

SPOT AL EQS Pyrometer Delivers Aluminium Extrusion Measurement Accuracy

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Since the 1950s, the use of steel and other metals began to give way to aluminium's inherent beneficial features. Providing substantial strength, malleability, high heat and electrical conductivity, corrosion resistance, and non-magnetic properties, the growth in aluminium use burgeoned, gaining strength during the past two decades. Several different grades of aluminium alloys have been created to match specific industry requirements, with specific grades designed for either corrosion resistance, strength or formability.

Today aluminium is the leading non-ferrous metal in use in such industries as aeronautics, beverage containers, construction and energy. It is second only to steel in select industries. Spurred by the need to reduce power and make parts that are smaller, less costly and lighter, aluminium delivers:

- Lightness—it is the lightest of all ordinary metals, almost 3 times lighter than steel
- Thermal and electric conductivity (unalloyed) that is approximately 60% that of copper
- Corrosion resistance that enables longer product life, lower maintenance costs and improved product appearance
- Alloys that, when combined with aluminium, offer the ability to match metal characteristics to such needs as weldability, corrosion resistance and mechanical performance
- 30% of the metal has been recycled after use for the past two decades—and it can be recycled an unlimited number of times.

Even considering global fluctuations and oversupplies, demand remains strong for aluminium. Automotive and aerospace increased aluminium useage in 2015, and the construction sector grew in countries such as India. Packaging continues to grow as well based on greater aluminium can demand.

While aluminium's use is ubiquitous, its extrusion is not without challenges. Specifically, the metal has unique emissivity characteristics and reflectivity considerations that complicate accurate and repeatable temperature measurements. Understanding and controlling temperature within the extrusion process is critical, therefore, to delivering quality aluminium extruded parts.

A look at emissivity and temperature

An objects ability to radiate its energy is known as Emissivity. If Emissivity is unknown or variable and is not compensated for, then temperature measurement will be inaccurate. Emissivity varies with wavelength, alloy grades and surface condition. Process temperatures dictate such characteristics as hardness and finish in the aluminium extrusion process.

With low Emissivity materials it takes a very small emissivity change to cause huge errors in temperature readings; and, for extruded aluminium, emissivity is not constant. Additionally Aluminium is processed at lower temperatures than most metals, meaning even less energy is emitted. It is extremely difficult, therefore, to compensate for emissivity variations, making accurate temperature measurements even more critical.

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Radiation thermometers detect emitted surface thermal radiation. However, for reflective surfaces with low emissivity, such as aluminium surfaces, thermometers receive less radiation, and surfaces appear colder unless the emissivity setting is adjusted. Aluminium extrusion alloys contain small amounts of copper, manganese, silicon, magnesium, or zinc that enhance aluminium's natural properties, and influence product performance parameters and the extrusion process. These alloys also affect aluminium emissivity, as does surface oxidation, texture, contamination and crystal structure. Hundreds of aluminium alloys exist and each has unique characteristics and emissivity. Identification of alloys used and adjusting for characteristics is problematic in the extrusion process.

The extrusion temperature also affects dimensional properties of final products. In aerospace applications, for example, should the temperature be even slightly high, the extrusion surface finish may feature markings and grooves and potentially form cracks. Extruding a product at an improper temperature can also cause it to not shrink to the desired physical size when cooled. Conversely, if the extrusion is slightly too cold, the die in the extrusion press may wear more rapidly based on the additional pressure necessary to push aluminium through the die, given that the hardness of the extrusion is affected. When the die wears, the physical sizing of the finished part will change. Dimensions and surface finish are very important—and it is imperative to continuously measure temperature as accurately as possible.

In addition to being able to take reliable temperature measurements throughout the extrusion process, and do it repeatedly, controlling material flow conditions, many conditions in the extrusion press also represent challenges. Carefully tuning die outlet geometry and billet and tool temperatures, for example, enables material flow. Within the high-pressure extrusion environment, die distortion is potentially an issue that must be compensated for.

Shape also determines extrusion ease, cost and size, as does scrap and tongue ratios, tolerance and finish join flow, thermal conditions, speed, pressure and die outlet geometry—and all the aspects are interrelated. While lower extrusion temperatures often produce shapes with high-quality surfaces and accurate dimensions, extruding at these temperatures requires higher pressures.

Where measurement is mandatory



Figure 1. Extrusions begin with aluminium billets. Source: AMETEK Land

The aluminium extrusion process has three critical locations where accurate temperature readings are necessary.

At the beginning of the process, the extrusion billet is solid and typically cylindrical, with 7-inch (178 mm) to 10-inch (254 mm) diameters, although this can vary. At this stage, heater performance deficiencies and a variety of billet lengths can adversely affect measurements. The correct temperature for this location provides for the best surface and tolerance conditions, as well as the shortest cycle time. Ideally, for example, the lowest temperature permitted by the process, coupled with correct extrusion speed, creates the best environment. At billet temperatures and extrusion speeds that are too high, metal flow is too fluid, filling larger voids in the die face, while resisting entry into constricted areas.

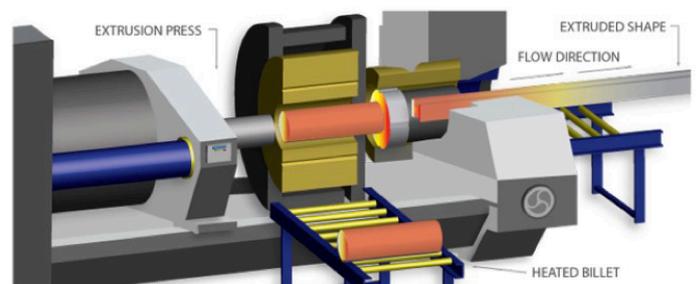


Figure 2. A rendering of the aluminium extrusion press die exit. Source: AMETEK Land

The extruded profile temperature at the exit of the press is the most important process parameter to optimize the efficiency and quality of the complete extrusion operation. By using a consistent and optimal operating temperature at the exit of the press, press speed can be optimized and potential problems with soft metal, cracks and blemishes eliminated. Improper temperatures make precise press exit temperature management challenging, leading to die wear and product quality variations.

Quality control requires verification of proper quench rates within the quench zone. When the rate is too slow, soft metal is a result; when it is too fast, dimensional tolerances are sacrificed.

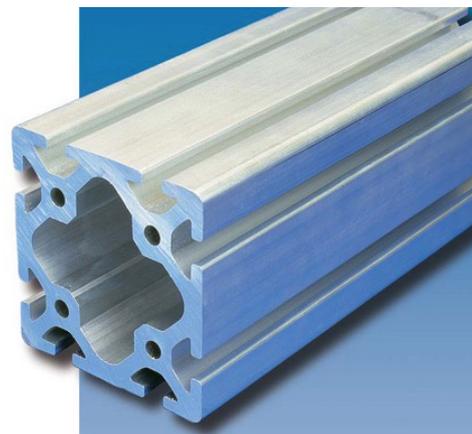


Figure 3. Fully integrated temperature measurement of die, billet 'taper', extruded sections and quench rate ensures usable extrusions with exact dimensions and clean surfaces.

Source: AMETEK Land

Infrared thermometry optimizes accuracy at each of the three locations. In the past, however, three thermometers were required to measure the temperature at each of the above locations—the extrusion press exit, the extrusion quench and billet.

SPOT AL EQS

Today the highly integrated SPOT AL EQS multi-wavelength pyrometer, with application-specific computational abilities by AMETEK Land, provides accurate measurements, identifies alloys and compensates automatically—and does so straight out of the box. All signal processing takes place in the pyrometer, while SPOT AL EQS high-speed digital processors perform emissivity and temperature computations. The combination of precision optics, sensitive detectors and advanced high-speed computational methods enables SPOT AL EQS to perform with significantly improved accuracy in more varied situations than competitive pyrometers.

Features and benefits of the SPOT AL EQS also include:

- Customers need to maintain only one spare thermometer, rather than the three the SPOT AL EQS replaces
- The superior onboard digital processing power of the AL EQS enables the processing of complex multi-dimensional algorithm equations.
- Easy-to-use, out-of-the-box setup
- Continuous, fast and accurate data
- Adjustments or recalibration are not necessary
- Automatically adjusts for alloy and surface finish

The easy-to-use SPOT AL EQS provides local or remote configuration as well as menus with multiple language choices, avoiding translational misunderstandings. Optional SPOT server software enables users to trend, record and display data simultaneously from up to 40 SPOT pyrometers. Precision optics provide well-defined target size and location, and multiple output formats match most customer needs. SPOT AL EQS easily and automatically accommodates partially filled target areas, varied alloy types, and flat and cavity sections.

SPOT AL EQS features a remote actuator output that detects the area of highest emissivity on the extrusion and automatically drives an optional actuator to that position. When sections change, it is not necessary to manually reposition SPOT AL EQS. When an uncommon alloy type is encountered, SPOT AL EQS is easily taught to accommodate it simply by using SPOT Viewer and entering reference temperatures taken by a verifying thermocouple probe. A background temperature value, if significant, can be entered to compensate for the effects of surrounding reflections further improving accuracy. A through-the-lens camera can be viewed on the pyrometer's local display or remotely via a standard Ethernet connection. Users can view and adjust settings or verify alignment remotely via any web browser. There is no need for custom software.

Finally, for 0-20 mA or 4-20 mA outputs, 24 V DC or Power over Ethernet (PoE) powers the SPOT AL EQS. For Ethernet for Modbus TCP, SPOT AL EQS uses PoE or 24 V DC and both power supplies can be connected simultaneously.

Global consumption of aluminium

According to *The Aluminium Market Analysis, Financials and Forecasting 2015-2025* published by Visiongain, the world market for aluminium was \$105.63 billion in 2015. Citing the volatility in the aluminium market over the past several years based on massive overproduction, the market experienced large quantities of inventory until now. Visiongain materials industry analyst Darja Potjakina predicts:

In the long term, we anticipate the prospects for aluminium to remain bright. The aluminium industry will greatly benefit from the growing global megatrends that will increase the consumption of aluminium in the near future. Massive production cuts will be another factor that will help stabilize the healthy growth of the aluminium market in the coming years, as oversupply has been a major restraint. We anticipate the strongest growth in aluminium demand to come from the BRIC nations and Middle East region. We also expect the transportation and construction sectors to be the major contributors to growth in this market.

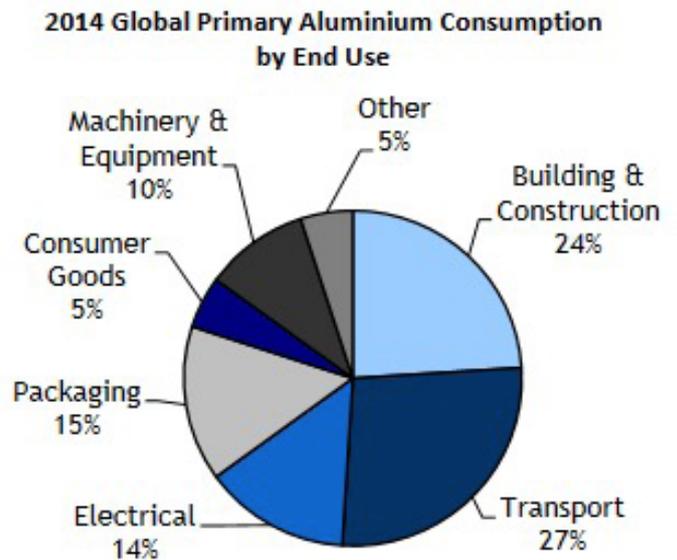


Figure 5. NIR-b on auto retraction mechanism – shown retracted

Industries using aluminium include aerospace, automotive, marine, rail, building, machinery, robotics, HVAC, energy distribution, energy, sports and leisure, and packaging. Especially within the automotive, aerospace and construction market segments, consistent material properties and accuracy are essential. Growing automotive uses include fuel cell-powered cars, as aluminium can be used to produce hydrogen fuel efficiently, which will spur the growth of this automotive segment while helping to arrest greenhouse emissions.

Aluminium production is energy intensive and, according to an [International Aluminium Institute \(IAI\) report](#), new stocks of aluminium account for 1% of total greenhouse gas emissions by humans. According to the report, every kilogram of a heavier material that is replaced by aluminium results in the reduction of 22 kilograms of carbon dioxide over the lifetime of the vehicle.

The recyclability of aluminium products is an important factor in its continued future growth. IAI also indicates that more than 63% of all aluminium cans are recycled globally. Aluminium recycling uses a mere 5% of the energy required for primary production, while emitting just 5% of the greenhouse gases.

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ABOUT AMETEK LAND

AMETEK Land is a global supplier of non-contact temperature measurement instrumentation, process imaging solutions and combustion and environmental analyzers. Founded in 1947, LAND has been the premium supplier of temperature measurement solutions and combustion emissions monitoring.

AMETEK Land has facilities in the United Kingdom, China, France, Germany, India, Italy, Japan, Singapore, Spain and the United States.

The full range of non-contact temperature products includes high accuracy hand-held portables, fixed system spot temperature sensors, thermal line scanners, process thermal imagers and calibration sources. Many application specific systems solutions are available