Applicant: Chimique inc

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Chemical Product Formula:C7H8ClN3O4S2

Chemical Product Name: 6-chloro-3,4-dihydro-2H-1,2,4-benzothiadiazine-7-sulfonamide 1,1 dioxide (Hydrochlorothiazide)

EHS Summary:

a. List the wastes generated and their quantity of generation.

The production of Hydrochlorothiazide using paraformaldehyde, liquid ammonia, NaOH can generate various wastes, including:

1. **Activated carbon:** 25 kg/day is fed in the reactor. The calculation assumes all the used activated carbon becomes waste. In reality, the disposal method might involve regeneration or reuse. If that's the case, the actual waste would be lower than 20.0 Kg/day.
2. **NH3:** Estimated Daily Ammonia Volume (assuming 50% concentration): = 3125 L/day.
   This estimated ammonia volume (3125 L/day) has limitations due to the assumption about concentration. For a more accurate value, we need to know the exact ratio of ammonia to water used in the process.
3. **Paraformaldehyde:** 9.536 kg/day

b. What are the current regulations for the above waste materials. (Limits to which it can be disposed in the environment)

a)Paraformaldehyde:

Carcinogen to humans – solutions can emit formaldehyde gas, May cause an allergic skin reaction, May cause respiratory irritation, Flammable solid,Suspected of causing cancer, Harmful if inhaled, Harmful if swallowed, Causes skin irritation, Causes serious eye damage.

b)Liquid ammonia:

Liquid ammonia disposal into the environment is strictly limited due to its hazardous nature.

Environmental and Health Risks:

Air and Water Pollution: Ammonia gas readily evaporates from liquid ammonia, polluting the air. In water, it converts to ammonium hydroxide, impacting aquatic life.

Human Health: Exposure to ammonia gas can irritate the eyes, skin, and respiratory system, causing severe health problems at high concentrations.

Limits on Disposal: Direct release of liquid ammonia is generally prohibited. Permitted facilities might have limitations on the amount of ammonia they can release based on factors like location, technology used for emission control, and ambient air quality. Accidental spills require immediate reporting and proper cleanup procedures.

c)Solid waste:

Solid waste regulations can vary depending on the type of waste and local regulations.Generally, solid waste is categorised into hazardous and non-hazardous waste. Non-hazardous solid waste is typically disposed of in landfills, while hazardous waste requires special treatment and disposal facilities.

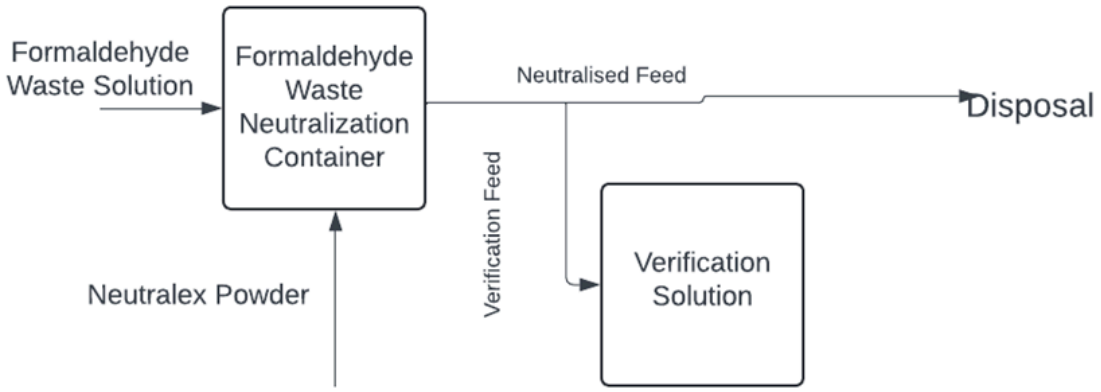
d)Activated carbon:

Activated carbon that has been used may be classified as hazardous or non-hazardous waste depending on the contaminants it has adsorbed and the concentrations present. Regulations typically define thresholds for hazardous waste based on the concentrations of specific chemicals. activated carbon may be regenerated or recycled for reuse, which can be more environmentally sustainable than disposal. Regulations may encourage or require recycling or regeneration where feasible

c. Describe the treatment procedure for wastes with a block diagram. Your chemical plant must be a zero liquid discharge plant.

1. Paraformaldehyde

Treatment of paraformaldehyde waste Untreated paraformaldehyde-containing solutions cannot be poured down the drain! Some laboratories may be able to treat their own paraformaldehyde waste, which helps us avoid the risks and costs of hazardous waste transport and disposal. Only paraformaldehyde solutions at concentrations less than 0.1% (1000 ppm) are acceptable for sewer discharge.



Collection and Neutralization

Input: Paraformaldehyde waste solution

- Process:
    - Collect waste in a designated and labelled "Paraformaldehyde Waste Neutralization Ensure the container is used within a chemical fume hood or ventilated enclosure with secondary containment.
    - Fill the container allowing space for mixing (avoid overfilling).
    - Add Neutralex powder according to the following guidelines:
        - ½ packet (375 g) for 2.5 gallons of waste solution

        - Full packet (750 g) for 5 gallons of waste solution
    - Mix the solution thoroughly by stirring or sealing the container and swirling it.

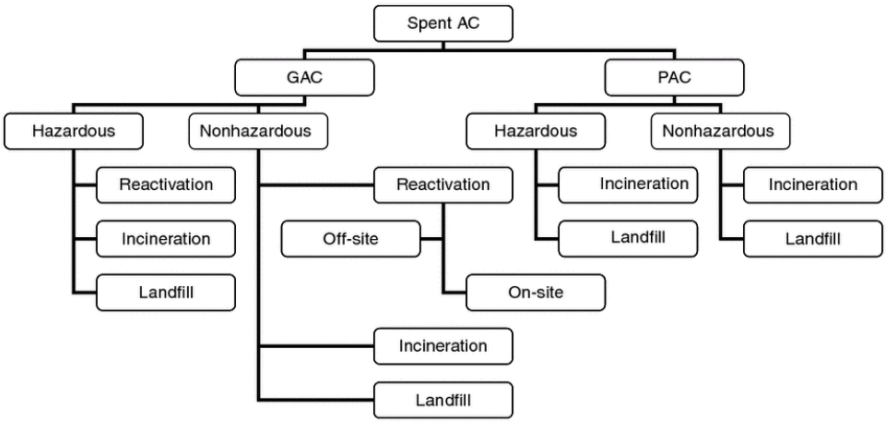
Treatment Verification

- Input: Neutralised waste solution
- Process:
    - Let the solution sit for 15 minutes. Swirl again before testing.
    - Measure the pH of the solution using a pH test strip. The pH should be between 6 and 9 for proper disposal.
    - Test for residual aldehydes using an aldehyde test strip. The residual aldehyde content should be below 100 ppm.

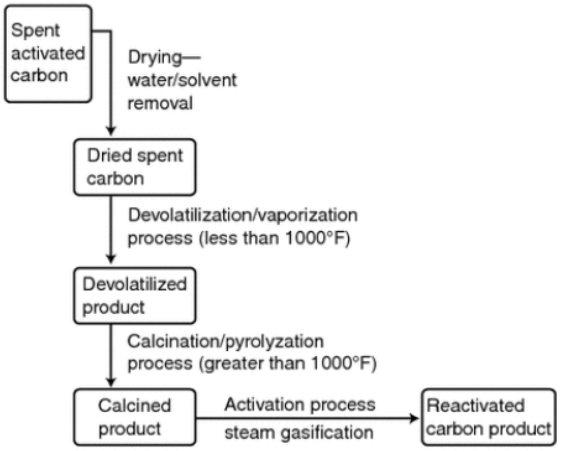
Block 3: Disposal

- Input: Treated waste solution (pH 6-9, residual aldehyde content < 100 ppm)

2. Activated Carbon



Reactivation process for Activated Carbon



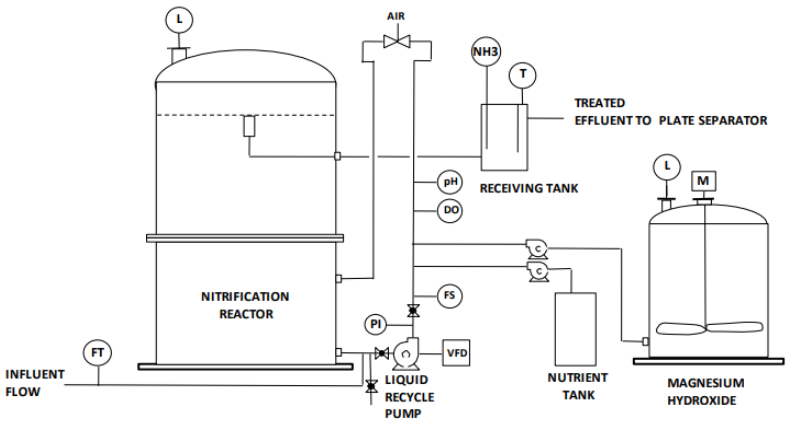
AC : Activated Carbon

GAC : Granular Activated Carbon

PAC : Powdered Activated Carbon

3. Liquid NH3

Biological Conversion of Ammonia:Ammonia can be removed by a biological, fixed-film process that uses live bacteria to oxidise the ammonia to nitrates and then simultaneously reduce the nitrates to nitrogen gas.



d. Are there any safety concerns for the chemicals. Give exposure limits: Time Weighted Average (TWA) for 8 hours and short-term exposure limit (STEL) for 15 minutes.

Some of the safety concerns related to the production of HCTZ include:

- **Toxicity:** HCTZ itself isn't highly toxic in small quantities. However, chronic exposure can lead to the health effects mentioned previously (electrolyte imbalance, etc.). Proper handling procedures and Personal Protective Equipment (PPE) are crucial to minimise exposure risks.
- **Flammability:** HCTZ is not flammable. No special precautions are needed for flammability during storage or handling.
- **Reactivity:** HCTZ is generally stable under normal conditions. However, strong acids or bases could potentially cause it to decompose. Reviewing the Safety Data Sheet (SDS) for HCTZ is recommended to understand any specific reactivity hazards.
- **Corrosivity:** HCTZ is not considered corrosive. However, dust or concentrated solutions might irritate the skin or eyes. Wearing gloves, safety glasses, and a lab coat is advisable when handling HCTZ powder or concentrated solutions.

Formaldehyde:-

TWA- 0.75 ppm for 8hr work shift

STEL- 2 ppm for 15 min

1. Toxicity:

- Inhalation and ingestion of paraformaldehyde dust can cause irritation and inflammation of the respiratory system and gastrointestinal tract. Symptoms can include coughing, difficulty breathing, nausea, vomiting, and abdominal pain. In severe cases, exposure can lead to pulmonary edema (fluid buildup in the lungs) and even death.

- Paraformaldehyde dust can cause irritation and inflammation of the skin and eyes upon contact. Symptoms may include redness, itching, burning sensation, and tearing.
- Paraformaldehyde is a flammable solid. It can ignite easily from heat, sparks, or open flames. Once ignited, paraformaldehyde can burn rapidly, releasing formaldehyde gas and other toxic fumes.
- Paraformaldehyde can be harmful to aquatic life if released into the environment. It's important to dispose of paraformaldehyde waste properly according to local regulations.

Activated Carbon (graphite, synthetic):-
total particulate = 15 mg/m3 (TWA)
respirable fraction = 5 mg/m3 (TWA).

- Activated carbon exists as a fine black powder. Inhaling this dust can irritate the respiratory system, causing coughing, wheezing, and shortness of breath. Long-term exposure to high levels of dust may lead to pulmonary fibrosis (scarring of the lungs).
- Activated carbon has a high surface area and can readily adsorb various gases and vapours. If exposed to flammable or oxidising gases/vapours in a concentrated **and unconfined space**, activated carbon can ignite due to the heat generated by adsorption. This can lead to a dust explosion.
- Activated carbon itself is not inherently harmful to the environment. However, depending on what substances it has adsorbed, spent activated carbon can become contaminated and require special disposal procedures.

Ammonia:-

TWA- 25 ppm or 17 mg/m3

STEL- 35 ppm or 24 mg/m3

- **Inhalation:** Ammonia is a severe respiratory irritant. Inhaling ammonia gas can cause coughing, wheezing, shortness of breath, and burning sensation in the nose, throat, and lungs. High concentrations can lead to pulmonary edema (fluid buildup in the lungs), which is a medical emergency.
- **Skin and Eye Contact:** Liquid ammonia can cause severe frostbite-like burns upon contact with skin and eyes. These burns can be deep and very painful. Eye exposure can lead to permanent vision loss.
- Ammonia vapours can form explosive mixtures with air under certain conditions. Leaking ammonia gas can create an explosion hazard if ignited by a spark or flame.
- Ammonia gas is highly toxic to aquatic life. Accidental spills or leaks can have a devastating impact on fish and other aquatic organisms.

References:

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2. https://ehslegacy.unr.edu/msdsfiles/30933.pdf
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List the contributions of each author:

- Author 1,2 and 3 determined the waste generation quantity.
- Author 3 carried out the literature search and found the current regulations.
- Authors 1 found necessary treatment steps and prepared the block diagram.
- Author 2 obtained the safety concerns and the TWA and STEL data.

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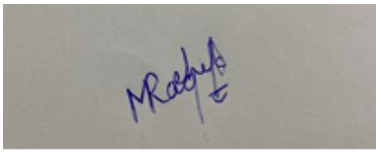
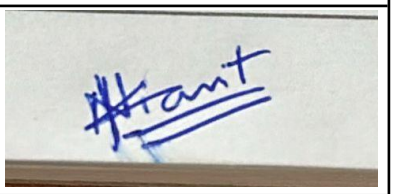
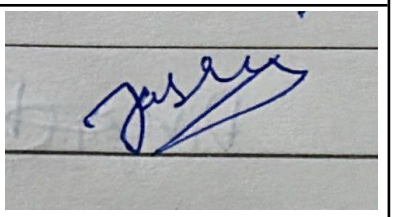
CEO Name	Mehek Agarwal	
First author Name	Nikant Yadav	
Second author Name	Jasraj Singh	
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