



Solar Thermal Solutions for Leather (Tannery) Industries

1. Industry Overview

Leather tanning is a water and heat intensive manufacturing activity. Important thermal operations include soaking/desalting, liming and unhairing, deliming, pickling, tanning, retanning, dyeing, finishing, hot-water preparation and drying. Thermal energy is commonly supplied through boilers or thermic-fluid heaters using fuels such as firewood, coal, furnace oil, diesel, natural gas or biomass. Solar heat can be integrated particularly well where tanneries require recurring hot-water duties and controlled drying.

Indian sector studies identify hot-water demand in tanning as a significant opportunity for solar thermal integration, with many relevant processes in approximately the 40–100°C range. Solar systems can therefore be connected at the process, hot-water-loop, boiler-feedwater or drying-air level, while conventional equipment remains available for cloudy periods and peak loads.

2. Typical Thermal Applications

Table 1: Leather sector applications, indicative temperature range and typical heat medium

Leather (Tannery) application	Indicative temperature	Typical heat medium
Soaking / desalting	30–50°C	Hot water
Liming / unhairing	40–60°C	Hot water
Deliming / pickling	30–50°C	Hot water
Chrome / vegetable tanning	50–80°C	Hot water
Retanning / dyeing	50–80°C	Hot water / steam
Finishing / coating	50–100°C	Hot air / thermal fluid
Leather drying	70–100°C	Hot air / steam
Boiler feedwater preheating	60–120°C	Hot water / suitable HTF

3. Solar Thermal Technology Options

The appropriate technology should be selected based on required process temperature, heat-load profile, available area, solar resource and integration point.

Table 2: Solar thermal technology options, indicative applications and temperature range

Solar thermal technology		Indicative application	Temperature range
Non-concentrating solar thermal	Flat Plate Collector (FPC)	Low-temperature hot water and utility/process water	30 - 80°C
	Evacuated Tube Collector (ETC)	Hot water, tanning/retanning and preheating	40 - 100°C
Non-imaging concentrating	CPC/evacuated-tube CPC/xCPC	Low/medium-temperature process heat	60 - 120°C
Concentrating Solar Thermal	Scheffler / parabolic dish	Steam and medium-temperature process heating	100 - 250°C
	Parabolic Trough Collector (PTC)	Thermal oil, steam and medium-temperature heat	100 - 250°C
	Linear Fresnel Reflector (LFR)	Steam and medium-temperature process heat	100 - 250°C
	Higher-temperature CST systems	Not applicable	Up to 400°C

Thermal storage can improve solar utilisation where solar availability and tannery demand do not coincide. For the common 40–80°C hot-water applications, insulated hot-water storage is generally the simplest integration option.

4. How Solar Heat Can Be Integrated

A key principle in industrial solar thermal design is to identify the most technically and economically suitable integration point rather than simply connecting the solar field to the main boiler. IEA SHC specifically highlights process integration and selection of the appropriate integration concept as a critical part of SHIP project design.

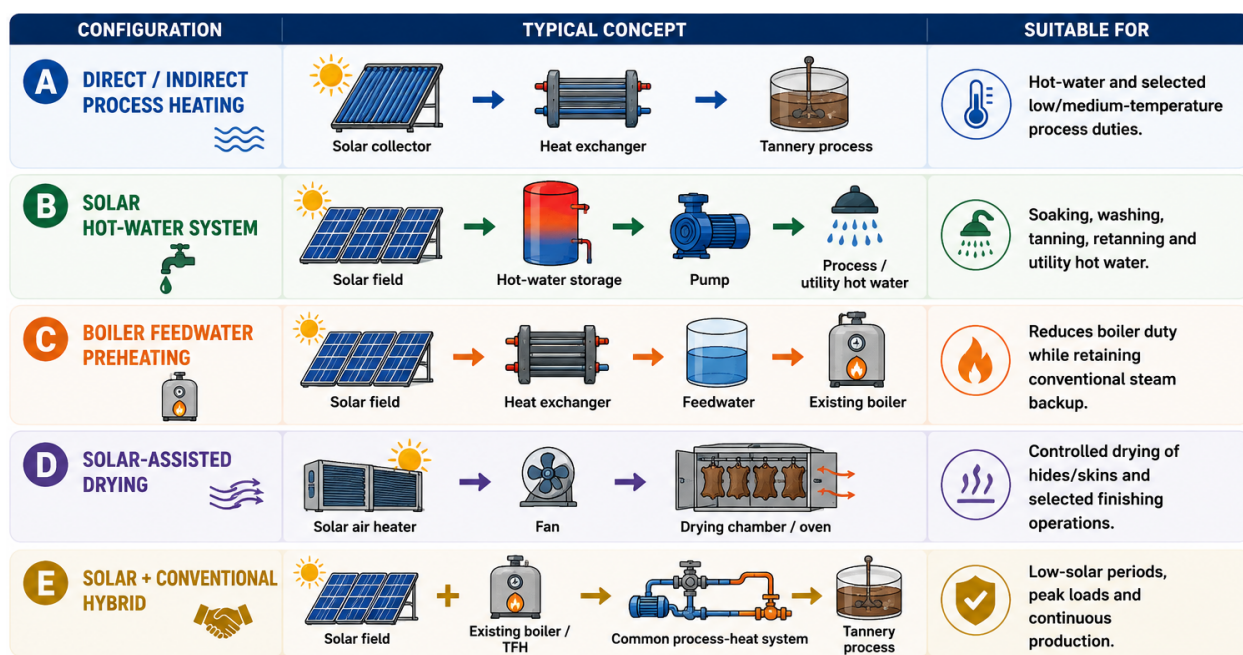


Figure 1: Illustration of solar heat integration to Leather (Tannery) industries

5. Key Benefits for Leather (Tannery) Processing MSMEs

Solar thermal systems can potentially supply a significant share of suitable Leather (Tannery) process-heat demand where solar resource, process temperature, operating schedule and collector area are well matched. As a preliminary screening range, a solar contribution of approximately 20–50% of suitable process heat may be considered; actual solar fraction and fuel displacement should be established through project-specific hourly heat-load and solar-yield analysis. Key economic indicators include annual solar heat delivered, fuel displaced, annual cost savings, O&M costs, LCOH, NPV, IRR and payback period.

Table below presents key benefits for Leather (Tannery) sector MSMEs.

Table 3: Key benefits for Leather (Tannery) sector MSMEs

BENEFIT	KEY BENEFITS
 ENERGY	Reduces suitable fossil-fuel/biomass use for hot-water and drying loads; reduces boiler/TFH duty; supplies renewable daytime process heat. 
 ECONOMIC	Reduces exposure to fuel-price fluctuations; can reduce thermal-energy cost and improve utilisation of existing heating equipment. 
 ENVIRONMENTAL	Reduces fossil-fuel consumption and associated GHG emissions; can reduce combustion-related local air pollutants. 
 OPERATIONAL	Can be integrated with existing boilers, thermic-fluid heaters, hot-water loops and dryers; hybrid operation maintains process reliability. 
 PROCESS QUALITY	Controlled hot-water and drying conditions can improve process consistency when temperature and moisture requirements are properly managed. 

6. Indian Case Example

Ranipet Tannery Effluent Treatment Company (RANITEC) operates a Common Effluent Treatment Plant (CETP) serving the tannery cluster at Ranipet. RANITEC's current information indicates that the CETP serves dozens of member tanneries and incorporates a Zero Liquid Discharge (ZLD) system.

As part of the ZLD system, a solar steam-generation system based on cross-compound parabolic concentrators (xCPC) was installed to provide renewable thermal energy for the evaporation process.

Parameter	Reported project information
Project	xCPC Solar Steam Generation at RANITEC, Ranipet, Tamil Nadu
Location	Ranipet, Tamil Nadu
Industry	Leather / tannery cluster
Host facility	RANITEC Common Effluent Treatment Plant (CETP)
Solar technology	Cross Compound Parabolic Concentrator (xCPC)
Number of modules	Approximately 380 modules
Collector area	Approximately 1,710 m ²
Reported steam output	RANITEC documentation identifies a 1 tonne/hour solar steam plant; approximately 2.5 t/h has also been reported in industry material as an operating/peak figure.
Application	Solar steam supply to the ZLD system
Main process	Multi-effect evaporation

Parameter	Reported project information
Solar Heat Integration	Solar radiation → xCPC solar field → steam generation → steam header → multi-effect evaporator → ZLD
Fuel Savings	60 tonnes of firewood/month × 12 months ≈ 720 tonnes/year
CO₂ emission avoided	1258 tCO ₂ /year (considering IPCC default emission factor of 112 kg CO ₂ /GJ and net calorific value 15.6 GJ/tonne for wood)

7. Sources and References

- 1) IEA SHC Task 49 / Task 64 resources on Solar Heat for Industrial Processes (SHIP).
- 2) MNRE, Concentrated Solar Thermal – CST for Heat Generation.
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- 4) CSTEP, Solar Resource Assessment & Technology Roadmap Report – leather industry process heat assessment.
- 5) Suresh, N.S. & Rao, B.S., Solar energy for process heating: A case study of select Indian industries, Journal of Cleaner Production.
- 6) Pillai et al., Integration of Solar Process Heat in Industries: A Review, Clean Technologies, 2022.
- 7) MNRE, User's Handbook on Solar Water Heater – leather industry example (Leo Leather).
- 8) CRSES, Klein Karoo International Tannery Case Study.