Application Note - Exactus® Blank Mould Temperature Measurement

The Exactus GM-100 blank mould temperature measurement system allows container manufacturers to understand and minimize the thermal variation in the blank mould. The reduction in variation and ability to establish an optimum blank mould temperature can ultimately increase product quality and yield through open or closed-loop control of the cooling air. Furthermore, reduced energy consumption is possible if variable frequency drives are used to adjust the blower speed.

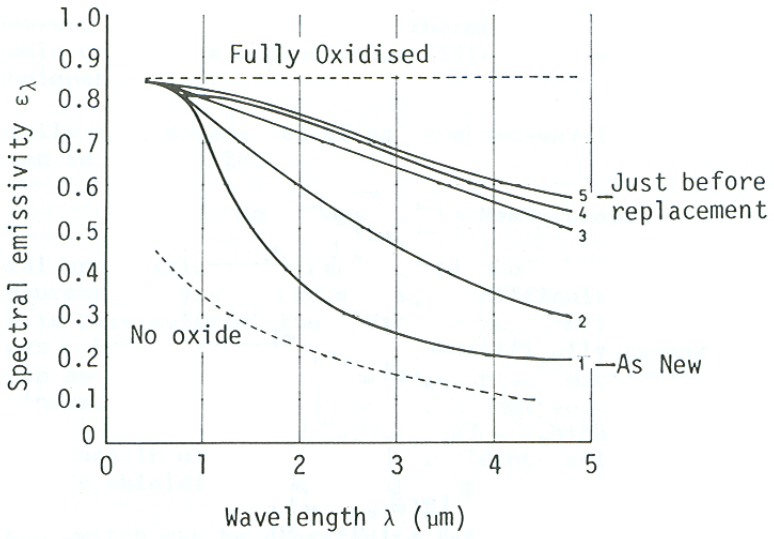
The Exactus blank mould temperature measurement system was specifically designed to continuously measure the inside surface of the blank mould while minimizing the impact of the changing surface condition (emissivity) on the measured temperature. This emissivity solution is based on a unique technique that utilizes the high-speed processing capability of the Exactus system. Installations include an optical sensor that is mounted above the cavity of interest, out of the way of the operators, and a remote electronics support cabinet. The system updates the plant's data/control system with a new blank mould temperature measurement once per machine cycle and does not require input from the IS machine.

Measuring the Blank Mould Temperature

It is known that conventional methods of measuring the blank mould temperature suffer from the following:

Emissivity error

The blank mould surface condition changes over time and therefore, due to the changing emissivity, optical temperature measurements become dependant on surface condition. Errors greater than 30ºC can be present when measuring a blank mould with a 1.6µm pyrometer while assuming the blank mould emissivity remains constant [1]. The magnitude of the error increases at longer measurement wavelengths, like those typically used for handheld optical pyrometers. The following graph shows how the emissivity of a blank mould changes over time at different measurement wavelengths.



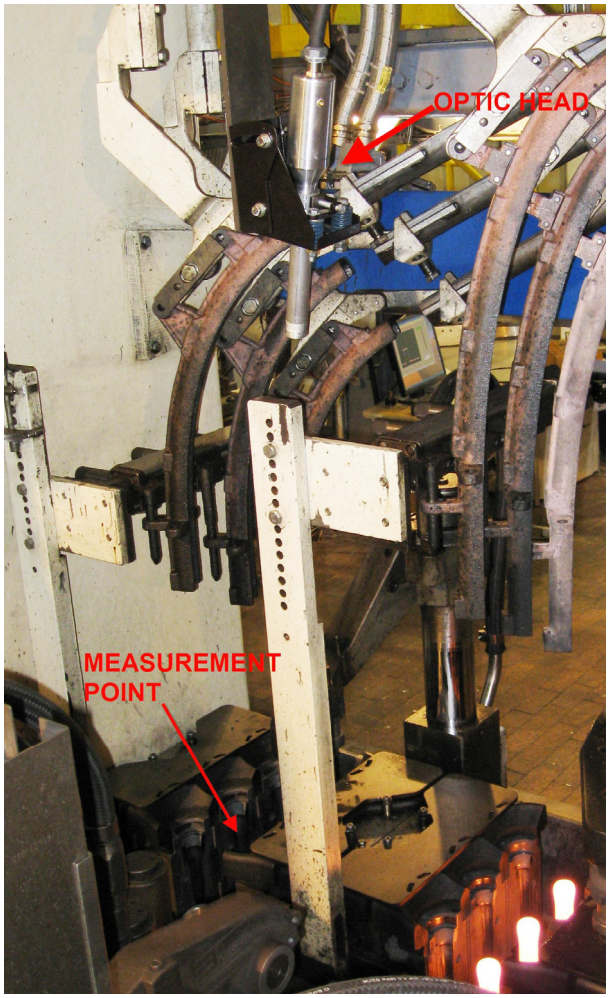
Effect of blank mould time in service on spectral emissivity[1]
Hours of Service: Curve 1 shows a new mould, Curve 2 = 8 hours,
Curve 3 = 13 hours, Curve 4 = 22 hours, Curve 5 = 34 hour

Manual operation

A common solution to the emissivity dependence explained above is to use shorter measurement wavelengths because emissivity has less of an impact on the measured temperature at shorter wavelengths. The problem with this concept is that it requires a special type of contact measurement optics to gather enough IR from the blank mould surface and be shielded from the ambient IR that's emitted from other light sources in the plant. Because these types of systems (sometimes called "wands") require an operator, it is difficult to measure the same location repeatedly. These systems are incapable of being used for control or continuous monitoring.

The Exactus GM-100

The Exactus GM-100 was designed to eliminate the above concerns. BASF has developed a unique measurement strategy that minimizes the effect of changing emissivity on the temperature measurement. The measurement strategy utilizes the Exactus technology's high-speed measurement and data processing capability. This high-speed capability also allows the sensor to be mounted above the section, out of the way of the operators, where there is only a brief moment when a reliable measurement can be made. Precise alignment is easily accomplished with a bright green laser target illuminator along with an adjustable optic head gimbal mount shown in Figure 1.



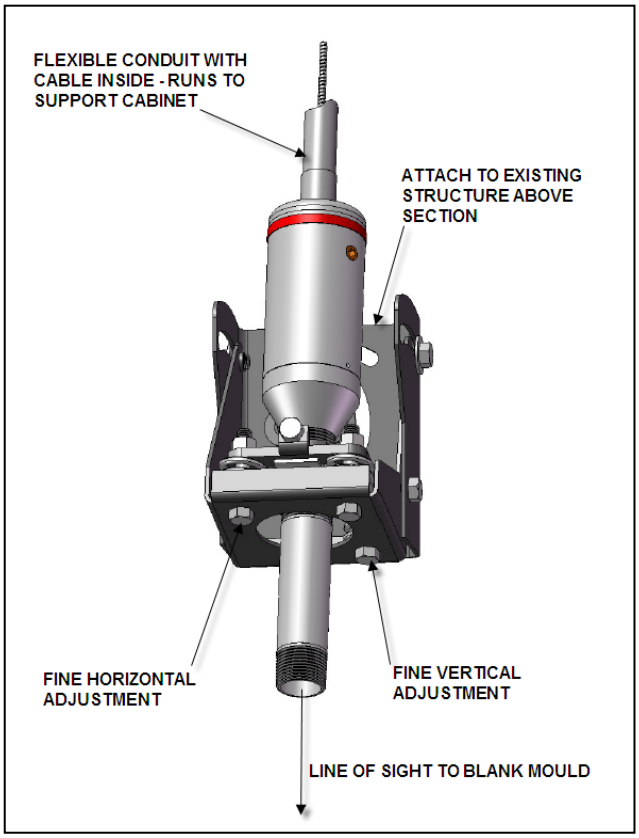


Figure 1: Installation and Drawing of Optic Head in Adjustable Gimbal Mount

When aligned to measure the blank mould, the data presented in Figure 2 is captured. Note that the gob and parison temperature is also measured in addition to the blank mould. By observing the raw data, engineers can better understand how the forming process impacts the glass temperature.

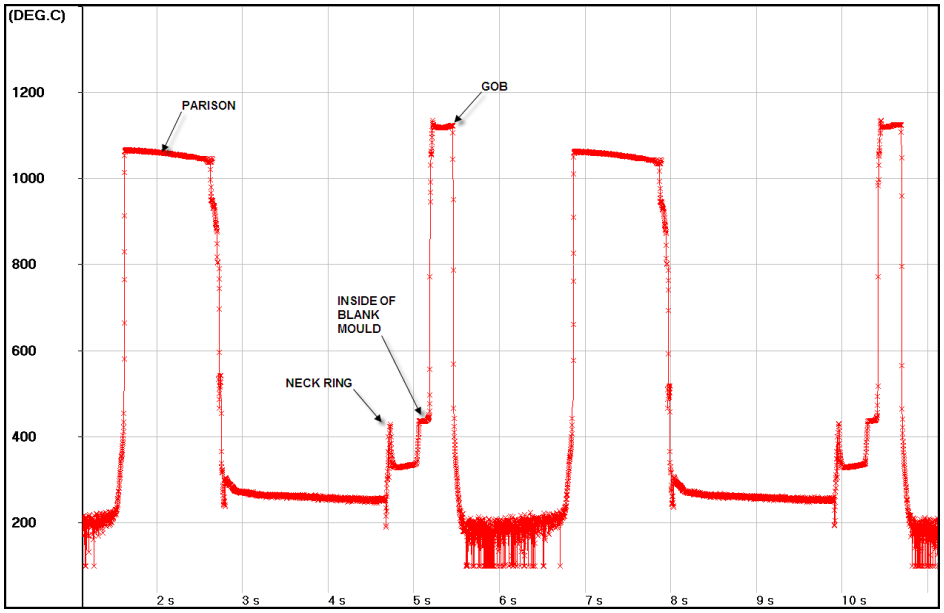


Figure 2: Raw Data from GM-100 Blank Mould Temperature Measurement System

The Exactus GM-100 includes a special *Plateau Mode*, specifically designed to isolate and output the blank mould temperature without requiring any inputs from the IS machine. The *Plateau Mode* algorithm takes user-defined values, including the leading edge temperature threshold, the trailing edge temperature threshold, and the number of points to ignore from the beginning and end. The algorithm considers only the data stream that crosses both threshold values, subtracts the data to be ignored, and determines the blank mould temperature. Figures 3 and 4 graphically display how the plateau mode algorithm isolates the blank mould temperature.

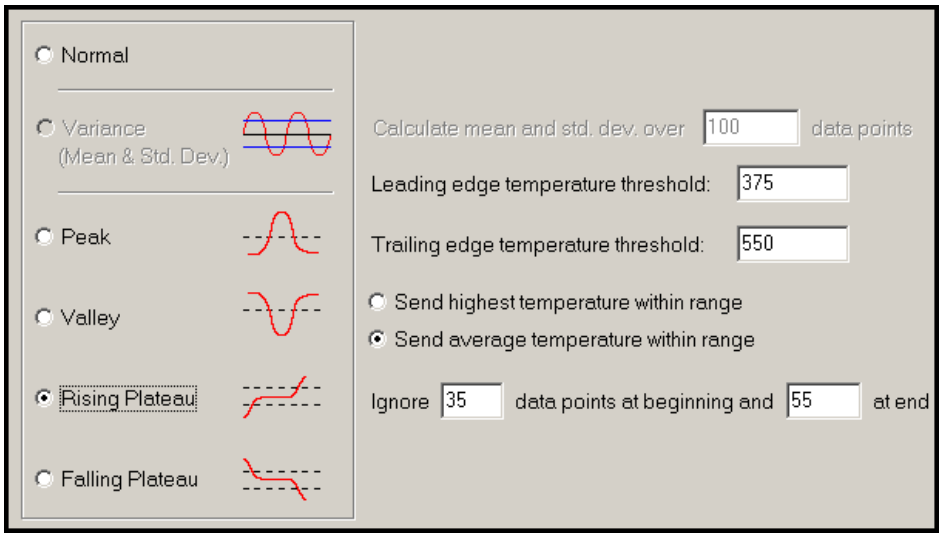


Figure 3: Plateau Mode Settings Window Displayed with GM-100 Software

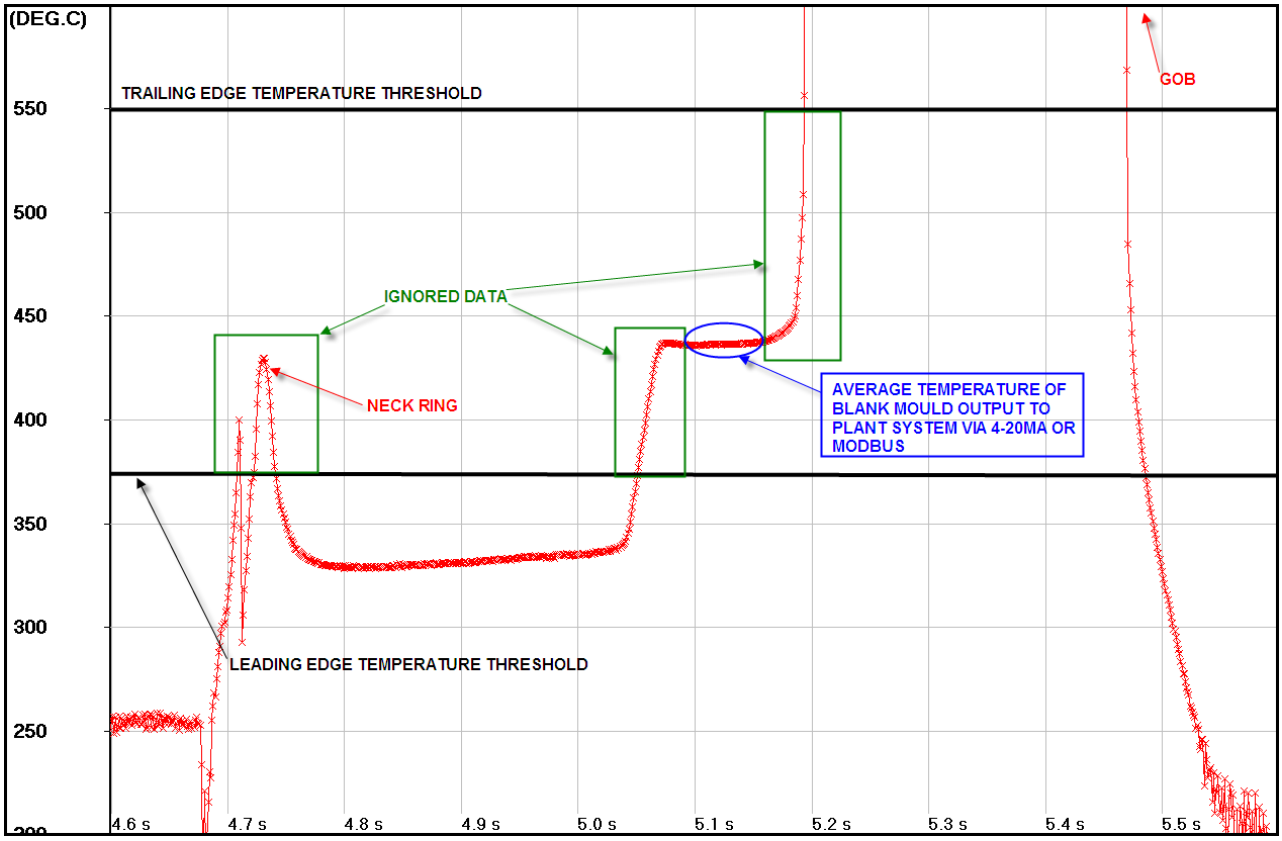


Figure 4: Plateau Mode Schematic (Illustrates Settings in Figure 3)

[1] D.P. Dewitt, G.D. Nutter, R. Barber, Theory & Practice of Radiation Thermometry, Chapter 18, John Wiley and Sons, New York, 1988.

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BF-8921, 02/19

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