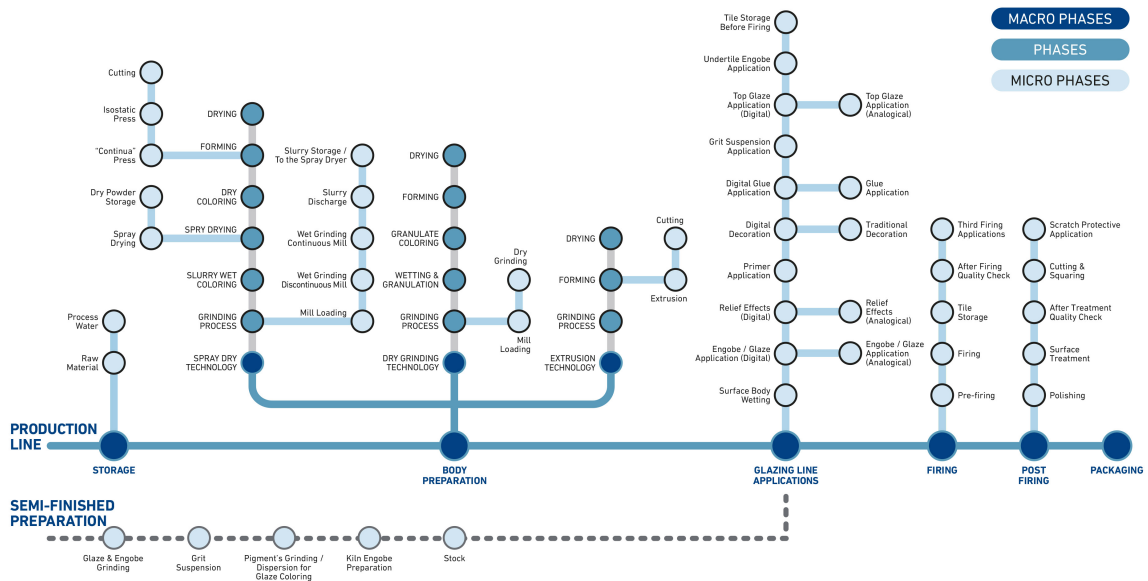




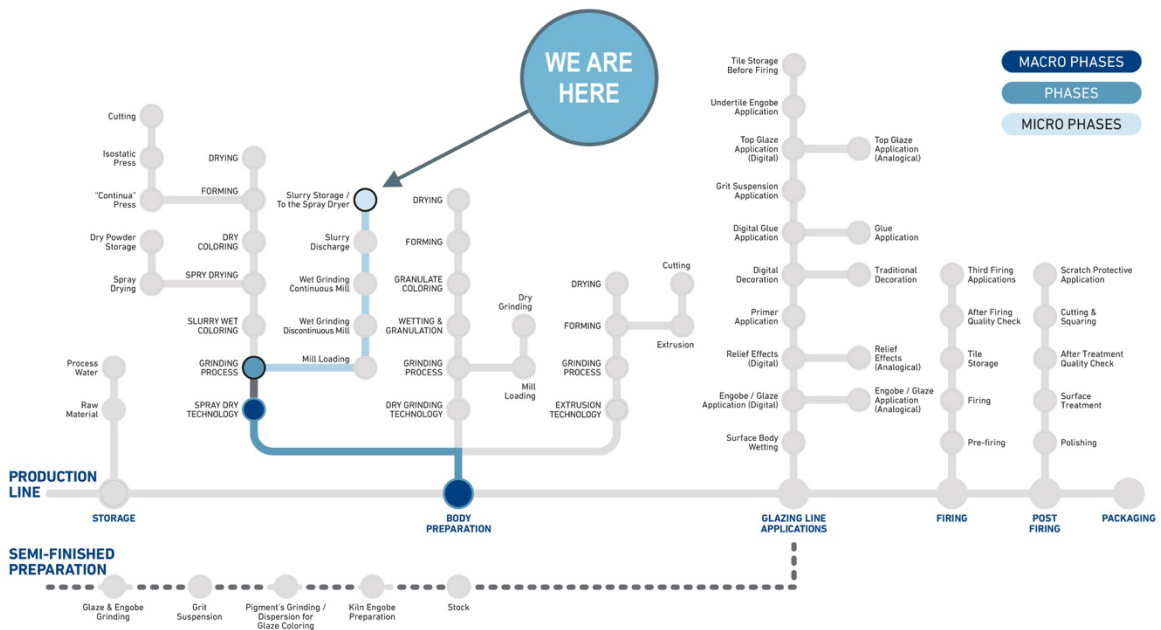
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APPARENTLY INVISIBLE YET CONSTANTLY PRESENT
At every stage of the ceramic production process

A journey through problems & solutions



#30 EXCESSIVE VISCOSITY OF THE SLIP: CAUSES & REMEDIES





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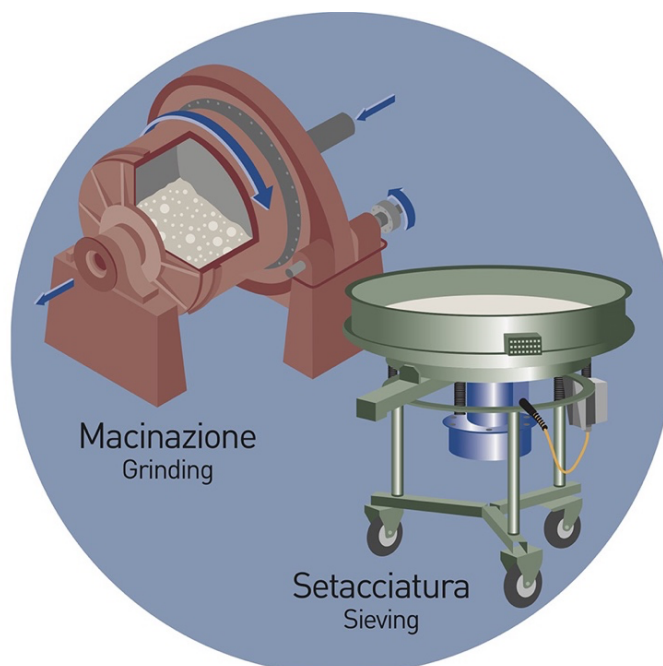
1. INTRODUCTION

The slip (or barbotina) is a viscous matter resulting from mixing by means of wet grinding processes water, clays and other raw materials. A mix that is the basis of ceramic mixtures. The barbotina is a **SUSPENSION** that can be marked by different density values according to the ratio of each component and to the chemicals involved (with particular reference to dispersant).

Three are the main ingredients: inorganic raw materials, water and dispersant.

Alsing mills are equipped with a large rotating cylinder lined with quartzite and porcelain bricks, and containing an amount of flint pebbles. The ceramic paste to be ground is mixed inside the mill with an equal amount of water, ground thanks to the impact with the pebbles. The result depends both on the rotation speed of the mill and on the pebbles' dimension.

The rates of materials and chemicals are usually defined and developed to reach at the end of the grinding process a slip marked by the highest density as possible. This means that the slip must contain the lowest water amount. Why?





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2. WATER, DENSITY & VISCOSITY

The reduction of water amount surely increases the industrial productivity, both during the milling process and inside the atomizers. This reduction, in fact, significantly reduces the energy consumption of the atomizers that must promote a proper evaporation process, turning the barbotina into atomized powder that, under the weight of the press, will form the raw ceramic tile.

The water elimination, in fact, is developed by using very strong heat sources: the higher the water content, the more energy will be used.

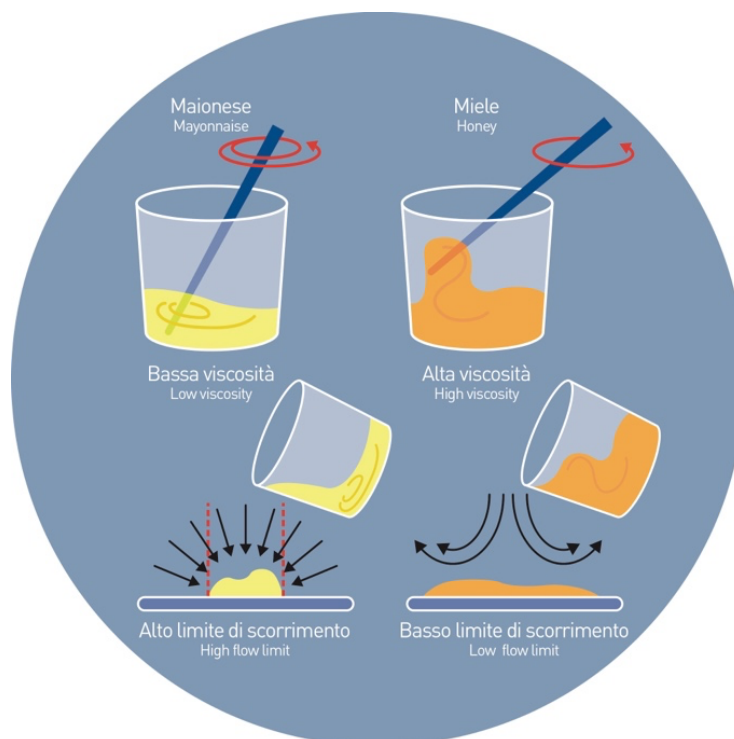
However, the frantic search of high densities may sometimes compromise the use of the slip. Even a very small change in the standard production conditions can lead to a sudden and rapid increase in the slip's density values. In case of very high values many problems may arise, until the stop of the production line.

3. VISCOSITY: DEFINITION & AND EXCESSIVE VALUES

DEFINITION

Viscosity (or viscous friction coefficient) measures a substance's attitude on generating friction between its layers. In other words, it defines the fluid resistance to flow.

In liquids, the viscosity coefficient is normally inversely proportional to temperature: the more the temperature increases, the lower the viscosity. From a microscopic point of view, the value of viscosity depends both on the shape/size of the molecules and on their kind of interaction.





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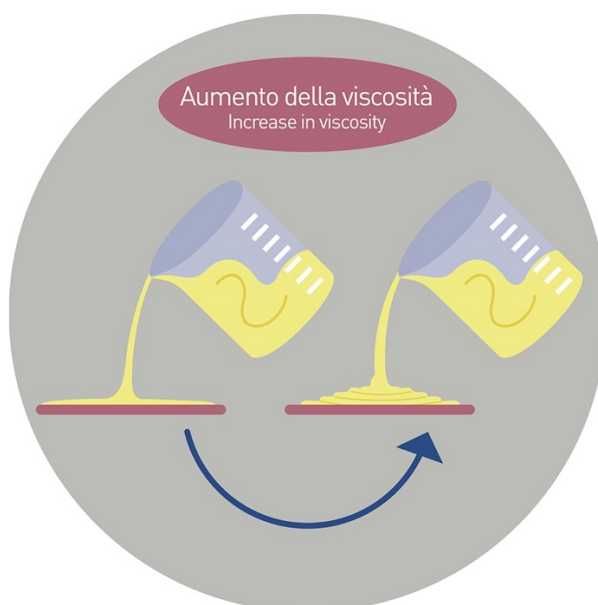
HIGH VISCOSITY VALUES: MAIN CONSEQUENCES

In this perspective, what are most important problems promoted by an excessive viscosity of the slip?

An excessive viscosity, especially when it occurs together with high flow limit and thixotropy values, may promote several problems.

The most frequent and significant can negatively affect the grinding process, making it more difficult. For example, the slip's discharging process can be slowed down and sometimes it can even remain incomplete.

Sometimes, critical issues may occur during the sieving process. In other cases, scale and jelly phenomena can arise inside tanks and pipes, forcing producers to partially or totally stop the process.



4. MAIN CAUSES OF SLIP'S EXCESSIVE VISCOSITY

If all the previous examples are about consequences, what are instead origins and causes that can significantly increase the slip's viscosity value?

a) CHANGE IN THE WATER'S QUALITY

This scenario can occur when the grinding water is rich in ions.

The high presence of ion, in fact, considerably increases the water electrical conductivity, resulting in turns in higher viscosity values.

In this perspective, it is very important to check the water electrical conductivity to avoid problems and to prevent change in the rheological values of the slip, including viscosity.

Grinding waters usually consist of well water and treated wastewater deriving from the glazing line, grinding departments and other steps of the production process.

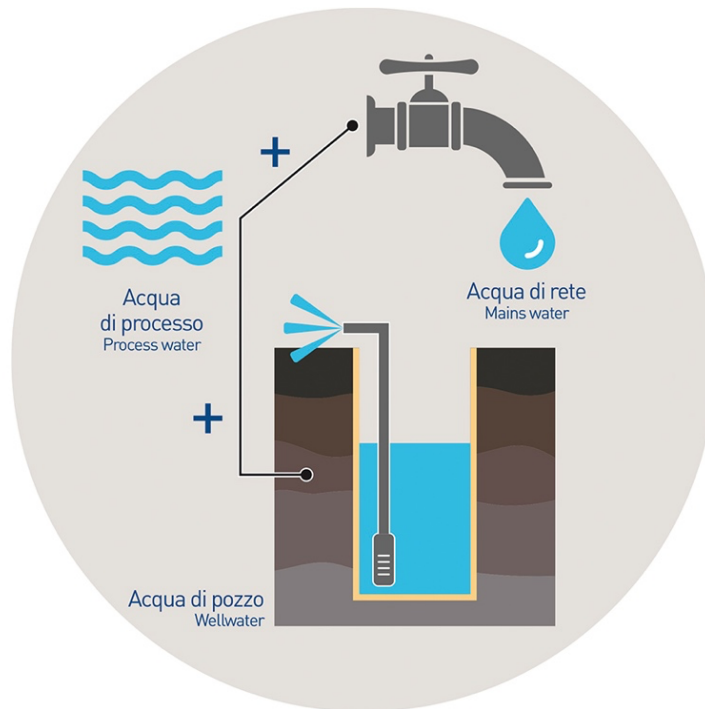
However, treated wastewaters are usually marked by a very high electrical conductivity that can often affect the stability of the watery system by significantly increase the viscosity.



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How can we reduce it, and therefore how can we act on the electrical conductivity of the grinding water?



Theoretically, there are some methods - such as osmotic systems - that would lower the conductivity values reaching the proper levels. However, such treatments are extremely expensive and therefore cannot be taken into account in any production process.

What can we do?

Is it possible to differently act?

The most efficient solution is in the use - during the grinding phase - of proper chemicals that develop a sequestering action, reducing the amounts of multivalent cations and at the same time promoting a cationic exchange with monovalent ions (such as sodium).

What does that mean?

Both cationic exchange and sequestrant action contribute to thickening the electrical double layer of the clay micelles, promoting a repulsion effect between them, and therefore reducing the viscosity value.

This action, actually, does not reduce the conductivity value but it promotes a deflocculation process, developing a fluidization action between the micelles.

If we exclude the use of proper chemicals, it is also possible to increase the water content within the system: this action, of course, decreases the viscosity but at the same time also affects the slip's density values.



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b) RAW MATERIALS OUT OF STANDARD

This scenario can appear, for example, in the presence of raw materials marked by high plasticity values or in case of high contents of cations and/or anions.

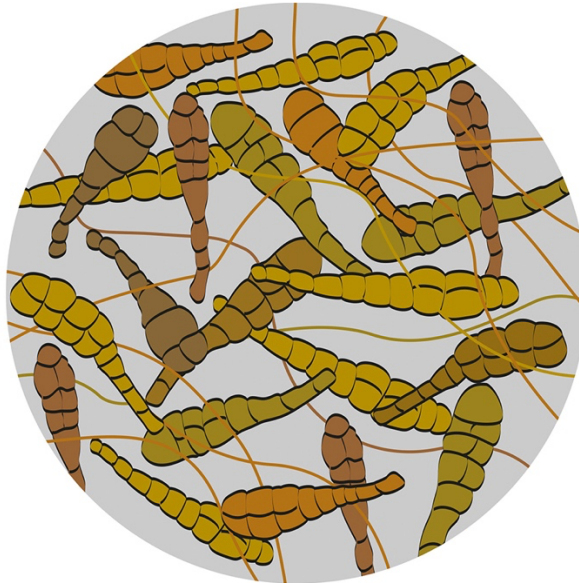
In such cases, there are many actions that can be taken even if they are usually not very effective. Even if it is an extreme decision, in fact, the replacement of the raw material is the right and best way to face the problem.

c) BACTERIAL PROLIFERATION

Sometimes, viscosity may increase even after the grinding process.

This often occurs due to a bacterial proliferation within the barbotina, deriving from process waters involved in the grinding process or from clays that are rich in bacteria.

Microorganisms, that feed on organic matters, expel ionic substances that, since they intensify the ionic charge of the slip, also increase its viscosity values.



In these circumstances, beside the use of biocides able to stop the proliferation, the only remedy is to add the slip with secondary dispersants able to lower the viscosity of the system.

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