DRY MILLING AS A MULTI STEP PROCESS

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Abstract:
Dry milling is normally considered as a mere mechanical operation but really offers a wide range of possible application if we fully understand it's logic. In this paper Dry Milling is considered as a Multi Step Process were, having total control of it's variables, it is possible to prepare genuine process formulations to achieve different fastness properties and effects.

What do we seek by dry milling:
Dry milling is one of the most traditional ways of softening Leather. After milling (or tumbling) we expect to achieve softness, uniform break, and also dust elimination. As in any other process in Leather Industry dry milling may be upgraded as much as we can control it's variables. These variables are:

- Room relative humidity
- Leather humidity
- Temperature
- Dry milling speed
- Running time
- Dry milling drum's load

As we will see each of these variables plays an important role during processing normally interacting between them.

Room relative humidity:
Relative humidity in working place, will influence dry milling dramatically. Too dry environment will propitiate with Leather friction during milling static electricity, which will not allow dust to be released. This effect is evident with the crocking test, where usually dust is the main cause of low fastness. Of course environment humidity will also influence Leather humidity.

Leather humidity:
Leather humidity will influence not only dust elimination, but also softness and grain aspect. As we know Leather fibres are very sensible to humidity. Also regulating humidity we may control chemicals absorption as we'll see later.

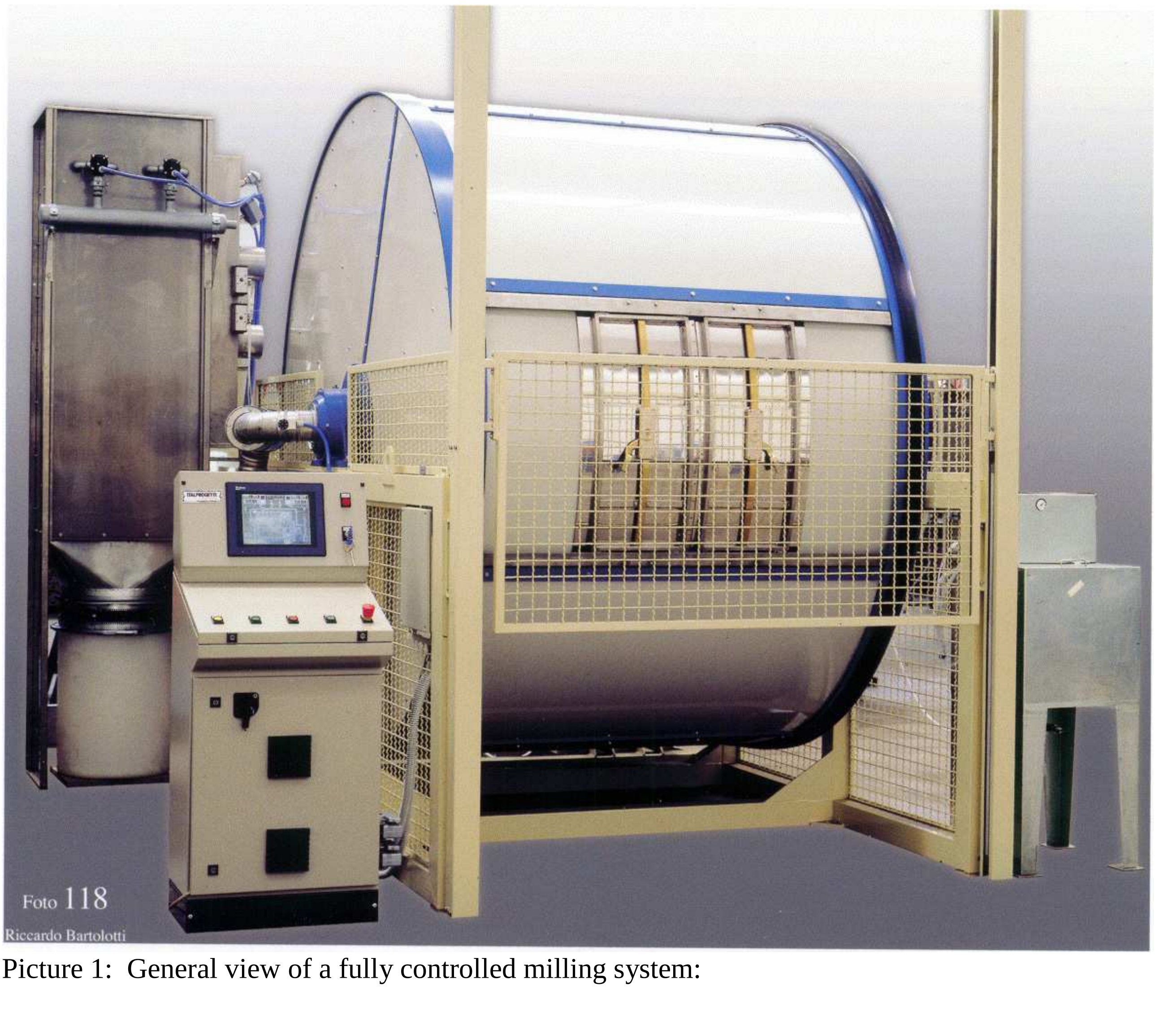
Temperature:
Temperature will help on melting or making not fixed fats more fluid, inducing penetration and thus deepest softness. In the system we propose, a rise in temperature also aids humidity reduction, and in certain articles will be used for drying Leather itself. In certain cases we can increase temperature for melting waxes and heavy fats for dry milling stuffing.

Dry milling speed:
Speed will influence directly mechanical action and thus grain effects. Low speed will promote friction between Leather, optimal speed will make Leather to fell from the highest part of the vessel, while higher speed will generate a lower mechanical action due to centrifugal effect.

Running time:
Obviously running time will regulate the strength of dry milling. In certain articles were we need high dedusting but no milling effect we must keep running time low while for uniform break higher.

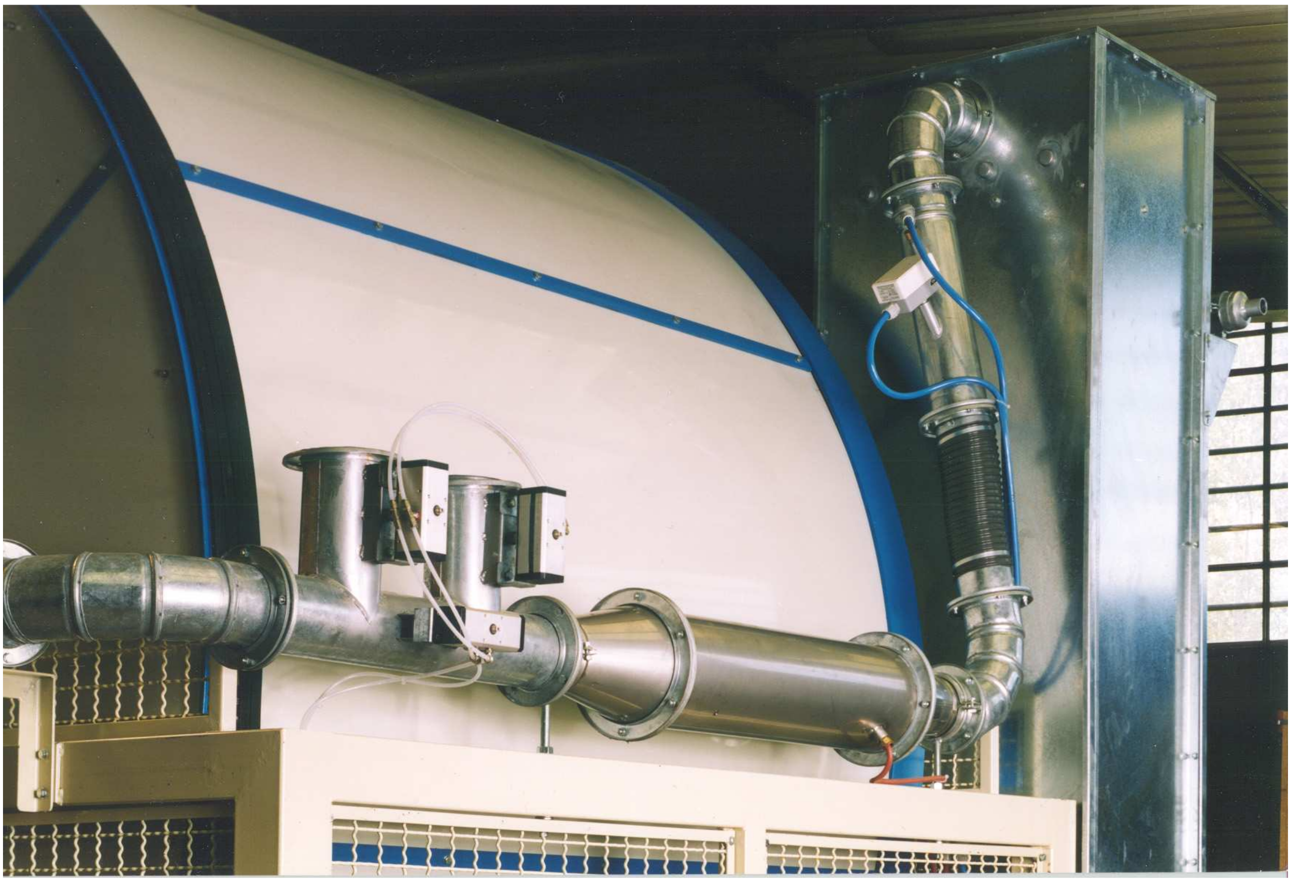
Dry milling drum's load:
As in a wet process drum optimal load is related to size and speed. To high a load, mechanical action will be reduced, too low a load no friction en hit effect on Leather.

Fully controlled dry milling:
Knowing the causes and effects of each of the described parameters, we have prepared a computerised controlled milling system were all the previous detailed parameters are under control: in the following images we can observe all the automated devices added to a dry milling drum:

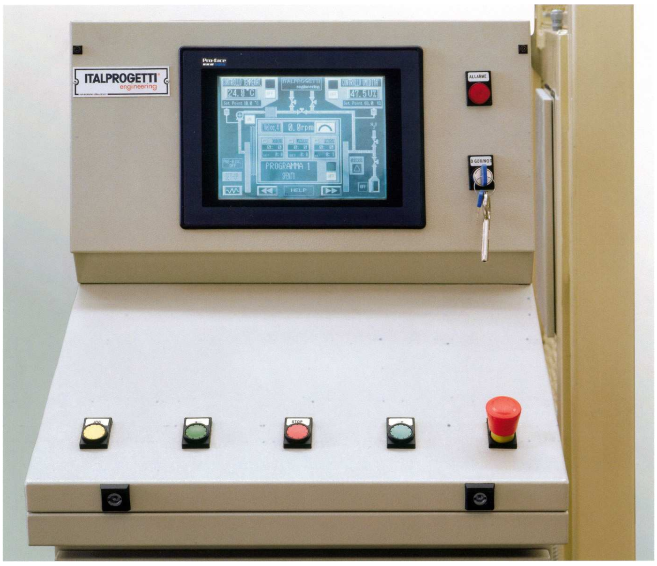


Picture 1: General view of a fully controlled milling system:

In Picture 1 we can observe a general view of fully controlled computerised dry milling system. We can observe the dust filtration column left and back, process touch screen control panel (left front), the vessel itself, and the chemicals addition device (right).



Picture 2: Heating systems with servo controlled valves.



Picture 3 and 4: Detail of the chemicals addition system and computerised control panel.

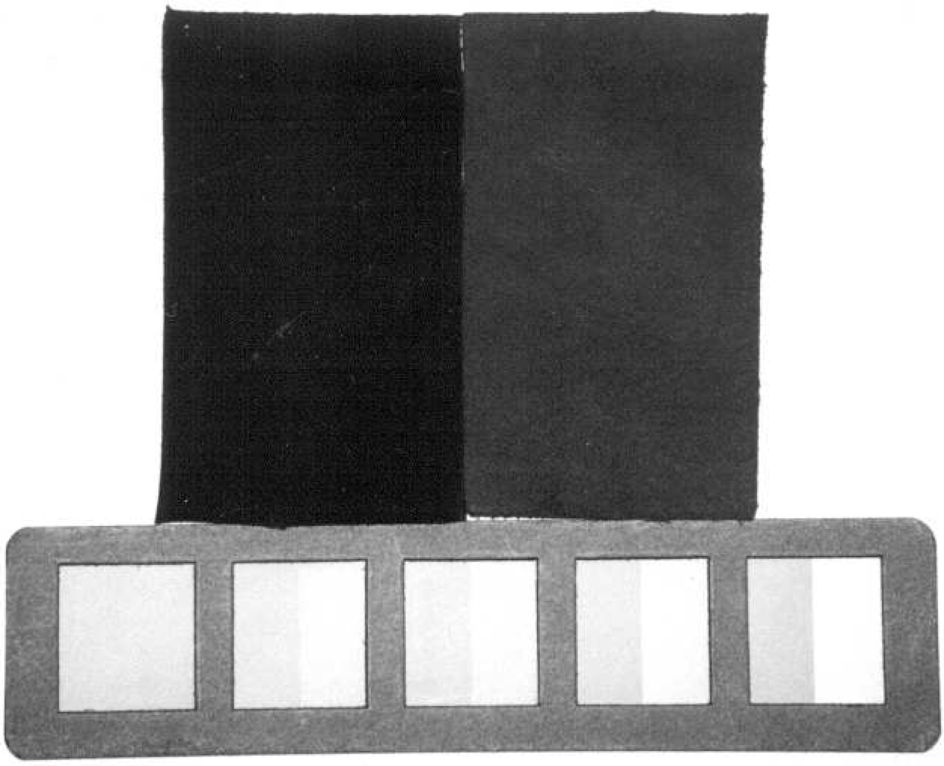
Chemicals addition:
Many improvements were achieved by means of specific auxiliaries added during dry milling. Properties such as Colour fastness, dust elimination, softness, touch effect, light fastness and Colour yield are some examples.

Colour fastness improvement:
Low Colour fastness values are normally caused not only by a not properly fixed of low quality dyestuff, but in most cases because of buffing dust in nubuck and splits. We can evaluate this effect by testing a sample a the crock meter before and after applying a compressed air jet on our sample. By applying an anti static chemical at the beginning of the process, is possible to release dust in a very short time and without increasing humidity too much. Applying a humidity reduction at a temperature of 30 / 33 °C dust elimination is near total. Once dust is released we are ready to add a fixing auxiliary to the milling. It is most important to apply this auxiliary chemical after accurate dedusting to avoid sticking dust to Leather, with consequent low wet and dry rub fastness values.

Colour yield improvement:
We find a typical everyday difficulty in one time process Black buffed article’s colour yield's reduction. This effect (or defect) oblige us to perform long processes, crusting, buffing, wetting back and dyeing again to achieve reasonable black intensity. In most cases apart of wet process characteristics one of the most common causes of this colour yield reduction is an optical effect, which may be upgraded by a temporary humidity increment. Adding certain specific cationic fatliquors is possible to increase Colour depth. To evaluate Colour yield increment we made measurements before and after milling process with a Colour Eye XTH Spectrophotometer.
Colour measurements showed a dramatic reduction of the L* axis showing a ΔL* around 10, only with humidity conditions adjustment and over 15 with a cationic fatliquor addition.
In the following images we can see Spectrophotometer during trial measurement, and Colour difference obtained by addition of a cationic fatliquor.

Picture 5: Samples measurement with Colour Eye ETH Spectrophotometer.

In picture 6 we can see a yield intensity which may be graded as 2-3 at the grey scale.

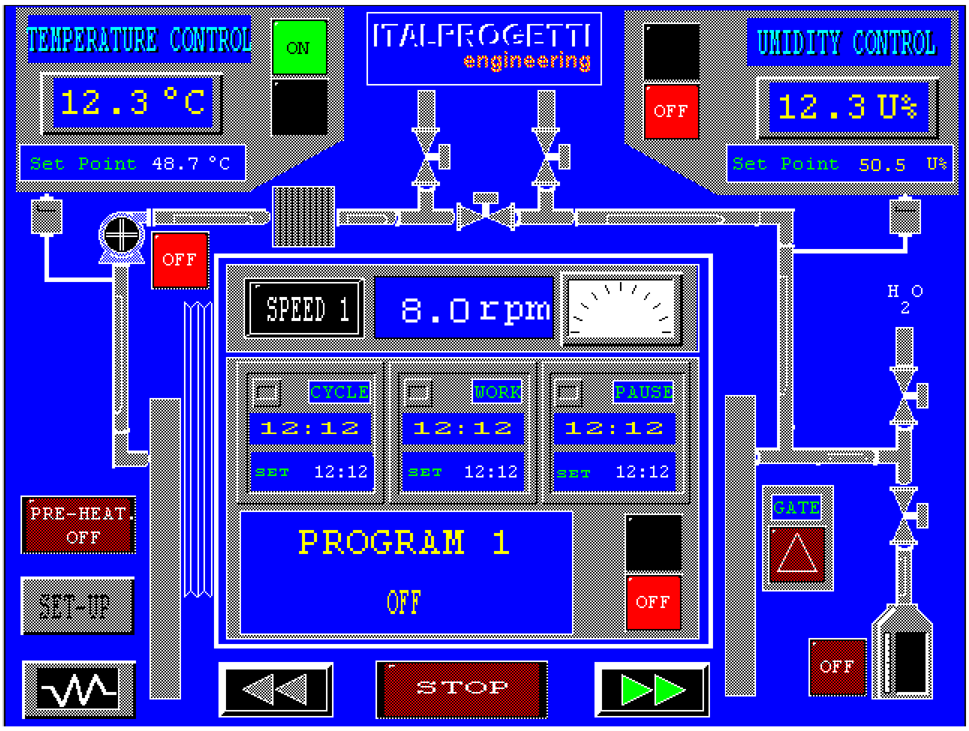


Picture 6: Colour differences in black splits samples before and after process.

Softness:

Depending on the desired effect Leather conditions should be adapted in order to regulate chemicals absorption. In normal conditions to propitiate deep softness it is advisable to achieve low humidity and to apply low molecular weight fatliquors. The contrary in case of a surface touch effect, were higher humidity and molecular weight fats or auxiliaries are needed.

In picture 7 we can observe the control panel of the milling drum were in an easy graphical way we can adjust the working conditions on line.



Picture 7: Dry milling drum’s control panel.

Multi Step Dry Milling process:
With all the previous data, we are able to generate a Multi Step Dry Milling process recipe. As we see in this recipe we may define different parameters and chemicals additions as we would do in a typical wet processing one.
The next example is a Multi Step Dry Milling process recipe for Goat Skins Gloving Leathers.

DRY MILLING PROCESS

Date	Process N°	Page N°
04/01/2001	**DM0004-01**	**1**

Customer: **Internal trial**	Area:	
Article: **Gloving Leather on Goat Skins**		

Step	Description	Temp.	Rel. H.	Run time		Chemical addition			Control / obs.
		°C / °F	%	min	R.P.M.	g/ft^2	Product	weight	
1	Preheat	33		20					
2	Dedusting								
	Antistatic chemical add.	33	40	20	20	0,2	**CHEMICAL 1**		1:3 dilution
3	Milling	33	60	30	20				
4	Conditioning	33	40	40	20				
5	Dye fixation chemical	33	40	30	20	0,3	**CHEMICAL 2**		1:3 dilution
6	Conditioning	33	30	40	20				
7	Softener chemical 1	33	30	40	20	0,3	**CHEMICAL 3**		1:3 dilution
8	Conditioning	33	60	30	20				
9	Softener chemical 2	33	60	180	20	0,2	**CHEMICAL 4**		1:3 dilution
10	Conditioning	33	20	40	10				
11	Final conditioning	20	/	30	5				

The logic of the process is as follows:
Step1- Pre heat. Optimal dry milling effect is achieved at least at 30°C. With a pre heat operation skins arrive to regime temperature without mechanical action effect.
Step 2 – Dedusting with Antistatic chemical addition. The best dust elimination results were achieved by adding an Antistatic chemical at low humidity levels.
Step 3 – Humidity increment and milling: Humidity increment at the early steps of the process provides finer grain, colour yield increment and aids dust elimination.
Step 4 – Conditioning: A humidity reduction at this step means the end of dedusting operation and in this case is adjusted to the optimal conditions for the dye fixation auxiliary chemical.
Step 5 – Dye fixation chemical addition: Applied once we are certain that no dust remained.
Step 6 – Conditioning: In this case we are adjusting conditions to apply a deep softness chemical.
Step 7 - Deep softness chemical addition:
Step 8 – Conditioning: Humidity conditions are adjusted to achieve the optimal conditions for the surface softener application.

Step 9 – Surface softener application.
Step 10 – Conditioning: Humidity reduction to end conditions.
Step 11 – Room temperature adjustment.

Conclusion:
By means of a Multi Step Dry Milling process is possible to achieve higher quality standards by controlling each parameter. The possibility of conditioning humidity and temperature with aid of auxiliaries allows a substantial comparative process time reduction.

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