



## ECUVAL PROJECT: A FEASIBLE SYSTEM TO RECOVER SALTS AND REDUCE WATER CONSUMPTION IN TEXTILE INDUSTRY

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### Abstract:

ECUVal system is based on the in situ degradation of organic compounds contained in saline effluents. ECUVal achieves the partial or total degradation of organic compounds by means of an electrochemical treatment combined with ultraviolet irradiation. The removal of organic matter is carried out only by means of electricity, without the addition of chemical reagents because the salts contained in the effluents are used as an electrolyte. After the electrochemical+UV treatment, the effluent still contains all the initial salts and it can be reused in a new production process. Thus, ECUVal process enables to reduce both water and salt consumption, with the subsequent economical and environmental benefits: saving of raw materials and process water, diminution of wastewater salinity and reduction of wastewater discharge taxes.

ECUVal system can be applied to remove organic compounds from any type of industrial wastewater with a high content of salts. The use of ECUVal process to treat textile wastewater is especially interesting because dyeing and washing effluents contain chemical additives and residual dyes, which cannot be easily degraded. In general, treatments based on biological processes are inefficient to remove dyes due to their low biodegradability. Physicochemical treatments such as coagulation-flocculation or membrane filtration are used with this purpose but these treatments generate a waste that requires a further treatment. In this sense, the main advantages of the ECUVal system are that no residues are generated and no chemicals are should be added. In addition, the reuse process allows saving 70-100% dyeing water and 15-60% dyeing electrolyte.

**Keywords:** electrochemical treatment, water reuse, dyes, textile effluents, salt recovery, salinity reduction



## 1. Introduction:

The aim of the ECUVal project is to solve a common problem in the textile sector: the large amount of wastewater generated by this industry in the preparation, dyeing and finishing processes. This wastewater is generally characterized by a strong coloration due to the presence of residual dyes and high concentration of salt.

In general, conventional biological treatments show low colour removal (Bes-Piá et al., 2005) and additional treatments are required to meet with the current legislation. On the other hand, the physical-chemical treatments, such as coagulation-flocculation, are very effective but they generate a concentrated that requires an additional treatment (Buscio, Marín, Crespi, & Gutiérrez-Bouzán, 2015). The discolouration by adsorption (e.g. with activated carbon) exhibits high colour removal for a great variety of dyes but is influenced by different parameters such as interactions between the dye and the adsorbent, surface area of the adsorbent, particle size, etc. Moreover, this technique, has a high cost since the adsorbent must be regenerated after several treatments (Sala, López-Grimau, & Gutiérrez-Bouzán, 2014).

The ECUVal system is based on the degradation of reactive dyes contained in the effluents from textile dyeing and washing by means of an electrochemical cell combined with ultraviolet radiation. The value of ECUVal lies in the removal of residual dyes without the addition of chemical reagents since this new system uses the salts already present in the effluents as electrolytes. In addition it does not generate other waste requiring further treatment. At the end of the ECUVal treatment, colourless water is obtained with a high salt content that can be reused in a new dyeing process. In this way, savings between 70 and 100% of dyeing water and between 15 and 60% of salt are achieved, with the consequent economic and environmental benefit. Therefore, the main objective of the ECUVal project is to introduce in the textile sector an eco-friendly technology which achieves significant savings on water and salts, making the textile industry more ecological and sustainable.

The different steps of the ECUVal process are shown in Figure 1.

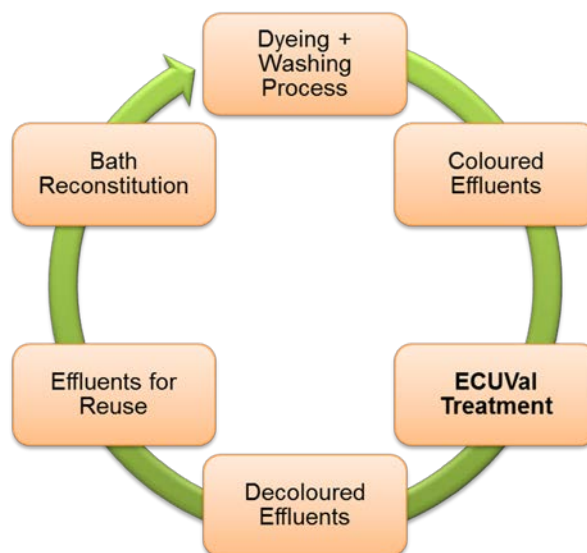


Figure 1. Steps of ECUVal process

Although ECUVal system is mainly addressed to treat effluents containing reactive dyes, it can also be applied to other industrial sectors which generate effluents containing salts and non-biodegradables compounds, as it is an independent module.



The ECUVal project started in January 2015, thanks to the co-financing obtained from the European Union, through the Eco-Innovation Initiative of the Executive Agency for Small and Medium Sized Enterprises (EASME).

The consortium that is carrying out the ECUVal project involves 4 partners: the Institute of Textile Research and Industrial Cooperation of Terrassa (INTEXTER-UPC), the Foundation for Textile Innovation of Igualada (FITEX), the machinery company ICOMATEX S.A. and the end user company GRAU S.A, being the UPC the leader of the project.

## 2. Experimental

Effluents from the Jet dyeing process were selected for this study. First of all, the effluents were treated at laboratory scale in a 0.5L electrochemical cell with a single compartment. In all cases, the intensity was set at 10A. The electrodes used had an active surface of 45 cm<sup>2</sup> (Figure 2).



Figure 2. *Electrochemical cell used at lab scale*

On the basis of previous results obtained by the research group at laboratory scale, a semi-industrial 0.4m<sup>3</sup> prototype was built and validated in a Spanish mill (Figure 3).



Figure 3. *Semi-industrial system*



Finally, thanks to the ECUVal project, an industrial prototype to treat 4m<sup>3</sup>/h of coloured and saline effluents has been built and installed in GRAUSA mill. Currently, different tests are being carried out to optimise the wastewater treatment conditions and to demonstrate the industrial viability of the technique.

## 2.1. Studies carried out at laboratory scale

The effluents treated were characterized before (Table 1) and after the electrochemical treatment (Table 2).

<i>Effluent</i>	<i>COD (mg/L)</i>	<i>Conductivity (mS/cm)</i>	<i>pH</i>	<i>Cl<sup>-</sup> (mg/L)</i>
<i>A</i>	3519	57	11	24204
<i>B</i>	1515	83	10	66223
<i>C</i>	1099	88	11	39050
<i>D</i>	2450	129	10	69065
<i>E</i>	1811	124	11	65952

Table 1. Wastewater characterization before the electrochemical treatment

From these results, it can be observed that effluents from the Jet dyeing process have alkaline pH and high conductivity.

<i>Effluent</i>	<i>COD (mg/L)</i>	<i>Conductivity (mS/cm)</i>	<i>pH</i>	<i>Colour removal (%)</i>
<i>A</i>	3098	60	11	100
<i>B</i>	1693	78	10	100
<i>C</i>	1474	87	11	100
<i>D</i>	1191	128	11	100
<i>E</i>	1661	121	11	100

Table 2. Wastewater characterization after the electrochemical treatment

The effluents were completely discoloured after 10 minutes of treatment (Figure 4). Regarding the COD removal, the values were found within a wide range, between 12 and 50%. The complete mineralization of the effluents could be achieved with longer treatment, but this is not the aim of the ECUVal treatment. For this purpose (COD removal), it is more advisable to select other methods, such as biological treatments, which are cheaper for the total degradation of organic matter.

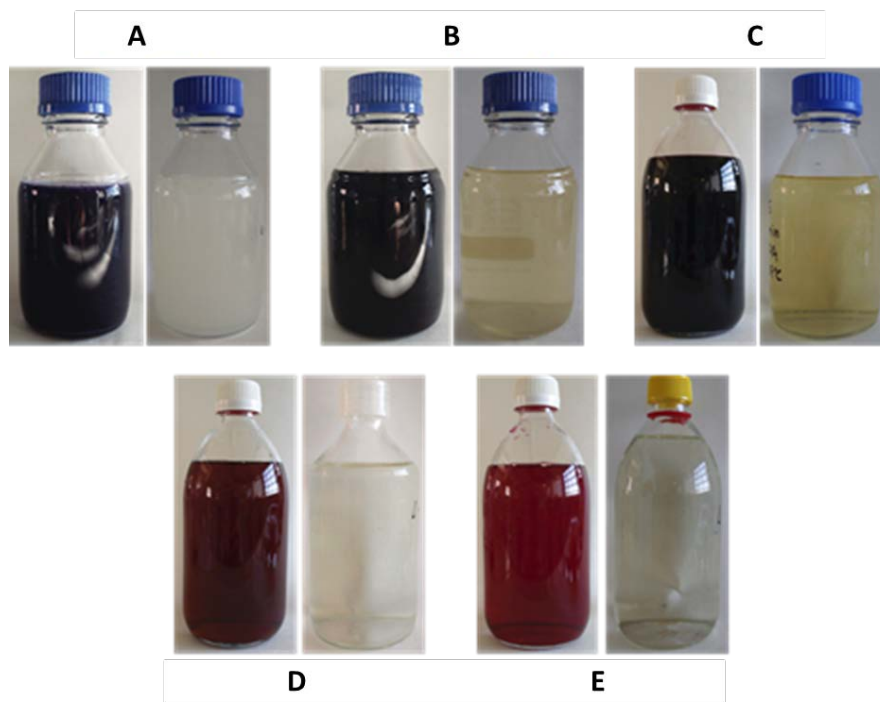


Figure 4. *Effluents before and after the electrochemical treatment*

## 2.2. Studies carried out with the ECUVal system

On the basis of the results obtained at lab scale, the functional requirements and design guidelines of the ECUVal system were established. The ECUVal system, equipped with the suitable control instruments, operates in batch mode.

Currently, the validation of the pilot at industrial scale is being carried out. The first tests have shown that the ECUVal system enables to discolour the mill effluents (Figure 5) and these decoloured effluents that can be reused in new dyeing processes, with both monochromies and trichromies. The viability of the ECUVal system and the potential consumers has been evaluated by means of a business plan study.



Figure 5. *Effluents before and after the ECUVal system*



### 3. Conclusions

Results obtained at laboratory scale showed the feasibility of the electrochemical treatment for the decolouration of the dyeing effluents. The effluents from the dyeing process with reactive dyes were completely decolourized after 10 minutes of electrochemical treatment.

On the basis of these results, ECUVal prototype was scaled, installed in a Spanish mill and is being validated with the real effluents of the company. Further information of the project can be consulted through the website [www.ecuval.eu](http://www.ecuval.eu).

### 4. Acknowledgements:

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