



ID	49871	Status	Date
Risk Area	Risikovurdering: Helse, miljø og sikkerhet (HMS)	Created	06.09.2022
Created by	Alicia San Martin Rueda	Assessment started	06.09.2022
Responsible	Alicia San Martin Rueda	Measures decided	
		Closed	

Risk Assessment:
CAT, Master Student, 2022, Alicia San Martin Rueda

Valid from-to date:
9/6/2022 - 9/6/2025

Location:
IKP

Goal / purpose
Risk assessment for my work as an exchange student on production of advanced biofuels from biomass via Fischer Tropsch process

Background

Catalysis synthesis

Chemicals:

- Cobalt(II) nitrate hexahydrate (precursor)
- Manganese(II) nitrate tetrahydrate
- Perrhenic acid solution
- Alumina Sasol Puralox SCCa (Particle size = 60-150 µm)

Methods:

- Incipient Wetness Impregnation
- Evaporation-drying (85-120 °C)
- Calcination (300-650 °C)

Manganese impregnation with water

Chemicals:

- Al₂O₃
- Mn(NO₃)₂·4H₂O

Methods:

- Mn(NO₃)₂·4H₂O dissolved in dionized water and then impregnated in alumina
- After impregnation the mixture is dried overnight in a convection oven at 110 °C
- Calcination of the solid for 10h at 300 °C.

Cobalt impregnation with water

Chemicals:

- Co(NO₃)₂·6H₂O
- HReO₄

Methods:

- Co(NO₃)₂·6H₂O dissolved in dionized water and mixed with a solution of perrhenic acid. Then it is impregnated in the MnAl₂O₃ calcined previously
- After impregnation the mixture is dried overnight in a convection oven at 110 °C
- Calcination of the solid for 10h at 300 °C.

Catalysis caracterizacion. Methods and equipments::

- XRD (Bruker D8 DaVinci X-ray diffractometer)
- H₂ chemisorption (Micromeritics ASAP 2020)
- BET surface area, N₂ adsorption/desorption (Tristar 3000)
- TPR (Altamira-300RHP)

Fischer Tropsch synthesis

- Reaction through a fixed bed stainless steel tubular reactor at 240 °C and 5 bar
- Used gases: H₂ and CO with a 1.7 ratio of H₂/CO (it is important to be careful. Ask for help if necessary)
- Addition of 4 different solutions of potassium (KOH, KClO₄, K₂SO₄, KNO₃) in syngas feed by a syringe pump
- Leak test with detector
- After mounting reactor it is pressurized with He and leak-tested before any CO or H₂ is used
- Waxes and lighter hydrocarbons (as C₆) are collected in two separate pots, which need to be emptied every now and then (wear face-protection and heat resistant gloves when doing this)

Spent catalyst de-waxing

- Soxhlet extraction using n-pentane as solvent, which needs to be heated to approximately 35-40 °C to boil

Description and limitations

Proper training

Safety measures

Awareness of physical risks in the laboratory (such as pressure, temperature, etc)

Protective equipment (such as lab coat, safety goggles, appropriate clothing, etc)

Safety Data Sheets for chemicals

Prerequisites, assumptions and simplifications



Switch off procedure for BET set up:

- Stop the analysis in the computer
- Remove the tube sample from the unit
- Insert the metal rod in the unit

Switch off procedure for chemisorption set up:

- Close all valves in the software
- Open valve 9, C6, CS, 7 and 5 to flow He into the system
- When the pressure is around 700 mmHg close all valves
- Open the reactor and remove the tube sample

Risk related with the shortage of personnel in the labs:

- Plan everything in advance and communicate the plan to the engineers
- Take extra care in the leak test before running any reaction
- Not running reactions after 4 PM

Download safety data sheets for chemicals

Attachments

CO_SDS.pdf
CobaltNitrateHex_SDS.pdf
H2_SDS.pdf
FT-Flowsheet.png
Mn_SDS.PDF
Pherrhenic_SDS.pdf
N2_SDS.pdf
K2SO4_SDS.pdf
KOH_SDS.pdf
KClO4_SDS.pdf
KNO3_SDS.pdf

References

[Ingen registreringer]



Summary, result and final evaluation

The summary presents an overview of hazards and incidents, in addition to risk result for each consequence area.

Hazard:		Handling toxic (CO)/inflammable gases (H2)			
Incident:		Danger of explosion			
Consequence area:	Helse	Risk before measures:		Risiko after measures:	
	Materielle verdier	Risk before measures:		Risiko after measures:	
Incident:		Danger of poisoning			
Consequence area:	Helse	Risk before measures:		Risiko after measures:	
	Ytre miljø	Risk before measures:		Risiko after measures:	
Hazard:		Pressurize and high temperature installation			
Incident:		Danger of explosion			
Consequence area:	Helse	Risk before measures:		Risiko after measures:	
	Materielle verdier	Risk before measures:		Risiko after measures:	
Incident:		Burn damage			
Consequence area:	Helse	Risk before measures:		Risiko after measures:	
	Materielle verdier	Risk before measures:		Risiko after measures:	
Incident:		Syngas or H2 leakage			
Consequence area:	Helse	Risk before measures:		Risiko after measures:	
	Ytre miljø	Risk before measures:		Risiko after measures:	
	Materielle verdier	Risk before measures:		Risiko after measures:	

**Hazard:** Hot products**Incident:** Burn damage

Consequence area:	Helse	Risk before measures:	 Risiko after measures:	
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Hazard: Handling chemicals during catalyst synthesis: $\text{Mn}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$, $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$, HReO_4 **Incident:** Spills. Danger of contact with skin or inhalation

Consequence area:	Helse	Risk before measures:	 Risiko after measures:	
	Ytre miljø	Risk before measures:	 Risiko after measures:	

Incident: Danger of burning or inhale vapors

Consequence area:	Helse	Risk before measures:	 Risiko after measures:	
	Ytre miljø	Risk before measures:	 Risiko after measures:	

Incident: Spilling or inhalation of $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$

Consequence area:	Helse	Risk before measures:	 Risiko after measures:	
	Ytre miljø	Risk before measures:	 Risiko after measures:	



Hazard: Handling N_2 : Adsorption/Desorption**Incident:** Burn damage







Consequence area:	Helse	Risk before measures:	 Risiko after measures:	
	Materielle verdier	Risk before measures:	 Risiko after measures:	

Hazard: Handling chemicals during catalyst testing: KOH , KNO_3 , KCl_4 , K_2SO_4 **Incident:** Spills

Consequence area:	Helse	Risk before measures:	 Risiko after measures:	
	Ytre miljø	Risk before measures:	 Risiko after measures:	



Hazard:	Handling chemicals during catalyst testing: KOH, KNO3, KCl4, K2SO4			
Incident:	Spills			
	Materielle verdier	Risk before measures:	 Risiko after measures:	

Hazard:	Handling chemicals during the catalyst dewax: n-pentane			
Incident:	Spills or inhalation			
Consequence area:	Helse	Risk before measures:	 Risiko after measures:	
	Ytre miljø	Risk before measures:	 Risiko after measures:	
	Materielle verdier	Risk before measures:	 Risiko after measures:	

Final evaluation



Organizational units and people involved

A risk assessment may apply to one or more organizational units, and involve several people. These are listed below.

Organizational units which this risk assessment applies to

- Institutt for kjemisk prosessteknologi

Participants

Oscar Luis Ivanéz Encinas

Edd Anders Blekkan

Estelle Marie M. Vanhaecke

Samuel K. Regli

Readers

Ketil Torset Helland

Jens-Petter Andreassen

Others involved/stakeholders

[Ingen registreringer]

The following accept criteria have been decided for the risk area Risikovurdering: Helse, miljø og sikkerhet (HMS):

Helse



Materielle verdier



Omdømme



Ytre miljø



Overview of existing relevant measures which have been taken into account

The table below presents existing measures which have been taken into account when assessing the likelihood and consequence of relevant incidents.

Hazard	Incident	Measures taken into account
Handling toxic (CO)/inflammable gases (H ₂)	Danger of explosion	Security Data Sheet
	Danger of explosion	Health, safety and environment training
	Danger of explosion	Safety and Protective Equipment
	Danger of explosion	Local exhaust
	Danger of explosion	Gas detector
	Danger of explosion	Leak test
	Danger of explosion	Instrument/Method training
	Danger of explosion	Apparatus card
	Danger of poisoning	Security Data Sheet
	Danger of poisoning	Health, safety and environment training
	Danger of poisoning	Safety and Protective Equipment
	Danger of poisoning	Local exhaust
	Danger of poisoning	Gas detector
	Danger of poisoning	Leak test
	Danger of poisoning	Instrument/Method training
	Danger of poisoning	Apparatus card
Pressurize and high temperature installation	Danger of explosion	Security Data Sheet
	Danger of explosion	Health, safety and environment training
	Danger of explosion	Safety and Protective Equipment
	Danger of explosion	Local exhaust
	Danger of explosion	Gas detector
	Danger of explosion	Leak test
	Danger of explosion	Instrument/Method training
	Danger of explosion	Apparatus card
	Burn damage	Health, safety and environment training
	Burn damage	Safety and Protective Equipment
	Burn damage	Leak test
	Burn damage	Instrument/Method training
	Burn damage	Apparatus card
	Burn damage	Fire alarm system
	Syngas or H ₂ leakage	Security Data Sheet
	Syngas or H ₂ leakage	Health, safety and environment training



Pressurize and high temperature installation	Syngas or H2 leakage	Safety and Protective Equipment
	Syngas or H2 leakage	Local exhaust
	Syngas or H2 leakage	Gas detector
	Syngas or H2 leakage	Leak test
	Syngas or H2 leakage	Instrument/Method training
	Syngas or H2 leakage	Apparatus card
	Syngas or H2 leakage	Fire alarm system
Hot products	Burn damage	Security Data Sheet
	Burn damage	Health, safety and environment training
	Burn damage	Safety and Protective Equipment
	Burn damage	Instrument/Method training
	Burn damage	Apparatus card
Handling chemicals during catalyst synthesis: Mn(NO ₃) ₂ ·4H ₂ O, Co(NO ₃) ₂ ·6H ₂ O, HReO ₄	Spills. Danger of contact with skin or inhalation	Security Data Sheet
	Spills. Danger of contact with skin or inhalation	Health, safety and environment training
	Spills. Danger of contact with skin or inhalation	Safety and Protective Equipment
	Spills. Danger of contact with skin or inhalation	Instrument/Method training
	Danger of burning or inhale vapors	Security Data Sheet
	Danger of burning or inhale vapors	Health, safety and environment training
	Danger of burning or inhale vapors	Safety and Protective Equipment
	Danger of burning or inhale vapors	Local exhaust
	Danger of burning or inhale vapors	Instrument/Method training
	Danger of burning or inhale vapors	Apparatus card
	Spilling or inhalation of Co(NO ₃) ₂ ·6H ₂ O	Security Data Sheet
	Spilling or inhalation of Co(NO ₃) ₂ ·6H ₂ O	Health, safety and environment training
	Spilling or inhalation of Co(NO ₃) ₂ ·6H ₂ O	Safety and Protective Equipment
	Spilling or inhalation of Co(NO ₃) ₂ ·6H ₂ O	Local exhaust
	Spilling or inhalation of Co(NO ₃) ₂ ·6H ₂ O	Gas detector
	Spilling or inhalation of Co(NO ₃) ₂ ·6H ₂ O	Instrument/Method training
Handling N ₂ : Adsorption/Desorption	Burn damage	Security Data Sheet
	Burn damage	Health, safety and environment training
	Burn damage	Safety and Protective Equipment
	Burn damage	Instrument/Method training
Handling chemicals during catalyst testing: KOH, KNO ₃ , KCl ₄ , K ₂ SO ₄	Spills	Security Data Sheet
	Spills	Health, safety and environment training
	Spills	Safety and Protective Equipment
	Spills	Local exhaust



Handling chemicals during catalyst testing: KOH, KNO ₃ , KCl ₄ , K ₂ SO ₄	Spills	Leak test
	Spills	Instrument/Method training
	Spills	Apparatus card
	Spills	Fire alarm system
Handling chemicals during the catalyst dewax: n-pentane	Spills or inhalation	Security Data Sheet
	Spills or inhalation	Health, safety and environment training
	Spills or inhalation	Safety and Protective Equipment
	Spills or inhalation	Local exhaust

Existing relevant measures with descriptions:**Security Data Sheet**

Read carefully and familiarize with the physical and chemical properties as well as the associated risk and the precautions, measures and handling required.

Health, safety and environment training

Proper training about the general principles of health, safety and environment in the laboratory

Safety and Protective Equipment

Wear the proper equipment in each situation

Lab coat

Safety goggles (mandatory in all laboratories)

Gloves (read sds in order to choose the correct gloves)

Gas mask (read sds in order to choose the correct filters)

Filter mask (read sds in order to choose the correct type)

Headphones as noise protector

Protection helmet

Local exhaust

It is required to verify that the local exhaust is working properly before experiments

Gas detector

It is required to verify that the gas detector is working before experiments.

Understand the two different alarms and how to act with each one.

Leak test

Verify the isolation of the installation before running experiments

Instrument/Method training

Proper training in order to understand the procedure of the techniques and equipment and be familiarized with them before experiments.

Ask about any possible troubles and risks and doubts about the procedure.

Apparatus card

Understand and be familiarized with the risk associated in the apparatus, the responsible person of them, possible hazards and routines for emergency shutdown

Fire alarm system

Know and be familiar with the nearest fire alarm, the location of the fire extinguishers and the evacuation routes and meeting points

Risk analysis with evaluation of likelihood and consequence

This part of the report presents detailed documentation of hazards, incidents and causes which have been evaluated. A summary of hazards and associated incidents is listed at the beginning.

The following hazards and incidents has been evaluated in this risk assessment:

- **Handling toxic (CO)/inflammable gases (H2)**
 - Danger of explosion
 - Danger of poisoning
- **Pressurize and high temperature installation**
 - Danger of explosion
 - Burn damage
 - Syngas or H2 leakage
- **Hot products**
 - Burn damage
- **Handling chemicals during catalyst synthesis: Mn(NO3)2·4H2O, Co(NO3)2·6H2O, HReO4**
 - Spills. Danger of contact with skin or inhalation
 - Danger of burning or inhale vapors
 - Spilling or inhalation of Co(NO3)2·6H2O
- **Handling N2: Adsorption/Desorption**
 - Burn damage
- **Handling chemicals during catalyst testing: KOH, KNO3, KCl4, K2SO4**
 - Spills
- **Handling chemicals during the catalyst dewax: n-pentane**
 - Spills or inhalation

Detailed view of hazards and incidents:

Hazard: Handling toxic (CO)/inflammable gases (H2)

Incident: Danger of explosion

Likelihood of the incident (common to all consequence areas): **Less likely (2)**

Kommentar:

Familiar with SDS, apparatus cards and instruments
Use of local exhaust
Gas detector and local alarm
Leak test
After mounting reactor it is pressurized with He and leak-tested before any CO or H2 is used

Consequence area: Helse

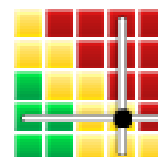
Assessed consequence: **Very large (4)**

Comment: According to SDS:

CO
H220 - Extremely flammable gas
H280 - Contains gas under pressure; may explode if heated
H331 - Toxic if inhaled
H360 - May damage fertility or the unborn child H372 - Causes damage to organs (central nervous system) through prolonged or repeated exposure
CGA-HG04 - May form explosive mixtures with air
CGA-HG10 - Asphyxiating even with adequate oxygen

H2
H220 - Extremely flammable gas
CGA-HG04 - May form explosive mixtures with air
H280 - Contains gas under pressure; may explode if heated
May displace oxygen and cause rapid suffocation

Risk:



Consequence area: Materielle verdier

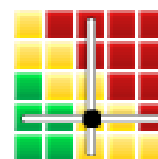
Assessed consequence: **Large (3)**

Comment: According to SDS:

CO
H220 - Extremely flammable gas
H280 - Contains gas under pressure; may explode if heated
CGA-HG04 - May form explosive mixtures with air

H2
H220 - Extremely flammable gas
H280 - Contains gas under pressure; may explode if heated
CGA-HG04 - May form explosive mixtures with air
Burns with invisible flame

Risk:



Incident: Danger of poisoning

Likelihood of the incident (common to all consequence areas): **Unlikely (1)**

Kommentar:

Use of local exhaust
Use of safety and protective equipment
Gas detector and local alarm
Leak test
After mounting reactor it is pressurized with He and leak-tested before any CO or H₂ is used

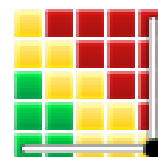
Consequence area: Helse

Assessed consequence: **Catastrophical (5)**

Comment: According to SDS:

CO
H220 - Extremely flammable gas
H280 - Contains gas under pressure; may explode if heated
H331 - Toxic if inhaled
H360 - May damage fertility or the unborn child H372 - Causes damage to organs (central nervous system) through prolonged or repeated exposure
CGA-HG04 - May form explosive mixtures with air
CGA-HG10 - Asphyxiating even with adequate oxygen
Acute toxicity
Serious health hazard
Poison gas

H₂
H220 - Extremely flammable gas
CGA-HG04 - May form explosive mixtures with air
H280 - Contains gas under pressure; may explode if heated
May displace oxygen and cause rapid suffocation
Burns with invisible flame
Contact with rapidly expanding gas may cause burns or frostbite

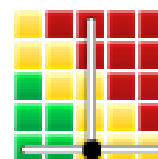
Risk:**Consequence area: Ytre miljø**

Assessed consequence: **Large (3)**

Comment: According to SDS:

CO
H220 - Extremely flammable gas
H280 - Contains gas under pressure; may explode if heated
CGA-HG04 - May form explosive mixtures with air
Poison gas

H₂
H220 - Extremely flammable gas
CGA-HG04 - May form explosive mixtures with air
H280 - Contains gas under pressure; may explode if heated

Risk:

Hazard: Pressurize and high temperature installation

Incident: Danger of explosion

Likelihood of the incident (common to all consequence areas): **Less likely (2)**

Kommentar:

Familiar with SDS, apparatus cards and instruments
Rig training
Use of local exhaust
Gas detector and local alarm
Leak test
After mounting reactor it is pressurized with He and leak-tested before any CO or H₂ is used

Consequence area: Helse

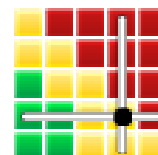
Assessed consequence: **Very large (4)**

Comment: According to SDS:

CO
H220 - Extremely flammable gas
H280 - Contains gas under pressure; may explode if heated
H331 - Toxic if inhaled
H360 - May damage fertility or the unborn child H372 - Causes damage to organs (central nervous system) through prolonged or repeated exposure
CGA-HG04 - May form explosive mixtures with air
CGA-HG10 - Asphyxiating even with adequate oxygen

H₂
H220 - Extremely flammable gas
CGA-HG04 - May form explosive mixtures with air
H280 - Contains gas under pressure; may explode if heated
May displace oxygen and cause rapid suffocation

Risk:



Consequence area: Materielle verdier

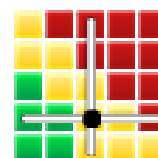
Assessed consequence: **Large (3)**

Comment: According to SDS:

CO
H220 - Extremely flammable gas
H280 - Contains gas under pressure; may explode if heated
CGA-HG04 - May form explosive mixtures with air

H₂
H220 - Extremely flammable gas
H280 - Contains gas under pressure; may explode if heated
CGA-HG04 - May form explosive mixtures with air
Burns with invisible flame

Risk:



Incident: Burn damage

Likelihood of the incident (common to all consequence areas): **Unlikely (1)**

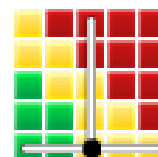
Kommentar:

Familiar with instruments and apparatus card, proper training
Rig training
Safety and protective equipment
Fire system alarm
After mounting reactor it is pressurized with He and leak-tested before any CO or H₂ is used

Consequence area: Helse

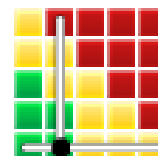
Assessed consequence: **Large (3)**

Comment: Some process, as the evaporation-drying of the catalyst and the calcination takes place at high temperatures (85-120 °C and 700-1000 °C, respectively) that can cause burns

Risk:**Consequence area: Materielle verdier**

Assessed consequence: **Medium (2)**

Comment: As a result of the high temperatures and pressures during the process, the equipments can be broken down if there is not control

Risk:

Incident: Syngas or H2 leakage

Likelihood of the incident (common to all consequence areas): **Unlikely (1)**

Kommentar:

Safety and protective equipment: lab coat, safety goggles and gloves
Familiar with SDS, instruments and apparatus card
Proper training and awareness of the HSE regulations
Operation under supervision
Leak test before every experiment

Consequence area: Helse

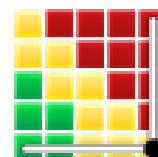
Assessed consequence: **Catastrophical (5)**

Comment: H2

May displace oxygen and cause rapid suffocation
Eye and skin contact: contact with rapidly expanding gas may cause burns or frostbite

CO

Toxic if inhaled
May damage fertility or the unborn child
Causes damage to organs through prolonged or repeated exposure
Asphyxiating even with adequate oxygen. Exposure to low concentrations for extended periods may result in dizziness or unconsciousness, and may lead to death
It cannot be detected by odor

Risk:**Consequence area: Ytre miljø**

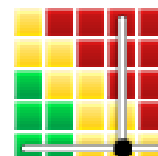
Assessed consequence: **Very large (4)**

Comment: H2

Extremely flammable gas
May form explosive mixtures with air
Burn with invisible flame

CO

Extremely flammable gas
Contains gas under pressure, may explode if heated
May form explosive mixtures with air

Risk:**Consequence area: Materielle verdier**

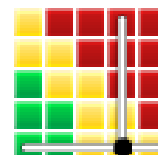
Assessed consequence: **Very large (4)**

Comment: H2

Extremely flammable gas
May form explosive mixtures with air
Contains gas under pressure; may explode if heated
Burns with invisible flame
Accidental releases pose a serious fire or explosion hazard

CO

Extremely flammable gas
May form explosive mixtures with air
Contains gas under pressure; may explode if heated
It cannot be detected by odor
Flammable gas may spread

Risk:



Hazard: Hot products

Incident: Burn damage

Likelihood of the incident (common to all consequence areas): **Less likely (2)**

Kommentar:

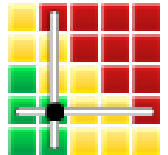
Familiar with instruments and apparatus card, proper training
Rig training
Safety and protective equipment

Consequence area: Helse

Assessed consequence: **Medium (2)**

Comment: The elevated temperatures of the products can cause burn damages

Risk:



Hazard: Handling chemicals during catalyst synthesis: $\text{Mn}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$, $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$, HReO_4

Incident: Spills. Danger of contact with skin or inhalation

Likelihood of the incident (common to all consequence areas): **Less likely (2)**

Kommentar:

Familiar with SDS, instruments and apparatus card

Proper training

Safety and protective equipment. Mandatory:

- Lab coat

- Safety goggles

- The glove material has to be impermeable and resistant to the product/substance. Selection of the glove material on consideration of the penetration times, rates of diffusion and the degradation

Consequence area: Helse

Assessed consequence: **Very large (4)**

Comment: According to SDS:

$\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$

Irritant and toxic substance

- Skin sensitization, category 1

Health hazard

- Germ cell mutagenicity, category 2

- Carcinogenicity, category 1B

- Reproductive toxicity, category 1B

- Respiratory sensitization, category 1

Suspected of causing genetic defects

May cause an allergic skin reaction

May cause allergy or asthma symptoms or breathing difficulties if inhaled

May cause cancer

May damage fertility or the unborn child

$\text{Mn}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$

Corrosive, health hazard, irritant

H302 Harmful if swallowed

H314 Causes severe skin burns and eye damage

H373 May cause damage to organs (Brain) through prolonged or repeated exposure if inhaled

Corrosive to the respiratory tract

HReO_4

Irritant, corrosive

Acute oral toxicity, category 4

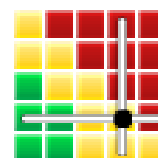
Skin corrosion/irritation, category 1A

Serious eye damage/eye irritation, category 1

H302 Harmful if swallowed

H314 Causes severe skin burns and eye damage

Risk:



Consequence area: Ytre miljø

Assessed consequence: **Very large (4)**

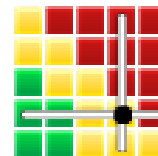
Comment: According to SDS:

Co(NO₃)₂·6H₂O
Irritant and toxic substance
May intensify fire; oxidizer
Very toxic to aquatic life
Very toxic to aquatic life with long lasting effects

Mn(NO₃)₂·4H₂O
Corrosive
H412 Harmful to aquatic life with long lasting effects

HReO₄
Corrosive

Risk:



Incident: Danger of burning or inhale vapors

Likelihood of the incident (common to all consequence areas): **Unlikely (1)**

Kommentar:

Familiar with SDS, instruments and apparatus card
Proper training
Safety and protective equipment
Work in fume hood or under local exhaust
Wait for cooling down to move the mixture

Consequence area: Helse

Assessed consequence: **Large (3)**

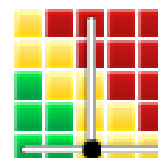
Comment: According to SDS:

Co(NO₃)₂·6H₂O
Irritant and toxic substance
Health hazard
- Germ cell mutagenicity, category 2
- Carcinogenicity, category 1B
- Reproductive toxicity, category 1B
- Respiratory sensitization, category 1
Suspected of causing genetic defects
May cause allergy or asthma symptoms or breathing difficulties if inhaled
May cause cancer
May damage fertility or the unborn child

MnN₂O₆·4H₂O
Corrosive, health hazard, irritant
H302 Harmful if swallowed
H314 Causes severe skin burns and eye damage
H373 May cause damage to organs (Brain) through prolonged or repeated exposure if inhaled
Corrosive to the respiratory tract

Re₂O₇(OH₂)₂
Acute oral toxicity, category 4
Skin corrosion/irritation, category 1A
Serious eye damage/eye irritation, category 1
H314 Causes severe skin burns and eye damage

Risk:



Consequence area: Ytre miljø

Assessed consequence: **Medium (2)**

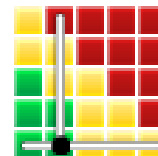
Comment: According to SDS:

Co(NO₃)₂·6H₂O
Irritant and toxic substance
May intensify fire; oxidizer

MnN₂O₆·4H₂O
Corrosive

Re₂O₇(OH₂)₂
Corrosive

Risk:



Incident: Spilling or inhalation of Co(NO₃)₂·6H₂O

Possibility of spillage of the substance while preparing the solution to be impregnated on the support or during the impregnation.

Also, risk of inhalation of gases produced during drying.

Likelihood of the incident (common to all consequence areas): **Less likely (2)**

Kommentar:

Safety and protective equipment: lab coat, safety goggles and gloves
Familiar with SDS, instruments and apparatus card
Proper training and awareness of the HSE regulations
Use of the fume hood while handling the substance
Ensure adequate ventilation and keep away from ignition sources

Consequence area: Helse

Assessed consequence: **Very large (4)**

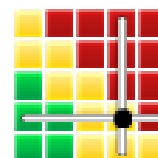
Comment: According to SDS:

Irritant, health hazard,
- Skin sensitization, category 1

Health hazard
- Germ cell mutagenicity, category 2
- Carcinogenicity, category 1B
- Reproductive toxicity, category 1B
- Respiratory sensitization, category 1
- Suspected of causing genetic defects
- May cause an allergic skin reaction
- May cause allergy or asthma symptoms or breathing difficulties if inhaled
- May cause cancer
- May damage fertility or the unborn child

Oxidizing
- May intensify fire; oxidizer

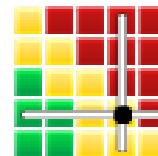
Risk:



**Consequence area: Ytre miljø**

Assessed consequence: **Very large (4)**

- Comment:* Irritant and toxic substance, environmentally damaging
- Acute hazards to the aquatic environment, category 1
 - Chronic hazards to the aquatic environment, category 1
 - Very toxic to aquatic life
 - Very toxic to aquatic life with long lasting effects

Risk:

Hazard: Handling N2: Adsorption/Desorption

Incident: Burn damage

Likelihood of the incident (common to all consequence areas): **Less likely (2)**

Kommentar:

Familiar with instruments and apparatus card, proper training
Safety and protective equipment
Adequate ventilation

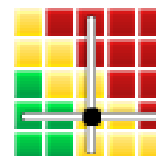
Consequence area: Helse

Assessed consequence: **Large (3)**

Comment: According to SDS:

Gas under pressure - refrigerated liquefied gas
May cause frostbite
May cause cryogenic burns or injury
May displace oxygen and cause rapid suffocation

Risk:

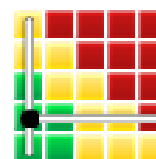


Consequence area: Materielle verdier

Assessed consequence: **Small (1)**

Comment: Equipment can be broken down as a result of the pressure increase due to an inadequate venting or pressure-relief devices on the containers

Risk:



Hazard: Handling chemicals during catalyst testing: KOH, KNO₃, KClO₄, K₂SO₄**Incident: Spills**
.....

Likelihood of the incident (common to all consequence areas): **Less likely (2)**

Kommentar:

Familiar with SDS, instruments and apparatus card

Proper training

Wear protective gloves/protective clothing, eye protection/face protection. Mandatory:

- Lab coat

- Safety goggles

- The glove material has to be impermeable and resistant to the product/substance. Selection of the glove material on consideration of the penetration times, rates of diffusion and the degradation

Keep the chemicals away from heat, hot surfaces, open flames and other ignition sources

Fire prevention, protection and regulation knowledge

Consequence area: Helse

Assessed consequence: **Large (3)**

Comment: According to SDS:

KOH

Irritant, corrosive

Acute toxicity, oral (category 4)

Skin corrosion (sub-category 1A)

Serious eye damage

H302 Harmful if swallowed

H314 Causes severe skin burns and eye damage

KNO₃

Oxidizing solid (category 3)

KClO₄

Oxidizing, irritant

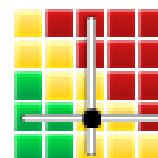
H271 May cause fire or explosion; strong oxidizer

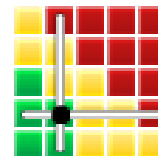
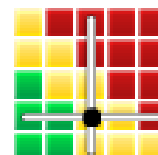
H302 Harmful if swallowed

K₂SO₄

Irritant

May cause of serious damage to eyes

Risk:

Consequence area: Ytre miljø*Assessed consequence:* **Medium (2)***Comment:* According to SDS:KOH
CorrosiveKNO₃
Oxidizing solid (category 3)
H272 May intensify fire; oxidizerKClO₄
Oxidizing
H271 May cause fire or explosion; strong oxidizer
The substance can be toxic to some marine species**Risk:****Consequence area: Materielle verdier***Assessed consequence:* **Large (3)***Comment:* According to SDS:KOH
H290 May be corrosive to metalsKNO₃
H272 May intensify fire; oxidizerKClO₄
H271 May cause fire or explosion; strong oxidizer**Risk:**

Hazard: Handling chemicals during the catalyst dewax: n-pentane

Incident: Spills or inhalation

Likelihood of the incident (common to all consequence areas): **Less likely (2)**

Kommentar:

Familiar with SDS and instruments

Proper training

Wear protective gloves and goggles. Use of fume hood during its handling

Keep chemicals away from heat, hot surfaces, open flames and other ignition sources

Consequence area: Helse

Assessed consequence: **Large (3)**

Comment: According to SDS:

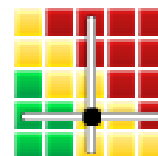
Flammable, toxic and health hazard

H224 Extremely flammable liquid and vapour

H304 May be fatal if swallowed and enters airways

H336 May cause drowsiness or dizziness

Risk:

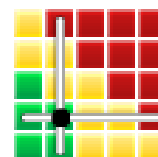


Consequence area: Ytre miljø

Assessed consequence: **Medium (2)**

Comment: Extremely flammable liquid and vapour
Toxic to aquatic life with long lasting effects

Risk:

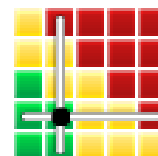


Consequence area: Materielle verdier

Assessed consequence: **Medium (2)**

Comment: Extremely flammable liquid and vapour

Risk:





Overview of risk mitigating measures which have been decided:

Below is an overview of risk mitigating measures, which are intended to contribute towards minimizing the likelihood and/or consequence of incidents:

Overview of risk mitigating measures which have been decided, with description:



Detailed view of assessed risk for each hazard/incident before and after mitigating measures