ECUVaI:
Degradació de colorants reactius dels efluents de tintura i acabat tèxtil

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Electrochemical techniques combined with UV irradiation for the treatment and reuse of textile dyeing wastewaters: Industrial marketing

www.ecuval.eu
THE PROBLEM

Water scarcity

- Appropriate management of water
- Reduction of water consumption
- Water reuse

2030: 47% of the world's population will live in areas with water stress

Freshwater 3%
Glaciers 68.9%
Ground-water 29.9%
Surface 1.2%

Saline Water 97%
WHY TEXTILE INDUSTRY?

- High water consumption (up to 100 L/kg textile product)
- Complexity and variability of wastewater
- Deeply coloured wastewater

THE PROBLEM

Tertiary treatments are required to remove colour.
Salts are not removed.

Discharge of textile effluent in the biological plant

Dyes: non biodegradable
THE PROJECT

ECUVal: electrochemical process + ultraviolet irradiation.

ECUVal focused on the treatment of saline effluents containing poorly biodegradable compounds, such as dyes.

No chemicals are added and no wastes are produced.

Pollutants removed by oxidants electro-generated in situ from the salts contained in the effluent:

Subsequent irradiation with UV light:
- increases the efficiency of the treatment
- removes all residual oxidants.
Textile effluents
high conductivity due to the salts added during the dyeing process.

ECUVal: UV-assisted electrochemical process that uses these residual salts as an electrolyte to generate oxidants in the cells, thus destroying the dye molecules.
APPLICATIONS

Coloured Effluent

ECUVal Treatment

Uncoloured water containing a high amount of salts

BIOLOGICAL TREATMENT for total degradation and wastewater discharge

EFFLUENT AND SALT REUSE for new dyeing process

Containing salts

No chemicals added

No wastes generated
New system to **treat** textile wastewater and to **reuse** of treated effluents and salts.

- Saving water
- Saving salt
- Reduction of effluent salinity and wastewater discharge rates
THE PROJECT

ECUVa! Project background

Basic research
5 Research projects
Semi-industrial tests
1 Innovative project

Current step

Lab. Pilot 2 L
Semi-Industrial Pilot 400 L
Industrial prototype 4m³/h
PROJECT INFORMATION

**UPC - INTEXTER:**
Project Coordinator
Know-how, design and development, laboratory and in situ studies, LCA study,…

**FITEX:**
Business Plan,
Dissemination activities,…

**ICOMATEX:**
Manufacture and installation
Exploitation of technology

**GRAUSA:**
End-user
Validation

**CE- EASME:**
First application and commercial replication

**Execution:**
36 months
(Jan 2015-Jan 2018)

**THE PROJECT**

Jornada Indústria Tèxtil i Sostenibilitat, Terrassa 22/06/18
Main objective
Introduce into the market an innovative eco-friendly technology for the treatment of industrial wastewater that provides an effluent able to be reused.

Specific objectives:
- Recycling 70-100% process water
- Recycling up to 100% salt in the industrial processes.
- Removal of poorly biodegradable compounds.
- In the case of dyes, up to 100% colour removal.
- Wastewater purification without the addition of chemical reagents.
- Green technology that does not produce wastes.
- Flexible system, operating at smooth conditions.
- High durability, minimal maintenance.
- Sustainable industrial processes: reduction of carbon footprint and environmental impact.
- Industrial viability to introduce the system into the market.
1. Decolouration function
   4m³/h

2. Reuse function
   Reconstitution steps:
   - Removal of carbonates and bicarbonates with an acid and stripping.
   - Neutralization with alkali.
   - Removal of residual oxidants with UV and reducing agent.

Especially suitable for effluents of reactive dyeing

Licenced to Icomatex for exploitation
1. Decolouration function

2. Reuse function
WHY REACTIVE DYEING EFFLUENTS?

The most used dyes in the dyeing of cellulosic fibre.

**Advantages**
- Dyes react chemically with fibres
  \[ \text{dye-X} + \text{Cel-O}^- \rightarrow \text{dye-O-Cel} + \text{X}^- \]
- Water soluble
- High wash and light fastness
- Wide range of shades

**Disadvantages**
- Dyes also react with water → hydrolysis
  \[ \text{dye-X} + \text{H}_2\text{O} \rightarrow \text{dye-OH} + \text{HX} \]
- Low exhaustion level
- Alkaline conditions and high amount of salt are required to fix dyes on the fibre

**Main characteristics of reactive dyeing effluents**

- Organic matter
- Alkaline pH
- High salinity
- Deep colour
DECOLOURATION MODE:

Electrochemical reactions:

(Anodic Oxidation) \(2\text{Cl}^- \rightarrow \text{Cl}_2(\text{aq}) + 2\text{e}^-\)

(Cathodic Reduction) \(2\text{H}_2\text{O} + 2\text{e}^- \rightarrow 2\text{OH}^- + \text{H}_2\)

Subsequent reactions:

(Hydrolysis) \(\text{Cl}_2(\text{aq}) + 2\text{OH}^- \rightarrow \text{H}_2\text{O} + \text{ClO}^- + \text{Cl}^-\)

(Oxidation of dye) \(\text{Dye} + \text{ClO}^- / \text{Cl}_2(\text{aq}) \rightarrow \text{dye fragments} + \text{Cl}^- \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{Cl}^-\)

(decoloration) (mineralization)
REUSE MODE
Reactions:

1. Removal of carbonates and bicarbonates with acid:
   \[ \text{Na}_2\text{CO}_3 + 2\text{HCl} \rightarrow 2 \text{NaCl} + \text{CO}_2 + \text{H}_2\text{O} \]
   HCl is added until pH 5 to ensure the complete removal

2. Neutralization of acid in excess by adding alkali:
   \[ \text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O} \]

3. Removal of residual oxidants with:
   - UV irradiation and
   - a reducing agent (only if required)
Colour removal: up to 100%

No chemicals added
No wastes generated

Exhausted reactive dyebaths (Jet)
Colour removal:

depends on:
• the **current intensity** and
• the **effluent conductivity**

The higher the intensity and the conductivity, the higher the amount of generated oxidants and the more efficient the decolouration.
Electric consumption

<table>
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<tr>
<th>INTENSITY (A)</th>
<th>CONSUMPTION (kWh/m³)</th>
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<tbody>
<tr>
<td>25</td>
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<tr>
<td>100</td>
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<td>200</td>
<td>4.2</td>
</tr>
<tr>
<td>400</td>
<td>8.5</td>
</tr>
</tbody>
</table>

* Cost kWh = 0.092€

Decolouration:
- The electricity is the only cost
- No reagents are required
- No wastes are generated
- The wastewater treatment is more efficient
Reuse:

The clarified effluents still contain high levels of salts.

Savings:
• 70-100% dyeing water
• up to 100% salt

ECUVVal
- solves the problem of effluent colouration
- and enables the reuse of water and salts in new dyeing processes
- with a low energy consumption.
LCA 1: environmental impact in the dyeing process (unit: kg textile)

Three scenarios:

**Current process**

The environmental impact decreases in 5%

**ECUVaL to decolourise**

The environmental impact is reduced in 30%

**ECUVaL to reuse**

ENVIRONMENTAL: life cycle assessment
Life cycle assessment 2: Environmental impact in the wastewater (unit: m³ wastewater)

**Current WW treatment**

Dyeing + other processes → Biological treatment → Tertiary treatment

**ECUVal to decolourise**

Dyeing process → ECUVal system to decolourise → Biological treatment → Tertiary treatment

Other processes → 10% < organic matter → 20% < colour

**ECUVal to reuse**

Other processes → Biological treatment → Tertiary treatment

20% < colour

Reduction of the environmental impact: 55%

Reduction in CO₂ generation: 56%
BENEFITS

Environment impacts

- Saving up to 100% salt
- Saving 70-100% water
- 21% reduction of carbon footprint
- Less chemicals in the wastewater treatment
- Wastewater with lower salinity and lower colour
Socio-Economic impacts

Less cost in water

Less cost in wastewater treatment

Almost no maintenance

Less cost in taxes

Less cost in salt
Economic benefits of ECUVal:

- No chemicals added
- No wastes are generated.
- Only cost: electric power supply.
- Only a part of wastewater is treated,
- Significant reduction of reagents and sludge disposal costs.
- Discharge taxes are lowered due to the reduction of wastewater salinity.
- No maintenance. Electrodes stable over 5-10 years.
- Less cost in water and salt.

ECUVal investment will be depreciated in 4-5 years.
Market segmentation of ECUVal with respect to other technologies
MARKET: POTENTIAL USERS

INDUSTRIAL SECTORS:
• Generation of non degradable compounds
• Receptors of green technologies (reuse of water…)

Validated
Textile Sector
Chemical Sector
Pharma Sector
Paper Sector
Leather Sector
Other potential users
NEW PROJECT

SPECIFIC OBJECTIVES:
• Demonstrations in fairs
• Companies could use the technology in situ and verify its efficiency
• Evaluate other applications of the technology such as direct dyes removal

FINAL OBJECTIVE:
to achieve the introduction of the technology into the market
NEW PROJECT: ELDE

ELECTRO-DEPURACIÓ D’AIGÜES RESIDUALS INDUSTRIALS: VIABILITAT TÈCNICA, AMBIENTAL I ECONÒMICA

LEATHER

PAPER

CHEMICAL

MARKET REPLICATION

RIS3CAT – COMUNITAT AIGÜES (ACCIÓ)
ECUVal is particularly efficient in the treatment and reuse of reactive dyeing and washing effluents.

Environmental and economic benefits

- No chemicals are required to remove colour.
- No residues are generated.
- Saving water.
- Saving salt.
- Lower salinity of wastewater.
- Lower cost of the wastewater discharge.
- Low maintenance.
ECUVal is addressed mainly to companies that generate effluents with high salinity and low biodegradability.

This new technology will reduce the environmental impact associated to the removal the poorly biodegradable compounds from wastewater.

ECUVal will also contribute to reduce the salinity of effluents (very important in low flow rivers)

Currently, there is no other wastewater treatment available for this purpose, economically feasible.
Additional information on ECUVal project:

- Website (English, Spanish and Catalan):  [www.ecuval.eu](http://www.ecuval.eu)
- Papers in water and textile journals
- Fairs
- Conferences and congresses
- Demonstrations and workshops
- Video on ECUVal project
THANK YOU !!

www.ecuval.eu