



Back to Basics: A Framework for Leather Manufacture

Richard Daniels and Walter Landmann

Reciprocating multi-roller machines: The fleshing machine in operation

The most generally employed fleshing machine is of the classic reciprocating multi-roller type. Throughfeed fleshers, increasingly put into service, essentially duplicate the roller configuration enabling whole skin fleshing in a single pass. Raw skin fleshing is carried out in abattoirs or in the tannery, and lime fleshing prior to tanning.

KEY OBJECTIVES:

Primary objective:

To remove flesh, fat and subcutaneous tissue adhering to the derma after flaying to obtain a clean flesh side, and to open veins embedded in the structure of the corium. This is achieved by the cutting action of the knife. No substance reduction of the corium itself, nor damage to it, is allowed to occur in this operation.

Secondary objective:

To take the first step in the multi-stage process of spreading, setting and equalising the substance of the skin to eventually optimise the area-weight ratio of the finished leather. This is achieved by the rubbing action of the knife, normally pushing the skin at an approximately 40° angle to the direction of skin travel, that is, opposite to the direction of rotation of the cylinder.

The skin at this stage responds well to this action as it is highly malleable. To a significant extent this is due to its high free water content as moisture and temperature of the skin significantly affect results (See Essay 10).

Benefits arising from the fleshing process in the subsequent tanning operations are the increased penetrability of chemical products, and a more stable grain as the products also penetrate from the flesh side. There is more effective use of chemical products as there is no waste material which otherwise would absorb such chemicals.

Fleshing machines for bovine skins, pig and small animal skins have varying constructions. Nevertheless, the action in relation to the material

can be explained based upon the characteristics of the normal bovine flesher.

The mechanism of fleshing

The normal configuration (*Panel E12/1*) of the flesher uses a “soft” rubber coated feed roller (*a*), twin transport cross grooved rollers (*b*), and an adjustable profile pad pressure bar or pressure roller (*c*). These are mounted on the opening and closing machine frame, whereas the left and right spiral bladed cylinder (*d*) is

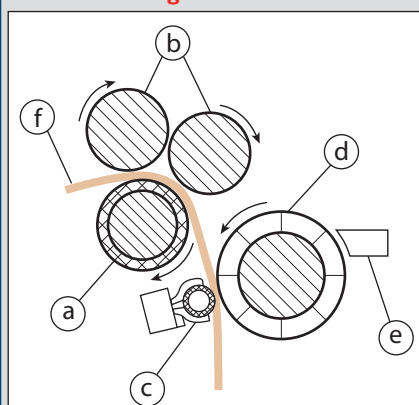
mounted in the static main frame. All these elements are controllable for speed and for pressure on the skin.

The classic fleshing operation takes place in outfeed. The operator with the machine open normally introduces the butt half, closes the machine and allows the transport rollers to feed out against the rotation of the blade roller. The skin is then reversed to be inserted neck half first and will again be fed out. Feeding out is under traction, that is, the skin is pulled out against the force exerted by the spiral cylinder.

The spiral blade is the cutting and setting tool, both functions determined by the cutting edge of the blade together with the spiral geometry. This in principle, is common in both fleshing and shaving.

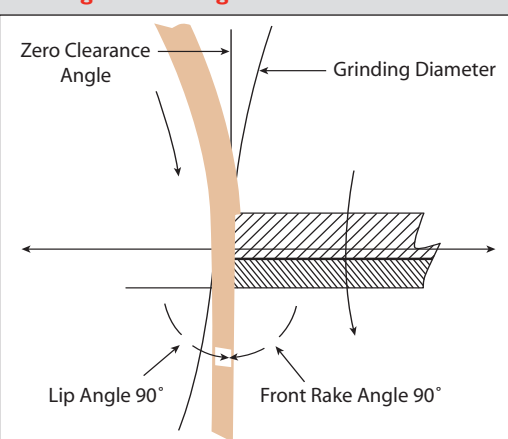
The fleshing machine spiral bladed cylinder was developed more than 100 years ago. Its application in the fleshing machine, can be compared with a milling cutter. However, bearing in mind the nature of the material processed and the operational mode of the machine, it has limitations. The cutting action is a scraping one rather than neat slicing because of the 90° rake angle (See *Panel E12/2*).

Panel E12/1: Fleshing in a multi-roller fleshing machine



a. Feed Roller, b. Transport Rollers, c. Pad Bar, d. Spiral Knife Cylinder, e. Knife Grinding Stone, f. Skin

Panel E12/2: Cutting geometry in fleshing and shaving



The spiral cylinder and the knives

A feed out speed of 25,000mm/min (25m/min) can be assumed with a spiral cylinder speed of 1,400 rpm. Fitted with 10 blades left and right, this results in 14,000 knife edges passing a given point in one minute at an average peripheral speed of 800m/min. Hence dividing the speed at which the skin travels by the number of knife passes shows that theoretically, every 1.8mm of skin undergoes cutting and pushing action. This may seem inadequate until the contact area between skin and knife is taken into account. This is not tangential, but at a small arc as the skin is elastic and is pressed against the knife. The cutting action is at the sharp edge of the knife, but pushing and spreading takes place throughout the thickness of the knife, normally 2.7mm.

Inherent drawbacks are the knife

**Panel E12/4****Interactions and effects: The fleshing operation**

Differences in outcome due to the influence of temperature and moisture content of the piece are presented in *Essay 10*, where the role of elastic and plastic behaviour in machine operations is discussed. The shifts in properties described should be taken into account within the following table.

PRE-LIME FLESHING - FROM GREEN**HIDES:**

- Combined fleshing and de-manuring. Some machines carry this out in one operation. Others can selectively do one or the other. The additional mechanics involved are a small driven knife cylinder and a free running smooth rubber covered pressure roller assembly located below the normal fleshing arrangement.
- Lowered bolster (pad or roller) pressure avoids skin damage, such as holes due to manure lumps, which may still adhere to the hide.
- Cold wash prior to fleshing sets fat, flesh and subcutaneous tissue. This firming makes flesh removal cleaner and easier.
- Higher knife cylinder speeds result in more even cutting action.
- Suitably determined bolster pressure allows hair on fleshing.
- Knife cylinder with greater cutting helix angle (55° - 65°) leaves less subcutaneous tissue in place—applies particularly in flank (axilla) areas.

PRE-LIME FLESHING - SOAKED RAW HIDE FLESHING IN THE TANNERY:

- Soaked skins are softer and easier to handle than limed material.
- Subcutaneous tissue is not completely removed.
- Liming chemicals are diffused from the flesh side—feel, grain elasticity and flank conditions benefit.
- Liming process requires change compared to non-fleshed systems to take the different piece form and rate of penetration into account.

LIME FLESHING:

- More rigid bolsters are used with un-haired skins, as there is less substance variation.
- Increased bolster (pad or roller) pressure results in more even spreading of the corium structure.
- Optimum pressure—visual inspection of correctly fleshed skins shows a pattern of some opened veins.
- Profiling the bolster—straight for light skins, concave for light cow, convex for heavy cow and double convex for heavy ox fleshing.
- Excessively worn down knives lower

fleshing quality—the flesh side becomes lumpy. Knife wear compensation is either by operator, or automatic on some machines.

- Programming substance settings—can be operator actuated or automatic to maintain even substance allowing for neck and butt variations.
- Continuous water spray into machine roller mechanism—helps gliding of the skin, i.e. fleshing is smoother. Heated water raises skin temperature—better spreading, cleaner grain and flatter skin results.

TRANSPORT SYSTEM EFFECTS:

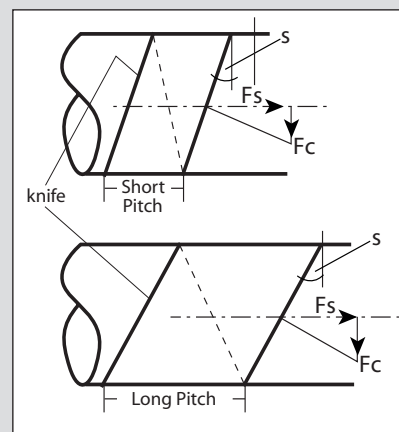
- Diamond pattern grooved transport rollers control fleshing speed. Fleshing is more even, and sliding of skins sideways is minimised avoiding pleating and cutting. Smooth rubber covered feed roller surface permits limited desirable sliding.
- Shallow grooving removes danger of “embossing” grain or formation of micro-cracks.
- Crowned transport and support rollers promote linear movement of skin through machine—minimises pleating.
- Groove pattern and conicity of support roller enhance spreading effect.

MACHINE CONSTRUCTION FACTORS:

- Single transport roller, combined support/pressure roller and no bolster is suitable for the fleshing of small animal skins.
- Combined support/pressure roller rubber cover hardness is higher for light substance small skins, and lower for spongy skins and heavy bovine skins.
- Twin transport rollers and support roller with bolster, pad or roller, is suitable for most bovine skins, perhaps except light calf.

FUNDAMENTAL LIMITATIONS:

- Working width never less than largest skin width.
- Engagement distance (between transport roller nip and knife cylinder nip) never less than half of the maximum skin length.

Panel E12/3: Showing effect of varying pitch of knife

s = Helix angle
 F_s = Lateral (setting) force
 F_c = Longitudinal (cutting) force

angle and the configuration imposed by the design of the machine. The knife (*blade*) is normally fitted into the cylinder at a right angle to the tangent, signifying that grinding of the cutting face can only occur at a right angle to the knife stem (*Panel E12/2*).

This angle is known as the front rake angle, and is normally 90° . However, for more effective cutting this would need to be more acute. Also, the whole face of the knife rubs against the material, again not the most efficient cutting configuration because the clearance angle is zero. (*Clearance angle in a cutting tool, as for example in metal or woodcutting, allows the chip to escape. Zero angle causes friction and heat, and absorbs power.*)

The pushing effect, however, is enhanced thus improving the setting action. This important action arises from the spiral geometry of the blade. Normally the pitch of the spiral is set to form a 40° angle of the blade with reference to an imaginary line running at 90° to the centre line of the cylinder, called the helix angle. (*Panel E12/3*).

As shown, at this angle the longitudinal force necessary for the cutting and the lateral one responsible for the setting, are about equal. Reducing the angle, as seen in some spiral cylinders, results in greater lateral force, hence greater setting action. The left and right geometry of the blade mounting is to ensure that setting and spreading occurs equally towards the right and left sides of the skin.

Additional Information:

*“The Machines in the Tannery – Walter Landmann
 Fleshing Machines, pages 85 - 97*