



Back to Basics: A Framework for Leather Manufacture

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Leather drying and conditioning: Vacuum drying

Overview

Vacuum drying apparatus for the leather industry was patented in the USA in the 1950s but was not applied until an Italian tanner developed the first practical production machine in 1962. Early mechanical problems and the need to adapt tannage and dyeing did not deter further rapid development leading to the technique's adoption by the world's tanneries almost overnight. The application displaced some classic drying methods as well as becoming an additional process to achieve certain effects.

The principle rests upon the leather to be dried being placed and slicked out grain down upon a heated flat plate. An airtight vacuum chamber then encloses the plate and atmospheric pressure is reduced, normally enough to lower the boiling point of water to approximately 30°C. Much faster water removal than under normal atmospheric pressure results.

conventional batch system.

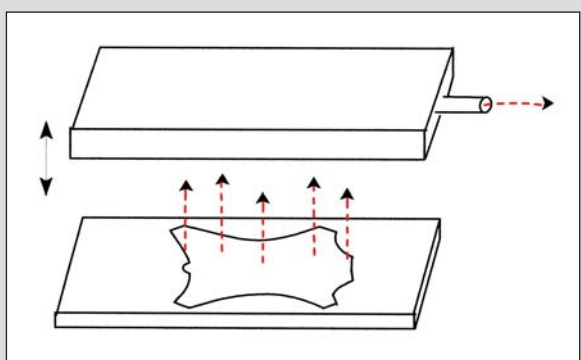
The successful adoption of vacuum drying satisfied these initial objectives but after overcoming teething problems also led to more consistent and enhanced leather properties.

Generally, the vacuum drying practised begins with a first-time drying where the water content is reduced from 50% or 60% down to around 25-30%, dependent upon leather type. Conditioning and/or re-humidification follows to prepare the leather for staking. After this operation second-time vacuum drying can take place. This reduces water content to an equilibrium condition, normally of the order of 14% to 18% for the ensuing finishing operations.

Vacuum drying machines can be equipped with full computer or PLC managed setting and feed back monitoring systems. The aim is to optimise drying times and energy consumption, and to produce leather to precisely specified properties.

- Faster and easier vaporisation is taken advantage of in the vacuum process.
- Energy requirement to achieve vaporisation is relatively low.
- The gentle effect on the leather of vacuum drying is connected with the vaporisation. This keeps the leather surface relatively cool, as long as the water content does not drop below approximately 25%.
- Actual first-time drying times—depending upon type, tannage and substance of the leather—may vary in the range of 3 minutes to 10 minutes.
- Residual water content after first-time drying is normally around 25% to 30%.
- Second-time drying times—depending upon type, tannage and substance of the leather—may be in the range of 1½ minutes to 3 minutes.
- Residual water content after second time drying is normal around 15% to 18%.
- Residual water content can be regulated with relative accuracy.
- The butt normally finishes drier than the flank parts.
- The higher temperature and degree of vacuum, the lower the final water content of the leather.

Panel E21/I: Vacuum dryer system



The following details are pertinent to vacuum drying leathers:

- Vacuum drying offers a permanence of grain set and improvement, along with fast and relatively uniform drying. Area gain or retention depends on type of vacuum dryer and drying conditions.

- Drying conditions are determined by temperature, degree of vacuum,

processing time and the pressure exerted upon the leather. All are manually and/or automatically controllable.

- The drying cycle, with the exception of placing the leathers, is both automatic and ergonomic.
- Heat transfer is by conduction from the heated contact plate to the grain side, and vaporisation takes place from the flesh side.

Objectives and outcome

Vacuum drying was conceived as a way to rationalise paste and toggle drying methods without compromising the characteristics and the quality of the finished leather. Energy input and human effort are a major cost factor in these drying methods. In addition, these methods blocked the development of line-production as distinct from the

Outcome in terms of leather characteristics:

- The process suits aniline-type leathers.
- After vacuum drying the grain is fine and firm.
- The process can improve yield.
- If chemical constituents are not firmly fixed migration and discolouration can occur.
- Higher pressure and temperature result in harder and emptier leather.
- Lower pressure produces softer and fuller leather.
- Ironing effect, gloss and smoothness increase with pressure.
- Scars and cuts tend to be sealed in vacuum drying generally, but better so



- under higher pressures.
- Drying to low water content under full pressure causes strong veining and a coarsening of grain break.
- Area shrinkage is highest with high temperature and low pressure on the leather.
- Substance loss is more significant when working under higher pressures, particularly with softer leathers.

Common elements of construction

Whilst vacuum dryers are built and used in a variety of forms they all have common functional components which are:

The drying table: This is normally a fabricated steel tank with a polished or sandblasted stainless steel top plate on which the leather is slicked out and dried. A pump circulates controlled temperature hot water to supply heat to the stainless steel plate. The tank is not a pressure vessel and is vented to atmosphere.

The heat exchanger: Heats the water supplied to the drying table. Some systems supply pressure controlled steam. In this case the drying table becomes a pressure vessel.

The vacuum chamber: Usually a fabricated structure incorporating fine meshes or felts made to fit to the drying table to form an airtight seal against it. It is connected to the vacuum system of the machine so a vacuum can be applied to the drying table. The mesh or felt layer normally exerts the full atmospheric pressure onto the leather as the vacuum is formed. Some systems allow modulation of this pressure.

The vapour condenser: This condenses the vapour and gases evaporated from the leather. Usually consists of a tubular vessel fitted internally with cold water circulation tubing. The vapour and gases are ducted through this vessel reducing their volume through condensation.

The vacuum pump: A proprietary pump is used, often of the water ring type, but oil ring or dry system pumps are also employed. In the water ring pump the gases contaminate the water which then is dumped. With the other two types of pump the gases are separated and are discharged.

High energy consumption is a factor in vacuum drying. This can be reduced by

incorporating cooling towers or by recovery of the heat transferred to the condenser cooling water. With the latter the thermal energy is used to contribute to the heating of the water circulated to the heated table. Minimising the volume of the vapour and gases extracted from the leather also allows the use of smaller vacuum pumps reducing the electrical load.

A system has been developed resulting in virtually total heat recovery within a drying temperature range of 30°C to 70°C. The extracted vapour is mechanically compressed and superheated before entering a condenser. The table heating water circulates through the condenser where it is re-heated by the compressed vapour giving up its thermal energy. A low capacity vacuum pump creates the vacuum evacuating non condensed gases and air.

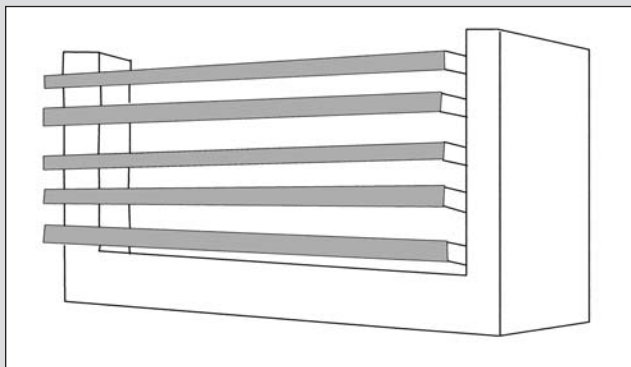
Modern vacuum dryers employ electronic instrumentation setting and monitoring many control points. This ensures high performance as well as maximum energy efficiency. 

Legend

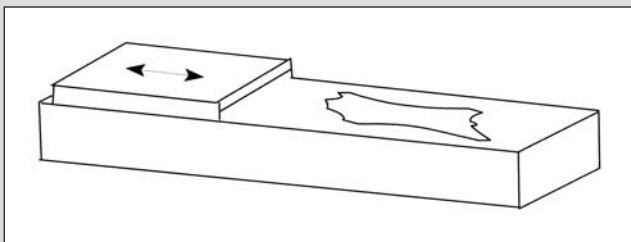
"The Machines in the Tannery" - Walter Landmann:
1) Vacuum dryers: Pages 210 to 218.

Main types of vacuum drying machines

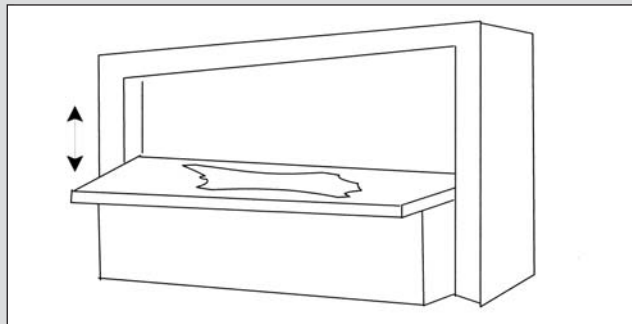
Panel E21/2: The multi-table machine horizontally stacking up to eight drying tables has become widespread. It is the most ergonomically efficient system for large production requirements.



Panel E21/4: Twin head systems shuttling across a single heating table are operator friendly.



Panel E21/3: Single or paired drying table machines are less sophisticated but can be efficient productivity and operator wise.



Panel E21/5: Three station rotary dryers have ergonomic advantages. A single large cylinder performs the function of heated tables. Three vacuum heads and the cylinder rotate about a horizontal axis one third of a turn at time presenting themselves to the operator in turn reducing fatigue.

