



# Use of naturalized coagulants in removing laundry waste surfactant using various unit processes in lab-scale



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## ABSTRACT

This lab-scale experiment is aimed at demonstrating a treatment system for purification and reuse of laundry rinsing water generated from households. The main objective of the study is to compare the efficiencies of various natural coagulants in removing laundry waste surfactants and other major pollutants from the laundry rinsing water. The treatment system consists of Coagulation–Flocculation, Sand filtration and Granular Activated Carbon (GAC) adsorption. Four experiments were conducted in batch process by varying the coagulants (Nirmali seed and Pectin extracted from pith of Orange peel). Coagulants have been selected due to their local availability at affordable cost and technical feasibility. From the study it is concluded that laundry rinsing water polluted with high turbidity and anionic surfactant treated with Nirmali seeds as coagulant at a retention time of 24 h gives the best results. The treatment system where Orange peel pectin is used as coagulant at a retention time of 24 h is found to be the most efficient one based on the weighted factor. Hence the treatment of laundry rinsing water by aforesaid combination results in better water quality.

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## 1. Introduction

Water is essential for socio-economic development and for maintaining healthy ecosystem. As population increases and development calls for increased allocations of groundwater and surface water for the domestic, agriculture and industrial sectors, the pressure on water resources intensifies, leading to tension, conflict among users and excessive pressure on the environment. (FAO: Natural Resources and Environmental Department, 2012)

India accounts for 2.45% of land area and 4% of water resources of the world, but it represents 16% of the world population. With the present population growth rate (1.9 per cent per year), the population is expected to cross the 1.5 billion mark by 2050. The Planning Commission, Government of India has estimated that the demand for water would increase from 710 BCM (Billion Cubic Meters) in 2010 to almost 1180 BCM in 2050 for domestic needs; industrial water consumption is expected to increase almost 2.5 times (CPCB, Ministry of Environment and Forestry). Water is a key resource and nothing can replace it. Water management deserves priority in the development of any area and it is very essential to develop low-cost technologies for sustainable water usage on a household scale.

The aim of this project is to develop a low cost technology for recycling water in laundry washing. The basic idea is to clean the polluted rinsed water and reuse it. In other words, the polluting components namely the added detergent and fabric dirt are removed during treatment. The treated water can be reused for household or irrigation purposes.

### 1.1. Laundry rinsing water

In a country like India with tropical climatic conditions, clothes become very dirty because of sweat, dust, etc. Therefore water used for washing is very dirty and not suitable for reuse. The rinsing water is much cleaner than washing water and hence much more suitable for reuse. The main constituents of rinsing water are ingredients of detergents used and dirt released from clothes.

The main component of a detergent is the surfactant. Surfactants have the unique ability to remove both particulate soils and oily soils. Linear Alkyl Benzene Sulfonate (LAS) is the mainly used anionic surfactant in detergents. In hard water, surfactants precipitate with magnesium and calcium ions and lose their functionality. This can be prevented by complexation, precipitation or ion exchange of magnesium and calcium ions by builders (Sabina Fijan et al., 2008).

Dirt constituents in laundry rinsing water are mainly particulate soil and oily soil. The rinsing water also contains some dye that leach from fabric during washing and rinsing.

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## 1.2. Reuse of laundry rinsing water

Water has always played a major role in industrial laundry operations, as this universal solvent is required in large quantities for the effective laundering of industrial garments and other textile goods. On an average, a laundry uses 15 L of water to process 1 kg of work and discharges 400 m<sup>3</sup> of waste water daily. In the household usage of water, 21.7% of the total water is used for laundry purpose (Ciabatti et al., 2009).

Especially in the southern states of India, laundry accounts for up to one fourth of the total water used. In every wash cycle (Shiv Prasad, 2011), an average of 70% of the water is spent in rinsing. This rinsing water is relatively clean and available in large volume; therefore an interesting source for reuse. Laundry rinsing water can be regarded as a valuable resource and not as a waste. If this waste water could be treated and reused, it contributes towards addressing demand for water. Laundry rinsing water has a great potential in reducing water stress currently faced by many regions of the world. Laundry waste water reuse is an effective measure for saving water at the domestic level. Where water is scarce and expensive, laundry rinsing water reuse may lead to considerable economic benefits.

In addition to addressing water demand, laundry water reuse also poses a check on pollution as the amount of waste water discharged is reduced. The treated laundry rinsing water can be used for doing laundry again, irrigation, cleaning purposes and so on.

The project is based on the above ideas. The objectives of the project are stated as follows.

1. To design and fabricate a clariflocculator which can accommodate 20 L of laundry rinsing water for the purpose of coagulation and flocculation.
2. To make use of naturally available material (Nirmali seed and Orange peel pectin as coagulants and charcoal as adsorbent) in the process of treatment.
3. To compare the efficiencies of various treatment processes in removing laundry waste surfactants and other major pollutants from the laundry rinsing water.

## 2. Materials and methods

### 2.1. Sample collection site

The sample taken for this study was laundry rinsing water. The laundry rinsing water was collected from a residential household in Madurai, a city in South India. The laundry rinsing water (type of waste water got as a result of rinsing clothes after washing) collected for the purpose of study is light to dark grey in color, with lot of foam accumulated on the surface. The sample taken for the study was collected immediately after washing.

The sample was only the rinsing water and not the washing water. It is because the rinsing water is relatively cleaner and is available in large volume compared to washing water. Rinsing water collected from the first two phases of rinsing cycles were mixed to make 20 L of dirty water, for one experiment cycle. Therefore, the study would directly relate to the potential reuse of the treated laundry rinsing water generated from household and not from commercial laundry units. However, the results of the study will serve as reference for future research and practices associated with laundry waste water treatment and reuse.

### 2.2. Natural coagulants and adsorbent used

*Strychnos potatorum* commonly known as clearing nut or Nirmali seed is a moderate sized tree found in southern and central



(a)



(b)



(c)



(d)



(e)

**Fig. 1.** (a) Fresh Orange peel showing the inner pith. (b). Separated pith. (c). Acidified pith. (d). Acidified pith + water. (e). Pectin extracted after boiling and filtration.

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