Solar air heating system

Introduction

The leather industry uses a considerable amount of thermal energy, particularly during the leather drying process — a mechanical operation which eliminates most of the water soaked up by the tanned leather. Thermal energy accounts for between roughly 50 and 55 percent of total energy consumption during leather making.

During autospray and roller coating, the leather is dried in tunnel driers through hot air of 80 to 90° C produced from steam or hot thermic oils. Until now, the industry has been using fossil fuels, coal, oil and natural gas, either with a conventional boiler or, in certain locations, with cogeneration.

Alternative technologies are available for the industry to produce hot air. One option is the use of thermal solar energy, which also reduces energy costs, decreases carbon emissions and greenhouse gases, and minimizes the reliance on fossil fuels. India is a tropical country, so its tanneries are favourably located for application of the solar air heating systems.

Solar energy potential in Kanpur

The solar insolation data for Kanpur (Latitude 26.45 Longitude 80.332) obtained from *NASA Surface meteorology and Solar Energy - Available Tables* is provided below in Table 1.

TABLE 1 **MONTHLY AVERAGED INSOLATION INCIDENT ON A HORIZONTAL SURFACE (KWH/M²/DAY) FOR KANPUR**

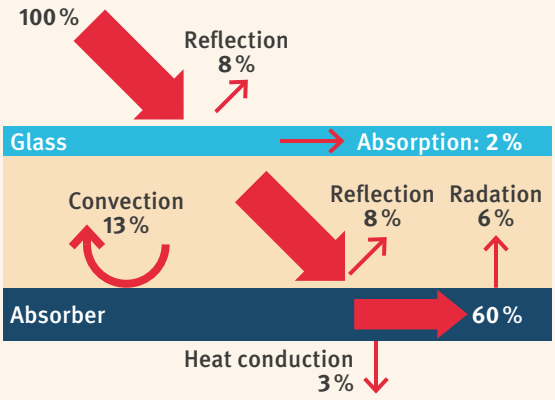
MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL AVERAGE
22 year average	3.72	4.67	5.75	6.32	6.57	5.91	4.8	4.48	4.51	4.87	4.26	3.6	4.95

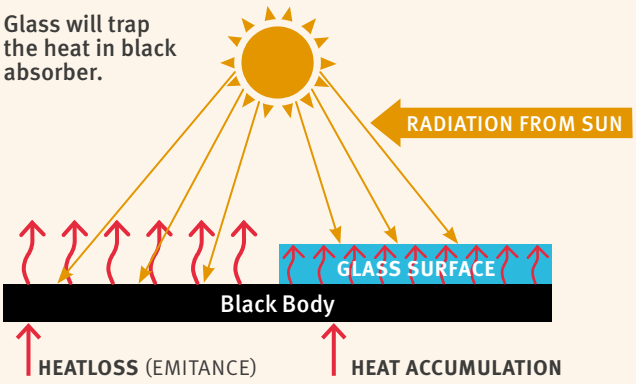
Source: https://eosweb.larc.nasa.gov

Brief description of the system

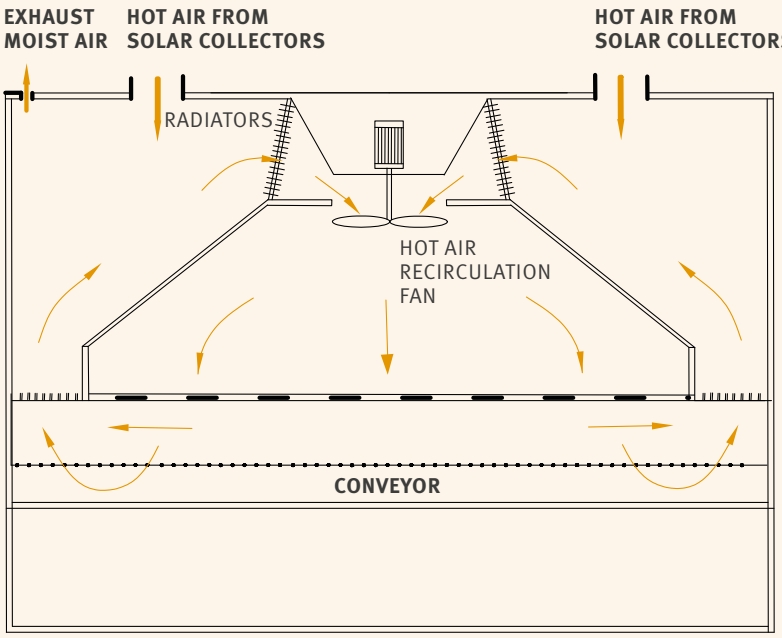
A black surface absorbs solar heat. Air is passed through the space between the glass and the corrugated black surface, thus allowing the air to be heated by the direct solar rays as well as the reflection from black surface. The heat convection from the black surface adds to the increased temperature of air. The heat loss below the black surface is prevented by insulation.

LET US SEE ABOUT HOW TO USE THE ACCUMULATED HEAT?





CONCEPTUAL DIAGRAM OF SOLAR HOT AIR GENERATION



CROSS SECTION VIEW OF AN AUTOSPRAY DRIER WITH THE INTRODUCTION OF SOLAR HOT AIR.

DISTRIBUTION HOT AIR INTO DRYING TUNNELS

SOLAR AIR HEATING SOLAR PANELS.

Main components of the system

1. Roof sheet made of metal comprising GI material of 0.45 to 0.56 mm thickness.

2. Solar collectors (flat plate collectors) made of corrugated black painted aluminium base material, with space for air flow and glass cover on top over an area of 270 m^2. Solar collector collectors are made of 144 aluminium boxes, each measuring about 1.875 m^2. Air heating is performed in 6 compartments, with each compartment comprising 24 solar collectors. The thickness of the aluminium collector boxes ranges from 0.45 to 0.56 mm.

3. Centrifugal hot air blower of maximum flow rate of capacity 7000 m^3/h.

4. Aluminium ducts, insulated using glass wool of 100 mm thickness.

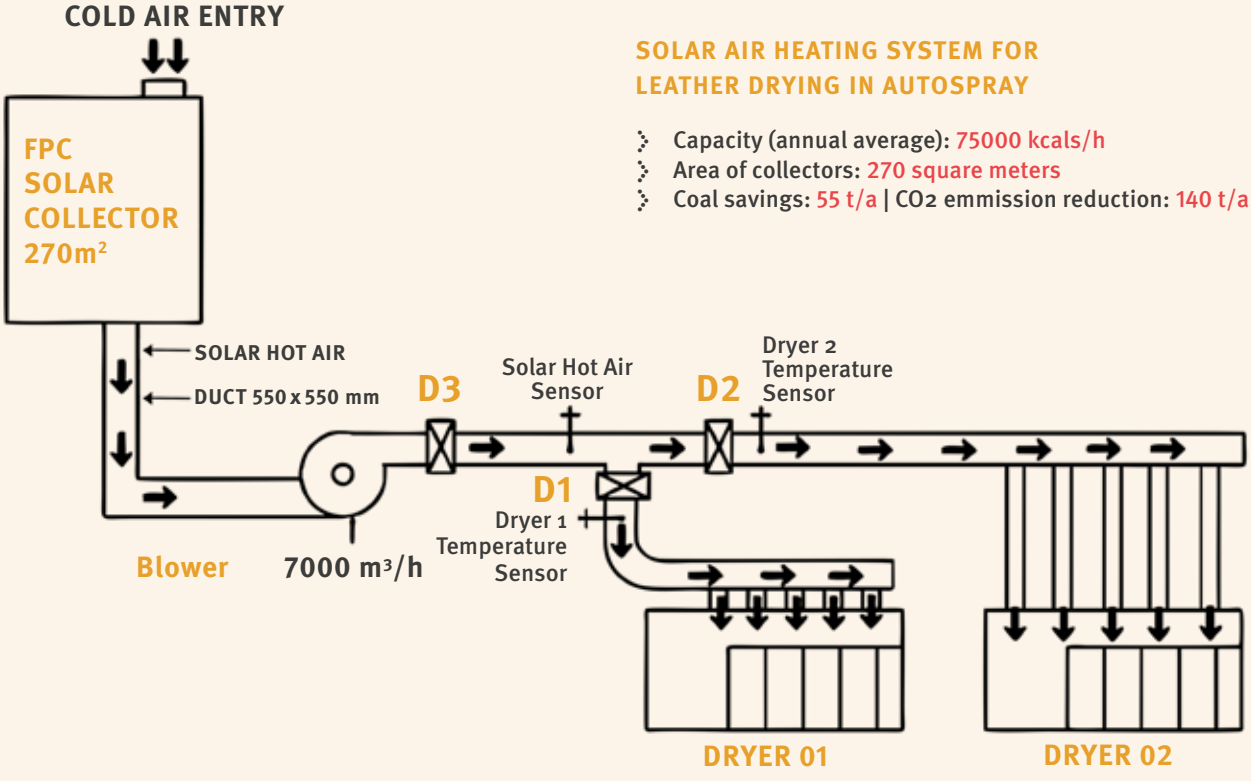
5. Steam flow meter to measure the steam flow.

6. Pneumatically operated steam control valve which is inbuilt in the autospray driers.

7. Control panel for the on/off switches, including the energy recorder device.

Technical description and process flow

The solar collector is made using aluminium extrusions, highly sensitive special absorbers, 4 mm thick toughened glass (partial double), mineral wool insulation, polyurethane sealant and an EPDM rubber. Almost all (92 percent) of the short wavelength radiation emitted by the sun is transmitted through the glass. When it falls on the black absorber, radiant energy is converted into thermal energy. Since glass blocks re-radiation [long wavelengths] from the



SOLAR AIR HEATING SYSTEM FOR LEATHER DRYING IN AUTOSPRAY

- Capacity (annual average): 75000 kcals/h
- Area of collectors: 270 square meters
- Coal savings: 55 t/a | CO_2 emmission reduction: 140 t/a

absorber, the temperature rises in the absorber. Fresh air meanders below the absorber sheet so that the collector delivers hot air in the range of 70–100° C, depending upon the solar radiation. After passing through three segments of solar collectors, the air finally exits through the insulated outlets, which are connected to an insulated metal box. A blower with specifications of 2.2 kW, 7000 m^3/h, and 1420 rpm draws the hot air from the panel and pushes it into the auto sprayer through the insulated duct.

In this pilot demonstration unit, the solar hot air is provided to one autospray drier and one roller coater drier. It is also possible to use only one of these driers at a time.

The steam flow meter measures the cumulative flow of steam to the autospray drier, which is used to calculate the energy savings. In addition, the control panel includes an energy recorder device which provides the energy supplied by the solar air heating in kWh units.

Operational data

The steam consumption without solar air heating in autospray drier is 210 kg/h @ 5 bar pressure.

DESCRIPTION / PARAMETER	FEBRUARY 2017	MARCH 2017	APRIL 2017
Savings in steam saved using solar hot air (9 AM to 5 PM)	**1127 kg/d**	**1586 kg/d**	**1656 kg/d**
Steam consumption along with solar	**553 kg/d**	**94 kg/d**	**24 kg/d**
Average maximum temperature obtained from solar collectors	**83° C**	**92° C**	**95° C**
Savings in coal (annualized)	**71 tonnes**		
Reduction in CO_2 emission	**181 tonnes**		

Energy and Environmental savings

The use of hot air in leather drying during the autospray process reduces dependency on fossil fuel and increases the renewable energy footprint.

Specific energy consumption in leather production	**54 MJ/m^2 of finished leather**
Energy savings from solar hot water	**7.47 MJ/m^2 of finished leather**
Savings in energy by using solar water heating system	**14%**
Reduction in CO_2 emissions	**1 kg of CO_2/m^2 of finished leather**

Cost benefit analysis

Investment cost	**Rs. 2,200,000**
Operating cost (electricity for blower) @ Rs.7 per kWh	**Rs. 26,000 per annum**
Cost of coal saved	**Rs. 642,000 per annum**
Annual net savings	**Rs. 616,000 per annum**
Payback period	**3.6 years**

THIS PILOT DEMONSTRATION UNIT HAS BEEN IMPLEMENTED BY
UNIDO KANPUR LEATHER DEVELOPMENT PROJECT,
A PROJECT OF DEPARTMENT OF INDUSTRIAL POLICY AND PROMOTION, GOVERNMENT OF INDIA.