Experimental Study of Laundry Waste Water Recycling on Low Cost Adsorbents

Dr. Hema S[1], Samuthradevi S[2], Srija VM[3]
[1,2,3]*Sri Ramakrishna Engineering college coimbatore*

***Abstract*—To reduce the consumption of freshwater, reuse/recycling is done. In this study, the characteristics of domestic laundry wastewater were evaluated using wastewater samples. The samples were analyzed for the physicochemical and bacteriological characteristics of the water. The parameters examined were: pH, temperature, conductivity, TDS, TSS, turbidity, colour, total hardness, BOD, COD, DO, phosphate, nitrate, chloride and sulphate. The pH of the wastewater ranges from 8.8 – 9.0, TDS ranges from 229 mg/L to 461mg/L, TSS ranges from 228.9–460 mg/L, Turbidity ranges from 25.3– 39.4 NTU and the colour ranges from 4.2-5.8 TCU. The BOD ranges from 144– 211.2 mg/L, and the COD ranges from 428.6-531.3 mg/L. The Total Coliform and E.coli in the wastewater ranges from 140-700 CFU. The pH, TDS, colour, total hardness, total coliform and E.coli are within permissible levels for toilet and laundry water reuse, while TSS, turbidity, BOD and COD exceed the limit. The result of this study reveals that there is a high potential of recycling laundry wastewater for reuse in toilets, irrigation and laundry with little treatment.**

I. INTRODUCTION

The report says that there is only 0.03% of surface water. In the face of shortages, recycling wastewater is often more cost-effective than conservation or desalination. Specifically, laundry wastewater (a type of "grey water") accounts for a significant portion of household usage. Moreover, this water also contains organic and inorganic substances like detergents, fats and heavy metals that make the treatment challenging. Water, vital to life on our planet, is beginning to emerge as a prized commodity and asset.

Effluents pose substantial environmental risks when discharged without adequate treatment, contributing to aquatic toxicity, eutrophication, and disruption of conventional wastewater treatment systems due to the persistent nature of these contaminants. Research indicates that laundry wastewater can account for a considerable share of urban wastewater, emphasizing the urgency to develop effective treatment and recycling strategies to mitigate pollution and conserve water resources.

Urbanisation and industrial activities have led to very high levels of demand for fresh water, adding unexpected pressure on the freshwater resources at global level, and so there is an urgent need for sustainable water management systems that combine conservation with environmental protection. From domestic waste, laundry wastewater ranks as one of the largest contributors of household and industrial effluents with a high load of surfactants, detergents, fine solids, oils, dyes and variable amount if organic matter in its composition.

In addition to physicochemical methods, oxidation techniques like ozone-based processes, catalytic cavitation, and photo-Fenton reactions have been explored for their ability to break down complex organic pollutants that resist regular treatments. These processes generate highly reactive radicals that can mineralize organic contaminants and lower microbial loads, which improves the quality of reclaimed water. Studies at both laboratory and pilot scales have shown significant removal rates for surfactants and COD using combinations of ozone, catalysts, and light treatment. This highlights the potential for scalable solutions in cleaning laundry wastewater. Alongside physicochemical and oxidative methods, new approaches like electro-hybrid ozonation and coagulation have proven effective in removing both dissolved organic compounds and emerging issues like microplastics and leftover surfactants. These developments broaden the potential for recycling laundry wastewater. They reflect a trend toward multi-stage treatment systems that reliably produce water of consistent quality while managing challenges like fouling, chemical use, and energy consumption Recycling laundry wastewater is essential not only for reducing pollution but also for meeting broader sustainability goals. Reusing treated laundry water in non-drinking applications like toilet flushing, landscape watering, laundry pre-wash cycles, and industrial processes can greatly lower freshwater use and lessen the environmental impact of water-heavy facilities. Research shows that no single treatment method works for every situation. The success of reclamation strategies depends on matching the processes to specific water quality goals and reuse needs. For instance, membrane processes provide high selectivity and effective separation without chemicals, while combining them with electrochemical and oxidation treatments boosts the removal of tough contaminants.

Despite significant progress, challenges remain in implementing laundry wastewater recycling technologies. Operational problems like membrane fouling, high energy use, and the cost-effectiveness of complex treatment systems pose barriers to widespread use, especially in decentralized and resource-limited areas. Additionally, the variation in laundry water quality, affected by detergent types, washing programs, and fabric materials, makes it hard to standardize process design and predict performance. These issues highlight the need for ongoing research that improves treatment efficiency while also addressing costs, scalability, and regulatory requirements for sustainable reuse.

Given the urgent concerns over global water shortages and strict environmental regulations, recycling laundry wastewater offers a promising approach to sustainable water management. By combining innovative treatment processes and customizing them for specific reuse scenarios, we can turn a typically overlooked waste stream into a dependable source of reclaimed water. This can help create circular water economies and promote long-term environmental care.

Laundry wastewater is a significant source of domestic and industrial water waste. It contains a complex mix of organic and inorganic pollutants, including surfactants, detergents, lint, dyes, suspended solids, and increasingly, microplastics. These pollutants can raise chemical oxygen demand (COD), biological oxygen demand (BOD), and turbidity. If left untreated, they can harm aquatic ecosystems and complicate traditional wastewater treatment. The large volume of laundry wastewater produced globally, from home machines to commercial laundries, highlights its potential as a recyclable water source. This could help reduce freshwater use and lessen environmental pollution.

Conventional treatment methods like coagulation, flocculation, and basic filtration are often not enough to meet current reuse standards. This is especially true for stubborn surfactants and complex organic materials. More effective and integrated treatment strategies are necessary. Researchers have found that combined approaches, such as pairing biological pretreatment with advanced oxidation processes (AOPs) or membrane filtration, can improve removal rates for many pollutants. They also enhance the quality of treated water for use in non-drinking applications.

Advanced oxidation processes (AOPs) can create highly reactive radicals that break down resistant organic pollutants in laundry wastewater. Studies comparing ozone, hydrogen peroxide, and UV-based systems have shown significant reductions in key indicators like COD and surfactant levels. This indicates that integrating these methods into large-scale systems is feasible. At the same time, membrane technologies, including microfiltration, ultrafiltration, and reverse osmosis, have become important for their ability to physically separate particles and organic materials. They can achieve high levels of purification when used in hybrid treatment systems.

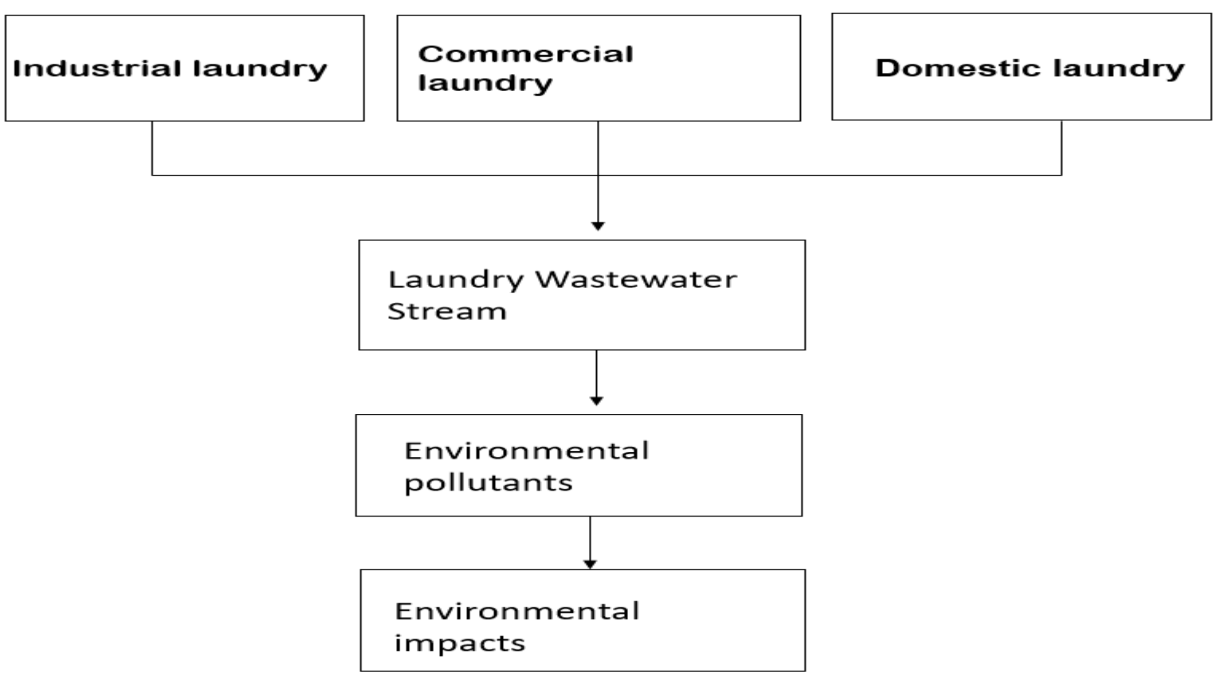
Despite advances, the adoption of laundry wastewater recycling systems in homes and industries faces economic, operational, and regulatory barriers. Issues like membrane fouling, energy use in advanced oxidation systems, and the variable nature of laundry wastewater make it hard to standardize treatment plans. Moreover, inconsistent reuse criteria across different regions hinder wider implementation. There is ongoing research into incorporating eco-friendly treatment options, such as biological flocculants and low-cost adsorbents, to explore more sustainable and affordable water reclamation methods.

The need to recycle laundry wastewater aligns with broader global goals of sustainable water management, resource conservation, and pollution reduction. Converting this significant waste stream into a dependable source of reclaimed water for non-drinking uses—like irrigation, toilet flushing, industrial processes, and even additional laundry cycles—can help reduce the environmental impact of

wastewater discharge. Continued research and innovation in treatment technologies, process optimization, and integrated system design are essential to unlocking the full potential of laundry wastewater recycling in various real-world scenarios.
The growing demand for freshwater resources, along with rapid urbanization and industrial expansion, has increased the pressure on global water supplies. Domestic and commercial water use makes up a large portion of total consumption, with laundry activities being a major source of wastewater. Laundry wastewater, often classified as greywater, is produced during washing in homes, hotels, hospitals, hostels, and commercial laundries. While it is usually less contaminated than municipal sewage, untreated laundry wastewater contains various chemical and physical pollutants that can harm the environment and public health. Recently, recycling and treating laundry wastewater has proven to be an effective way to tackle water scarcity and lessen environmental pollution. Treated laundry wastewater can be reused for several non-drinking purposes, thus decreasing the need for freshwater and reducing the volume of wastewater discharged. Proper treatment technologies allow for the safe reuse of laundry effluent while minimizing negative impacts on ecosystems.
This section outlines the sources, characteristics, environmental effects, and treatment methods related to laundry wastewater, emphasizing its potential for sustainable reuse.

Sources and Composition of Laundry Wastewater
Laundry wastewater comes from washing processes that use water, detergents, softeners, bleaching agents, and mechanical agitation. Its composition varies based on washing conditions, detergent types, water quality, fabric types, and load sizes. Unlike blackwater, laundry wastewater does not contain fecal matter; however, it has a complex mixture of pollutants that need treatment before reuse or discharge.
Common contaminants in laundry wastewater include surfactants, suspended solids, organic matter, oils, grease, fabric fibers, and dissolved salts. In institutional laundries, like hospitals, wastewater may also have pathogens and pharmaceutical residues. The use of synthetic detergents and additives raises the levels of chemical oxygen demand (COD) and biochemical oxygen demand (BOD), indicating a high organic load.

Figure 1 shows the primary sources and contaminant pathways linked to laundry wastewater generation.



- Figure 1. Schematic representation of laundry wastewater sources and major contaminant inputs.

Environmental Impacts of Laundry Wastewater Discharge

Discharging untreated or poorly treated laundry wastewater into surface water bodies can lead to severe environmental damage. Surfactants in detergents lower water surface tension, impede oxygen transfer, and disrupt aquatic ecosystems. Excess foam and decreased dissolved oxygen levels harm fish and other aquatic life.

Phosphate-based detergents contribute to nutrient overload, causing eutrophication in rivers and lakes. Eutrophication encourages excessive algae growth, blocking sunlight and consuming oxygen during decay. Additionally, microfibers shed from synthetic fabrics linger in the environment and contribute to microplastic pollution.

Discharging laundry wastewater also increases the hydraulic and organic load on municipal wastewater treatment plants. Treatment and recycling at the source can significantly lessen this impact while enhancing overall treatment efficiency.

Importance of Laundry Wastewater Recycling

Recycling laundry wastewater provides important environmental, economic, and social benefits. For water conservation, treated laundry wastewater can replace potable water for non-drinking uses like toilet flushing, irrigation, floor washing, and cooling systems. This is especially helpful in areas with limited water supplies.

From an economic standpoint, recycling reduces the costs associated with acquiring water and disposing of wastewater, especially in large commercial and institutional settings. Environmentally, recycling minimizes pollutant discharge and supports sustainable water practices consistent with circular economy principles.

Table 1 summarizes the main benefits of laundry wastewater recycling.

ASPECT	BENEFIT
Water conservation	Reduction in freshwater demand
Pollution control	Lower wastewater discharge and pollutant load
Economic impact	Reduced water and sewage costs
Infrastructure	Decreased load on centralized treatment plants
Sustainability	Supports circular water use

- Table 1. Environmental and economic benefits of laundry wastewater recycling.

Characteristics of Laundry Wastewater Relevant to Treatment

The effectiveness of laundry wastewater treatment depends heavily on its physical, chemical, and biological traits. Physically, it contains lint, fibers, and suspended solids that increase turbidity and need removal during initial treatment stages. Chemically, laundry wastewater shows variable pH levels, high COD and BOD concentrations, and significant surfactant content.

Biological contamination is generally lower than in sewage, but notable microbial loads may be present in wastewater from healthcare or industrial laundries. These characteristics require a multi-stage treatment process to ensure safe reuse.

Table 2 presents typical quality parameters of laundry wastewater.

Parameter	Typical Range
pH	7.0 – 10.5
COD (mg/L)	400 – 1500
BOD (mg/L)	150 – 600
Total suspended solids (mg/L)	50 – 300
Surfactants (mg/L)	10 – 40

- Table 2. Typical characteristics of laundry wastewater.

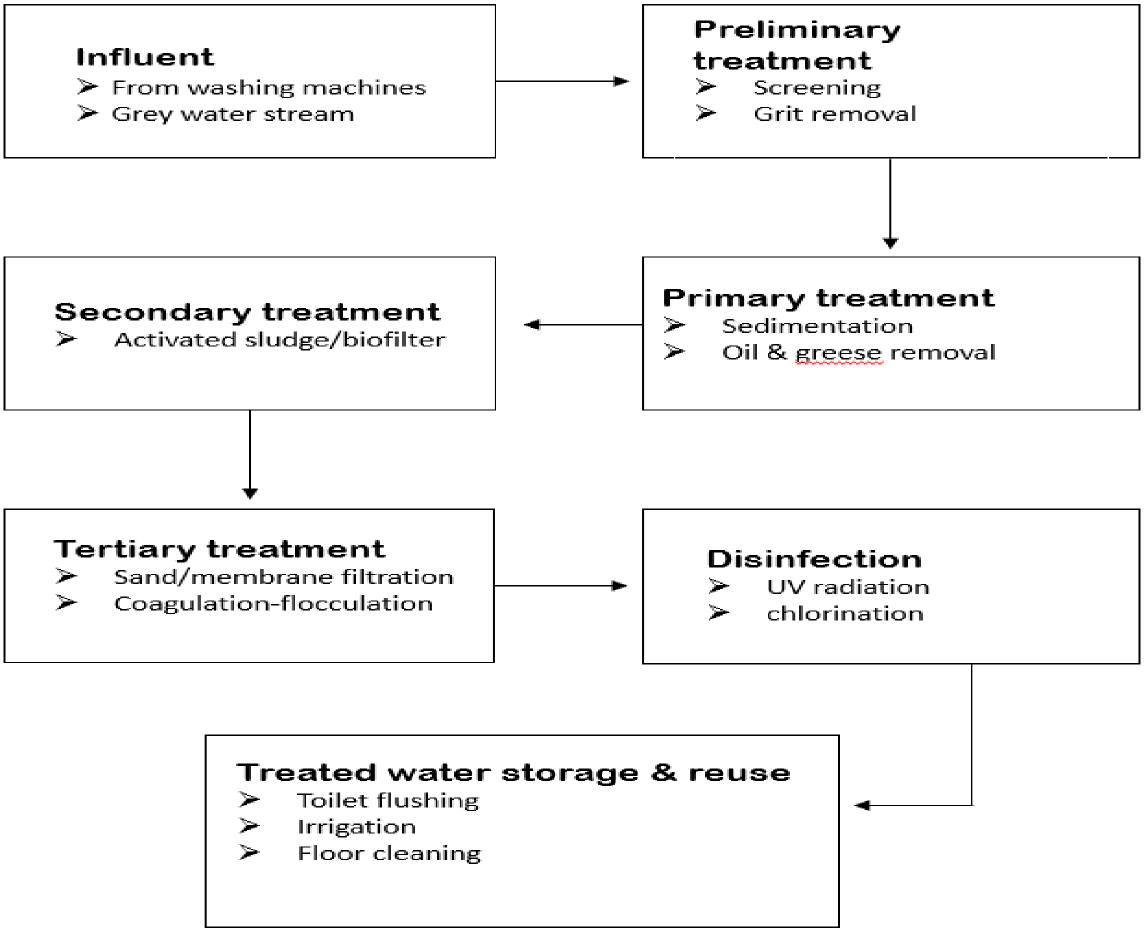
Laundry Wastewater Treatment Technologies

Treating laundry wastewater usually involves a mix of physical, chemical, and biological processes. The choice of treatment methods depends on the intended reuse and regulatory standards.

Physical processes like screening, sedimentation, and filtration remove coarse solids and suspended particles. Chemical methods such as coagulation and flocculation improve the removal of fine particles and surfactants. Oxidation processes may degrade persistent detergent compounds.

Biological methods use microorganisms to break down organic matter and lower BOD and COD levels. Systems such as activated sludge processes, biofilters, and constructed wetlands are commonly used. Advanced treatment technologies, including membrane filtration, reverse osmosis, and ultraviolet disinfection, are needed when high-quality reclaimed water is required.

Figure 2 outlines a generalized flow diagram of a laundry wastewater treatment and recycling system.



- Figure 2. Typical treatment sequence for laundry wastewater recycling.

Reuse Applications of Treated Laundry Wastewater
After proper treatment, laundry wastewater can be reused for a range of non-potable purposes. Common applications include toilet flushing, landscape irrigation, pavement cleaning, cooling systems, and fire protection. In commercial laundries, treated water may be reused for pre-washing cycles, cutting overall water use.
The quality of treated wastewater must meet reuse guidelines to safeguard public health and ensure system reliability. Regular monitoring and maintenance are crucial for successful reuse programs.

Challenges and Future Perspectives
Despite its potential, recycling laundry wastewater encounters challenges like high initial costs, public acceptance issues, operational complexity, and variations in wastewater quality. Poorly designed or maintained systems can lead to unpleasant odors, clogging, and microbial regrowth.

Future research and development will focus on low-cost, energy-efficient, and decentralized treatment systems. Advances in membrane technologies, hybrid treatment systems, and real-time monitoring aim to improve treatment effectiveness and encourage wider adoption.

II. MATERIALS USED

The team carefully chose materials for the laundry wastewater recycling system by considering factors like availability, cost, filtration efficiency, environmental friendliness, and ease of maintenance. Each material plays a specific role in the multi-stage filtration process and helps to improve the quality of the wastewater.

LIST OF MATERIALS AND THEIR PURPOSE

S.NO	MATERIAL	PURPOSE
1.	Gravel	Removes large particles and supports upper layers
2.	Tempered Glass	Acts as a protective layer and prevents damage to the inner components
3.	Biochar	Absorbs detergent residues, odour, and organic impurities
4.	Coconut Husk	Acts as a natural fibrous filter and improves water clarity
5.	Fine Sand (small stones)	Removes fine suspended particles

1. GRAVEL

Gravel serves as the main filtration material in the early stages of the wastewater treatment system. Laundry wastewater has large suspended particles, such as dirt, lint, fabric fibers, and solid impurities. These need to be removed before finer filtration can occur.

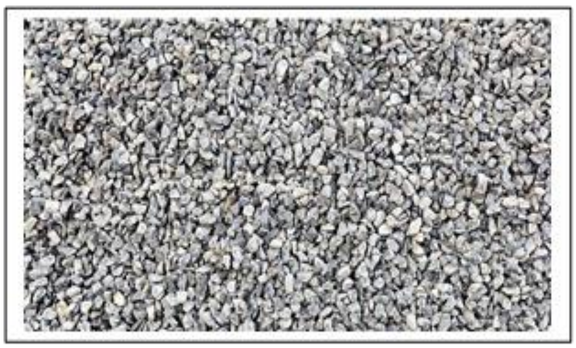


Figure.1 GRAVEL

Purpose

- Supports upper filtration materials.
- Allows water to flow freely while trapping large impurities.

Role in the System

- Performs coarse filtration.
- Prevents finer materials like sand and biochar from clogging.
- Maintains the structural stability of the filtration bed.

Advantages

- Readily available and inexpensive.
- Durable and reusable.
- Has high mechanical strength.
- Requires little maintenance.

Reason for Selection

Gravel is favoured because it offers effective primary filtration without limiting water flow. Its porous structure helps wastewater pass through easily while holding back large particles, making it perfect for the first filtration stage.

2. TEMPERED GLASS

Tempered glass acts as a protective layer in the first filtration box. In this project, tempered glass, which is like the protective glass on mobile phone screens, is used to shield the lower filtration materials and maintain the filtration system's integrity.

FIGURE.2 TEMPERED GLASS

Purpose

- Serves as a protective and shielding layer.
- Prevents wastewater from directly impacting sensitive filtration materials.

Role in the System

- Evenly distributes wastewater flow.
- Protects gravel and biochar layers from sudden pressure changes.
- Prevents damage and displacement of filtration materials.

Advantages

- Strong and durable.
- Chemically inert, meaning it doesn’t react with wastewater.
- Has a smooth surface that reduces material breakdown.
- Offers a long lifespan.

Reason for Selection

Tempered glass was chosen for its strength, non-reactive nature, and availability. It boosts the system's durability and prevents erosion or disturbances in the filtration layers, especially during constant wastewater flow.

3. BIOCHAR

Biochar is crucial in this project due to its high adsorption capacity. Laundry wastewater contains detergent chemicals, surfactants, and organic pollutants that physical filtration cannot remove alone.

FIGURE.3 BIOCHAR

Purpose

- Removes chemical contaminants.
- Absorbs odours and colours.
- Lowers detergent concentration.

Role in the System

- Acts as an adsorptive filtration medium.
- Traps dissolved organic and chemical substances.
- Improves water clarity and quality.

Advantages

- Highly porous with a large surface area.
- Effective in removing detergents and organic matter.
- Environmentally friendly and sustainable.
- Can be regenerated or reused.

Reason for Selection

Biochar was picked because it is a natural, low-cost alternative to activated carbon. Its excellent adsorption properties make it well-suited for treating detergent-rich laundry wastewater.

4. COCONUT HUSK

Coconut husk is a natural fibrous material used as a secondary filtration medium. It effectively traps fine particles while allowing water to flow smoothly.

FIGURE.4 COCONUT HUSK

Purpose

- Serves as a natural fiber filter.
- Enhances the removal of fine particles.

Role in the System

- Captures suspended solids.
- Reduces turbidity.
- Supports biological filtration.

Advantages

- Biodegradable and eco-friendly.
- Easy to find in tropical regions.
- Low cost.
- Improves water flow distribution.

Reason for Selection

Coconut husk was selected for being sustainable and biodegradable, with good filtration properties. Its fibrous structure is ideal for trapping fine impurities without blocking the system.

5. SAND

Fine sand is used for final-stage filtration, where very small suspended particles are removed from the wastewater.

FIGURE.5 SAND

Purpose
- Removes fine suspended solids.
- Improves water transparency.

Role in the System
- Acts as a polishing filter.
- Enhances the clarity of treated water.
- Completes the filtration process.

Advantages
- High filtration efficiency.
- Easy to clean and reuse.
- Widely available.
- Has low operational costs.

Reason for Selection
Fine sand is chosen due to its effective fine filtration and common use in water treatment systems. Its small particle size helps trap impurities that pass through earlier layers.

III. METHODOLOGY

1. Overview of the Methodology
This project uses a two-stage parallel filtration system followed by a final filtration stage to recycle laundry wastewater. The system treats the wastewater with natural, low-cost, and eco-friendly materials, avoiding the use of electricity.

Laundry wastewater is split into two flow paths:
Path 1: Gravel and Tempered Glass filtration
Path 2: Gravel and Biochar filtration
The treated water from both paths goes to a common filtration box with sand and coconut husk, where final purification happens before collection.
2. Principle of Operation
The system operates on the principles of:
- Gravity-driven flow
- Physical filtration
- Adsorption
- Natural fiber filtration

Wastewater flows from a higher elevation to a lower one using gravity. The parallel filtration paths effectively remove different impurities before final polishing.

3. Collection of Laundry Wastewater
The laundry wastewater produced from washing clothes includes detergent residues, suspended solids, dirt, and fabric fibers. This wastewater is collected directly and sent into the filtration system without any chemical pre-treatment.

4. Two-Stage Parallel Filtration System
4.1 Stage 1: Primary Parallel Filtration
In the first stage, the laundry wastewater is divided into two parallel filtration paths to improve filtration efficiency.

4.1.1 Path A: Gravel and Tempered Glass Filtration
Materials Used:
- Gravel (3 to 4 cm layer)
- Tempered Glass (1 to 2 cm layer)

Process Description:
Wastewater enters the first box with a gravel layer that removes large suspended particles like lint, dirt, and fabric fibers. The tempered glass layer above the gravel acts as a barrier, ensuring even distribution of the wastewater.

Purpose:
- Remove large impurities
- Protect the filtration media
- Regulate flow

Outcome:
- Reduced turbidity
- Removal of large particles

4.1.2 Path B: Gravel and Biochar Filtration
Materials Used:
- Gravel (3 to 4 cm layer)
- Biochar (3 to 4 cm layer)

Process Description:
In the second parallel path, wastewater flows through gravel and then biochar. The gravel removes large particles, while biochar adsorbs detergents, organic pollutants, and odours.

Purpose:
- Remove chemical and organic impurities
- Reduce odour

Outcome:
- Lower detergent concentration
- Better colour and smell

Primary Parallel Filtration Stages:

Filtration path where impurities removed	Materials used	Main function
Path A	Gravel + Tempered Glass	Physical filtration & protection (Lint, dirt& large solids)
Path B	Gravel + Biochar	Physical + adsorption (Detergents, odour& organics)

- Table 2. Primary parallel filtration

5. Stage 2: Final Filtration (Sand and Coconut Husk)
After primary filtration, the partially treated water from both paths moves into the filtration box which contains sand and the coconut husk.

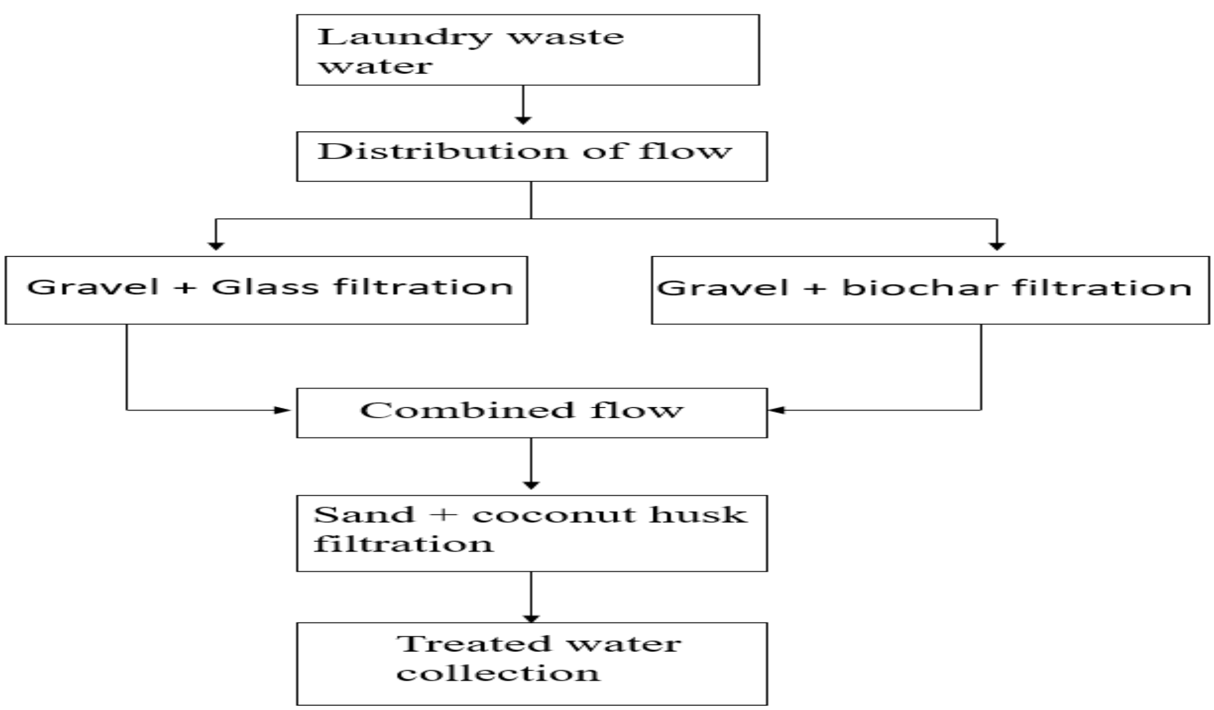
Materials Used:
- Sand (3 to 4 cm layer)
- Coconut Husk (fibrous layer)

Process Description:
The mixed wastewater flows through the sand layer, which removes fine suspended particles. The coconut husk further filters the water by trapping remaining impurities and enhancing clarity.

Purpose:
- Final polishing of water
- Remove fine particles
- Improve clarity and appearance

Outcome:
- Clear, low-odour water
- Suitable for non-potable reuse

6. Flowchart of the Methodology



- FIGURE 1. flow chart of methodology

7. visual representation :
8. Gravity-Based Flow Arrangement
The filtration boxes are set up in a stepwise descending layout to allow wastewater to flow continuously using gravity alone.
Advantages of This Arrangement:
1. No power required
2. Simple operation
3. Low maintenance
4. Cost-effective

9. Methodological Parameters

Parameter	Specification
Number of filtration stages	2 + final common stage
Flow type	Gravity-driven
Filtration paths	Parallel
Power requirement	None
Materials used	Natural & eco-friendly

- Table 2: System Parameters

10. Treated Water Collection and Reuse
Filtered water is collected in a storage container at the system's lowest point. The treated water is reused for:
- Gardening
- Toilet flushing
- Vehicle washing

11. Maintenance Methodology
Gravel and sand are cleaned regularly. Biochar is replaced after extended use. Coconut husk is changed if it gets clogged.

IV. CONSTRUCTION DETAILS

Introduction
The laundry wastewater recycling system was built to create a simple, low-cost, gravity-based filtration unit using natural materials. The system features two parallel primary filtration paths, followed by a common final filtration unit. This design improves filtering efficiency while keeping construction straightforward.
Construction of Filtration Boxes
A. Selection of Boxes
- Filtration boxes are made from plastic or acrylic
- Each box is leak-proof and resistant to corrosion
- Holes are added at the bottom or side for water drainage
- Mesh or perforated sheets prevent material loss

B. Construction of Primary Filtration Units (Parallel System)
The primary filtration stage has two separate filtration boxes that work in parallel.
Primary Filtration Box – Path A (Gravel and Tempered Glass)
Layer Arrangement:
- Bottom layer: Gravel (3–4 cm thick)
- Top layer: Tempered glass (1–2 cm thick)

Construction Steps:
1. Clean and dry the box thoroughly.
2. Fix a perforated base or mesh at the bottom.
3. Wash the gravel and place it evenly to a depth of 3–4 Carefully place the tempered glass pieces above the gravel.
4. Fit an outlet pipe at the lower end of the box.
5. Function :
   - Removes coarse impurities like lint and dirt
   - Protects the gravel layer from direct water impact
   - Regulates the flow of wastewater

C. Primary Filtration Box – Path B (Gravel and Biochar)
Layer Arrangement
- Bottom layer: Gravel (3–4 cm thick)
- Top layer: Biochar (3–4 cm thick)

Construction Steps
1. Prepare the box with a mesh base.
2. Place cleaned gravel evenly at the bottom.
3. Carefully add biochar above the gravel layer.
4. Fix the outlet pipe at the right height.

Function
- Gravel removes large particles
- Biochar adsorbs detergent chemicals and odours

Table 1: Construction Details of Primary Filtration Units

Component	Path A	Path B
Number of boxes	1	1
Bottom layer	Gravel	Gravel
Top layer	Tempered glass	Biochar
Layer thickness	3–4 cm + 1–2 cm	3–4 cm + 3–4 cm
Filtration type	Physical	Physical + Adsorption

D. Construction of Common Final Filtration Unit

Final Filtration Box (Sand and Coconut Husk)

This box receives partially treated water from both primary filtration paths.

Layer Arrangement

- Bottom layer: Fine sand (3–4 cm thick)
- Upper layer: Coconut husk (uniform layer)

Construction Steps

1. Fix a perforated sheet at the bottom.
2. Spread washed fine sand evenly.
3. Place coconut husk above the sand layer.
4. Connect inlet pipes from both primary boxes.
5. Fix the outlet pipe at the bottom leading to the collector.

Function

- Removes fine suspended particles
- Improves water clarity and appearance
- Acts as a polishing filtration stage

E. Collector Tank Construction

- Position the collector tank at the lowest level
- It receives treated water from the final filtration box
- Fit a lid to prevent contamination

F. System Stability and Support

- Place boxes on stands or platforms
- Maintain a proper slope for gravity flow
- Secure the system to avoid movement

G. Safety and Maintenance Considerations

- Handle sharp edges of tempered glass carefully
- Clean gravel and sand periodically
- Replace biochar and coconut husk when clogged

V. OBSERVATION

Observations were made at each filtration stage by visually assessing water quality, odour, and clarity.

Observation of Water Quality:

Parameter	Before Filtration	After Filtration
Color	Cloudy	Clear
Odor	Strong detergent smell	Mild / almost no odor
Suspended particles	High	Very low
Foam presence	Visible	Negligible

- Table 3: Observation of Water Quality

Stage-wise Observations

- After First Box:

Large particles and lint were removed, but the water was still cloudy.

- After Second Box:

There was a noticeable reduction in detergent smell and foam.

- After Third Box:

Water clarity improved significantly.

- After Fourth Box:

Water appeared clear and suitable for reuse.

Performance Observation

- Continuous flow without clogging
- No electricity required
- Natural materials worked effectively

VI. RESULTS

The filtration system improved water quality significantly. Cloudy wastewater with strong odour and high suspended particles became clear with low odour and negligible foam after treatment. Physical impurities were removed effectively, and detergent concentration was reduced.

VII. DISCUSSION AND CONCLUSION

The multi-stage filtration using gravel, biochar, sand, and coconut husk worked efficiently. Gravel removed large particles, biochar reduced chemicals and odour, and sand with coconut husk improved clarity. However, complete removal of dissolved and microbial contaminants may require additional treatment.

The system is simple, low-cost, and eco-friendly for recycling laundry wastewater. It produces water suitable for non-potable uses like gardening and toilet flushing, helping in water conservation and sustainable management.