

WOOLSHED Project – Report M1

Field	Details
Work Package	WP3 MAKE
Project	Development of a midi washing plant for animal fibres
Authors and contributors	Alberto Pezzin (TCP) and Zoe Romano (CC)
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Subject

This report presents the analysis of the selected Hollander-type paddle machine, together with the modifications made and those proposed following the washing tests carried out.

Description

The development of the mini washing plant starts from a study of how industrial wool scouring plants work; these are currently considered the state of the art in washing and achieve excellent cleaning quality. To this end, a Hollander-type paddle machine, already used for garment dyeing, was chosen for this plant; this machine is commercially available in sizes ranging from 5 kg to 60 kg of processed fibre.



Figure 1 - Hollander-type paddle machine for garment dyeing

This machine basically consists of an oval tank into which the water is loaded and the material to be dyed is introduced; depending on its size, it is fitted with a single- or double-paddle handling system that keeps the loaded material in motion. Looking at a traditional scouring plant, several similarities can be seen, since there too the material is placed unpressed in the washing bowls and is moved by rake systems that advance it along the bowls.

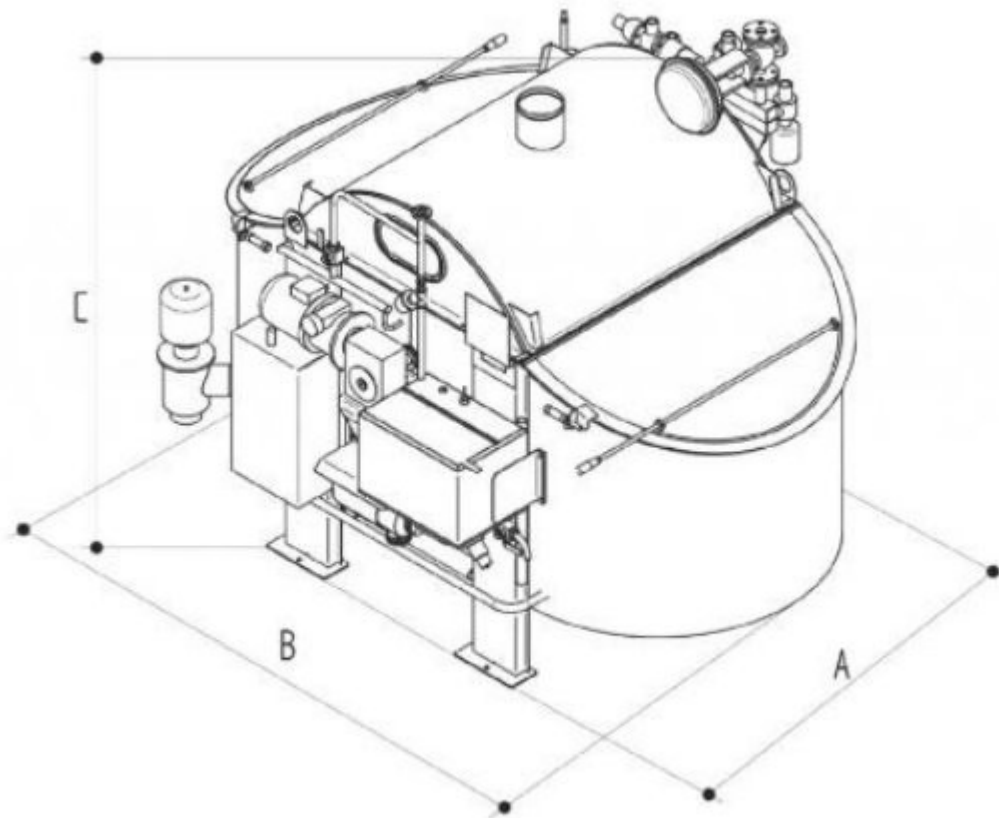


Figure 2 - Dimensions

Capacity (litres)	130	250	600	1000	1600
Nominal load in dyeing (kg)	4	7	20	40	60
Estimated load in washing (kg)	6-8	12-16	30-40	50-65	80-100
Machine width A (mm)	1000	1000	1300	1650	1950
Machine depth B (mm)	1300	1600	2000	2400	3400
Machine height C (mm)	1200	1200	1300	1550	1750

Figure 3 - Dimensional and production data

The main feature of this machine is its material-handling system: in the smaller models it consists of a single rotating paddle located on one of the straight sides of the machine, while in the larger models it consists of two rotating paddles located on both straight sides.

This handling system is currently the closest to the one found in an industrial scouring plant, since it pushes the material slightly below the surface of the liquid while at the same time advancing it.



Figure 4 - Detail of the handling paddle

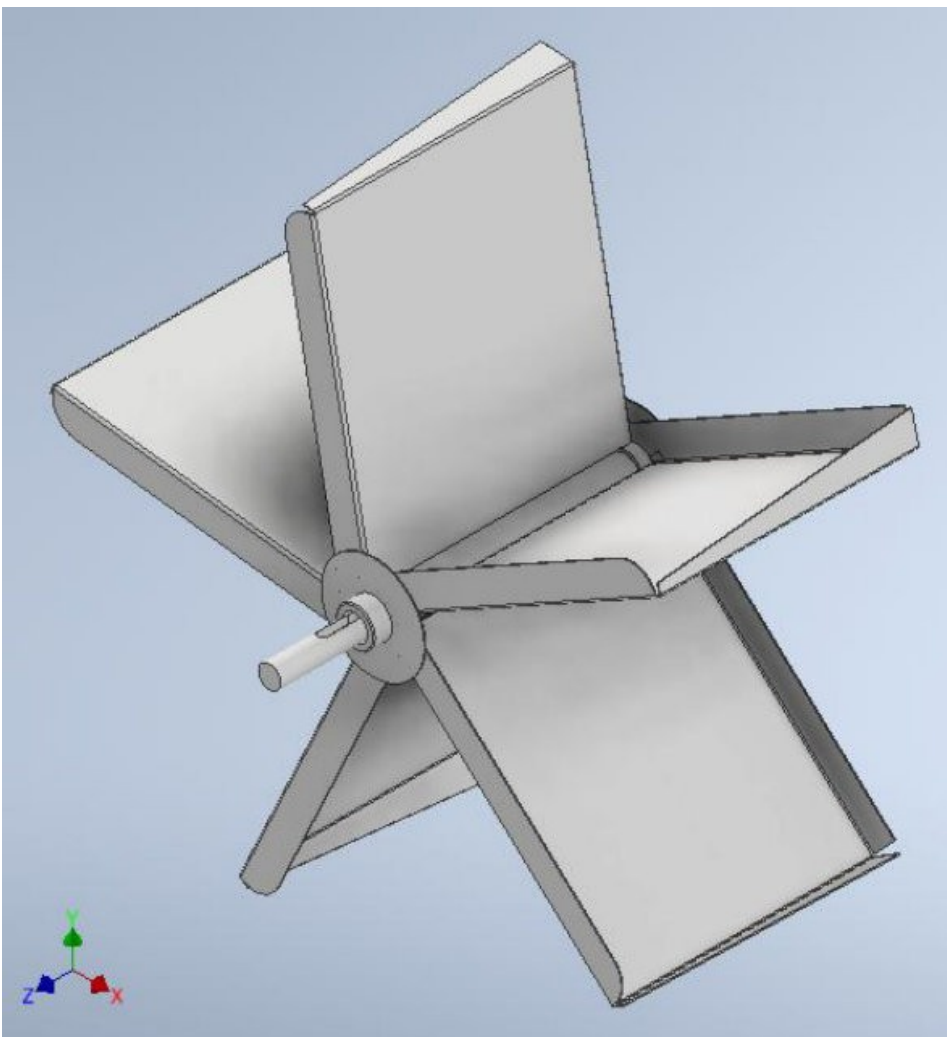


Figure 5 - Drawing of the current paddle

A paddle with cylindrical or triangular teeth was also considered but, unlike traditional scouring plants where the system moves by translation, here the rotation causes part of the material to get caught on the teeth and gradually build up, eventually clogging the handling system itself. The tests carried out showed that the material is moved correctly provided that the material load is not excessive relative to the volume of liquid. The machine used for the tests has a nominal volume of 1000 litres, with a minimum volume of 650 litres required to keep the paddles immersed. The maximum-load test was carried out with about 25 kg of material and showed good material movement, provided that a fairly brisk paddle rotation speed was maintained. This leads to slight felting of the material, which suggests the need to fit a second paddle to assist movement on the side where no paddle is present.

The machine has the following features:

- Maximum volume 1000 litres
- Minimum volume 650 litres
- No. 1 five-sector paddle
- Steam heating system with coil
- Water cooling system
- Paddle drive motor with mechanical speed reducer, allowing the speed to be adjusted down to a few rpm
- Cycle management system via electronic controller (covered in report M3)
- Pneumatic control and drain valves

Description of main parts

The main identifying parts of the machine are shown below.

The first two images (fig. 6 and 7) show the safety locks that prevent the doors from being opened while the handling paddles are moving.



Figure 6 - Detail of safety lock on right-hand door

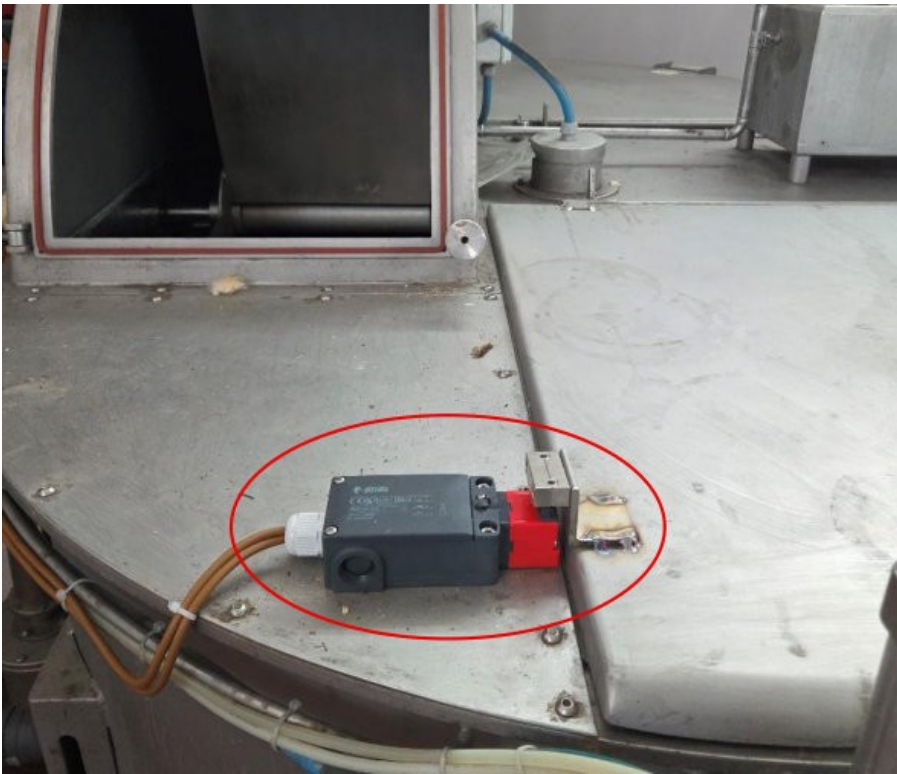


Figure 7 - Detail of safety lock on left-hand door



Figure 8 - Detail of paddle motor and drain valve

Fig. 8 shows the motor with gear reducer that drives the paddles, and the water drain valve used at the end of the cycle.

Fig. 9 shows the PT100 temperature probe, positioned right next to the water drain valve.



Figure 9 - Detail of temperature probe

Figure 10 shows the details of the connections:

- A. Water meter
- B. Water inlet valve
- C. Steam inlet valve
- D. Cooling water inlet valve
- E. Three-way valve for heating/cooling
- F. Steam trap

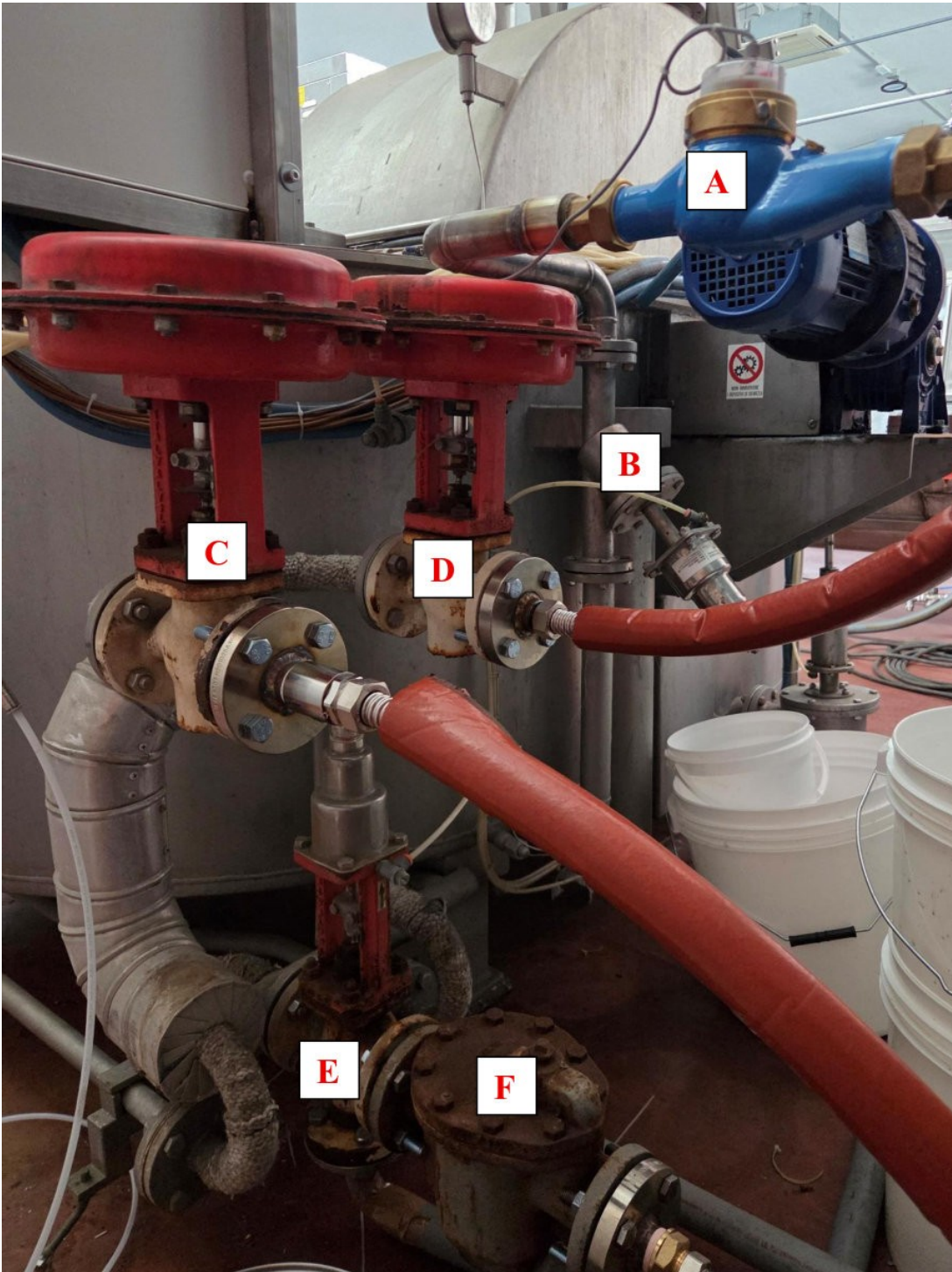


Figure 10 – Valves and water meter

Modifications made

The following modifications were made to the original configuration of the Hollander-type paddle machine:

- Added PT100 temperature probe (Figure 11)
- Added water meter for metering the fill water (Figure 10-A, 12 and 13)
- Added safety locks on the opening doors (Figure 6, 7, 14 and 15)

The following describes how to carry out these modifications.

The PT100 temperature probe ([TITEC](#) model) with ½” threaded connection was installed by screwing it into an existing threaded port on the machine, just behind the drain valve. Its exact position is not critical, as long as it is in the lower part of the machine so that the temperature can be measured even with low liquid volumes. The signal cable was then routed to the electrical panel, cable-tied along the machine frame.



Figure 11 - PT100 probe

The water meter was then added to the water inlet pipe by cutting the original pipe and welding on a 1¼” threaded fitting, so that the meter, which has threaded connections, could be screwed on. The meter is the Idro-Olona dry-dial model with [pulse emitter made by Gioanola](#) , which sends pulses to the programmer in order to control the water inflow. Any water meter fitted with a pulse emitter can of course be used.



Figure 12 - Water meter

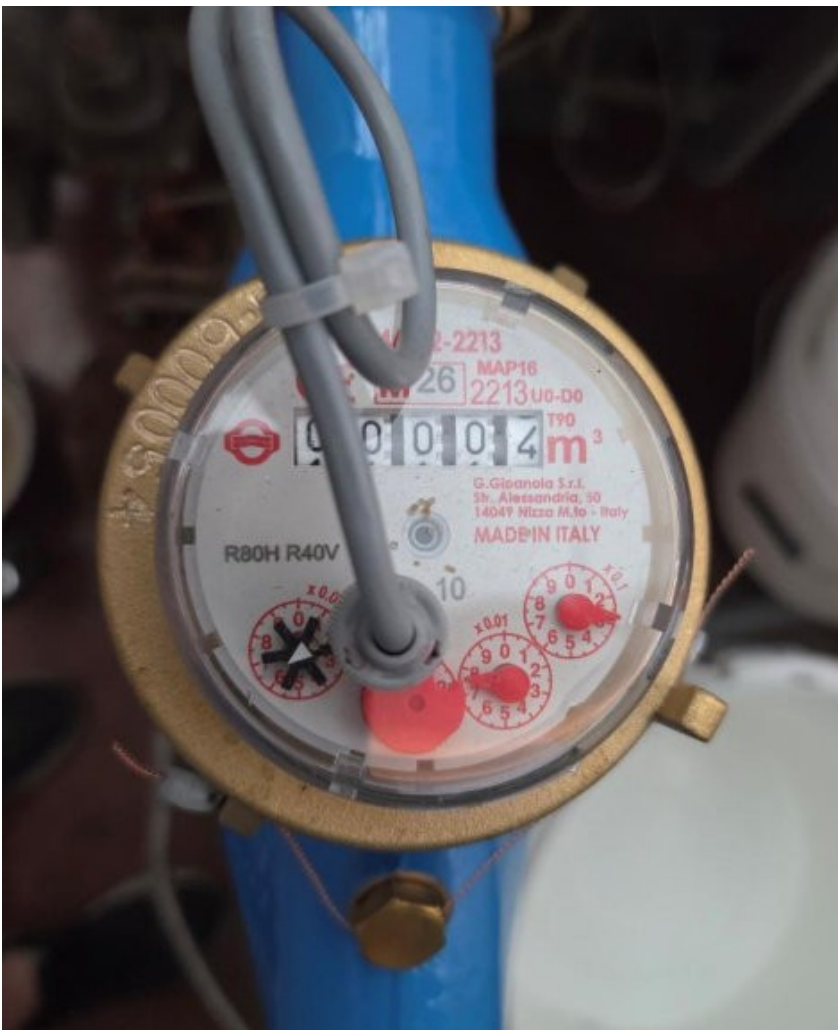


Figure 13 - Detail of the dial with pulse emitter

The last modification involved installing two safety locks on the machine's access doors, as it had none. For the installation, an L-shaped bracket was made to hold the actuator key, while the base of the safety switch was screwed directly onto the machine.

The safety switches are model [FS 2896D024-F8](#) made by Pizzato; here too, the electrical cables were routed to the electrical panel and cable-tied to the machine frame.

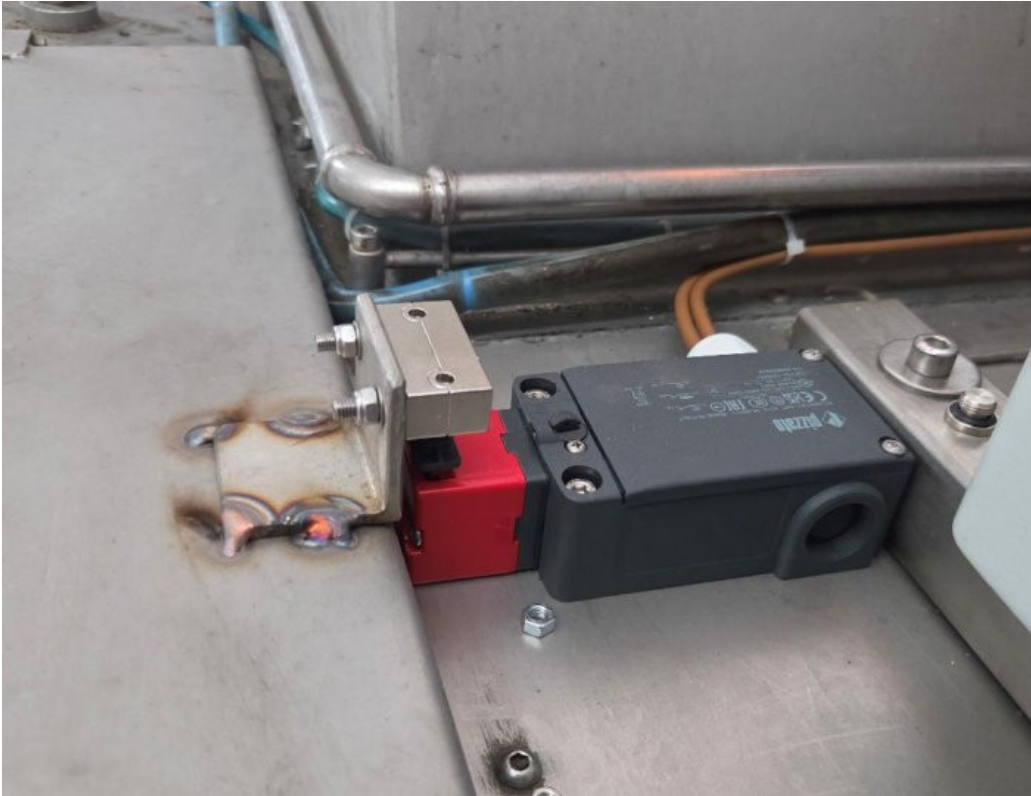


Figure 14 - Detail of safety lock on right-hand door



Figure 15 - Detail of safety lock on left-hand door

Operating instructions

The machine is operated as follows:

1. Connect the machine's electrical and pneumatic supplies
2. Check that the drains are closed
3. Enter the desired water volume on the controller and start the water fill
4. Once the desired volume is reached, start the paddles
5. Set the desired temperature and start heating
6. Once the washing temperature is reached, dose the soap (about 1 l per 350 l of water) and sodium carbonate to bring the pH to about 8
7. Load the material to be washed and keep it in the wash for about 10 minutes
8. Remove the washed material, spin-dry it and set it aside for the rinsing stage
9. If there are several batches to wash, repeat steps 7 and 8
10. At the end of the washing stage, drain the liquid
11. Close the drain
12. Enter the desired water volume on the controller and start the water fill
13. Once the desired volume is reached, start the paddles
14. Set the desired temperature and start heating
15. Once the rinsing temperature is reached, load the material and keep it in the rinse for about 10 minutes
16. Remove the washed material, spin-dry it and send it to the drying stage
17. If there are several batches to rinse, repeat steps 15 and 16
18. At the end of the rinsing stages, open the drain

Washing and rinsing times and temperatures, as well as the number of washes and/or rinses required, depend greatly on the quality of the fibre being processed.

As a general guide, the best results (for wool) are obtained with the following parameters:

1. 1st wash: 60°C, 1 l of soap per 350 l of water, sodium carbonate to pH 8, 10 minutes
2. 2nd wash: 60°C, 0.1 l of soap per 350 l of water, sodium carbonate to pH 8, 6 minutes
3. 1st rinse: 45°C, 6 minutes
4. 2nd rinse: 35°C, 6 minutes

Proposed improvements

Following the tests carried out, two possible improvements were identified:

- Adding a second handling paddle to help move the material, especially with high loads
- Adding a removable grid, inserted only for the material unloading stage, so that the material collects on the grid, making its removal from the machine easier and quicker