Application Report

Contact angle determination in process control

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Author(s):	AE
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In-line process control with MobileDrop: monitoring cleaning performance on glass surfaces

Introduction

In in-line processing quality assurance is usually carried out rapidly and on-site. Contact angle measuring for monitoring cleaning stages places special demands on the measuring technique: the instrument must be mobile and measure non-destructively. MobileDrop offers the necessary flexibility. In contrast, with a stationary laboratory instrument the optimal process parameters and the action limits for quality assurance can be determined. Using the example of contact angle measurements with MobileDrop and the DSA100 on unassembled glass panes for double glazing we can demonstrate the smooth integration of the contact angle measuring method into planning and the production sequence.

Background

It is impossible to imagine the building trade today without double glazing or multi-glazing. In addition to providing thermal insulation, they also shield the interior from external noise and strong solar radiation. The ecological importance of double glazing is also continually increasing because of its energy-saving effects.

Fig. 1: Not a greenhouse, but offices – thanks to double glazing (photo: Bill Holmes)

In double glazing or multi-glazing two or more panes of glass are bonded to an aluminum frame by a sealing compound.

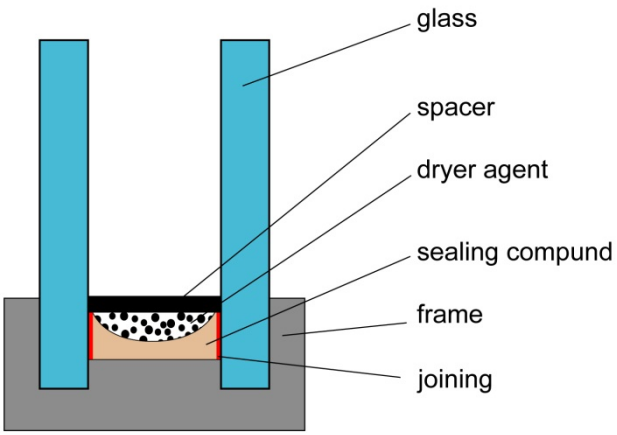

Fig. 2: Double glazing arrangement

The low thermal conductivity of the air layer provides the insulation effect; the sandwich structure can even contribute to the stability of the whole building.

Before a double glazing window can be assembled the glass surfaces at the contact areas must be pretreated to create optimal adhesive properties. Subsequently the panes are thoroughly cleaned. Residues on the glass edges result in poor bonding with the sealing compound; this can lead to bubble formation and even breakage of the double glazing panes. The cleanness of the glass edges can be checked with mobile contact angle measuring instruments.

Quality assurance for the cleaning process

Quality assurance for the cleaning process can be integrated at two stages in the manufacturing process. In the first stage a stationary contact angle measuring instrument is used to define suitable process parameters – type of cleaning agent, concentration, contact duration, drying. The action limits for the subsequent inline process control are also determined in laboratory tests. In the second stage the process is controlled by using mobile contact angle measurements during production.

Determining the action limits (lab instrument)

For the tests in the quality control lab with the drop shape analysis system DSA100 samples are first cut out from the panes of glass. Water drops are deposited on the glass samples and the shapes of these drops are analyzed.

The degree of scatter is somewhat greater than for inline measurements because of the necessary sample preparation steps and the longer time between cleaning and measurement. This means that process optimization should be carried out using a broad series of measurements. In the tests presented here the contact angles were between 10° and 20°.

Monitoring during production (mobile instrument)

Checking the cleaning during the production process is made possible by the MobileDrop drop shape analysis system. This particularly handy instrument works together with a notebook and does not need an external power supply. The cleaning stages are checked non-destructively and on site. If the result is positive the sample is returned to the production process.

The measurements are made at the edge of the glass, i.e. the actual contact surface for the subsequent bond. As the measurement is made immediately after the cleaning process, any differences in the contact angle can be directly related to the production stage that has just been completed.

Results

The following results obtained from a test phase show the differences between thorough and inadequate cleaning. The measurements were made at room temperature; the amount of liquid deposited was 2 µl.

	Contact angle (°)
Glass immediately after thorough cleaning (in-line test)	< 10
Glass immediately after poor cleaning (in-line test)	25

Tab. 1: Comparison of contact angles for different cleaning qualities

The surfaces of the window panes are obviously hydrophilic, which can be recognized by the uniformly small contact angles. The differences in quality shown by the contact angle data can already be recognized in a visual assessment of the drop image.

After successful cleaning: After inadequate cleaning:

Fig. 2: Drops on a pane of glass

In this application contact angles below 10° indicate a successful cleaning process, so that good adhesion between the glass and the sealing compound can be expected. Above the action limit of 15° determined for this process it can be assumed that the pane of glass has been inadequately cleaned.

The results show that an effective cleaning process can be recognized very easily from the contact angle data. Possible problems in the later production process can be recognized at an early stage and can be avoided.

Summary

The use of contact angle measurements in inline process control helps to improve the quality of the product and reduce costs.

The limit values for the contact angle determined in the laboratory test are used as guideline for the rapid and easy check of the contact angle during production. Once the defined limit has been exceeded a selective intervention in the process can be made immediately.

In our example the wettability of panes of glass could be measured at their edges before these are bonded to the frames. In this way the cleaning process can be effectively checked and the wastage rate reduced.

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