Aluminium

Non-contact temperature measurement in aluminium processing

- Special Aluminium Pyrometer
- Emissivity Enhancer
- Extrusion
- Rolling
- Forging
- Pouring
- Process Control
- Software

IMPAC - Specialist in non-contact thermometry
Temperature is an important parameter for aluminium processing. Whether it is extrusion, rolling, pouring or forging – only precise temperature control secures the required material properties.

### IS 12-Al aluminium pyrometer

The IS 12-Al is a high quality, fully digital pyrometer which has been developed especially to measure aluminium surface temperatures. The IS12-Al uses special measurement and analysis technologies to assess the temperature. With this technology the emissivity of aluminium is sufficient to guarantee highly accurate measurement results from 350°C upwards. If the surface condition of the aluminium target changes significantly from piece to piece, the IS12-Al should be combined with an emissivity enhancer.

Due to the underlying physics the IS12-Al is susceptible to ambient light (e.g. daylight or artificial light) at low temperatures. Consequently, the unit and target area has to be shielded. Quite often this protection is achieved by the choice of the optimised measurement location within the machine.

### Emissivity enhancer

To reduce systematic measurement errors the emissivity of the target should be as high as possible. IMPAC has developed an optical emissivity enhancer, an innovative accessory, which "amplifies" the characteristically low emissivity aluminium.

Taking the above mentioned conditions and properties into consideration, IMPAC has developed special pyrometers, which cover the majority of the measurement tasks of aluminium processing. Specifically the IS12-AI pyrometer and the emissivity enhancer offer solutions to achieve reliably and robust measurement results without extensive efforts.

**Non-contact measurement of aluminium**

All materials emit electro-magnetic radiation (infrared radiation). A pyrometer uses this radiation to measure temperature. Materials have different properties and a characteristic radiation. The parameter used to characterise this radiation is called emissivity.

Another property of aluminium is of great importance for the non-contact temperature assessment. Pure, shiny or polished aluminium almost has in the total infrared bandwidth a very low emissivity, in other words the reflectivity of the material is quite high.

Furthermore, due to exposure to oxygen, the surface is covered by an oxide film. This film permanently grows non-linearly and changes the properties of the surface and hence the emissivity of the infrared radiation significantly. This change of parameters reduces the accuracy of the measurement using an ordinary pyrometer.

There have been numerous attempts to tune measurement instruments to the difficult, permanently changing conditions by a "teaching" process – a complex process with few results.

In many production locations the temperature is only randomly measured using contact thermometers. This method does not allow total and continuous temperature monitoring. In contrast non-contact thermometry is an optimised solution for measurement of molten aluminium, hot finished products and hot machine parts.

### Your advantages in one glance

- Non-contact thermometry using pyrometers
  - Monitoring and controlling of the total heating process
  - Process documentation by recording the measurements
  - Securing product quality at a high level
  - Cost reduction by enhanced process stability
  - Output maximisation by efficiency improvement
  - Correction of process parameters in time and consequently reduction of scrap

IMPAC offers stable measurement results in aluminium processing applications.

**Pic. 1: Non-contact temperature measurement after the extruded profile exits the die.**

**Pic. 2: The precise temperature measurement in aluminium processing is a challenge for many companies.**

**Pic. 3: Fixed pyrometer IS 12-AI especially developed by IMPAC for the temperature measurement of aluminium surfaces.**

**Pic. 3: Emissivity Enhancer.**
To measure temperatures between 300°C and 400°C, which occur in the process of rolling aluminium, the IGAR 12-LO is the pyrometer of choice. This 2-colour pyrometer provides high accuracy by compensating the emissivity changes of the aluminium surface by the use of special algorithms.

The temperature of the die used in the extrusion process is measured in an effective and flexible way by the portable pyrometers IGA 8 plus and IGA 15 plus.

To allow multiple reflections of the radiation the mirror should be mounted within 30mm of the target.

Additional pyrometers

For most of the applications in the aluminium industry the IS12-Al is the best solution.

For special measurement tasks other pyrometers are applicable. Because the IS12-Al is capturing temperatures from 350°C upwards, IMPAC has developed alternatives for lower temperatures.

The IP 140 is able to measure from 50°C and should be used along with an emissivity enhancer for measuring the temperature of extruded profiles in the cooling zone.

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Application: Extrusion

Extrusion is a process in which an aluminium billet is pressed into a die by a ram. The die determines the form of the extruded strand. Using this process tubes, wires, solid or hollow profiles can be extruded.

This process has several critical sections which demand temperature monitoring:
After pre-heating of the billet, in the pressing process of the profiles and in the cooling section of the extruded products. After changing a die, the temperature should also be checked.

Application Measurable Not measurable Comment

<table>
<thead>
<tr>
<th>Application</th>
<th>Measurable</th>
<th>Not measurable</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extrusion</td>
<td>x</td>
<td></td>
<td>Billet heating; profile measurement; cooling process</td>
</tr>
<tr>
<td>Rolling</td>
<td>x</td>
<td></td>
<td>Directly after forming</td>
</tr>
<tr>
<td>Forging</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molten (in crucible)</td>
<td></td>
<td>x</td>
<td>Due to the fast oxidising of the surface no measurement possible</td>
</tr>
<tr>
<td>Molten (moving/flowing)</td>
<td>(x)</td>
<td></td>
<td>Measurement only with continuous &quot;breaking&quot; of oxide coating directly after the melt</td>
</tr>
<tr>
<td>Pouring</td>
<td>x</td>
<td></td>
<td>Directly on the pouring stream</td>
</tr>
</tbody>
</table>

Billet measurement

To be pressed through the die without any problems, the billet has to be pre-heated to between 400°C and 500°C to be soft enough. The optimal pre-heating temperature is important because it guarantees a solid production process and improves process speed and throughput.

The surface of the billet oxidises variably unless un-machined. The IS12-Al with emissivity enhancer provides temperature measurement of most aluminium billets.
Extruded profile measurement
Exiting the die the extruded aluminium profile has a temperature of around 500°C. The extrusion process heats the billet additionally by the plastic transformation.

In general, high temperatures speed up the production process. But if the material gets too hot, it starts to melt and loses its shape and properties. Too cold temperatures eventually could damage or destroy the die. Using non-contact pyrometry in those critical process areas the production can be monitored extensively and controlled respectively.

For above application the assessment of the aluminium temperature is also achieved using the IS 12-Al. The surface structure at this point of the production is quite constant and does not require the use of an emissivity enhancer.

The measurement itself should be executed from the top using an opening within the extrusion tool or directly after the profile exits the die. Another possibility is aiming into the press jaw targeting at the extrusion profile.

For processes of parallel multiple extrusion strands with varying shapes and positions or frequent changing of the die and the respective profile geometries, IMPAC has developed the IS12-Al with an integrated scanner. The unit does not require to be re-aligned for each new extrusion shape because the exit is permanently "scanned" to automatically detect the production strands.

Cooling process
After extrusion the produced profile is cooled. To guarantee consistent high quality of the final product the cooling speed has to be controlled.

To monitor the strand temperature an IP 140 or IPE 140 in combination with an emissivity enhancer is used. Measuring temperatures from 5 and 50 °C upwards these pyrometers are the perfect units for the quenching process.

Measurement of the die temperature
Before installing a new die, it should be pre-heated to the billet temperature. If a pre-heated billet hits a cold die the resulting temperature shock will cause problems. The top of the billet hitting the cold die will cool, become harder and jam the extrusion process. Thanks to non-contact temperature measurement the die temperature can be monitored easily and quickly, which avoids problems from the start.

The die is made of metal - the ideal target for short wavelength standard pyrometers. IMPAC recommends for fixed installations the IGA 5 digital pyrometer. Flexible alternatives are the portable products e.g. IGA 8 plus with through lens sighting or the IGA 15 plus with laser target light.

<table>
<thead>
<tr>
<th>Type</th>
<th>Temperature Range [°C]</th>
<th>Response time [ms]</th>
<th>Application</th>
<th>Emissivity enhancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS 12-Al</td>
<td>350 ... 900</td>
<td>1,5</td>
<td>Extrusion: profile measurement</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Extrusion: billet heating</td>
<td>yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Forging</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pouring stream</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rolling</td>
<td>–</td>
</tr>
<tr>
<td>IS 12-Al/S</td>
<td>350 ... 900</td>
<td>1,5</td>
<td>Extrusion: multiple extrusion</td>
<td>–</td>
</tr>
<tr>
<td>IGA 5</td>
<td>250 ... 3000</td>
<td>2</td>
<td>Extrusion: die temperature</td>
<td>–</td>
</tr>
<tr>
<td>IP 140</td>
<td>50 ... 1300</td>
<td>1,5</td>
<td>Extrusion: Cooling process</td>
<td>yes</td>
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<tr>
<td>IPE 140</td>
<td>5 ... 1200</td>
<td>1,5</td>
<td>Extrusion: Cooling process, rolling</td>
<td>yes</td>
</tr>
<tr>
<td>IGA 12-LO</td>
<td>300 ... 2200</td>
<td>2</td>
<td>Rolling</td>
<td>yes</td>
</tr>
</tbody>
</table>

**Fixed pyrometers**

**Portable pyrometers**

<table>
<thead>
<tr>
<th>Type</th>
<th>Temperature Range [°C]</th>
<th>Response time [ms]</th>
<th>Application</th>
<th>Emissivity enhancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>IGA 8 plus</td>
<td>300 ... 1300</td>
<td>1</td>
<td>Extrusion: die temperature</td>
<td>–</td>
</tr>
<tr>
<td>IGA 15 plus</td>
<td>250 ... 1800</td>
<td>10</td>
<td>Extrusion: die temperature</td>
<td>–</td>
</tr>
</tbody>
</table>
Application: Pouring stream

The surface of molten aluminium in a melting furnace is fully oxidised at temperatures of around 700°C. Even "stirring" of the molten mass will not prevent the surface from being quickly oxidised. This causes a significant change in the radiation of the molten aluminium surface, which is impossible to be compensated by an infrared pyrometer.

A possibility to measure the molten aluminium is at the pouring stream in the pouring process.

The dross is pushed back by a strong stream of air generating an almost oxide free surface which can be measured. The measurement of poured aluminium is only possible using non-contact infrared technology. Due to the fast response time of the IS 12-Al the pouring stream temperature as well as aluminium temperature in the channel can be assessed precisely.

Your advantages using IMPAC technology

IMPAC is your partner for all aspects of non-contact temperature measurement using infrared technology. IMPAC offers system solutions, industry solutions or special customised solutions that cover your individual tasks.

Our customers benefit from our long-term experiences in pyrometer technology:

- Highest quality standards
- Analysis of rapid processes
- Measurement of moving objects
- Long term support for all products
- Ease of use
- Full digital signal conditioning
- Open software protocol UPP® (integration into your equipment)

Automatic process control

Beside the visualisation of temperature trends, pyrometers enable automatic process control. The pyrometer sends temperature data to the PLC-control of the machine. Cooling or process speed could be controlled by this data input of the infrared sensors. As an alternative the analogue output of the pyrometer could be used to control processes directly.

Special solution: Software

IMPAC offers software for visualisation, data-logging and analysis for various products.

InfraWin: InfraWin is the standard software shipped with all digital pyrometers from IMPAC. Additionally to visualisation, data-logging and analysis all parameters can be adjusted by software.

All IMPAC pyrometers utilise the Universal Pyrometer Protocol (UPP®). This enables the seamless integration of pyrometers into existing user software.

MultiTemp: MultiTemp is software for combining the data-logging of several pyrometers. Temperatures are visualised, logged and can be analysed from a central computer. Also all parameters of all attached pyrometers are adjustable.

For additional customer specific software requests IMPAC systems will provide individual solutions.

Individual application solutions

Our experienced staff will answer your questions and provide individual solutions based on our technologies.

Additional information can be found on our website with regards to data sheets, application brochures, news etc. or ask us directly at IMPAC.