Equipment Spotlight…

Accurate Temperature Measurement for Aluminum Extrusions

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Understanding temperature and controlling press speed and quench rates during the extrusion process are critical to producing high-quality profiles that meet required specifications and properties, particularly in demanding industries such as automotive. For example, the temperature of the extrusion at the press exit affects the dimensional properties and surface finish of the final product. If the temperature is too high, the surface finish may suffer imperfections that, apart from being unattractive, can potentially lead to cracks. On the other hand, if the temperature is even slightly too cold, the die in the extrusion press may wear more rapidly due to the increased hardness of the metal and the additional pressure required to extrude it. As a die wears, the physical size of the extruded section changes, not to mention that replacement of the die is expensive. Therefore, it is imperative to continuously monitor press exit temperature as accurately as possible.

Non-Contact Temperature Measurement

Aluminum extruders measure temperature at various locations, the three most common being at the billet, the press exit, and the quench exit. Temperature measurement methods that involve direct contact are not well suited to the extrusion process, as they are often taken manually at a single point and can damage the surface. In comparison, non-contact temperature measurement sensors (infrared pyrometers) use radiated energy emitted from the aluminum surface for measurement. This allows extruders to continuously measure the temperature of the metal at each stage of the process without risking damage to the profile surface.

Aluminum alloys have unique reflectivity and emissivity (an object's ability to radiate infrared energy), characteristics that create a challenge for conventional infrared pyrometers. As a result, small changes in emissivity have the potential to cause errors in the temperature readings. However, modern application-specific infrared pyrometers are now available that can address these challenges.

AMETEK Land developed SPOT AL EQS multi-wavelength pyrometers that use complex signal processing algorithms combined with powerful high-speed digital signal processing and ultra-low noise signal amplification to produce accurate results over a wide range of different alloys and surface conditions. The pyrometer has an integrated video sighting system (Figure 1) that allows the operator to easily and correctly position the device with a motorized focus adjustment between 300 mm and infinity. In addition, the bright, green, pulsed LED focus pattern projection makes it easy to verify target alignment, the actual measurement spot location, and spot size. All configuration choices can be programmed on the pyrometer via the push buttons and digital display screen. The pyrometer also features an integrated web server, which allows all configuration choices to be set remotely over a standard ethernet connection, using any standard web browser (e.g. Chrome, Internet Explorer, Firefox, Safari).

Figure 1. The pyrometer provides video sighting to ensure precise alignment.

The pyrometer has three scalable modes E, Q, or S, allowing it to be optimized for the press exit (E) or quench exit (Q) positions in extrusion plants, as well as for aluminum strip rolling mills (S). This enables the same model of pyrometer to be used at all three measurement locations, making it simple and affordable to keep a spare pyrometer on hand.

Billet Taper: At the start of the extrusion process, a billet is heated to temperature in a specialized reheat furnace. Extruders often measure the billet temperature with either a single reading on its cut face or a profile reading along the side of the billet from head to tail. However, many extruders prefer to measure the billet profile temperature just as the billet arrives at the extrusion press. AMETEK Land offers a motorized actuator that rapidly scans the SPOT AL EQS pyrometer along the length of the billet (Figure 2), generating a temperature profile. The actuator can either be integrated with the press control system or driven manually using a hand-operated controller.

Press Exit: The SPOT AL EQS (set in E mode) can be positioned above the press exit to scan the profile (Figure 3). This can either be a fixed installation with a manually adjustable mount that can be re-oriented

Figure 2. A pyrometer with a motorized actuator (A) scans the temperature of the billet length using a targeting LED spot (B).

Figure 3. At the press exit, the pyrometer targets an extruded profile by emitting a green LED spot to improve the accuracy of the temperature measurement.

following a die change or it can be combined with a motorized actuator allowing the pyrometer to be automatically aimed at the optimum measurement position on the new profile. This temperature measurement is typically fed back to the press control system to enable dynamic press speed. The small and

Figure 4. A SPOT AL EQS being implemented at the exit of the quench.

well-defined measurement spot of the pyrometer, combined with its rapid 15 m/s response speed, facilitates this dynamic tracking.

Quench Exit: For extruders who produce high-strength profiles or profiles with specialized characteristics, the quench exit is another important measurement location. The SPOT AL EQS (set in Q mode) can be positioned at the exit of the quench section looking downwards onto the profile (Figure 4). The pyrometer is often combined with a motorized actuator in this case. While the extrusion moves laterally, the actuator tracks the movement of the extrusion, enabling the pyrometer to be automatically aimed at the optimum measurement position on the profile. As with the press exit, the defined measurement spot of the pyrometer and the 15 m/s response speed facilitate such dynamic tracking.

AL EQS software is available that combines data from multiple SPOT pyrometers and calculates quench rates. Some extruders may choose to integrate the pyrometers directly into their PLCs or press controls.

Conclusion

Future application of extruded aluminum requires improved surface finishes and metallurgy. Knowledge of exact temperatures throughout the process will allow producers to improve quality and increase production yields. Fully integrated temperature measurements of billet taper, extruded sections, and quench rate can help to ensure superior extrusions with exact dimensions and excellent surface finish. ■