Applicant:QuantiVex

Inventors: Arnav Harshit, Om Jee Singh

Chemical Formula: R-C6H4-SO3Na

Chemical Name: Linear Alkylbenzene Sulphonate (LABS)

Process Title: EHS

1. Introduction

This report presents the Environmental, Health, and Safety (EHS) assessment of Linear Alkylbenzene Sulfonate (LABS) production. LABS is a key surfactant in household and industrial detergents. The assessment evaluates environmental impact, health hazards, safety measures, regulatory compliance, and mitigation strategies.

2. Waste Generation & Quantities

Waste Generated in LABS Production:

1. **Residual Sulfuric Acid (H_2SO_4):**
    - Generated during sulfonation.
    - Quantity: ~0.01 - 0.02 kg per kg of LABS (since H_2SO_4 content in the sulfonic acid product is 1-2%).
2. **Unreacted Linear Alkylbenzene (LAB):**
    - Quantity: ~0.01 kg per kg of LABS (since ~1% of unsulfonated matter remains).
3. **Wastewater (Containing Neutralized Sulfonic Acid & Impurities):**
    - Generated during neutralization and washing processes
    - Quantity: ~0.8 - 1.5 kg per kg of LABS.
4. **Sulfur Oxides (SO_2, SO_3) Emissions:**
    - Generated during sulfonation using SO_3 gas.
    - Quantity: <0.05 kg per kg of LABS.
5. **Volatile Organic Compounds (VOCs):**
    - Includes benzene traces, aldehydes, and residual solvents.
    - Quantity: ~0.01 kg per kg of LABS.

3. Regulatory Limits & Disposal Standards

Waste Component	Regulatory Limit (ppm)	Disposal Method
Sulfuric Acid (H_2SO_4)	<100 ppm in effluent	Neutralization & Recycling
LAB Residue	Should not exceed 0.1% in final product	Recycle in process
Wastewater BOD	<30 ppm	Treatment via activated carbon
SOx Emissions	<500 mg/m^3	Scrubbing & Adsorption
VOCs	<10 ppm	Adsorption on Activated Carbon

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4. Waste Treatment & Zero Liquid Discharge Measures

4.1 Acid Neutralization & Recovery

Process:

- Residual sulfuric acid is neutralized using NaOH or $Ca(OH)_2$.
- By-product (Na_2SO_4 or $CaSO_4$) is collected and used in the cement industry.

4.2 Water Treatment Process

- **Primary Treatment:** Sedimentation & filtration to remove suspended solids.
- **Secondary Treatment:** Activated sludge process for organic compound removal.
- **Tertiary Treatment:** Reverse osmosis for achieving zero liquid discharge.

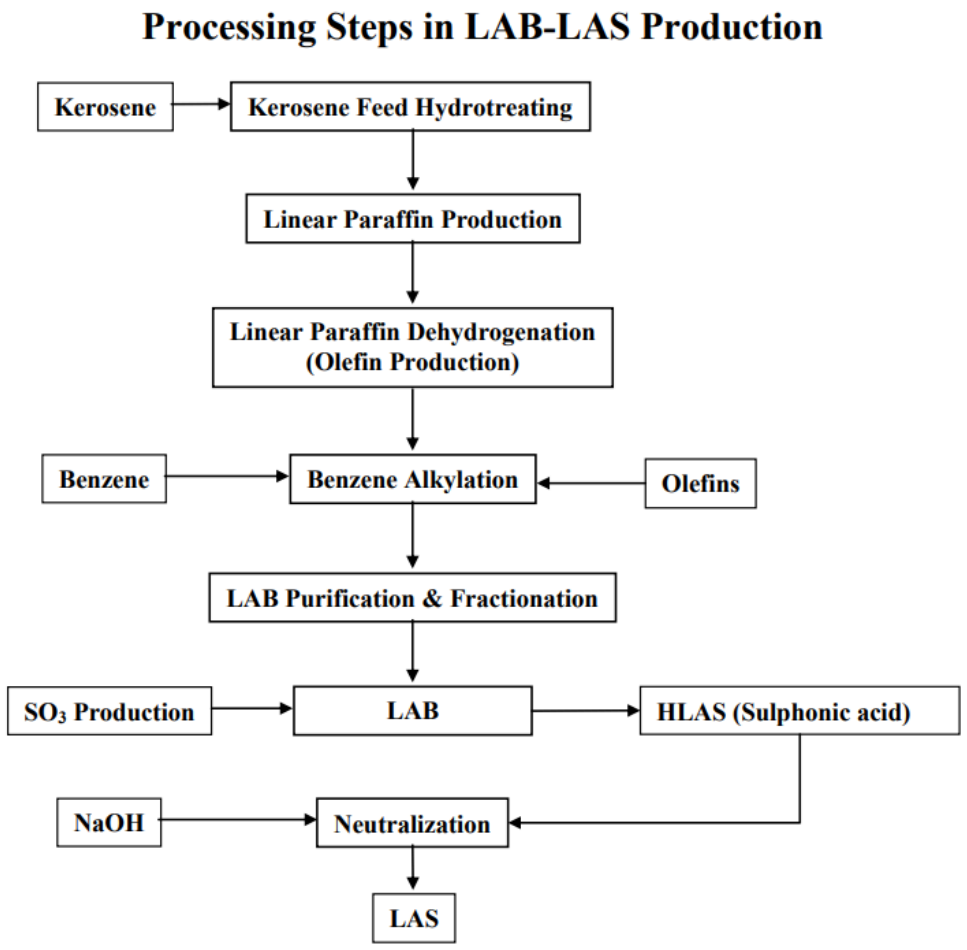
4.3 Gas Treatment for SOx & VOC Emissions

- **SOx Removal:** Scrubbers using lime slurry ($Ca(OH)_2$) or ammonia (NH_3).
- **VOC Control:** Activated carbon adsorption & biofiltration.

Flowchart: Zero Liquid Discharge System

LABS Production → Wastewater Collection → Neutralization (NaOH) → Filtration →

Reverse Osmosis → Sludge Separation → Water Reuse → Zero Liquid Discharge



5. Health & Safety Concerns

5.1 Occupational Exposure Limits (OELs)

Chemical	TWA(8hr)	STEL(15min)	Health Risks
Sulfuric Acid (H_2SO_4)	1 mg/m^3	3 mg/m^3	Skin & eye irritation, respiratory issues
LAB Vapors	5 ppm	10 ppm	Irritation, dizziness, long-term exposure risks
Benzene (Trace)	0.5 ppm	2.5 ppm	Carcinogenic, bone marrow suppression
VOCs (General)	50 ppm	100 ppm	Neurological effects, respiratory issues

5.2 Personal Protective Equipment (PPE) Requirements

- **Eye Protection:** Chemical-resistant safety goggles with face shields.
- **Respiratory Protection:** N95 masks or respirators for airborne chemicals.
- **Skin Protection:** Chemical-resistant gloves & full-body PPE.
- **Emergency Measures:**
    - Eye wash stations and safety showers.
    - Fire extinguishers (CO_2, foam type) in storage areas.

6. Risk Assessment & Mitigation

Hazard Identification & Control Measures:

Hazard	Risk Level	Control Measure
Chemical Spillage	**Medium**	Secondary containment & spill kits
Acidic Vapors	**High**	Scrubber system & PPE
Fire/Explosion	**Medium**	Proper ventilation & ignition control
Waste Handling	**Medium**	Automated handling systems

7. Emergency Response Plan

7.1 Spill response Protocol

- Use **spill kits** for sulfuric acid and LAB containment.
- Isolate and neutralize acid spills using **lime or soda ash**.

7.2 Fire & Explosion Response

- Evacuation procedures and fire containment measures.
- Fire extinguishers and automated suppression systems in high-risk areas.

7.3 First Aid Measures

- Immediate washing for acid exposure.
- Oxygen therapy for VOC inhalation incidents.

8. Process Safety Measures

- **Hazardous Reaction Control**: Safe handling of sulfonation exothermic reactions.
- **Pressure & Temperature Monitoring**: Automated detection of pressure surges.
- **Leak Detection Systems**: Real-time monitoring of pipeline leaks.

9. Sustainability & Green Chemistry Approach

- **Alternative Green Surfactants**: Bio-based LABS alternatives to reduce environmental footprint.
- **Energy Optimization**: Waste heat recovery and renewable energy utilization.
- **Carbon Footprint Reduction**: Strategies to minimize greenhouse gas emissions.

10. Training & Compliance Audits

- **Employee Training Programs**: Ensuring workers understand EHS risks and mitigation.
- **Regular Audits & Compliance Checks:** Internal and third-party audits for regulatory adherence

11. Conclusion & Recommendations

- **Adopt closed-loop wastewater treatment** to achieve zero liquid discharge.
- **Improve SOx & VOC mitigation** by implementing multi-stage scrubbers.
- **Strengthen workplace safety** through real-time monitoring & PPE compliance.
- **Comply with national & international safety standards** for environmental impact reduction.

References

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2. Technical Analysis of LABS (2025).
3. Market & Patent Analysis for LABS (2025).

List the contributions of each author:

- Arnav Harshit led the EHS assessment, structured the report, and ensured regulatory compliance. He verified waste generation data and developed risk assessment and mitigation measures. He also outlined OELs, PPE requirements, and integrated sustainability strategies.
- Om Jee Singh conducted the literature review, identified separation processes, and researched scrubbing techniques for SO_x and VOC control. He assisted in waste disposal planning, formulated training and compliance audits, and refined the risk assessment and emergency response plan.

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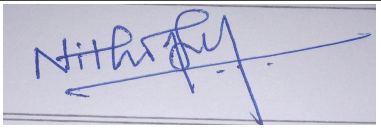
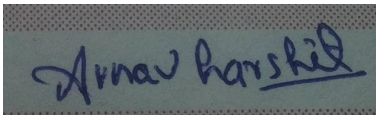
Nithin TM	230709	
Arnav Harshit	230200	
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