Application brochure

impac®
Mikron Group

Aluminium

Non-contact temperature measurement in aluminium processing

zertifiziert ISO 9001:2000 IMPAC Infrared

- 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.

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

To give an example: In the pressing process of extrusion a too high temperature will soften the profile to be formed too much. The product will lose the desired form (production of scrap). Using a too low temperature the aluminium billet will be not soft enough to be pressed through the die without a problem (quality problems, reduced throughput). Additionally, a too hard billet will damage the die.

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

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.

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

IMPAC offers stable measu rement results in aluminium processing applications.

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-Al* pyrometer and the emissivity enhancer offer solutions to achieve reliably and robust measurement results without extensive efforts.

IS 12-Al aluminium pyrometer

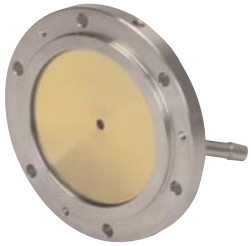
The *IS 12-Al* is a high quality, fully digital pyrometer which has been developed especially to measure aluminium surface temperatures. The *IS12-Al* uses special measurement and analysis technologies to assess the temperature.
With this technology the emissivity of aluminium is sufficient to guarantee 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.

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

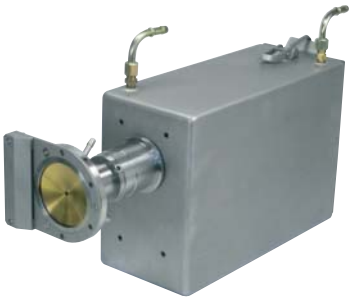
Due to the underlying physics the *IS12-Al* is susceptible to ambient light (e.g. daylight or artificial light) at low temperatures. Consequently, the unit and target area has to be shielded. Quite often this protection is achieved by the choice of the optimised measurement location within the machine.

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.



Pic. 3: Emissivity Enhancer.



Pic. 4: IS 12-AI with cooling jacket and Emissivity Enhancer for measurement in hot environments.

Pic. 5: IMPAC pyrometer IP 140 / IPE 140.

Pic. 6: IMPAC pyrometer IGAR 12-LO.

The *emissivity enhancer* consists of a gold plated concave mirror, which bundles the multiple reflection of the aluminium radiation into the centre of the small hole in the middle of the mirror. The pyrometer is mounted directly behind the central hole and measures the "mechanically"multiplied optical radiation.

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.

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.

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.

Billet measurement
To be pressed through the die without any problems, the billet has to be preheated to between 400°C and 500°C to be soft enough. The optimal preheating 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.

Pic. 7: Temperature control of preheated billet before extrusion.

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

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.

Pic. 8: Temperature control of extruded profile after the profile exits the die.

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.

Pic. 9: Portable IMPAC pyrometers IGA 8 plus and IGA 15 plus.

Type	Temperature Range [°C]	Response time [ms]	Application	Emissivity enhancer
Fixed pyrometers				
IS 12-Al	350 ... 900	1,5	Extrusion: profile measurement	–
			Extrusion: billet heating	yes
			Forging	–
			Pouring stream	–
			Rolling	–
IS 12-Al/S	350 ... 900	1,5	Extrusion: multiple extrusion	–
IGA 5	250 ... 3000	2	Extrusion: die temperature	–
IP 140	50 ... 1300	1,5	Extrusion: Cooling process	yes
IPE 140	5 ... 1200	1,5	Extrusion: Cooling process, rolling	yes
IGAR 12-LO	300 ... 2200	2	Rolling	yes
Portable pyrometers				
IGA 8 *plus*	300 ... 1300	1	Extrusion: die temperature	–
IGA 15 *plus*	250 ... 1800	10	Extrusion: die temperature	–

Pic. 10: Temperature measurement of molten aluminium.

Application: Rolling

The customer base supplied by aluminium rolling mills takes a wide variety of products such as plates, foils and strips, demanding the highest quality products. To roll high-grade products the decisive difference is the precise temperature control.

If the required temperatures are maintained precisely, the product quality can be assured and damages to the roll stand will be avoided.

Rolling aluminium results in temperatures which are quite differing. In a first step the block to be rolled is pre-heated to 200°C. Entering the rolling mill the aluminium block has a temperature of around 450°C. Exiting the rolling mill the temperature drops to below 100°C.

The reading of the higher temperatures at the process start of the rolling mill are measured most accurately by the *IS 12-Al*. The emissivity enhancer is not required. Lower temperatures are measured using the *IPE 140* family or the ratio- (2-colour) pyrometer *IGAR 12-LO*. Both products should be used in combination with the *emissivity enhancer*.

Application: Forging

Forging processes or a forging press require temperature measurement before and after the forming process.
Before forging or extruding a billet, it is pre-heated to 500°C to 550°C. After the forming process the surface of the product is free of oxide films, which guarantees highly reproducible measurement conditions.
For reliable temperature measurement in both cases the *IS 12 -Al* could be used with or without emissivity enhancer.

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)

Pic. 11: IMPAC pyrometers stand for cutting edge quality in technology and workmanship.

For more than 45 years our customer base benefits from a constant high quality level, an attractive cost - value ratio and the reliability of IMPAC products.

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.

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