ECWRTI | TOTAL WATER RECYCLING IN TEXTILE INDUSTRY

Extensive wastewater re-use in the textile industry

Success in technology, barriers for implementation

The Consortium for Electro Coagulation for Water Recycling in the Textile Industry (ECWRTI) has charted the prospects of the innovative EColoRO concept for extensive wastewater re-use in textile industry. Pilot studies underpin the technological opportunity for 'future-proofing' the industry with respect to water usage. It has also become clear that local circumstances and regulatory issues strongly determine the conditions for practical application.

For further information: ecwrti.eu

EColoRO | ISPT | EURATEX | INOTEX Ltd. | Tintoria Pavese S.P.A. | Utexbel | VITO

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The setting: water as a valuable resource

Global freshwater availability is under permanent stress. The United Nations Environment Programme (UNEP) therefore calls for action to increase the efficiency in water use. Quoting the UNEP 5 report: 'Increasing water-use efficiency in all sectors is vital to ensure sustainable water resources for all uses'. And as the European Water Framework Directive (2000/60/EC) states: 'Water is not a commercial product like any other but, rather, a heritage which must be protected, defended and treated as such'.

There is thus a need for 'future-proofing' the industry with respect to water usage. This is particularly true for the textile industry, where dyeing and printing processes require considerable amounts of fresh water and produce large and often very polluted wastewater streams. The latter are addressed according to regulations which may vary significantly across the globe. This wastewater, usually containing a mix of colorants, chemicals, salts, metals and other organic and inorganic compounds, must be treated before discharging to the environment. Depending on the local conditions, the waste water is treated on-site by the textile company and then discharged to the environment, or it is supplied to the municipal wastewater treatment plant (with or without a pre-treatment by the company).

Showing responsibility in water use will be increasingly important in the textile industry as it is under increasing public scrutiny. While customers of the textile industry are becoming more and more demanding in terms of sustainable production, however the increase in their demands are not necessarily reflected in price-policies. In regions experiencing or expecting water shortages, extensive industrial water recycling will relieve the pressure of the industry on water supply and will increase the fresh water availability. Some regions outside Europe are even promoting or requesting Zero Liquid Discharge, i.e. wastewater treatment ending up in almost full water recycle and a solid salt waste stream.

The technology: EColoRO

The EColoRO concept offers a solution to treat the wastewater of textile industry with a minimal use of chemicals and energy. By doing so, nearly 70% of the reclaimed wastewater can be reused in the textile manufacturing process. The core of the concept is formed by Electro Coagulation, an additive-free process to remove the majority of all pollutants, colorants and chemicals. It is based upon the release of Fe^{3+} ions from an iron source by means of a low voltage electrolytic action. The ions coagulate and flocculate with impurities present in the water so that these can be removed by means of sedimentation or flotation. Subsequently, the water is passed through ultrafiltration and reverse osmosis membranes, after which it can be re-used. Pollutants thus end up in the sludge (from flocculation) and the concentrated brine (from membrane filtration). As a result, EColoRO creates new approaches for water treatment and water management within a factory.

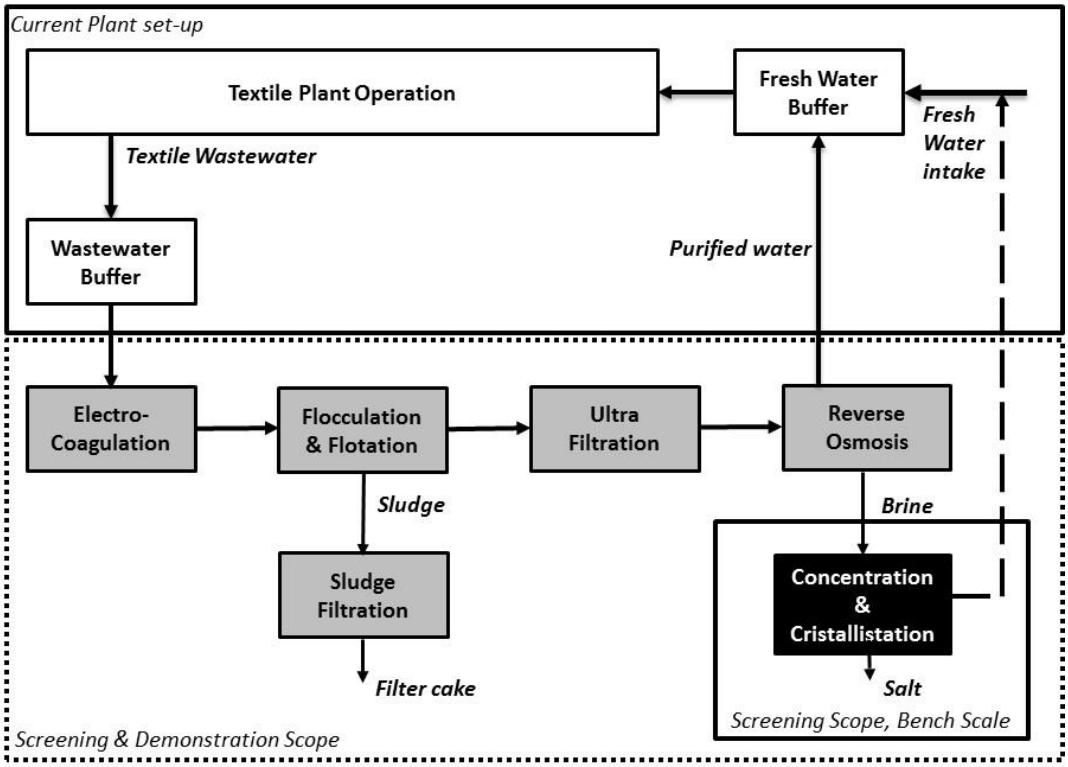

Figure 1. The EColoRO concept in the textile factory

The project: pilot testing and additional studies

The EColoRO concept was tested at *pilot scale* at four sites in three different countries and on different kind of wastewaters:

- Utexbel Snoecklaan (Belgium) - *Advanced textiles for special applications*
- Utexbel Ninovestraat (Belgium) – *Yarn dying mill*
- Tintoria Pavese (Italy) - *Cellulosic linings (Viscose, Cupro, Acetate) and cotton linings*
- Setex (Germany) - *Fashion fabrics and home textiles*

Scale-up towards *demonstration plant scale*, foreseen at the Utexbel Snoecklaan site, was not further pursued as of unforeseen delays in granting of permits and more costs related to the complexity of the waste water. This resulted in an insufficient ECWRTI budget to construct the *demonstrator*. In addition, during the project the business case diluted because of tax reduction on discharge. Scale-up foreseen at Tintoria Pavese was not further pursued as the concentration of brine components exceeded the current local discharge limits.

Additional studies were performed on concentration of the brine produced as a result of the EColoRO treatment. Furthermore, the project entailed a cross-market analysis, a techno-economic feasibility study, an analysis of wastewater handling, an LCA analysis and an EU wide legal scan. The project has identified the relevant factors determining the technological feasibility at individual sites, these factors has also been used to create the courseware material for Industry and students to

provide the information supporting their own decision on the implementation of the Electrocoagulation.

The results: technology, business, regulatory

Technology results

The EColoRO-technology performed well at all four pilot sites, achieving recovery rates of water of 70% and above. EColoRO delivers thus a broadly applicable solution that can be considered relatively cheap and is applicable in many situations and complex textile wastewaters. There is a good perspective that this will also be the case for other sectors (paper and pulp, breweries, dairy, sugar beets, and paints and varnishes).

As a result of the pilot experiments, modifications were proposed to optimize the EColoRO process. In case strong fouling compounds are present in the wastewater, addition of a flotation unit as pre-treatment of the raw wastewater and the use of ceramic instead of polymer membranes is advised. It was also concluded that energy consumption strongly depends on the amount of oxidizable pollutants (COD) in the wastewater and the conductivity of the water, and that at higher temperatures the floc formation can become more difficult.

The further treatment of brine was evaluated for three technlogies (Galicos, DC-MD and air-gap MD), the Galicos system tests led to a bench scale process in a stable operation up to high concentration factors. This indicates the technical feasibility of a zero liquid discharge solution. However, this would require an additional investment comparable to that for the EColoRO process itself.

Understanding the business case

There is no such thing as a 'typical' textile wastewater.

Different plants producing different products have different requirements and release different types of waste. The costs of application of total water re-use, therefore, depends on parameters that are very specific for each individual textile plant and thus have to be evaluated case by case.

Each individual business case is to a large extent defined by the capital expenditures (CAPEX) and the operating expenditures (OPEX). The latter is determined by factors such as the type of the freshwater source (groundwater, surface water, tap water), the processed volume of water, the pollution load of the wastewater and the required amount of energy for the EColoRO process and the discharge taxes. The combination of these factors does not always turn out positive: water can be cheap; discharge prices for untreated wastewater can be low, and energy can be expensive. In many situations, the cost of water, energy and/or discharge of waste thus weakens the business case. It has to be noted that these costs are mainly dependent on local governmental policy, while on the other hand costs-cutting pressure on textile manufactures depends by buyers demands, external factors and international competitiveness

Regulatory aspects

Adding to the pricing mentioned above, legal affairs add to the feasibility of the concept of total water recycling. In general, obtaining permits for the discharge of sludge and brine is a difficult process. Elaborated discussions with the local authorities are needed to reach consensus on this. In one case, brine discharge with increased concentrations of certain pollutants can be accepted when

applying extended water reuse, in another case, increased concentrations of certain pollutants can result in adverse ecotoxic effects and hence brine cannot be discharged.

The chemical sludge resulting from the electrocoagulation process poses another obstacle since it is considered hazardous waste and has to be transported and disposed of accordingly.

Evaluation and recommendations

The ECWRTI studies have demonstrated that the EColoRO-concept for re-use of water is broadly applicable in the textile industry. The project has identified the relevant factors determining the technological feasibility at individual sites, which mainly depends on the composition of the wastewater. Implementation, however, is impeded by tailored-made costs-benefit analysis, operational expenses, costs pressure and regulatory requirements that both heavily depend on governmental policies.

In general, there is a clear interest of textile companies in adopting technologies for the re-use of water. In particular, experienced or forecasted water shortages are a 'natural' driver for this technological change. A mind-set of appreciation of water as a scarce good in general would be a further motivation for implementing water conservation strategies. The latter can be encouraged by providing financial instruments. In addition it is advised to organise new national or regional workshops in combination with SDG 12 events. This might be organized using local water stewards.

Whether a business case can be found for the application of the EColoRO water re-use concept heavily depends on water and energy pricing and discharge policies (regarding cost as well as permits). A legislative obstacle for water re-use is that brine cannot always be discharged due to elevated concentrations of certain pollutants. As such, the brine resulting from the EColoRO process needs to be treated further e.g. crystallisation. This hampers the business case.

Finally, in the perspective of a circular economy, the brine and sludge resulting from water re-use technology could be further valorised. In some cases, REACH legislation applies on the recovered substances and thus products would needs to be registered. This complex procedure may hamper recovery and recycling from wastewater and as such hamper the total circular use of water.

At level of industrial policy, public policy measures able to balance the additional costs for evaluating and testing innovative water-treatment technologies such as the EColoRo concept would significantly remove barriers. Measures supporting investment may complement and support widespread adoption in the sector.

Crucial obstacles and possible solutions for feasible recycling and recovery need to be taken into account if policy is to create a level playing field and enable circular use of water.

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