CHROME RECYCLING AND RECOVERY
IMPROVING RESOURCE EFFICIENCY IN LEATHER
Chrome Management in Tanning Yard

Chrome tanning is the most commonly used type of tanning in the world. Chrome tanned leather is characterized by top handling quality, high hydro-thermal stability, user-specific properties and versatile applicability. In the conventional chrome tanning process, only 60-70 per cent of chromium is taken up by the hides while 30-40 per cent of the chromium goes out as effluent waste. Moreover, on a positive note, the entire chromium discharged in the effluent can be recycled and reused. The quality of the recycled chromium and the leather produced using recycled chromium meets the desired quality requirements.

Environmental Impact:

The environmental impact of chrome discharged from tanneries has been a subject of extensive scientific and technical dispute. Although the legislative limits on the disposal of solid chrome-containing waste have been relaxed in some countries, liquid waste remains strictly regulated throughout the world. Limits on total chrome discharge in effluent vary widely between 0.05 and 10 mg/l for discharges into water bodies (direct discharge) and 1-50 mg/l on discharges into sewage systems (indirect discharge) around the world. In Pakistan, Punjab Environmental Quality Standards (PEQS) set the limit on chrome discharge [Trivalent and Hexavalent] in effluent as 1.0 mg/l for discharge in in-land water body [direct discharge] as well as for sewerage water [indirect discharge].

Chrome discharged in effluent from individual operations is given in the following table:

<table>
<thead>
<tr>
<th>Description</th>
<th>Units</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>spent tanning float</td>
<td>Cr$_2$O$_3$ kg/t of hide</td>
<td>4.1</td>
</tr>
<tr>
<td>sammyning and draining floats</td>
<td>Cr$_2$O$_3$ kg/t of hide</td>
<td>1.5</td>
</tr>
<tr>
<td>post-tanning float</td>
<td>Cr$_2$O$_3$ kg/t of hide</td>
<td>1.3</td>
</tr>
<tr>
<td>washing float after post-tanning</td>
<td>Cr$_2$O$_3$ kg/t of hide</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>Cr$_2$O$_3$ kg/t of hide</td>
<td>7.1</td>
</tr>
<tr>
<td><strong>Utilization</strong></td>
<td>[%]</td>
<td>66</td>
</tr>
</tbody>
</table>
Principles of Chrome Recycling

The chrome-tanning stream from the tanning drum is the influent to the chrome recycling system. In order to recycle this stream, the following steps should be taken:

• Tanning effluent should be collected in the pH-reducing tank from all tanning drums.

• This effluent should be homogenized with the help of an agitator.

• Then pH of this homogenized effluent should be determined.

• The addition of sufficient Sulfuric Acid to this spent chrome liquor will decrease the pH from 3.9 to 2.8. The chrome content of this liquor should then be determined.

• In order to recycle the chrome effluent, the drum of the next lot should be drained after the pickle.

• Then the required amount of effluent from the pH-reducing tank should be added in the drum at the pickle stage.

• Required amount of Basic Chromium Sulfate should be added to achieve necessary chrome concentration in the tanning float.
Description of Chrome Recycling Plant

The proposed chrome recycling plant consists of one reactor that will serve as a storage tank and a pH reducing reactor.

Location

The location of the chrome recycling plant is selected as close as possible to the chrome tanning section of the tannery. Availability of space is also the governing factor keeping in view the tanner’s convenience. It is recommended that Chrome Recycling plants should be constructed alongside the drums in the tan house.

Reactor

This reactor is a cylindrical vessel with a flat bottom, made up of fiberglass 6 mm thick. One valve is fitted at the base of the reactor to remove the sludge or washings. Another valve is fitted around one foot above the base of the reactor for extraction of liquid. The reaction tank is provided with a stirrer for mixing Sulfuric Acid with the exhaust liquor. The stirrer is fixed with two sets of blades for proper mixing.

Conveyance

The exhaust liquor will be pumped directly from the drum into reactor. In case the exhaust liquor is not conveniently sucked by the pump from the drum, due to the presence of wet blue, then the exhaust liquor should be discharged into the trolley and then pumped into the reactor.
Cost Benefit Analysis

Estimated Cost
(Capital cost + O&M cost)
Reactor (Capacity 4.0 m³/d), Pump,
Plant Piping, Reactor Platform,
Trolley & Screening + Man Power,
Chemicals, Electricity etc. for 2,500 kg/d hides
Producing 3.7m³/d spent liquor

Estimated Savings [@25% Chrome]

Payback

<table>
<thead>
<tr>
<th>Description of Chrome Recovery</th>
</tr>
</thead>
</table>

Recovering chrome from spent tanning floats after precipitation constitutes an indirect means of recycling and reusing the chrome in processing. By adopting indirect chrome reuse after precipitating the residual tanning floats, the tanner can avoid the problem of increasing float volume. In those cases, where the chrome precipitated from floats contains numerous impurities, the chrome recovered is not reused; it is simply dumped.

The principle is based on recovering the chrome from floats containing residual chrome by means of precipitation, separation and subsequent redissolution in acid for reuse. The base used to precipitate the chrome can vary. Two principal options offer themselves:

1. Chrome Recovery Reactor
2. Chrome Regeneration Tank
3. Collection Tank
Option A

Rapid precipitation with sodium hydroxide or sodium carbonate, enhancing coagulation with polyelectrolyte, thereafter thickening and dewatering the voluminous sludge by filtration. A simple flow diagram of this recovery system is shown in Figure 1:

![Figure 1: Flow diagram of the recovery system.](image-url)
**Option B**

Slow precipitation with magnesium oxide, settling of the suspension, decantation of the supernatant (no need for a filter press) and subsequent acidification of the relatively dense precipitate. A simple flow diagram of this recovery system is shown in Figure 2:

*Figure 2*
Cost Benefit Analysis

Chrome recovery techniques have a direct bearing on capital and running costs. The choice between an alkali sodium salt and MgO is decisive in terms of capital costs since as a rule, a filter press is not needed to dewater the chrome oxide precipitated with MgO.

<table>
<thead>
<tr>
<th>Estimated Cost</th>
<th>PKR</th>
<th>1,500,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Capital cost + O&amp;M cost)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reactor (Capacity 4.0 m³/d), Pump,</td>
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<td></td>
</tr>
<tr>
<td>Plant Piping, Reactor Platform,</td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Producing 3.7m³/d spent liquor</td>
<td></td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Estimated Savings [@30% Chrome]</th>
<th>PKR/d</th>
<th>6,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payback</td>
<td>days</td>
<td>250</td>
</tr>
</tbody>
</table>
European Union

The Member States of the European Union have decided to link together their know-how, resources and destinies. Together, they have built a zone of stability, democracy and sustainable development whilst maintaining cultural diversity, tolerance and individual freedoms. The European Union is committed to sharing its achievements and its values with countries and people beyond its borders.

International Labour Organization

The International Labour Organization (ILO), founded in 1919, is devoted to promote social justice and internationally recognized human and labor rights, pursuing its founding mission that social justice is essential to universal and lasting peace. It is the only tripartite UN agency, which brings together governments, employers and workers of 187 member states, to set labour standards, develop policies and devise programmes that promote decent work for all women and men. Today, the ILO’s Decent Work agenda is helping advance economic and working conditions that gives workers, employers and governments a stake in lasting peace, prosperity and progress.

WWF-Pakistan

WWF’s mission is to stop the degradation of the planet’s natural environment and to build a future in which people and nature thrive.

International Labour and Environmental Standards Application in Pakistan’s SMEs (ILES)

The ILES project (2016-2022), funded by the European Union, and implemented by ILO and WWF-Pakistan, aims to improve national compliance with international labour and environmental standards. It provides necessary policy and capacity building support to the federal and provincial governments as well as extends hands holding and capacity building support to the enterprises from the textile and leather industry. It has introduced its targeted enterprises to different approaches/methodologies that enables them to reduce waste production, ensure efficient resource utilization as well as have better working conditions, which in turn enables them to increase productivity and be more environment friendly. The project targets to contribute significantly to increasing competitiveness, as well as promote sustainable and inclusive growth in leather and textile sectors in Pakistan.