECTION 4. FIRST AID MEASURES

General advice : In the case of accident or if you feel unwell, seek medical advice immediately.
When symptoms persist or in all cases of doubt seek medical advice.

If inhaled : If inhaled, remove to fresh air.
Get medical attention if symptoms occur.

In case of skin contact	:	In case of contact, immediately flush skin with plenty of water. Remove contaminated clothing and shoes. Get medical attention if symptoms occur.
In case of eye contact	:	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. If easy to do, remove contact lens, if worn. Get medical attention immediately.
If swallowed	:	If swallowed, DO NOT induce vomiting. If vomiting occurs have person lean forward. Call a physician or poison control center immediately. Rinse mouth thoroughly with water. Never give anything by mouth to an unconscious person.
Most important symptoms and effects, both acute and delayed	:	Effects of breathing high concentrations of vapor may include: Central nervous system depression Dizziness confusion Lack of coordination Drowsiness Unconsciousness narcosis Repeated exposure may cause skin dryness or cracking. Ingestion may provoke the following symptoms: Vomiting Eye contact may provoke the following symptoms Irritation Pain tearing Swelling of tissue Redness Impairment of vision Lung damage Causes serious eye damage. May cause drowsiness or dizziness.
Protection of first-aiders	:	First Aid responders should pay attention to self-protection, and use the recommended personal protective equipment when the potential for exposure exists (see section 8).
Notes to physician	:	Treat symptomatically and supportively.

SECTION 5. FIRE-FIGHTING MEASURES

Suitable extinguishing media	:	Water spray Alcohol-resistant foam Carbon dioxide (CO2) Dry chemical
Unsuitable extinguishing media	:	High volume water jet

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Chemours

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Specific hazards during fire fighting	:	Do not use a solid water stream as it may scatter and spread fire. Flash back possible over considerable distance. Vapors may form explosive mixtures with air. Exposure to combustion products may be a hazard to health.
Hazardous combustion products	:	Carbon oxides Hydrogen fluoride carbonyl fluoride potentially toxic fluorinated compounds aerosolized particulates
Specific extinguishing methods	:	Use extinguishing measures that are appropriate to local circumstances and the surrounding environment. Use water spray to cool unopened containers. Remove undamaged containers from fire area if it is safe to do so. Evacuate area.
Special protective equipment for fire-fighters	:	In the event of fire, wear self-contained breathing apparatus. Use personal protective equipment.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures	:	Remove all sources of ignition. Ventilate the area. Use personal protective equipment. Follow safe handling advice and personal protective equipment recommendations.
Environmental precautions	:	Discharge into the environment must be avoided. Prevent further leakage or spillage if safe to do so. Prevent spreading over a wide area (e.g., by containment or oil barriers). Retain and dispose of contaminated wash water. Local authorities should be advised if significant spillages cannot be contained.
Methods and materials for containment and cleaning up	:	Non-sparking tools should be used. Soak up with inert absorbent material. Suppress (knock down) gases/vapors/mists with a water spray jet. For large spills, provide diking or other appropriate containment to keep material from spreading. If diked material can be pumped, store recovered material in appropriate container. Clean up remaining materials from spill with suitable absorbent. Local or national regulations may apply to releases and disposal of this material, as well as those materials and items employed in the cleanup of releases. You will need to determine which regulations are applicable. Sections 13 and 15 of this SDS provide information regarding certain local or national requirements.

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Nafion™ PFSA 20% Dispersions - D2021CS

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SECTION 7. HANDLING AND STORAGE

Technical measures	:	See Engineering measures under EXPOSURE CONTROLS/PERSONAL PROTECTION section.
Local/Total ventilation	:	If sufficient ventilation is unavailable, use with local exhaust ventilation. If advised by assessment of the local exposure potential, use only in an area equipped with explosion-proof exhaust ventilation.
Advice on safe handling	:	Do not breathe vapors or spray mist. Do not swallow. Do not get in eyes. Avoid prolonged or repeated contact with skin. Handle in accordance with good industrial hygiene and safety practice, based on the results of the workplace exposure assessment Non-sparking tools should be used. Keep container tightly closed. Keep away from heat and sources of ignition. Take precautionary measures against static discharges. Take care to prevent spills, waste and minimize release to the environment.
Conditions for safe storage	:	Keep in properly labeled containers. Store locked up. Keep tightly closed. Keep in a cool, well-ventilated place. Store in accordance with the particular national regulations. Keep away from heat and sources of ignition.
Materials to avoid	:	Do not store with the following product types: Strong oxidizing agents Organic peroxides Flammable solids Pyrophoric liquids Pyrophoric solids Self-heating substances and mixtures Substances and mixtures which in contact with water emit flammable gases Explosives Gases
Recommended storage temperature	:	0 - 32 °C
Further information on storage stability	:	Do not freeze.

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Ingredients with workplace control parameters

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Components	CAS-No.	Value type (Form of exposure)	Control parameters / Permissible concentration	Basis
Propan-1-ol	71-23-8	TWA	200 ppm 492 mg/m³	CA AB OEL
		STEL	400 ppm 984 mg/m³	CA AB OEL
		TWA	100 ppm	CA BC OEL
		TWAEV	200 ppm 492 mg/m³	CA QC OEL
		STEV	250 ppm 614 mg/m³	CA QC OEL
		TWA	100 ppm	ACGIH
Ethanol	64-17-5	TWA	1,000 ppm 1,880 mg/m³	CA AB OEL
		STEL	1,000 ppm	CA BC OEL
		TWAEV	1,000 ppm 1,880 mg/m³	CA QC OEL
		STEL	1,000 ppm	ACGIH

Occupational exposure limits of decomposition products

Components	CAS-No.	Value type (Form of exposure)	Control parameters / Permissible concentration	Basis
Hydrofluoric acid	7664-39-3	TWA	0.5 ppm 0.4 mg/m³ (Fluorine)	CA AB OEL
		(c)	2 ppm 1.6 mg/m³ (Fluorine)	CA AB OEL
		C	2 ppm (Fluorine)	CA BC OEL
		C	3 ppm 2.6 mg/m³ (Fluorine)	CA QC OEL
		TWA	0.5 ppm (Fluorine)	ACGIH
		C	2 ppm (Fluorine)	ACGIH
Carbonyl difluoride	353-50-4	TWA	2 ppm 5.4 mg/m³	CA AB OEL
		STEL	5 ppm 13 mg/m³	CA AB OEL
		TWA	2 ppm	CA BC OEL
		STEL	5 ppm	CA BC OEL
		STEV	5 ppm 13 mg/m³	CA QC OEL
		TWAEV	2 ppm 5.4 mg/m³	CA QC OEL
		TWA	2 ppm	ACGIH
		STEL	5 ppm	ACGIH
Carbon dioxide	124-38-9	STEL	30,000 ppm 54,000 mg/m³	CA AB OEL

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		TWA	5,000 ppm 9,000 mg/m³	CA AB OEL
		TWA	5,000 ppm	CA BC OEL
		STEL	15,000 ppm	CA BC OEL
		TWAEV	5,000 ppm 9,000 mg/m³	CA QC OEL
		STEV	30,000 ppm 54,000 mg/m³	CA QC OEL
		TWA	5,000 ppm	ACGIH
		STEL	30,000 ppm	ACGIH
Carbon monoxide	630-08-0	TWA	25 ppm 29 mg/m³	CA AB OEL
		TWA	25 ppm	CA BC OEL
		STEL	100 ppm	CA BC OEL
		TWAEV	35 ppm 40 mg/m³	CA QC OEL
		STEV	200 ppm 230 mg/m³	CA QC OEL
		TWA	25 ppm	ACGIH

Engineering measures : Processing may form hazardous compounds (see section 10).
Minimize workplace exposure concentrations.
If sufficient ventilation is unavailable, use with local exhaust ventilation.
If advised by assessment of the local exposure potential, use only in an area equipped with explosion-proof exhaust ventilation.

Personal protective equipment

Respiratory protection : If adequate local exhaust ventilation is not available or exposure assessment demonstrates exposures outside the recommended guidelines, use respiratory protection.

Filter type : Combined particulates, acidic gas/vapor and organic vapor type

Hand protection
Material : butyl-rubber
Glove thickness : 16 - 32 mm

Remarks : Choose gloves to protect hands against chemicals depending on the concentration specific to place of work. For special applications, we recommend clarifying the resistance to chemicals of the aforementioned protective gloves with the glove manufacturer. Wash hands before breaks and at the end of workday. Breakthrough time is not determined for the product. Change gloves often!

Eye protection : Wear the following personal protective equipment:
Chemical resistant goggles must be worn.
If splashes are likely to occur, wear:
Face-shield

Skin and body protection	:	Select appropriate protective clothing based on chemical resistance data and an assessment of the local exposure potential. Wear the following personal protective equipment: If assessment demonstrates that there is a risk of explosive atmospheres or flash fires, use flame retardant antistatic protective clothing. Skin contact must be avoided by using impervious protective clothing (gloves, aprons, boots, etc).
Hygiene measures	:	If exposure to chemical is likely during typical use, provide eye flushing systems and safety showers close to the working place. When using do not eat, drink or smoke. Wash contaminated clothing before re-use.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	:	liquid
Color	:	clear, colorless, light yellow
Odor	:	alcohol-like
Odor Threshold	:	No data available
pH	:	2
Melting point/freezing point	:	No data available
Initial boiling point and boiling range	:	No data available
Flash point	:	18 °C Method: Pensky-Martens closed cup
Evaporation rate	:	No data available
Flammability (solid, gas)	:	Not applicable
Flammability (liquids)	:	Ignitable (see flash point)
Upper explosion limit / Upper flammability limit	:	No data available
Lower explosion limit / Lower flammability limit	:	No data available

Vapor pressure	:	No data available
Relative vapor density	:	No data available
Density	:	1.01 - 1.03 g/cm³
Solubility(ies)		
Water solubility	:	dispersible
Partition coefficient: n-octanol/water	:	Not applicable
Autoignition temperature	:	No data available
Decomposition temperature	:	No data available
Viscosity		
Viscosity, dynamic	:	50 - 500 mPa.s (25 °C)
Viscosity, kinematic	:	No data available
Explosive properties	:	Not explosive
Oxidizing properties	:	The substance or mixture is not classified as oxidizing.
Particle size	:	Not applicable

SECTION 10. STABILITY AND REACTIVITY

Reactivity	:	Not classified as a reactivity hazard.
Chemical stability	:	Stable under normal conditions.
Possibility of hazardous reactions	:	Highly flammable liquid and vapor. Vapors may form explosive mixture with air. Can react with strong oxidizing agents. Hazardous decomposition products will be formed at elevated temperatures.
Conditions to avoid	:	Heat, flames and sparks.
Incompatible materials	:	Oxidizing agents

Hazardous decomposition products

Thermal decomposition	:	Hydrofluoric acid Carbonyl difluoride Carbon dioxide Carbon monoxide

SAFETY DATA SHEET

Chemours

Nafion™ PFSA 20% Dispersions - D2021CS

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SECTION 11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure

Inhalation
Skin contact
Ingestion
Eye contact

Acute toxicity

Not classified based on available information.

Product:

Acute oral toxicity	:	Acute toxicity estimate: > 5,000 mg/kg Method: Calculation method
Acute dermal toxicity	:	Acute toxicity estimate: > 5,000 mg/kg Method: Calculation method

Components:

Propan-1-ol:

Acute oral toxicity	:	LD50 (Rabbit): 2,823 mg/kg
Acute inhalation toxicity	:	LC50 (Rat): > 33.8 mg/l Exposure time: 4 h Test atmosphere: vapor Assessment: The substance or mixture has no acute inhalation toxicity
Acute dermal toxicity	:	LD50 (Rabbit): 4,032 mg/kg

Ethanol:

Acute oral toxicity	:	LD50 (Rat): > 5,000 mg/kg Method: OECD Test Guideline 401
Acute inhalation toxicity	:	LC50 (Rat): 124.7 mg/l Exposure time: 4 h Test atmosphere: vapor

Skin corrosion/irritation

Not classified based on available information.

Product:

Exposure time	:	1 h
Method	:	In Vitro Membrane Barrier Test Method for Skin Corrosion - CORROSITEX
Result	:	No skin irritation

Components:

Propan-1-ol:

Species	:	Rabbit

Result : No skin irritation

Ethanol:

Species : Rabbit
Method : OECD Test Guideline 404
Result : No skin irritation

Serious eye damage/eye irritation

Causes serious eye damage.

Components:

Propan-1-ol:

Species : Rabbit
Result : Irreversible effects on the eye

Ethanol:

Species : Rabbit
Result : Irritation to eyes, reversing within 21 days
Method : OECD Test Guideline 405

Respiratory or skin sensitization

Skin sensitization

Not classified based on available information.

Respiratory sensitization

Not classified based on available information.

Components:

Propan-1-ol:

Test Type : Maximization Test
Routes of exposure : Skin contact
Species : Guinea pig
Result : negative

Ethanol:

Test Type : Local lymph node assay (LLNA)
Routes of exposure : Skin contact
Species : Mouse
Result : negative

Germ cell mutagenicity

Not classified based on available information.

Components:

Propan-1-ol:

Genotoxicity in vitro : Test Type: Bacterial reverse mutation assay (AMES)
Method: OECD Test Guideline 471
Result: negative

Test Type: In vitro mammalian cell gene mutation test
Method: OECD Test Guideline 476
Result: negative

Test Type: Chromosome aberration test in vitro
Method: OECD Test Guideline 473
Result: negative

Ethanol:

Genotoxicity in vitro : Test Type: In vitro mammalian cell gene mutation test
Result: negative

Test Type: Bacterial reverse mutation assay (AMES)
Result: negative

Genotoxicity in vivo : Test Type: Rodent dominant lethal test (germ cell) (in vivo)
Species: Mouse
Application Route: Ingestion
Result: equivocal

Carcinogenicity

Not classified based on available information.

Reproductive toxicity

Not classified based on available information.

Components:

Ethanol:

Effects on fertility : Test Type: Two-generation reproduction toxicity study
Species: Mouse
Application Route: Ingestion
Result: negative

STOT-single exposure

May cause drowsiness or dizziness.

Components:

Propan-1-ol:

Assessment : May cause drowsiness or dizziness.

STOT-repeated exposure

Not classified based on available information.

Repeated dose toxicity

Components:

Propan-1-ol:

Species : Rat
NOAEL : > 8 mg/l
Application Route : inhalation (vapor)

Method : OECD Test Guideline 413

Ethanol:

Species : Rat
NOAEL : 1,280 mg/kg
LOAEL : 3,156 mg/kg
Application Route : Ingestion
Exposure time : 90 Days

Aspiration toxicity

Not classified based on available information.

Components:

Propan-1-ol:

The substance or mixture causes concern owing to the assumption that it causes a human aspiration toxicity hazard.

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity

Components:

Propan-1-ol:

Toxicity to fish : LC50 (Pimephales promelas (fathead minnow)): 4,555 mg/l
Exposure time: 96 h

Toxicity to daphnia and other aquatic invertebrates : EC50 (Daphnia magna (Water flea)): 3,644 mg/l
Exposure time: 48 h
Method: DIN 38412

Toxicity to algae/aquatic plants : EC50 (Pseudokirchneriella subcapitata (green algae)): 9,170 mg/l
Exposure time: 48 h

Toxicity to daphnia and other aquatic invertebrates (Chronic toxicity) : NOEC (Daphnia magna (Water flea)): > 100 mg/l
Exposure time: 21 d

Ethanol:

Toxicity to fish : LC50 (Pimephales promelas (fathead minnow)): > 1,000 mg/l
Exposure time: 96 h

Toxicity to daphnia and other aquatic invertebrates : EC50 (Ceriodaphnia (water flea)): > 1,000 mg/l
Exposure time: 48 h

Toxicity to algae/aquatic plants : ErC50 (Chlorella vulgaris (Fresh water algae)): 275 mg/l
Exposure time: 72 h

EC10 (Chlorella vulgaris (Fresh water algae)): 11.5 mg/l
Exposure time: 72 h

Toxicity to daphnia and other aquatic invertebrates (Chronic toxicity)	:	NOEC (Daphnia magna (Water flea)): 9.6 mg/l Exposure time: 9 d
Toxicity to microorganisms	:	EC50 (Pseudomonas putida): 6,500 mg/l Exposure time: 16 h

Persistence and degradability

Components:

Propan-1-ol:

Biodegradability	:	Result: Readily biodegradable. Biodegradation: 75 % Exposure time: 20 d

Ethanol:

Biodegradability	:	Result: Readily biodegradable. Biodegradation: 84 % Exposure time: 20 d

Bioaccumulative potential

Components:

Propan-1-ol:

Partition coefficient: n-octanol/water	:	log Pow: 0.2

Ethanol:

Partition coefficient: n-octanol/water	:	log Pow: -0.35

Mobility in soil

No data available

Other adverse effects

No data available

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods

Waste from residues	:	Dispose of in accordance with local regulations.
Contaminated packaging	:	Empty containers should be taken to an approved waste handling site for recycling or disposal. Empty containers retain residue and can be dangerous. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, flame, sparks, or other sources of ignition. They may explode and cause injury and/or death. If not otherwise specified: Dispose of as unused product.

SAFETY DATA SHEET

Nafion™ PFSA 20% Dispersions - D2021CS

Version	Revision Date:	SDS Number:	Date of last issue: 11/15/2019
4.6	03/09/2020	1334128-00037	Date of first issue: 02/27/2017

SECTION 14. TRANSPORT INFORMATION

International Regulations

UNRTDG

UN number	:	UN 1993
Proper shipping name	:	FLAMMABLE LIQUID, N.O.S. (Propan-1-ol, Ethanol)
Class	:	3
Packing group	:	II
Labels	:	3

IATA-DGR

UN/ID No.	:	UN 1993
Proper shipping name	:	Flammable liquid, n.o.s. (Propan-1-ol, Ethanol)
Class	:	3
Packing group	:	II
Labels	:	Flammable Liquids
Packing instruction (cargo aircraft)	:	364
Packing instruction (passenger aircraft)	:	353

IMDG-Code

UN number	:	UN 1993
Proper shipping name	:	FLAMMABLE LIQUID, N.O.S. (Propan-1-ol, Ethanol)
Class	:	3
Packing group	:	II
Labels	:	3
EmS Code	:	F-E, S-E
Marine pollutant	:	no

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code

Not applicable for product as supplied.

Domestic regulation

TDG

UN number	:	UN 1993
Proper shipping name	:	FLAMMABLE LIQUID, N.O.S. (Propan-1-ol, Ethanol)
Class	:	3
Packing group	:	II
Labels	:	3
ERG Code	:	128
Marine pollutant	:	no

Special precautions for user

The transport classification(s) provided herein are for informational purposes only, and solely based upon the properties of the unpackaged material as it is described within this Safety Data Sheet. Transportation classifications may vary by mode of transportation, package sizes, and variations in regional or country regulations.

SAFETY DATA SHEET

Nafion™ PFSA 20% Dispersions - D2021CS

Version	Revision Date:	SDS Number:	Date of last issue: 11/15/2019
4.6	03/09/2020	1334128-00037	Date of first issue: 02/27/2017

SECTION 15. REGULATORY INFORMATION

SECTION 16. OTHER INFORMATION

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Before use read Chemours safety information.
For further information contact the local Chemours office or nominated distributors.

Full text of other abbreviations

ACGIH	:	USA. ACGIH Threshold Limit Values (TLV)
CA AB OEL	:	Canada. Alberta, Occupational Health and Safety Code (table 2: OEL)
CA BC OEL	:	Canada. British Columbia OEL
CA QC OEL	:	Québec. Regulation respecting occupational health and safety, Schedule 1, Part 1: Permissible exposure values for airborne contaminants
ACGIH / TWA	:	8-hour, time-weighted average
ACGIH / STEL	:	Short-term exposure limit
ACGIH / C	:	Ceiling limit
CA AB OEL / TWA	:	8-hour Occupational exposure limit
CA AB OEL / STEL	:	15-minute occupational exposure limit
CA AB OEL / (c)	:	ceiling occupational exposure limit
CA BC OEL / TWA	:	8-hour time weighted average
CA BC OEL / STEL	:	short-term exposure limit
CA BC OEL / C	:	ceiling limit
CA QC OEL / TWAEV	:	Time-weighted average exposure value
CA QC OEL / STEV	:	Short-term exposure value
CA QC OEL / C	:	Ceiling

AICS - Australian Inventory of Chemical Substances; ANTT - National Agency for Transport by Land of Brazil; ASTM - American Society for the Testing of Materials; bw - Body weight; CMR - Carcinogen, Mutagen or Reproductive Toxicant; DIN - Standard of the German Institute for Standardisation; DSL - Domestic Substances List (Canada); ECx - Concentration associated with x% response; ELx - Loading rate associated with x% response; EmS - Emergency Schedule; ENCS - Existing and New Chemical Substances (Japan); ErCx - Concentration associated with x% growth rate response; ERG - Emergency Response Guide; GHS - Globally Harmonized System; GLP - Good Laboratory Practice; IARC - International Agency for Research on Cancer; IATA - International Air Transport Association; IBC - International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk; IC50 - Half maximal inhibitory concentration; ICAO - International Civil Aviation Organization; IECSC - Inventory of Existing Chemical Substances in China; IMDG - International Maritime Dangerous Goods; IMO - International Maritime Organization; ISHL - Industrial Safety and Health Law (Japan); ISO - International Organisation for Standardization; KECI - Korea Existing Chemicals Inventory; LC50 - Lethal Concentration to 50 % of a test population; LD50 - Lethal Dose to 50% of a test population (Median Lethal Dose); MARPOL - International Convention for the Prevention of Pollution from Ships; n.o.s. - Not Otherwise Specified; Nch - Chilean Norm; NO(A)EC - No Observed (Adverse) Effect Concentration; NO(A)EL - No Observed (Adverse) Effect Level; NOELR - No Observable Effect Loading Rate; NOM - Official Mexican Norm; NTP - National Toxicology Program; NZIoC - New Zealand Inventory of Chemicals; OECD - Organization for Economic Co-operation and Development; OPPTS - Office of Chemical Safety and Pollution Prevention; PBT - Persistent, Bioaccumu-

SAFETY DATA SHEET

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lative and Toxic substance; PICCS - Philippines Inventory of Chemicals and Chemical Substances; (Q)SAR - (Quantitative) Structure Activity Relationship; REACH - Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals; SADT - Self-Accelerating Decomposition Temperature; SDS - Safety Data Sheet; TCSI - Taiwan Chemical Substance Inventory; TDG - Transportation of Dangerous Goods; TSCA - Toxic Substances Control Act (United States); UN - United Nations; UNRTDG - United Nations Recommendations on the Transport of Dangerous Goods; vPvB - Very Persistent and Very Bioaccumulative; WHMIS - Workplace Hazardous Materials Information System

Sources of key data used to compile the Material Safety Data Sheet	:	Internal technical data, data from raw material SDSs, OECD eChem Portal search results and European Chemicals Agency, http://echa.europa.eu/
Revision Date	:	03/09/2020

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and shall not be considered a warranty or quality specification of any type. The information provided relates only to the specific material identified at the top of this SDS and may not be valid when the SDS material is used in combination with any other materials or in any process, unless specified in the text. Material users should review the information and recommendations in the specific context of their intended manner of handling, use, processing and storage, including an assessment of the appropriateness of the SDS material in the user's end product, if applicable.

CA / Z8

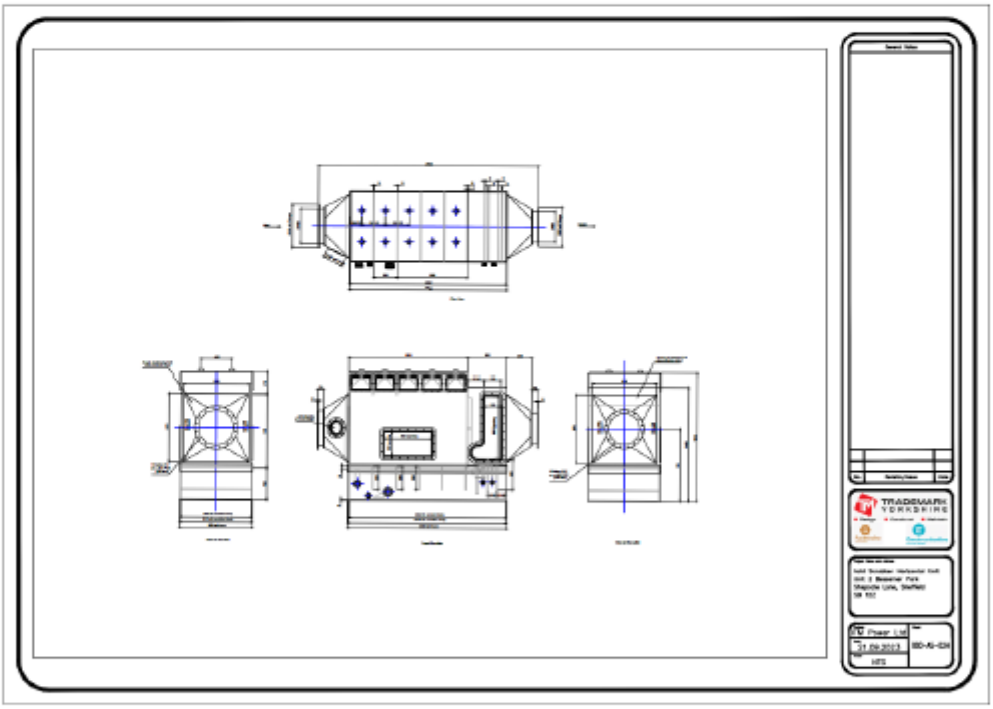
Appendix 2: Technical specification for wet gas scrubber

CONTENTS

1

1: Acid Scrubber Horizontal Unit Outline Details

1 N° APMG high efficiency counter current packed bed fume scrubber
1 N° recirculation system
1 N° Extract Fan
1 N° Interconnecting ductwork between process equipment, fan, scrubber, and discharge stack
1 N° Chemical Dosing System
1 N° Control Panel
1 N° Plant bund



2

2: Basis of Design

Environmental Monitoring Results

LEV O7 Master Etch HCl

Monitoring Results

where MU = Measurement Uncertainty associated with the result (95% Confidence)

Substance		Concentration Limit (mg/m³)	Concentration Result (mg/m³)	Concentration Measurement Uncertainty (MU) +/-	Reference Conditions	Mass Emission Limit (g/hr)	Mass Emission Result (g/hr)	Mass Emission Measurement Uncertainty (MU) +/-	Sampling Date	Sampling Times
Chloride (as HCl)	R1	-	73.2	6.0	273k, 101.3kPa, Wet Gas	-	66.1	6.4	16/06/2023	12:36-13:06
Volumetric Flow Actual	R1	-	981 m³/h	50.3	As Measured	-	-	-	16/06/2023	12:20-12:30
Volumetric Flow @ REF	R1	-	903 m³/h	48.3	273k, 101.3kPa, Wet Gas	-	-	-	16/06/2023	12:20-12:30

LEV 07 Master Etch Sulphuric Acid

Monitoring Results

where MU = Measurement Uncertainty associated with the result (95% Confidence)

Substance		Concentration Limit (mg/m³)	Concentration Result (mg/m³)	Concentration Measurement Uncertainty (MU) +/-	Reference Conditions	Mass Emission Limit (g/hr)	Mass Emission Result (g/hr)	Mass Emission Measurement Uncertainty (MU) +/-	Sampling Date	Sampling Times
Chloride (as HCl)	R1	-	22.6	1.8	273k, 101.3kPa, Wet Gas	-	51.7	4.8	25/07/2023	13:10-14:10
Sulphuric Acid	R1	-	0.04	0.00	273k, 101.3kPa, Wet Gas	-	0.01	0.00	25/07/2023	13:10-14:10
Water Vapour	R1	-	1.7%	-	As Measured	-	-	-	-	-
Volumetric Flow (Actual)	R1	-	2,498 m³/h	113	As Measured	-	-	-	25/07/2023	11:50-11:55
Volumetric Flow (REF)	R1	-	2,292 m³/h	104	273k, 101.3kPa, Wet Gas	-	-	-	25/07/2023	11:50-11:55

LEV 06 Acid Rinse Sulphuric Acid

Monitoring Results

where MU = Measurement Uncertainty associated with the result (95% Confidence)

Substance		Concentration Limit (mg/m³)	Concentration Result (mg/m³)	Concentration Measurement Uncertainty (MU) +/-	Reference Conditions	Mass Emission Limit (g/hr)	Mass Emission Result (g/hr)	Mass Emission Measurement Uncertainty (MU) +/-	Sampling Date	Sampling Times
Sulphuric Acid	R1	-	0.0	0.00	273k, 101.3kPa, Wet Gas	-	0.3	0.05	25/07/2023	14:40-15:40
Water Vapour	R1	-	2.1%	-	As Measured	-	-	-	-	-
Volumetric Flow (Actual)	R1	-	2,389 m³/h	108	As Measured	-	-	-	25/07/2023	14:35-14:40
Volumetric Flow (REF)	R1	-	2,175 m³/h	98.6	273k, 101.3kPa, Wet Gas	-	-	-	25/07/2023	14:35-14:40

3

3: Design

Air Volume (Extract):	5000 m³/hr
Air Temperature:	Assumed below 40°C @ scrubber inlet.
Contaminants:	Hydrochloric Acid 18.5%, Sulphuric acid
Site Location:	Sheffield

The basis of the master etch has an extract rate of 2496m³/hr. with an HCL concentration of 73.2mg/m³. When incorporating the acid rinse into the same system with an extract rate of 2389m³/hr. this provides a total gas volume of 4885m³/hr. This increased gas flow would now contain 37.4mg/m³ of HCL. To give a scrubber outlet HCl below 10 mg/m3. This is designed using standard chemical engineering practice by 2 methods, a) Using kGa values from the literature/previous experience and/or b) standard correlation of mass transfer from Onda et al. We also include a safety factor well below this required limit.
The level of packing is determined using the above two methods.

With regards to the level of dosing, this is best determined during commissioning, but we would expect to operate between pH10 and pH12. The dosing system would be automated, therefore when the pH level drops off the required setpoint, the pH controller would initiate the dosing pump to begin pumping NaOH (Sodium Hydroxide) into the scrubbing liquor bringing the pH level back inline with the design parameters.

Based on the input levels of HCL provided, and assuming the NaOH (Sodium Hydroxide) available is a 32% w/w solution we would expect the usage to be 6.3l/hr. (or pro-rata). This also includes a large portion for atmospheric CO2 which is around 400ppm.

The outlet gas concentration would be designed to be well below 10 mg/m3, however this can only be demonstrated during the operation of the plant, with the inlet concentration of HCL testing and the stack emissions testing carried out simultaneously to ensure both results are taken during like for like conditions. Alternatively, a pilot plant can also offer the same demonstration.

We have taken the sulphuric acid into consideration, but as the levels are already below the required limits this shouldn't be a problem.

4: The scrubbing process:

The contaminated air or gas enters the scrubber inlet where it is contacted with scrubbing liquor draining from the packed bed. The flow of gas then rises counter-current to the flow of the scrubbing liquor, through the packed section where neutralisation or removal of the contaminants takes place.

To efficiently absorb contaminants such as HCL, SO2 and NH3, a large surface area of contact is required to achieve interaction between the liquid and gaseous phases. It is the nature of the contaminant, the concentration at the inlet and the desired efficiency which determine the type, size, and quantity of packing.

We design the packing to promote mass transfer with its multiple gas/liquid contact points, providing a large surface area, active surface renewal of the liquid phase and turbulent air flow characteristics.

Before discharging to the atmosphere, the treated air passes through a droplet eliminator section at the top of the column.

5

5: Equipment Specification

The unit will be a horizontal packed bed scrubber.

It will be manufactured off site and lifted into location on the plant deck as indicated is section "15: Proposed location details".

Construction:

The unit will be approximately 3000mm x 1000mm x 1624mm. The scrubber will be manufactured from Celmar polypropylene fabric backed sheet (approximately 4 mm thick wall) externally reinforced with chopped strand matt impregnated with general purpose Polyester resins (GRP).

The reinforcement is to be designed to provide the scrubber with sufficient strength to be a self-supporting structure.

The external finish of the structural GRP will be one layer of "C" glass veil, to "blind" the surface of the chopped stand matt from exposure, with a resin rich flood coat colour pigmented to any BS or RAL colour of your choice.

Body flanges are to be provided as described above, constructed from 20mm thick polypropylene sheet. The flanges are to be bolted together with size M120 Stainless steel sets at 120 mm centres maximum, washers are to be used under both bolt head & nut faces, closed cell Neoprene sponge gaskets are to be used between the flange faces.

All body and joints are to be hot gas welded with a minimum of 1 x 3 mm diam. cores applied internally and 3 x 3 mm diam. cores applied externally.

All welded joints are to have metallic earthing strips positioned over the weld prior to the application of the GRP reinforcement to facilitate high frequency spark testing of all joints following final completion or in the future.

The units will have raised internal bases so that when drained a minimal amount of liquor remains within the sump.

6

6: Internals

The packing media used will be 'Pall Ring' design manufactured from Polypropylene, of sufficient volume to achieve the design requirements, the packing is to be adequately supported within the column on a Polypropylene support structure.

The scrubbing liquor distribution system is to be designed to provide adequate "wetting" over the total surface of the "Pall ring" packing. The method will be an easily removable Polypropylene spray pipe positioned above the packing. The spray pipe will be sufficiently supported within the column to prevent "sagging".

The carry-over of droplets from the scrubber column to the discharge stack is to be prevented by use of a vane type eliminator. Supported from the walls of the column, the eliminator will be manufactured from Polypropylene material.

Access for maintenance/ cleaning will be provided at the following positions:

a) The sump area of the scrubber.

b) Base of packing to facilitate removal of packing media.

c) Above packing to facilitate access to the spray nozzles minimum size 450mm x 250mm.

d) Above the mist eliminator minimum size 450mm x 250mm.

All access covers will be manufactured from Clear PVC sheet with a minimum thickness of 10 mm, each will be provided with Handles and a 1" BSP threaded tapping points complete with plug. Bolting to the scrubber access spigots will be size M10 in Stainless steel, a Neoprene "O" ring gasket is to be used between the faces.

Nozzles: - We have included nozzles as follows: -

- Gas Inlet
- Gas Outlet
- Pump suction
- Pump delivery
- Drain
- Overflow
- Water make-up
- Access ports as detailed above

7

7: Process Description:

The contaminated air enters the gas inlet where it is cooled to its adiabatic saturation temperature by the flushing spray.
The air then passes through a section of random packings. The packing media used will be 'Pall ring' design manufactured from Polypropylene, of sufficient volume to achieve the design requirements, the packing is to be adequately supported within the unit on a Polypropylene support structure.

The scrubbing liquor distribution system is to be designed to provide adequate "wetting" over the total surface of the "Pall ring" packing. The method will be a series of spray nozzles position within the lid of the scrubber positioned above the packing.

The air then flows horizontal though a vane mist eliminator section which prevents carry-over of the scrubbing liquor in the outlet air stream.

The air stream is transported by the induced draught centrifugal fan which is installed on the outlet of the fume scrubber.

The scrubbing liquor is stored in the liquor recirculation tank which will be an integral part of the scrubbing vessel at the base. The liquor flows into the recirculation pump and is fed to the various spray nozzles, and the flushing spray at the scrubber inlet. It flows vertically cross current, and back to the recirculation tank by gravity.
It is also necessary to have a freshwater make-up to allow for evaporation losses and continuous or intermittent liquor drain-off from the system. This will be controlled via a manual ball float valve.

Access for maintenance/ cleaning will be provided at the following positions:

a) Both sides of scrubber body

b) At the gas inlet for access to the spray nozzle

c) At the top of the scrubber, again to access the spray nozzles

d) At the mist eliminator section

All access covers will be manufactured from Clear PVC sheet with a minimum thickness of 10 mm, each will be provided with handles. Bolting to the scrubber access spigots will be size M10 in Stainless steel, a Neoprene "O" ring gasket is to be used between the faces.

Nozzles: - We have included nozzles as follows: -

- Gas Inlet
- Gas Outlet
- Pump suction
- Pump delivery
- Drain
- Overflow
- Water make-up
- Access ports as detailed above.

8

8: Pumps

The scrubber will be provided with re-circulation pump.

The pump will be selected from the AMX magnetic drive series by Crest Pumps or equal and approve and will be sized to meet the required duties and will be fitted with IP55 arduous duty, hostile environment electric motor. Suitable for use with a 415v/3Ph/50Hz electrical supply. We have included for this pump to be controlled via an inverter.

The pump will be mounted on a suitable support frame.

9: Re-circulation pipework

The scrubber unit will be complete with a re-circulation pipework system which will deliver scrubbing liquor stored within the sump, via the pump, to the spray distribution system.

A pressure gauge will be incorporated within the system to indicate correct flow of liquor to the sprays.

The system will be manufactured from standard PVC pressure pipe and fittings supplied in kit form for on-site assembly.

The pipework will be configured to facilitate scrubbing liquor bleed/ pump-off to drain via the recirculation pump using an automated operated control valve. This will be fed to an IBC positioned on ground level. We have included for this pipe run to be dual contained. We have also included for a variable flow indicator to be fitted within this pipeline.

10: Liquor Level Control

An APMG limited liquor level control system would be employed which has been designed to combine several functions.

- To maintain a constant operating level within the scrubber.
- Give visual indication of the liquor level within the scrubber.
- Emergency high level alarm

11: Fan

The extract fan would be selected from our 'H' series range of forward curved fans to achieve the required duty of 5000m³/hr at an assumed system pressure of 1500Pa. We propose the use of directly driven fan with the fan speed being controlled via an inverter.

The fan case will be manufactured from polypropylene sheet material reinforced with GRP, the impeller manufactured from polypropylene and the pedestals manufactured from mild steel plate and angle finished with hot dipped galvanise.
The fan unit will be mounted on anti-vibration mounts.

9

12: Interconnecting Ductwork Between process equipment, scrubber, fan, and discharge stack

The ductwork will be manufactured from standard extruded PVC duct sections and fittings sized to meet a minimum duct velocity of 10m/s, with the discharge stack not exceeding 9m/s. All joints will be solvent cemented and suitable Unistrut channel supports, and duct clips will be fitted to at regular intervals to ensure the duct run is supported.
We have included for the stack to extend above the building by 3m and have included for stack emission sampling points.

13: Chemical Dosing System

The scrubber unit will be provided with pH correction to maintain the scrubbing liquor Alkalinity in the form of a dedicated panel mounted pH controller which will control a separate dosing pump unit capable of delivering sufficient caustic solution. The scrubbing liquor will be monitored via a dip electrode mounted within a PVC pH sample pipeline which will be incorporated within the main recirculation system. The pH controller will regulate the flow of caustic with a pulse train output to the dosing pump which in turn will discharge caustic via an injection nozzle directly into the scrubber sump. The discharge pipework's from the dosing pump to the scrubber unit will be dual contained.
A caustic supply drum or IBC (supplied by others) will need to be positioned local to the scrubber tower.

14: Scrubber plant bunding

We have included for a PP/GRP bunding area sized to contain the full contents of the fume scrubber sump.
The bund will surround the fume scrubbing unit and recirculation pump, pipework's, and valves.
We have included for a leak detection probe within the bunded area.

10

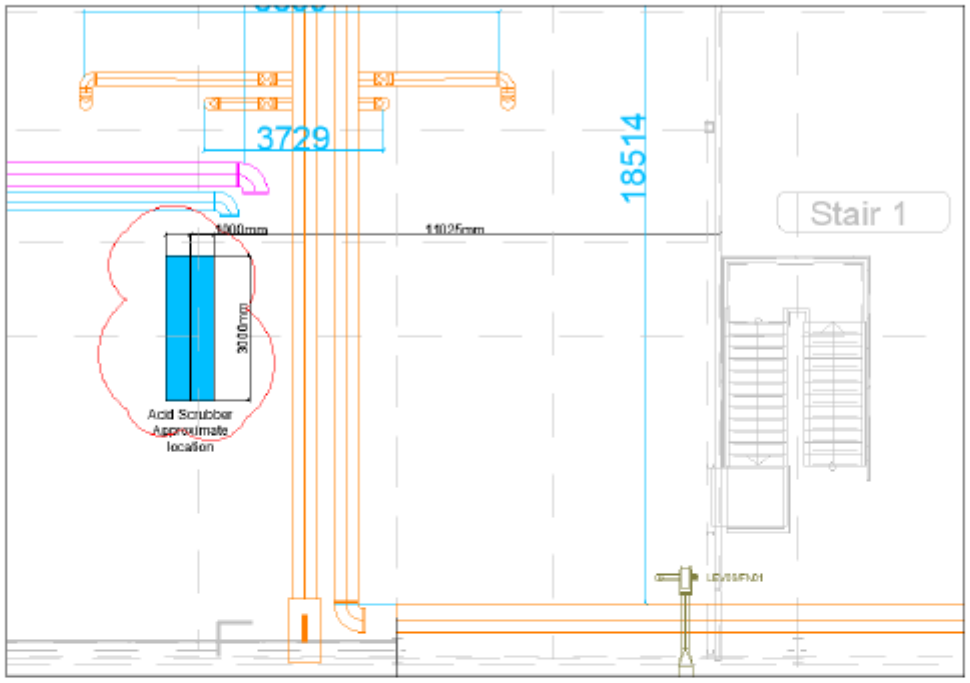
15: Control Panel

We have included for the control panel to provide the following functions: -

- 415v 3phase Control with neutral
- Recirculation pump start/stop illuminated push button.
- Built in fan inverter with stop/start illuminated push button.
- Panel mounted pH monitor controlling an independent dosing pump.
- Water level control system, operating solenoid valve between high- and low-level probes.
- Built in timer to control solenoid valve for pump off drainage. (To open valve at a set time each day, for a specific period) Includes high level probe control in IBC along with proximity sensor to detect IBC.
- The solenoid valve will not open if:
- IBC is not present.
- The IBC is full.
- Bund leak detection alarm
- A stacked strobe light which will provide visual indication of the following: -
- Recirculation Pump tripped.
- Extract Fan tripped.
- Leak detected within bund.
- IBC for drainage is full.
- Dosing chemical level is insufficient.

11

16: Proposed location details



12

17: Operational Guarantee

The above information and chemical engineers' calculations based on the environmental monitoring are to reduce the record 73mg/m3 of HCL to below the required 10mg/m3 specified by the Environmental Agency. We the manufacturers and installers warrant that all goods to be manufactured and installed under this proposal shall achieve levels of HCL lower than 10mg/m3 and be free from defects in workmanship and materials. We hereby extend our full twelve-month defects liability period.

APMG will carry out on site commissioning, deliver the client with a walk through of the system and how it operates and provide an operating and maintenance instruction manual.

APMG will also be on hand to carry out any adjustments that may be required once the system is in full operation.

APMG hope the above assists with reassuring ITM power with the confidence we have in delivering a suitable scrubbing system for their application.

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