

Aluminum Processing

Non-contact Temperature Measurement in the Aluminum Processing Industry



Non-Contact Temperature Measurement in Aluminum Industry

In all industries, one of the most important physical measurement is temperature measurement and this is also a basic requirement for production control of the processes in the aluminum industry.

Non-contact temperature measurement with pyrometers is becoming increasingly significant because of its advantages:

- Highly accurate temperature measurement
- Small spot sizes
- Fast response times
- Fully digital signal processing

In the aluminum industry temperatures of molten aluminum or hot final products can be measured as well as temperatures on machine parts used in the process.

This report gives a short explanation of the peculiarities of aluminum temperature measurement observing the surface constitution and other factors of influence. Additionally further aspects of using pyrometers in the aluminum industry are described.

Mikron has more than 40 years experience in non-contact temperature measurement, exemplified by specific expertise in the application of pyrometers within the aluminum industry.

Aluminum as a measuring object for non-contact temperature measurement

Aluminum is one of the most used metals after steel in the industry. Due to different surface conditions the emissivity is differing a lot which constitutes in one of the major problems of non-contact temperature measurement of aluminum. The emissivity of pure, shiny, polished aluminum for example is so low for the complete infrared spectrum, that the temperature with standard pyrometers can't be measured exactly. The contact with oxygen causes gradually an oxide film which increases the emissivity over a longer period up to 43%. Dependent of the thickness of these oxide film, interference effects

(color artifacts like an oil film on the water) will be generated. In this condition the measurement with a correct adjusted emissivity is hardly possible because the measurement depends on the wavelength (see also fig. 1).

Despite the described problems with the measurement of aluminum, Mikron has developed the high-quality pyrometer MI-S 12-AI which allows the non-contact temperature measurement of aluminum. The measurement is possible in a special narrow band range where the emissivity is nearly constant between 30 and 43%. The instrument works highly accurate. Even smallest misadjustments of the emissivity cause only very little temperature display errors, compared with a conventional pyrometer.

Due to physical aspects in the beginning of the measuring range the MI-S 12-AI is sensitive against ambient light (daylight, fluorescent lamps or light bulbs). The pyrometer has to be shielded against these ambient light (see example drawing fig. 2) for temperatures up to 650°C. If the illumination of the measuring object is necessary this can be done with a lamp in combination with a blue glass filter, which completely filters out the undesired radiation.

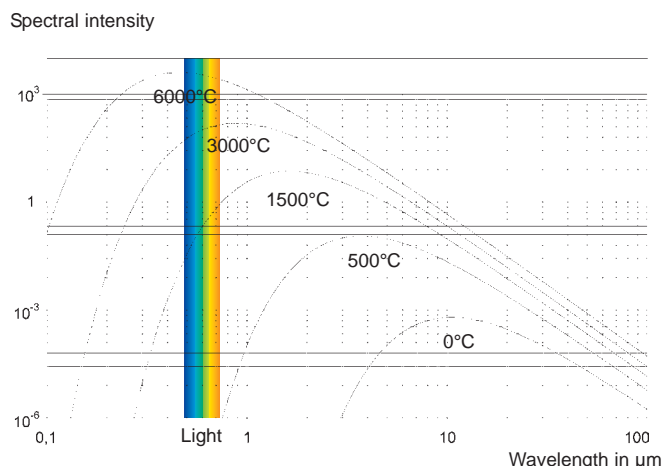


Fig.1: Diagram of spectral intensity

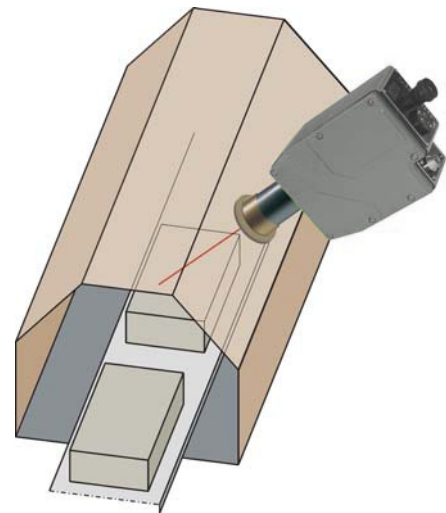


Fig. 2: Screening the MI-S 12-AI against ambient light

As a further possibility to measure aluminum applications with other pyrometers, Mikron has an optical emissivity enhancer in the product range. This mechanical accessory is for use at lower temperatures. Mounted close to the measuring object, it focuses the emitted energy of the aluminum directly on the lens of the pyrometer. This technique increases the emissivity of the measured aluminum up to 50%, so that measurements can be

done with standard pyrometers for metal measurement. Dependent on the pyrometer's type temperature measurements between 30 and 1300°C are possible.

Extrusion molding

The production process of extrusion molding profiles can be controlled completely using non-contact temperature measurement. The quality of the final product can be improved drastically.

There are three critical locations in the production process where Mikron pyrometers can be used for controlling these applications:

- After preheating the billet
- Profile exits the die
- If the profile is quenched

After preheating the billet the aluminum temperature is about 400°C. In this case the pyrometer MI-GA 5 in combination with the optical emissivity enhancer suites best. The emissivity enhancer increases the emissivity up to 50% and ensures a stable measurement. All components necessary for installation and operation e.g. mounting angle or cooling jacket are provided as standard.

When the final pressed aluminum profile exits the die, its temperature ranges between 500 and 600°C. Here a temperature measurement only makes sense with the MI-S 12-AI (see also front cover photo). With a temperature range of 350 ... 900°C and the response time of only 8 ms a quick and reliable measurement can be done.



Fig. 4: Pyrometer MI-S 12-AI for measuring of aluminum

To ensure an unobstructed and error free production process and quality assurance it is necessary to control parts of the machinery and installation at regular intervals.

To prevent delays when changing the die, this part has to be preheated. Because the die is a metallic object a pyrometer in a short infrared wave range and with a fast response time (1 - 2 ms) has to be selected. Stationary or portable instruments can be used but the actual choice of the type of the instrument is determined by the production process requirement.

Mikron offers the stationary digital pyrometer MI-GA 5 or the MI-GA 8 plus as a portable instrument (Fig. 5). The instruments have measuring ranges between 250 and 1300°C. They are equipped with laser pilot light or through-the-lens-sighting for exact alignment. Additionally to standard analog outputs 4 or 0 to 20 mA a serial interface (RS232 or RS485) for communication with a PC is provided. Accessories for mounting and cooling etc. are available.

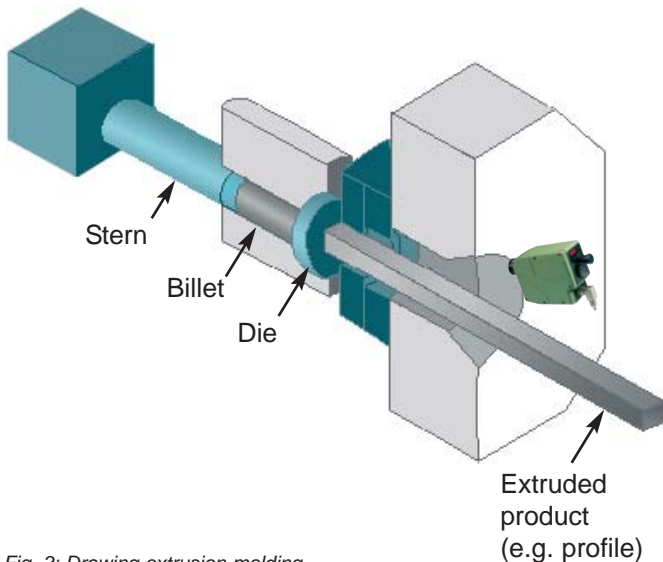


Fig. 3: Drawing extrusion molding

Quenching the profile after molding, the quality of the final product depends heavily on the speed of this process. For monitoring the aluminum temperature the MI-P 140 can be used in this case, again in combination with the emissivity enhancer. This pyrometer features a temperature range between 50 and 400°C and is the optimal choice for this task.



Fig. 5: Stationary pyrometer MI-GA 5, portable pyrometer MI-GA 8 plus, water cooling jacket with integrated air purge unit

Aluminum melt

In the melting pot of an aluminum melt the temperature of aluminum exceeds 600°C. It is possible to measure the temperature directly down in the melting pot. But for a correct measurement the liquid aluminum has to be stirred. Otherwise the oxide film would change the result of the measurement. Here as well the MI-S 12-AI has to be used.

Aluminum forging

When forging aluminum, temperatures between 500 and 550°C have to be reached which is close to the melting point. After forming with e.g. a sledge-hammer the surface is blank and free of any oxide film. Here is another field of application where the MI-S 12-AI can be used optimally.

Rolling

Rolling aluminum is done in very different temperatures. Approx. 200°C after preheating is reached and approx. 450°C at the beginning of the rolling mill is seen. Towards the end of the rolling mill temperatures below 100°C can be measured. In this case the highly accurate pyrometer MI-GAR 12-LO with a temperature range of 300 to 1000°C is suitable. The MI-PE 140 already measures temperatures from 30°C (see fig. 8). Both instruments have to be used in combination with the emissivity enhancer.

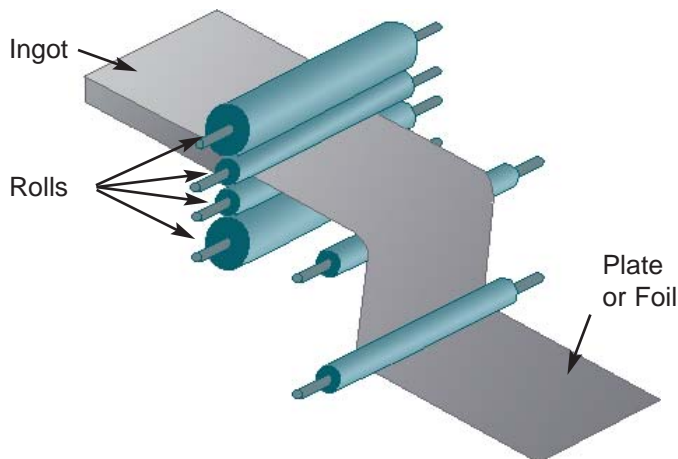


Fig. 7: Rolling mill

Measurements of pouring aluminum stream

Basically the pouring stream of aluminum can only be measured with pyrometers. Due to the high flow rate and the material condition the MI-S 12-AI with its short response time and the high accuracy is perfectly suitable again. A high measurement accuracy will be reached because no oxide film is built up and the measuring signal is not influenced by emissivity variations.



Fig. 6: Molten aluminum



Fig. 8: Pyrometer MI-PE 140 and optical fibre pyrometer MI-GAR 12-LO

Reference probes

For a correct initial setting of the emissivity at the pyrometer a reference temperature with a contact probe should be taken. If the temperature at the pyrometer and at the probe are corresponding, the correct emissivity is found and has to be adjusted at the pyrometer accordingly. Mikron offers a wide range of thermocouples with temperature ranges between -200 and 1300°C. They are available as surface probe, roller surface probes or as immersion probes and suitable for use in the aluminum industry.

Customised solutions

For questions or individual solution requests please contact our well trained specialists team. They are pleased to help you solving your measuring tasks.

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