Capillarity natural dye recovery application to improve wool dyeing process

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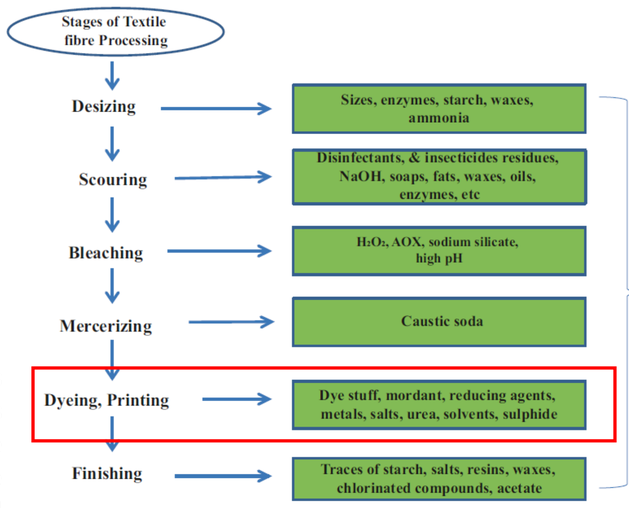
1. Introduction

Since 1856 with the discovery of the first synthetic dye, more than 10,000 different types have been commercialized worldwide, being half of these categorized as **azo** dyes[1]. Numerous textile and dyeing factories are in developing countries, where unfortunately the wastewater is poorly treated. Approximately 280,000 tons of textile dyes are discharged annually as industrial wastewater and is estimated that at least 2% of the dyes are directly released into the aqueous effluent and 10% lost during the colouring process[3].

A dye molecule consists of the dye group and the auxiliary pigment. The compound presents complex and stable structure with intense colour even at low concentrations[4]. Heavy metals are often used for dye fixation, releasing trace amounts of Cu, Cr, Ar and Zn to the environment[2]. Direct dyes are the most popular for being economically friendly, and their wide range of colour, containing di and tri azo-moieties. Alizarin red is considered a direct, ionic and acidic dye[1]. Contact with azo dyes results in skin, lung and gastrointestinal problems, capable to induce cancer in humans and animals[5].



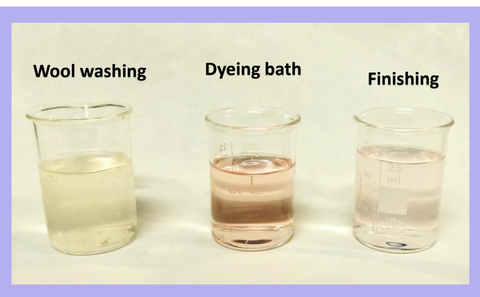
Possible pollutant and the nature of effluent released from each step of the wet process[2].

Composite textile wastewater is primarily characterized by analysing, Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), Suspended Solids, and dissolved solids (DS) are some of the most relevant physicochemical parameters defined to stablish the quality of the wastewater before being discharged to the environment[4]. The BOD/COD ratio for composite textile wastewater is approximately 0.25. This indicates that wastewater contains a large amount of non-biodegradable organic substances. Colour sewage poorly treated affects the extent of light and oxygen penetration resulting in damaged ecosystems[6]

Appropriate treatment method depends on the production process (physic-chemically and economically). The need to address the quality of discharges in developing countries where most textile industry is situated, motivated the implementation of a low technology capillarity filtering system with the objective of treating and recovering the dye. This provides a suitable alternative to these communities to reduce their environmental impact without disrupting their economic development.

2. Methodology

Wool dyeing wastewater production



Wool washing
(40 °C/60 min)
Nekanil 907 - 1%

Dyeing bath
(80 °C/90 min/Ph=4.5)
Alizarin 1% + $CuSO_4$ 10% +
Nekanil 907 - 1%

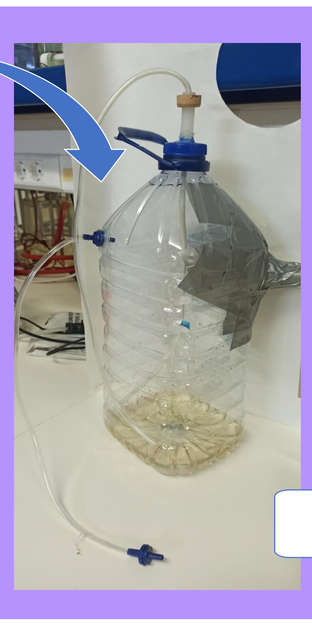
Finishing bath
(25 °C/30 min)

Physicochemical parameters determination
(pH, Disolved O_2, Conductivity, Total Disolved Solids, COD, BOD)

Synthetic wastewater establishment

1% of dye complex original concentration after wool dyeing bath

Capillarity filtration treatment



Applied pressure < 250 mPa

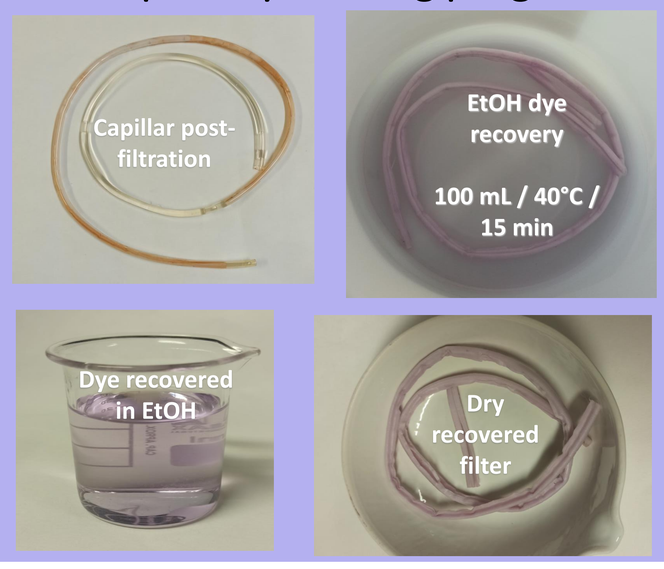
3. Results

Wastewater characterization

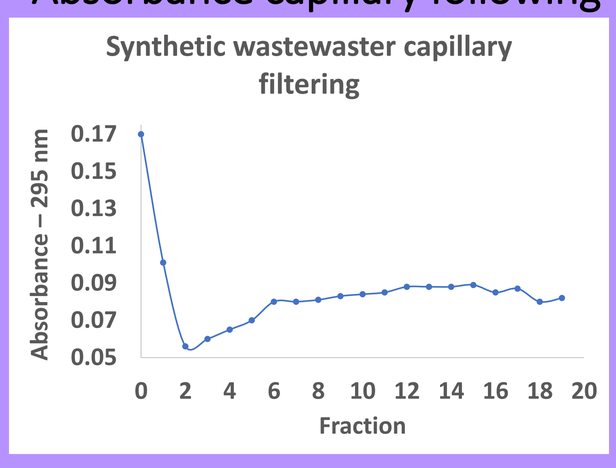
Stage	pH	Redox Potential	Disolved Oxygen (%)	Conductivity (µS/cm)	Total DS (ppm)
Wool washing	6.8	153.3	62.1	131	65
Dyeing	4.5	279.9	55.1	831	416
Finishing	5.3	236.7	54.2	103	51

Stage	BOD_5 (mg/L)	BOD/COD ratio	COD (mg/L)
Wool washing	42.50 ± 3.54	0.20	216.50 ± 1.67
Dyeing	5.00 ± 0.00	0.11	47.61 ± 0.96
Finishing	17.50 ± 3.54	0.13	139.28 ± 0.96

Capillarity filtering progression



Absorbance capillary following



Subsequent fractions collected and evaluated at 295 nm against the initial concentration

4. Conclusions

- **The system is capable of under low pressure (< 250 mPa) retain almost half of the azo dye initial concentration.**
- **Using simple solvent change, medium temperature, and agitation for a short period of time (EtOH/40 °C /15 min/100 rpm) it is possible to recover the dyeing matter treated and reuse the filter for another round of wastewater dye extraction.**
- **BOD/COD ratio reveal the need for treating wastewater produced at every stage of wool dyeing process with alizarin.**
- **Other materials testing, as well as pre and post treatment characterization are essential to ensure the capabilities of the capillarity system.**

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