Achieving Ecological Sustainability in Wool Scouring

Dr. Jock Christoe
Problems with Scouring Effluents

- Organic load
- Biorefractory nature of wool wax
- Pesticide residues
- Detergent residues
- Potassium levels
## Contaminants on Wool

<table>
<thead>
<tr>
<th></th>
<th>Amount on wool</th>
<th>COD factor</th>
<th>COD on wool (g/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>wool wax</td>
<td>15%</td>
<td>2.97</td>
<td>446</td>
</tr>
<tr>
<td>suint</td>
<td>5%</td>
<td>0.83</td>
<td>41</td>
</tr>
<tr>
<td>dirt</td>
<td>15%</td>
<td>0.65</td>
<td>98</td>
</tr>
<tr>
<td><strong>total</strong></td>
<td></td>
<td></td>
<td><strong>585</strong></td>
</tr>
</tbody>
</table>
Drivers for Change

- Regulatory
- Market
- Economic
Regulatory Approach

Chinese NEPA
## China NEPA Regulations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>COD</td>
<td>100 ppm</td>
</tr>
<tr>
<td>BOD</td>
<td>25 ppm</td>
</tr>
<tr>
<td>Colour</td>
<td>40 dilutions</td>
</tr>
<tr>
<td>pH</td>
<td>6 - 9</td>
</tr>
<tr>
<td>Suspended Solids</td>
<td>70 ppm</td>
</tr>
</tbody>
</table>
## Discharge to Surface Waters

<table>
<thead>
<tr>
<th>Treatment Type</th>
<th>COD on Wool (g/kg)</th>
<th>COD in Effluent (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No treatment</td>
<td>565</td>
<td>56,500</td>
</tr>
<tr>
<td>With wax recovery (30%)</td>
<td>431</td>
<td>43,100</td>
</tr>
<tr>
<td>Chemical (95%)</td>
<td>60</td>
<td>6,000</td>
</tr>
<tr>
<td>Biological (90%)</td>
<td>5</td>
<td>500</td>
</tr>
</tbody>
</table>
Meeting Chinese Regulations

- Dilution
- Mixing with other effluents
  - Dyeing / Finishing
  - Carbonising
  - Shrinkproofing
## Effect of Dilution

<table>
<thead>
<tr>
<th>Treatment</th>
<th>10 litres/kg</th>
<th>50 litres/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>No treatment</td>
<td>56,500</td>
<td>11,300</td>
</tr>
<tr>
<td>With wax recovery (30%)</td>
<td>43,100</td>
<td>8,620</td>
</tr>
<tr>
<td>Chemical (95%)</td>
<td>6,000</td>
<td>1,200</td>
</tr>
<tr>
<td>Biological (90%)</td>
<td>500</td>
<td>100</td>
</tr>
</tbody>
</table>
Market-Driven

EU Eco-label
Organic Wool
EU Ecolabels

- Requirements
- Meeting Requirements
Requirements

- Auxiliary Chemicals
- Biodegradability
- Effluent Discharge
Auxiliary Chemicals

- Prohibited Chemicals
  - Alkylphenoletethoxylates (APEO)
  - Linear alkylbenzene sulphonates (LAS)
  - Ethylene diamine tetra acetate (EDTA)

- Verification
  - Declaration of non-use
Biodegradability

- **Definition**
  - ≥ 95% degraded or eliminated in treatment

- **Verification**
  - Documentation, MSDS, test reports showing test methods and compliance
Effluent Discharge

- **Sewer Discharge**
  - COD < 60 g/Kg greasy wool
  - COD reduced by ≥ 75% in off-site treatment
- **Surface Waters**
  - COD < 5 g/Kg greasy wool
  - pH 6 – 9
  - Temperature < 40°C
- **Verification**
  - Data & test report using ISO 6060
## Sewer Discharge

<table>
<thead>
<tr>
<th>Treatment</th>
<th>COD on wool (g/kg)</th>
<th>COD in effluent (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>10l/kg</td>
</tr>
<tr>
<td>No treatment</td>
<td>565</td>
<td>56,500</td>
</tr>
<tr>
<td>With wax recovery (30%)</td>
<td>431</td>
<td>43,100</td>
</tr>
<tr>
<td>Sirolan CF (87%)</td>
<td>56</td>
<td>5,600</td>
</tr>
</tbody>
</table>
## Surface Waters

<table>
<thead>
<tr>
<th>Treatment</th>
<th>COD on wool (g/kg)</th>
<th>COD in effluent (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No treatment</td>
<td>565</td>
<td>56,500</td>
</tr>
<tr>
<td>With wax recovery (30%)</td>
<td>431</td>
<td>43,100</td>
</tr>
<tr>
<td>Chemical (95%)</td>
<td>60</td>
<td>6,000</td>
</tr>
<tr>
<td>Biological (90%)</td>
<td>5</td>
<td>500</td>
</tr>
</tbody>
</table>
Organic Wool

- Organic wool production
- Organic wool processing
Organic wool production

Based on

- the harmonious relationship between land, water, plants and livestock
- respect for the physiological and behavioural needs of livestock
- feeding of good quality, organically grown feedstuffs.
- No synthetic pesticides
Organic Wool Processing

- Aromatic solvents prohibited
- Complexing agents and detergents (APEO, EDTA, LAS) prohibited
- Halogenated solvents prohibited
- Heavy metals prohibited
- Chlorination of wool prohibited
- Carding/spinning auxiliaries only paraffin oils and products based on natural products permitted
- Metal-complex dyes, chrome dyes and AOX containing dyes are prohibited
## Difference between Ecolabel and Organic

<table>
<thead>
<tr>
<th></th>
<th>Ecolabel</th>
<th>Organic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pesticides on greasy wool</td>
<td>Small amounts allowed</td>
<td>prohibited</td>
</tr>
<tr>
<td>Detergents</td>
<td>No APEO, LAS, EDTA</td>
<td>As ecolabel</td>
</tr>
<tr>
<td>Top making chemicals</td>
<td></td>
<td>limited</td>
</tr>
<tr>
<td>Chlorination</td>
<td>Only on tops</td>
<td>prohibited</td>
</tr>
<tr>
<td>Heavy metals</td>
<td>Small amounts allowed</td>
<td>prohibited</td>
</tr>
<tr>
<td>Effluent discharge to sewer</td>
<td>60 g COD/kg greasy</td>
<td>No stated</td>
</tr>
<tr>
<td>Effluent discharge to surface water</td>
<td>5 g COD/kg greasy</td>
<td>Not stated</td>
</tr>
</tbody>
</table>
Economic Driver

A Rational Approach
Ecological Sustainability

- Waste minimisation
- No waste discharges
- Contaminants used as a resource
Features of a Rational Approach

- Waste minimization
- Separation of waste streams
- Resource rather than a waste
- Integration with scouring process
- Modular
- One sludge
Waste Minimisation

SCOURING

RECOVERY LOOPS

WASTE TREATMENT

SLUDGE TREATMENT

Ecological Sustainability

treated sludge

fertiliser

recovered wool wax

reuse

recycle

effluent

AWTTC
AUSTRALIAN WOOL TEXTILE TRAINING CENTRE
Sirolan CF - The Cornerstone to a Rational Approach

- Simple
- In-line treatment
- No mixing tanks
- Dry sludge
Sirolan CF in Australia

Ecological Sustainability

AUSTRALIAN WOOL
TEXTILE TRAINING CENTRE
Option 1

SCOURING

contaminant recovery

Sirolan CFB

chemical

biological

effluent

Sirolan CF

RINSING

wool wax

Recycling

sludge (wool wax, dirt)

compost, fuel
Biorefractory Suint - Effect on COD Removal

Ecological Sustainability

TOC and BOD$_5$ (mg/L)

COD

BOD$_5$

TOC

COD (mg/L)

Treatment Time (min.)
Option 2

**Ecological Sustainability**

- **SCOURING**
  - contaminant recovery
  - concentrate
  - sludge
- **RINSING**
- **Sirolan CF**
- **recycling**

- concentrate (suint)
- sludge (wool wax, dirt)
- fertiliser
- compost, fuel
- wool wax

---

AUSTRALIAN WOOL TEXTILE TRAINING CENTRE
Potassium Uptake

Potassium in Plant Tissue, mg/kg dry

Control | Potash | Suint

- Control: The graph shows a lower potassium content compared to Potash and Suint.
- Potash: The potassium content is significantly higher than Control and Suint.
- Suint: The potassium content is the highest among the three treatments.

Ecological Sustainability

AUSTRALIAN WOOL TEXTILE TRAINING CENTRE
SUMMARY