LIFE 09 ENV/IT/000185

MDPATC

NEW ECO-PROCESS OF SUPERFICIAL TREATMENT
OF THE METALLIC WIRE PRODUCTS

Mass and Energy balance

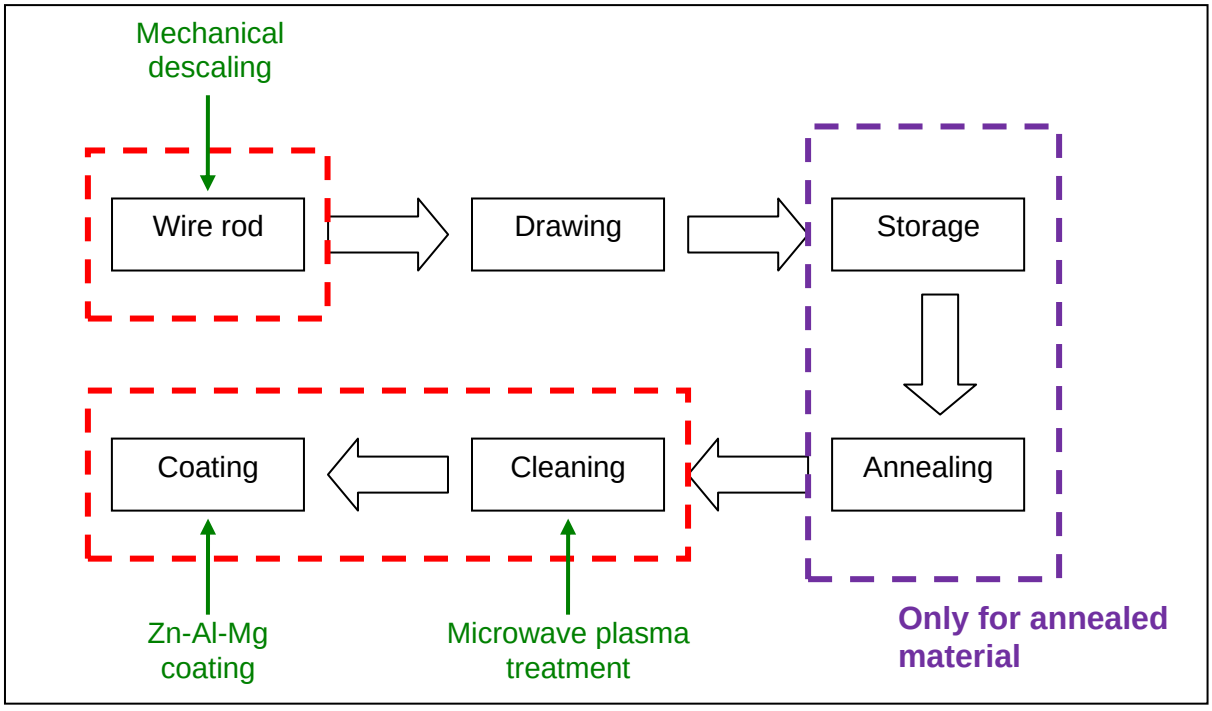
CAVATORTA 50°

1. Introduction

When evaluating the metallic wires treatment, it results particularly important to define the mass and energy balance of the plant.
The present analysis' goal is to define the quantity of mass and energy used, how it is transformed, which and how many waste are produced and if they can be recovered.
As shown in the picture below, the project has introduced substantial innovations in several parts of the process for wire treatment, even if not in all of them; the data referring to those parts not of interest for the project, come from standard processes.

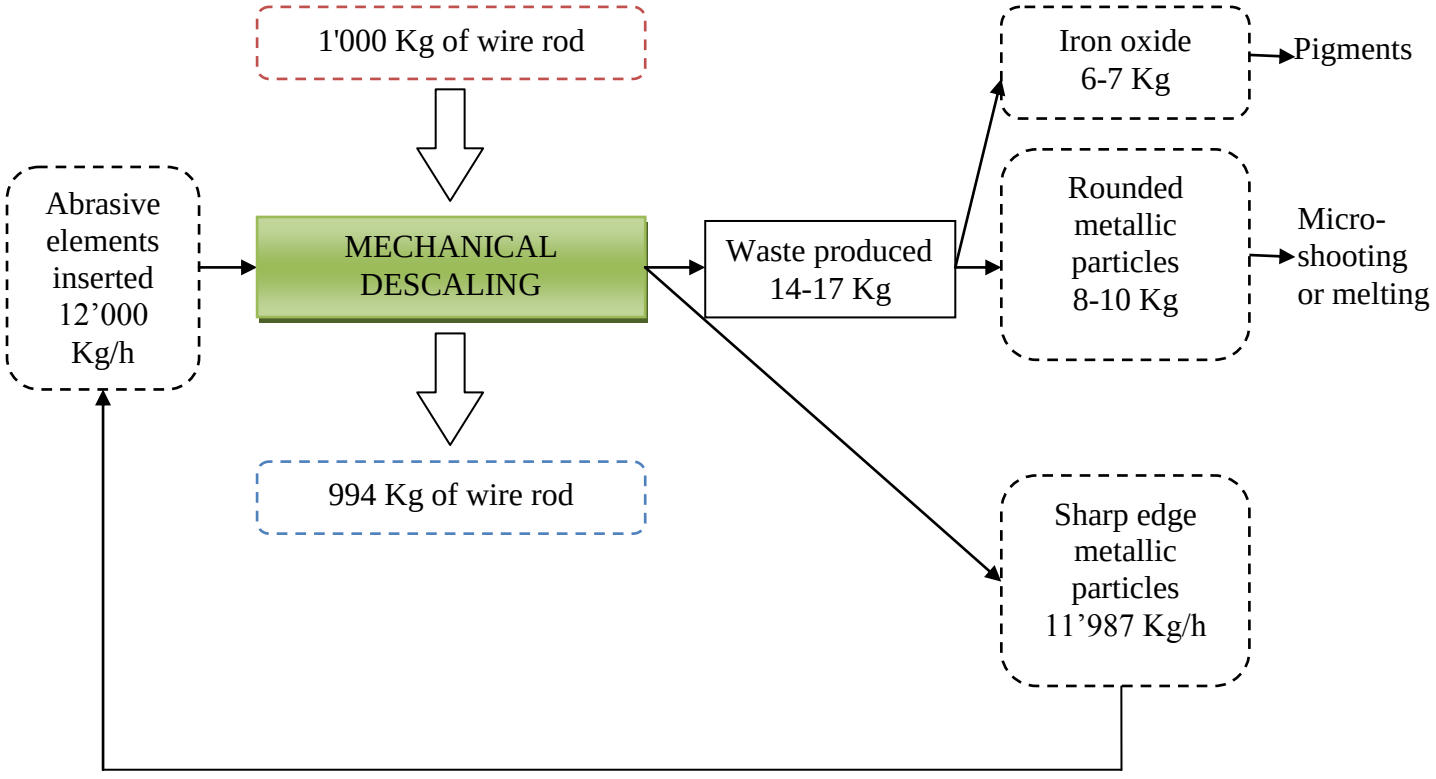
It is interesting the evaluation of the changes which take place at mass and energy level in the treatment phases to which the project is referred to, therefore it will be ignored activities such as storage and firing.

Below the coordinator gives a representation of the phases necessary for metallic wires' treatment, the phases colored in red represent the treatments addressed by the project:



2. Mass balance of the system

The innovative pilot line implemented is able to treat 1'000 Kg/h (4'000 ton/year) of metallic wires therefore the coordinator has assumed a quantity of material entering the plant equals to the maximum capacity of the system developed.
The wire rod entering into the plant undergoes, in primis, a mechanical descaling treatment; the cleaning of the wire rod is an essential phase, before wire drawing, for removing flakes and calamine formed during the steel treatment and oxides and impurities formed during the storage phase.
The cleaning phase takes place with a mechanical descaling system which operates through a continuous collision of abrasive elements with the wire rod, without making use of acids or other chemical substances for the cleaning of the surface.
It is also possible to use, as abrasive elements, also scraps coming from other treatments (e.g. cuttings and scaps produced during the formation of screws or when imparting the proper geometry to nails). The mechanical descaling system is composed by a waste separation system which operates in continuous, able to separate 3 different kinds of recyclable waste: fine powders of iron oxide, usable as pigments; prismatic metallic particles or sharp edge particles to be used inside the descaling system; metallic particles which have lost their edges and results rounded and smaller, reusable in microshooting systems or sent to dedicated melting systems.



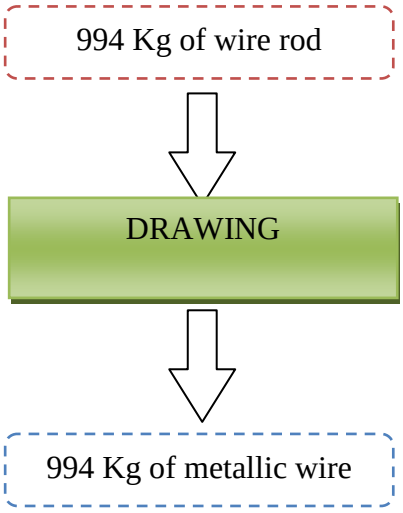
As can be easily seen observing the figure above, the entering wire rod (1'000 Kg), is hit constantly by the abrasive material aiming at cleaning the surface of the products. This process determines the detachment of impurities from the wire rod, aspect which determine a lower weight of the product when exiting from the system (around 0,6-0,7% less).

The remaining material exiting from the system is divided into 2 groups:

- Waste: material which is used in different industrial processes;
- Sharp edge metallic particles which are reintroduced into the system as abrasives.

The quantity of abrasive used is high so as its turnover, during a shift it can be used up to 12’000 Kg of abrasives; their recover at the end of every single treatment and up to the end of their life, avoid the generation of waste and the reduction of costs related to purchasing abrasive components. A sieve tool divide the metallic particles between those reusable in the system and those to be used in other productive processes or to be melted.
Once the abrasive life ends, they are used in other kinds of industrial treatments or melted again.

Wire drawing is an industrial process which treat the wire until the wished diameter is reached. The wire enters into different matrixes, each one is smaller than the previous one until the desired dimensions are achieved.
With wire drawing the volume of the wire remain the same since with this system no material is removed, therefore the mass of the product remain the same: reducing the diameter it is obtained an increase in its length.



Once the wire rod has been cleaned and drawned, the metallic wire undergoes the plasma-microwave treatment instead of the conventional treatment with ammonium chloride. Such treatment has the double objective of removing the impurities still

present on the wire and activate it for the next dip coating bath. In this phase the variations of the mass due to the removal of impurities are negligible since the particles removed are visible only with the microscope. 95% of the impurities are removed with the mechanical descaling. The phase analyzed here is extremely important for the next coating phase which could not be performed without the activation of the wire (implemented by the microwave-plasma process).

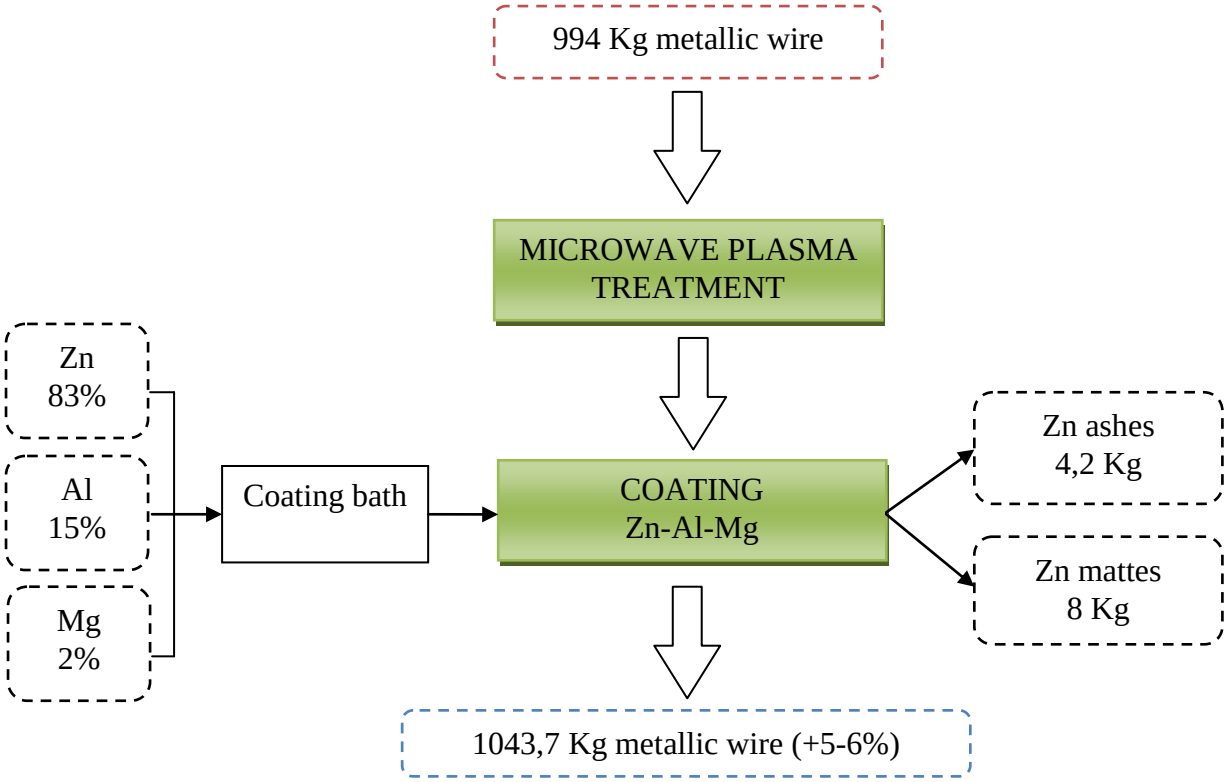
The metallic wire coating takes place thanks to the coating bath composed by Zn-Al-Mg. With this process the coating is applied on the metallic wire making it more resistant, more deformable and more protected from the corrosive effects of the external agents.
The treatment takes place at high temperature even if lower than those reached with standard treatments (450°); therefore a lower amount of Zinc ashes and mattes is produced.

The composition of the coating bath results more or less the following:

- 83% Zn;
- 15% Al;
- 2% Mag.

It is not necessary to add rare earths in order to reach the objectives.
The composition slightly change depending on the composition of the wire to be treated.

The cohesion of the coat on the metallic wire results more effective if compared to traditional methods but it determines also an increase of the total mass of the product which increase by 5-6%.



The treatment implemented, as shown in the above analysis, is able to minimize the components entering in the system and those exiting from the system itself. In the case of waste products, these are reused in the system itself or in other treatments. The only products that have to be disposed of are the Zn mattes and ashes which are produced in a lower quantity if compared to the traditional systems since the new coating system operates at lower temperatures.

Moreover, if compared to traditional systems, the following materials are NOT used:

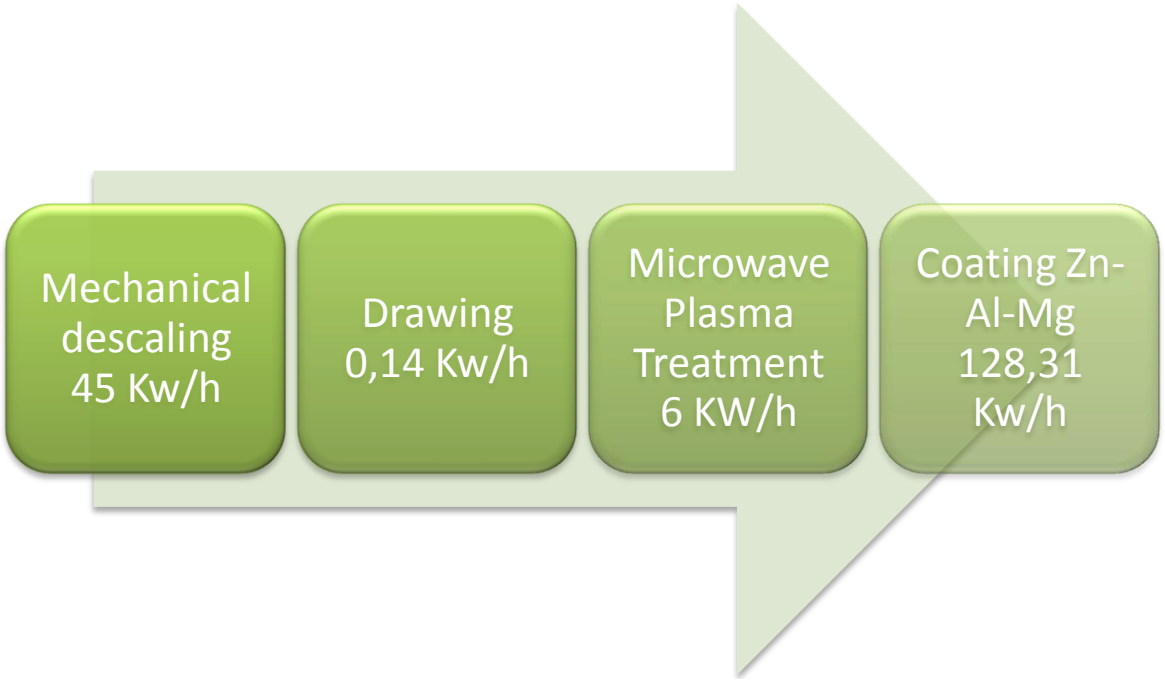
- Water;
- Hydrochloric acid;
- Sulfuric acid;
- Acid sludge.

3. Energy balance of the system

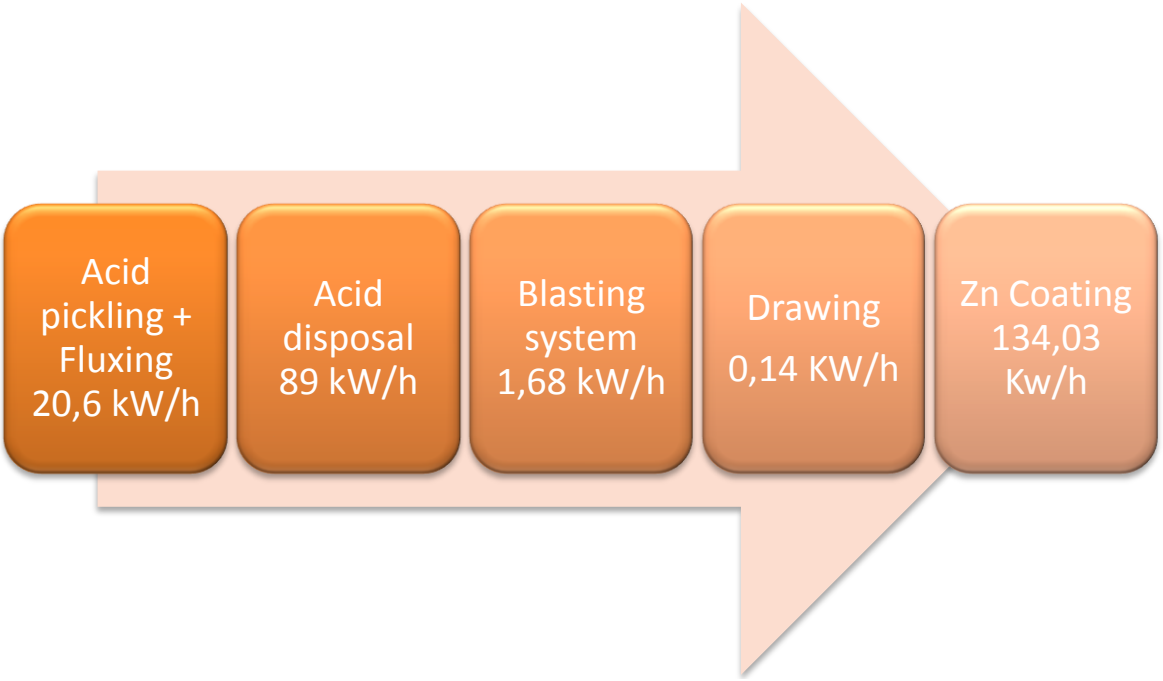
It results important to quantify the energetic consumption of the plant since energy supplies represent an important voice in the final year balance sheet of the company and, often, energy is produced from sources which can not be defined as “Green”; a lower energy consumption would mean also a lower environmental impact of the system implemented.

Hereafter we give a representation of the Energy consumption of the plant comparing it to a standard system for the treatment of the wire rod:

INNOVATIVE SYSTEM



STANDARD SYSTEM



As can be easily observed from the graphs presented above, the traditional systems and the innovative system presents different energy consumptions.

We have not considered in the present analysis the wire wrapping and unwrapping systems since they are exactly the same in the two systems not determing, therefore, any variations in energy consumptions.

The mechanical descaling system present slightly higher energy consumption than acid pickling, however the pickling process operates thanks to acids therefore it should be considered the energy consumptions for waste disposal and water treatments. Because of the materials used for the pickling treatment, the waste disposal is quite complicated and the energy spent for it is quite high.

The new system, not only determines the consumption of lower amount of energy but the cleaning efficacy of the treatment results also increased since it can reach up to 95% of residuals removed.

While the drawing phase is exactly the same, in the following steps the energy balance appears unbalanced favoring the new system.

In traditional systems, the wire is activated and prepared for the following coating phase implementing two treatments (acid pickling and fluxing) while the new system needs only a microwave plasma treatment. The new system (microwave plasma treatment) eliminates also the use of water.

The last phase, related to wire coating is source of other energy savings; the lower temperatures of the bath and the lower thickness of the covering, determines

substantial energy savings, equal to 5,72 kW/h. Energy savings derive mainly from the lower temperatures needed for the new system to operate and the lower thickness of the covering; the surface covering the new system is equal to 0,04 mm while the standard treatment needs a covering of at least 0,06 mm When calculating the energy balance we have considered the treatment of approximately 1'000 Kg of product per hour.

Total savings are equal to:

	Standard System	New System
Mechanical descaling		36 kW/h
Drawing		0,14 kW/h
Microwave plasma treatment		6 kW/h
Coating Zn – Al - Mg		128,31 kW/h
Acid Pickling + Fluxing	20,6 kW/h	
Acid Disposal	89 kW/h	
Blasting system	1,68 kW/h	
Drawing	0,14 kW/h	
Zn coating	134,03 kW/h	
Total		-75 kW/h

Most of the data presented above have been obtained using the CED software.

Based on the previous calculations, if we consider the maximum productivity of the pilot plant, which is approximately 4'000 ton/year, the resulting energy savings would determine great benefits for the company. The result is extremely positive not only for the environment but also for the economic balance of the project which results more economic than the standard one.

The results obtained are not only referred to energy savings, with the mechanical descaling system it is possible to eliminate all the categories presented in the table below which are directly connected to the pickling process and responsible for damages to the environment and to human health. With the standard pickling system, the following consequences are produced:

Category	Climate change	Human toxicity
Udm	kg CO2 eq	kg 1,4-DB eq
Pickling HCl and water consumption	2046731,32	2411151,48
Cleaning, water consumption	4,37	3,80
Bath – HCl consumption	22,89	6,16
Bath – water consumption	20,48	17,80
Energy consumption	11,99	2,17
Waste disposal	200,05	26,55
Water treatment	718,99	348,65
Total	2047710	2411557

Data refers to the treatment of 5 ton of wire. Data have been calculated using the method "ReCiPe 2008".