The quality control system of our production plants has historically been set up through the control of the materials produced through laboratory determinations to verify compliance with the target specification parameters. The plant is equipped with a system for detecting process parameters through DCS (Distributed Control System), and the plant manager intervenes in regulation based on this precise information (temperatures, pressures, levels, etc.)

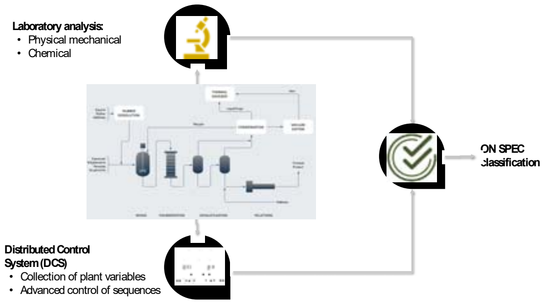

Figure 1

This management system has at least two main limitations:

1. it is slow, since the intervention time is determined on the frequency of laboratory analyzes, which is usually in the order of hours.
2. it is not very effective in the case of transients with a higher frequency than the sampling and analysis times, that can occur without the system being able to identify them, unless they involve significant changes in the process parameters at DCS.

In the first case, the slowness with which it is possible to intervene to correct the anomaly leads in any case to significant fractions of non-standard product.

Furthermore, an untimely intervention can aggravate the effect of anomalies which, if not corrected quickly, can have effects that cannot be perfectly recovered, such as fouling or inefficiency of plant sections.

In the second case, however, this in the presence of short transients, if these are not particularly serious, they are not perceived by the variations of the process parameters at DCS and are not measured by the laboratory analyzes of samples collected before and after the phenomenon occurred.

Transients of this type can occur due to changes in the batches of raw material fed, temporary inefficiencies of tools or machines, or plant utilities.

The material produced during these transients is classified, based on the laboratory analyzes of the samples collected subsequently, of optimal quality, but when this is supplied to the final customers it can lead to problems and complaints.

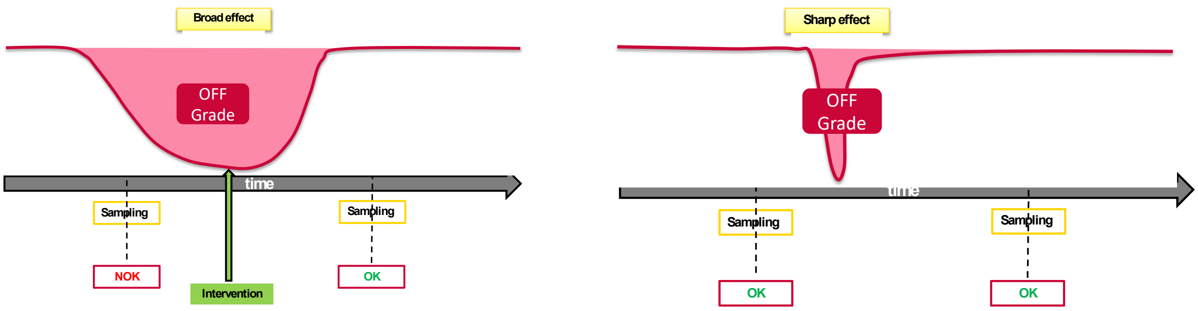

Figure 2

Overcoming these limits is not possible simply by increasing the sampling and analysis frequency, as this would involve excessive and unsustainable costs.

The solution comes from technology, or rather from the application of a measurement system in real time.

Obviously, the systems are already equipped with on-line probes, but these only allow to detect process variables, such as temperature, pressure, levels, electrical absorption, etc.

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The on-line measurement system introduced uses NIR technology, which means that a spectrum in the Near Infrared can be acquired in real time. The spectral data can at this point be used through appropriate chemiometric calibrations to derive the compositional parameters of the process streams, and to obtain the main performance parameters (impact, fluidity) on the final product as well as the composition. These values are then processed and registered by DSC and became part of an advanced quality control philosophy.
The ability to control product quality in real time allows immediate action, first of all by segregating non-compliant material and thus reducing to virtually zero the risk of supplies to customers that are not of optimal quality, and on the other hand allowing prompt intervention on the process to correct the anomaly.

A couple of examples allow us to show in detail the advantages obtained with the application of the on-line NIR control.

1. Reduction in the use of polybutadiene.

Polybutadiene rubber is used for the reinforce impact of styrenic materials. The process involves the dissolution of the rubber in the starting monomers, which in the case of ABS are styrene and acrylonitrile, and then the subsequent mass polymerization. In this phase the growing SAn copolymer reacts by grafting with the rubber, and the final material will contain a target fraction of rubbery phase dispersed as particles in the material itself.
The NIR system measures in real time the concentration of the rubber in the starting solution, and the impact and size parameters of the particles in the finished material, in the melted phase in the finishing extruder.
The graphs in figure 3 clearly show how this management system has made it possible to reduce the amount of rubber used by approximately 2% (0.25% in absolute), with a saving of approximately 100 tons / year, as result from the laboratory analysis of the lots.
In addition to the economic saving aspect, it should be remembered that rubber has a worse carbon footprint than resin, therefore thisreduction also goes in the direction of greater sustainability.

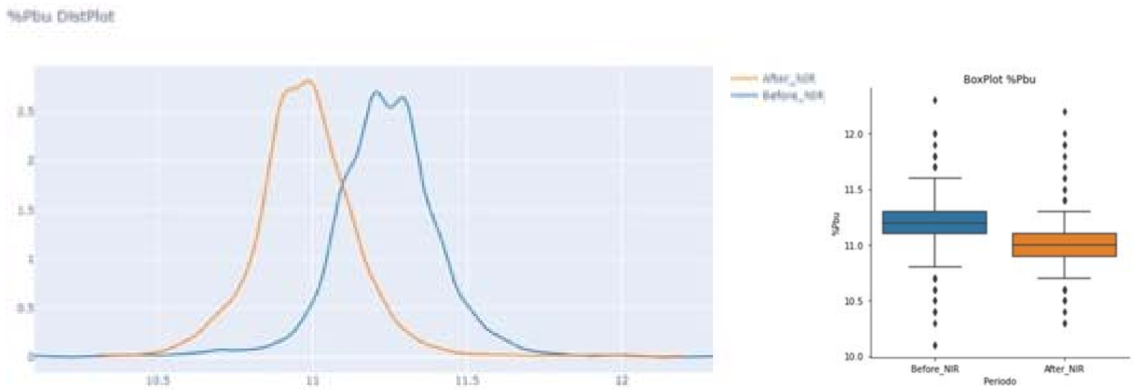

Figure 3

2. Production constancy

Two fundamental parameters for the definition of ABS performance characteristics are fluidity, measured as Melt Flow Index (MFI), which accounts for the workability of the material, and the impact resistance of the material, measured by the Izod impact strength test.
Both these parameters are measured by combining the NIR spectral data on the molten polymer at the output of the finishing extruder, and the combination by means of chemometric data fusion algorithms with process data.
The graphs in figure 4 (MFI) and 5 (Izod) clearly show how the statistical distribution for both parameters is significantly improved.
The data reported refer to the measurements carried out in the laboratory, relative to the production period before and after the introduction of the NIR control and are therefore perfectly comparable in that point obtained in a similar way.

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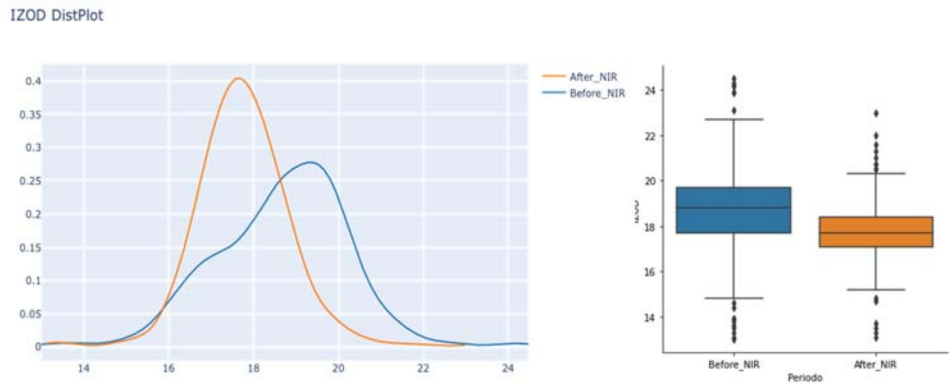

Figure 4

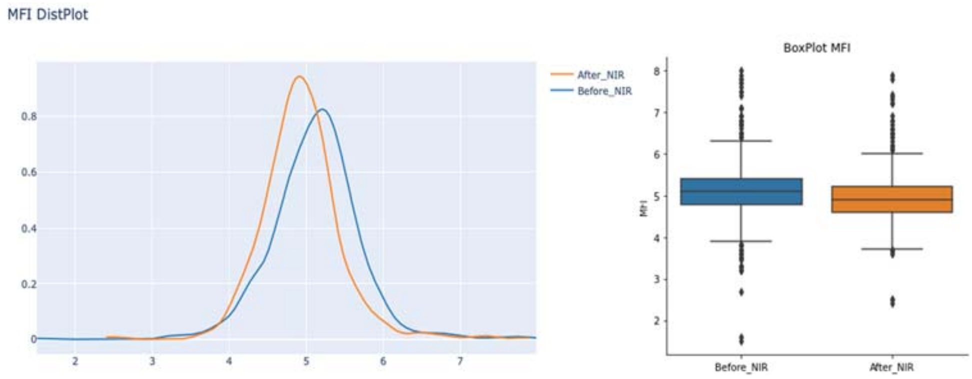

Figure 5

3. Additional benefits

The NIR control system has generally made it possible to obtain two fundamental advantages on all productions:

1. reduction in the number of control analyzes.
2. management of campaign changes between different product grades

In the previous set-up, quality control included 3 to 4 daily samples for checking the composition and the main chemical-physical parameters of the material. Thanks to the control in real time and the production consistency obtained, the sampling was reduced to one sample per day.

The production changes between one grade of product and the next were previously managed in a standard way, providing about 40 tons of material to cover the transition. Today with the real-time control system, this window is reduced to about 15 / 20ton of transition material. As already mentioned, both advantages involve a considerable economic gain, a constant and assured quality for the customer, a significant reduction of the environmental impact.

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