



Back to Basics: A Framework for Leather Manufacture

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Process vessels: Design and operation

The process vessel serves two major purposes:

- It enables chemical processing of hides and skins to take place in a controlled manner
- It applies mechanical forces to hides and skins

These two events occur simultaneously. The processing vessel is therefore a reactor in which a chemical process can take place, and a machine that can apply very precise forces during this reaction. The chemical control is managed by the major parameters of time, temperature and concentration: the mechanical forces by the construction, internal configuration and motion of the vessel. These forces are received by the pieces according to their prevailing physical properties. In turn this affects the rate and depth of chemical penetration, and deformation both in-situ and in terms of the processed piece.

These complex issues regarding the way that forces are received by hides and skins and their outcome are discussed in *Essays 6 and 7*.

There are many categories of process vessels, and there are considerable variations found within these different types. This affects the outcome in terms of movement and deformation and is largely dependent upon:

- The major design and construction of the vessel, being addressed in *Essay 16 Part 1*
- The internal configurations and effects at different process stages, being addressed in *Essay 16 Part 2*

The classic drum

The tannery drum came into being in the mid to late 1800s in conjunction with the introduction of the chrome tanning process. This is because the process required more severe mechanical action than was possible in the then long established pits and paddle systems.

The simple timber built rotating vessel with internal shelf arrangements remained unchanged until well into the 1900s and in time developed the applications for which it is now widely used as given:

- Washing and soaking
- Liming and de-liming
- Pickling and tanning
- Re-tanning, fatliquoring and dyeing
- Dry milling

To fulfil the many drum functions with their variations effectively, precisely and economically new devices and elements have been added on. The general basic drum construction remains a timber body consisting of slabbed ends with laggings (staves). It is electrically driven through gearing or Vee belts. Two speed driving is classic, but infinitely variable speed is becoming more common as this offers fine-tuning of the mechanical action^[Legend 1]. Revolution control devices ensure the precise positioning of the doors.

Classic type drum bodies are also manufactured in stainless steel and are occasionally in use for tanning and dyeing. More rarely, such drums are also made in thermoplastic materials. Mechanical action characteristics are not significantly different from those found with wooden drums. Heat losses through stainless steel bodies may need to be compensated for.

CONSTRUCTIONS

Improved construction methods result in larger drums coming into general use (up to 4.5m in length and 5m in diameter —approximately 40,000-litre volume). Shelves are nearly always fitted, as they are an integral part of the construction.

A pattern of internal pegs is now frequently fitted. These in the main are cylindrical in section but may also be oval or flat. The functions of pegs are:

- To produce relative differential speed of movement between float and the goods. This promotes faster osmotic exchange

- To induce continuous flexing of the goods
- To tease the goods to individualise the pieces
- To promote chemicals uptake through a peristaltic pumping action within the skin or leather created by stretch/compression and relaxation

Robust drum construction externally reinforced with steel hoops and tie bars also allows loading above axle height when valves are fitted at axle openings. Automatic venting avoids the build up of dangerous pressure within the drum. Where less mechanical action is required, such as in soaking and liming, 90% utilisation of total drum volume can be adopted. Systems to introduce CO₂ are also used.

THE RECIRCULATION SYSTEM

This function has been an add-on to drum systems for some time. Originally this was achieved by pumping the liquors through the drum by means of an external pump and ducting. The accepted method now uses hollow shelves or scoops to lift the liquor inside the drum, then ducting through the hollow axle. This is frequently connected to an external tank connected to a second duct in the hollow axle, sending the liquor back into the drum.

Perforated ducts or shelves then distribute the return flow across the length of the drum thereby achieving uniform mixing. Dry or liquid chemicals may also be introduced via the tank. The liquid in circulation may be heated in the tank, and its pH may be monitored and corrected. An in-line filter may be fitted into the system.

Benefits can be summarised as:

- Uniform reaction of skins in process to chemicals introduced
- Rapid dispersion and faster uptake of chemicals
- Monitoring and adjustment of float temperature
- Rapid detection and correction of pH



Panel E16/1: The classic drum



Shelves in a drum (perforated for recirculation) combined with pegs.

- values without stopping the drum and opening the door to take a sample
- If a filter is part of the system hair can be separated/recovered in a hair saving liming process
 - The extraction of any unwanted particles in all processes using the filter

ANCILLARY EQUIPMENT

Reliability, repeatability, precision, and a database of formulations and documented recording of processes has become the norm following the introduction of semi-automatic and automatic process control equipment.

Volume, temperature and timing of water introduction can be by separate programme and control modules. These may also be part of a wider process control system, which also dispenses liquid or dry chemicals in measured quantities, changes floats, and sets time intervals according to a formulation programme

Mechanical handling equipment to load and receive discharged goods is widely used. Large, mechanically driven doors facilitate discharging of the goods. Ducting and valving of float emptying is controlled and is used to segregate for recycling or discharge direct to the effluent treatment plant.

The multi-compartment vessel

Two or three section vessels are frequently adopted for re-tanning and dyeing as well as for tanning. Usually built of stainless steel these take two main forms:

- Solid wall cylindrical compartmental drums with perforated divisions.

Panel E16/2: The multi-compartment vessel



Compartmental design combining shelf profiling and pegs.

These divisions are sometimes curved or double curved to help with the movement of the goods, although pegs may be fitted for the same purpose

- Compartmental vessels with a rotating inner perforated wall body within an outer fixed hull acting as a float tank. In turn the compartments of the rotating body dip into the float thus promoting vigorous agitation and mixing. Variants exist in-so-far as the hull may be cylindrical or polygonal in shape, it may be formed just around the inner body or it can have an integral lower tank thereby holding more float

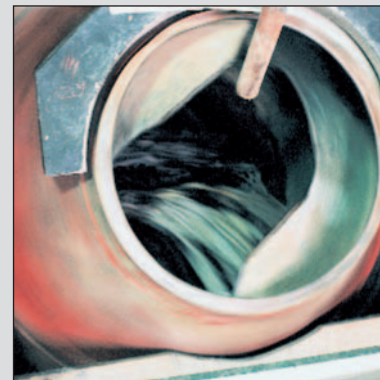
To help avoid tangling of the goods, the multi-compartment drum is provided with a timed reversing drive. Each compartment has its own access door. The feeding and emptying of liquids is straightforward as no moving parts are involved.

The mixer (or "processor")

Originally an adaptation of the concrete mixer, the processor retains the basic shape of such vessels. Its axis normally lies at approximately 15°, but variations of the system revolve on a horizontal axis.

A variable speed drive is used to rotate the vessel. Perforated spiral shelves provide the mechanical action when the vessel rotates clockwise, and discharges the goods through the open mouth when rotating anticlockwise. The internal float is continually in turbulence by virtue of its flow through the perforations. Float is circulated or re-circulated and all the automation systems can be applied.

Panel E16/3: The mixer (or "processor")



Floats are returned to the mouth of the vessel by feed pipe. Helically arranged fins are used for movement of hides.

The construction is generally polyester lined plain steel or stainless steel, but also comes in glass reinforced polyester bodies.

The paddle

Paddles are used in many tanneries for washing, soaking and liming because their mechanical action is gentle. They are flexible in terms of capacity, in the sense that their simple timber construction can be easily built in a great variety of sizes. However, the correct relationship between rotor position and vessel body must be maintained^[Legend 2]. Paddles are readily adaptable to mechanical goods handling systems. The large discharge doors on modern paddles are mechanically actuated.

The dry drum

Timber built dry milling drums are still used in many tanneries, however, the increasing tendency has been to install stainless steel or plastic bodied units. Internally, shallow shelves are fitted to provide gentle lift and drop. Timed reversing drives avoid tangling or rolling up of the goods. Air circulation with controlled temperature and humidity, generally with in line dust filtration is the specific feature of the modern milling drum. Controlled injection of small amounts of liquid chemicals to aid the leather softening process is frequently adopted.

Additional Information:

"The Machines in the Tannery" - Walter Landmann:

- 1) Mechanical action, drum speed and drum inside diameter relationship: See page 69.
- 2) Formula for the correct relationship between rotor position and vessel body: See page 72.