

Approaches Towards Tannery Modernization and Up-Gradation: Leather Industry 4.0: Multi-Disciplinary Approach

by

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Abstract

Analysis of various approaches for tannery modernization and up-gradation as leather industry 4.0 need to be analyzed keeping in view of significant advancements made in different disciplines of relevance to leather sector. Holistic views and plans for cleaner image with better environmental aspects are essential for the sustainable growth of the leather sector. In this paper, various plans and strategies for the next phase of tannery modernization denoted as TAN MOD 4.0 have been presented with the main objectives of near zero discharge of chemicals, waste minimization, value addition, productivity enhancement and safe & healthy environment in tannery. Different components such as basic up-gradation concepts, modern leather processing techniques and engineering inputs for leather sector such as process control systems, necessary automation tools and Internet of Things (IoT) are discussed.

Introduction

In the growing technological advancements in various fields, leather industry also needs to have enhanced outlook. In this regard, the primary motivation of a framework for tannery modernization and up-gradation is to identify critical areas of weakness of the leather sector with reference to the context of global developments and prepare a strategic plan based on the strength of untapped opportunities.

The Indian leather industry is divided into three sectors as large, medium and small. It enjoys the strength of vast raw material (approx. 10% of global supply), rich expertise pool and unlimited human capital. Untapped potentials result from some weakness of the industry originating from resource-link-constraints. Industry suffers from un-clean image of environmental commitments, occupational health & safety of workers and global market quality. During recent years, global competition in leather and allied products trade are increasing. Lack of expertise ensuring high productivity and quality for cost leadership for low priced market segment, have

been identified as weakness. The industry also requires cleaner image and better environmental aspects. According to the above reasons, tannery up-gradation and modernization plans are essential for the sustainable growth of leather sector.

The following areas need to be upgraded and modernized:

- Tanning sector (wet processing & material handling)
- Occupational health and safety
- Pollution control
- Energy utilization

Tannery Modernization of Initial Phase

Tannery Modernization - Phase I has been carried out at CSIR-CLRI in 1990's under the LTM program.¹ Government of India had set up Leather Technology Mission (LTM) involving a grass root approach of taking technology to correct local deficiencies and to strengthen the ability of the cottage, rural and small scale sectors to cope with technological changes and integrate efficiently in the overall development of leather industry. This technology driven development grid for the Indian leather sector thus aims to augment raw material availability, upgrade technology, promote cleaner technologies and standardize quality and develop organizational and human skills in a significant measure to generate multiplier effects.

One of the work plan strategies of the Mission was to set up demonstration units for process control and cleaner tannery wet operations in a tannery to demonstrate the viable cleaner technologies in a number of commercial tanneries at various locations in India. Whereas, there are some un-filled gaps such as catering to Large as well as Medium Small Micro Enterprises (MSME) need to be analyzed. The small sectors (below 3000 Kg/day) of tannery also need to be considered in the present scenario. In addition, some of the relevant concepts of Tannery Modernization and Industry 4.0 also need to be considered for Leather sector.

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Industry 4.0

In the 21st century, Industry 4.0 incorporates cutting-edge technologies including additive manufacturing, robotics, artificial intelligence and other cognitive technologies, advanced materials, and augmented reality, according to the article “Industry 4.0 and Manufacturing Ecosystems” by Deloitte University Press.

The development of new technology has been a primary driver of the movement to Industry 4.0. Some of the programs first developed during the final stages of the 20th century, such as manufacturing execution systems, shop floor control and product life cycle management, were farsighted concepts that lacked the technology needed to make their complete implementation possible. Now, Industry 4.0 can help these programs reach their full potential and also connects the internet of things (IoT) with manufacturing techniques to enable systems to share information, analyze it and use it to guide intelligent actions.²

The Fourth Industrial Revolution (or Industry 4.0) is the ongoing automation of traditional manufacturing and industrial practices, using modern smart technology. Large-scale machine-to-machine communication (M2M) and IoT are integrated for increased automation, improved communication and self-monitoring, and production of smart machines that can analyze and diagnose issues without the need for human intervention.³

Considering the scenario of Industry 4.0 with relevant applicability to Leather sector and various aspects for the next level of Tannery Modernization as Tan-Mod 4.0 are presented in this paper.

Un-Filled Gaps in Tannery Modernization

- Wide Coverage also to Micro, Small and Medium sectors
- Wider coverage in entire country
- Skill development and training with regard to tannery modernization tools at worker level
- Realizing: mechanization is only a part of modernization and not the only goal
- Incorporating Environmental, Safety and Hygiene concepts at the tannery level

Tannery Modernization 4.0: Objectives

Various plans under Tannery Modernization are termed as TAN-MOD 4.0. In addition, TAN MOD 4.0 is focused not only for large scale units but would cater to MSME sector also. In this regard, programs on MSME for leather sector have also been studied and considered in TAN MOD 4.0. The small sectors (below 3000 Kgs/

day) of tannery also need to be taken care of in the present phase of implementation. Various plans are as follows:

- Process Optimization
- Improve Process Efficiency
- Better Design & Process Control
- Better Material Handling systems (lay out)
- Machinery up-gradation
- Energy audit: Use of non-conventional resources
- Primary treatment systems
- Environmental, Health and Safety
- Waste Minimization: Bye-product Utilization
- Better communication and information technology (IoT)

Present Plan under Tannery Modernization: TAN-MOD 4.0

The components for TAN-MOD 4.0 shall be broadly classified in to three categories (Fig. 1) as follows,

1. Basic Up-gradation concepts (BASICS)
2. Modern Leather processing techniques (LEAPRO)
3. Engineering for Leather Process (ENGG-LEAP)

The work elements for each component have been worked out as presented earlier in LERIG-2016.⁴ Various approaches for Tannery up-gradation and Modernization in Leather Sector TAN MOD 4.0 are presented as Sustainable solution (Fig. 2).

Some of the concepts envisaged under TAN-MOD 4.0 for leather sector shall comprise the following modules,

1. Lay-out Design and Facilities
2. Process control systems
3. Process Intensification tools
4. Odor abatement module
5. Occupational and Environmental Safety Module
6. Non-conventional Energy Module
7. Energy audit etc.

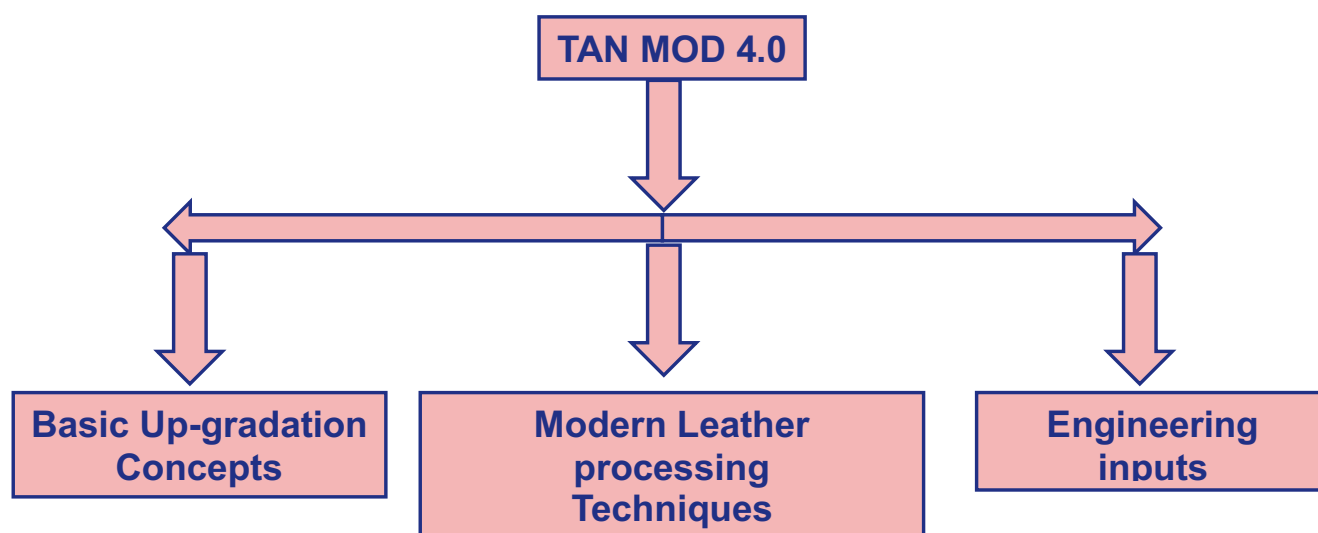


Figure.1. Schematic Plan for Tannery Modernization - TAN-MOD 4.0

The above components could cater to both more productivity as well as for emission control.

Benefits Envisaged from TAN MOD 4.0

- Near Zero discharge of chemicals – Pollution reduction at source (In-plant)
- Quality Consistency (95-100%)
- Water Minimization
- Waste Minimization (15-30%)
- Value addition for leather
- Productivity enhancement (25%-50%)
- Safe, Healthy Environment in Tannery

Basic Up-gradation concepts

- Basic Studies
 - Quality of chemicals
- Quantity & Quality of chemicals audit
- Quality/ Quantity of water
 - Hardness impairs quality of leather; TDS ↑
- Process vessels: Drums, Paddles or Pits
- Leather machinery

Quantity & quality of chemicals, leather process vessels and quality of machinery used for leather processing need to be selected properly and optimized for each unit operation.

Engineering for Leather Process (ENGG-LEAP)

- System for Recycle of spent liquors
 - Soak, Lime, Pickle, Chrome liquor recycling (RECYCLE)
- Process control systems⁵
- Process Intensification Tools: Near zero discharge of chemicals
- Energy audit & Solar energy for leather (ESOLAR)
- Tannery Odor control system
- Leather machinery up-gradation (LEAMAC)
- Tannery Lay-out up-gradation
- Scheduling and Sequencing
- Environmental, Health and Safety for Leather (EHSL)
- Better communication and information technology (IoT)
- R&D and Testing Centre

Various engineering for leather processing as shown above is necessary for waste minimization, optimal utilization of resources, energy control, and production management and for the safety of staff and environment. IoT could be used for online real time data transfer with regard to process parameters, process trouble shooting, product quality, inputs related to trade etc.

Materials storage facility

- Cold storage facility for preservation of raw skins/hides
- Wet-blue storage systems with automated water sprinklers
- Finished leather storage system with temperature and humidity controls
- Hazardous chemicals storage and dispensing facility (e.g. acids etc.)
- Leather specialty chemicals storage facility (fatliquors, dyes, syntans, etc.)

Since the materials under the process involves natural materials such as raw skins, hides and other intermediate goods, the storage of which become important with proper control of temperature, relative humidity etc. in order to avoid putrefaction

Materials Handling facility

- Trolley for raw skins/hides movement
- Electric forklift attached transport vehicles for raw skins/ limed pelts/wet-blue/dyed leather/finished leather etc.
- Bulk chemicals transport

Similarly, the materials handling systems are necessary in order to provide efficient and safe movement of materials from one yard to another or shifting within the same yard.

Modern leather processing techniques (LEAPRO)

- New eco-friendly pre-tanning technologies
 - Salt-less preservation
 - Enzymatic processes
- Novel eco-friendly / high-exhaust tanning process technologies
 - E.g. CLRI salt free tanning process
 - Float-less/ Float free tanning technologies
- New eco-friendly, high-exhaust post-tanning process technologies, REACH compliance
- New finishing methods
- Novel leather process recipes for high-end segments for value addition

In the growing demand for adopting Eco-benign processes and products and for compliance to environmental norms and achieving near zero discharge of chemicals (TDS, BOD, COD, Cr etc.), modern leather processing techniques (LEAPRO) become necessary. Various new eco-benign processes and products as developed become important.

Environmental, Health and Safety (EHS)

- Cleanliness and hygiene
- Occupational Health & Safety (OHS)
- Safety audit
- Personal protection equipment
- Inter-locking systems & trips
- Alarms
- Emergency management systems

Since leather processing involves various unit operations, types of raw materials which are biological in nature and use a range of chemicals starting from general bulk chemicals to specialty

chemicals and generation of liquid, solid and gaseous wastes, Environmental, Health and Safety (EHS) aspects become important in order to protect both the staff as well as environment.

Conclusions

Face lift and enhanced outlook as Leather Industry 4.0 through the concepts of leather, environmental and engineering sciences (in a broader sense) as multi-disciplinary approach are necessary in the growing environmental concern, market demand and economics. Various options for tannery modernization and up-gradation for leather sector have been discussed taking into consideration of advancements made in different areas of relevance to leather sector. Industry 4.0 with relevant applicability to leather sector and various aspects for the next level of tannery modernization as Tan-Mod 4.0 are presented in this paper. Plan for tannery modernization (TAN-MOD 4.0) has been discussed with main themes such as basic up-gradation concepts (BASICS), engineering for leather process (ENGG-LEAP), modern leather processing techniques (LEAPRO).

The main objectives and goals for this TAN-MOD 4.0 are to achieve near zero discharge of chemicals with pollution reduction at source (in-plant), waste minimization, value addition for leather, productivity enhancement and safe & healthy environment in tannery. Emphasis would be given for micro, small and medium sectors. Skill development and training program with regard to tannery modernization tools at worker levels are also essential and to improve EHS concepts.

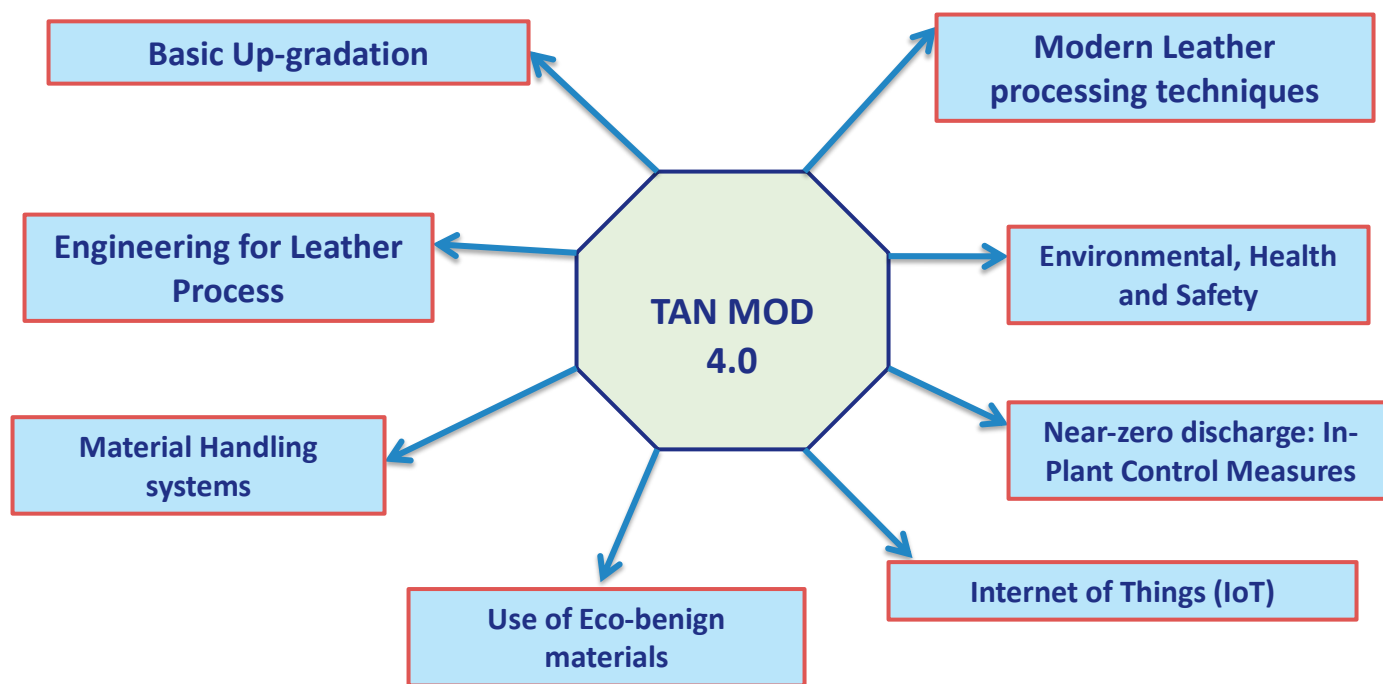


Figure 2. Approaches for Tannery up-gradation and Modernization in Leather Sector TAN MOD 4.0 as Sustainable solution.

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