

Technology Strategy Consultants (tsc) aim to promote thinking and innovation within the aluminium industry.

During the course of our research we often encounter items of interest to the world of semi-fabricated aluminium products which, on their own, may seem insignificant but, when added together, could be seen as a step-change in their field of technology.



Totally Flexible Rolling

Traditional hot rolling

Many aluminium sheet producers have invested heavily in hot rolling plant, often comprising a reversing break down mill in series with either a coil-to-coil or multi-stand hot finishing mill.

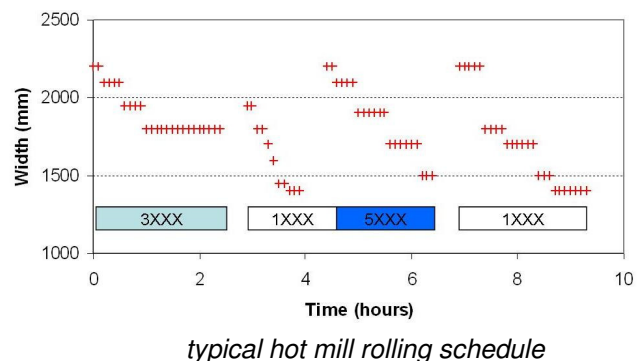
Hot mills like to make the same product repeatedly: historically this has been can stock. The mill can achieve a steady-state operating condition: the work rolls reach a constant temperature, with heat input from the strip balanced by the heat removed by the cooling system. This gives excellent consistency in coil to coil product quality.

However the market increasingly wants a range of products, comprising different alloys, widths and gauges. In order to achieve acceptable delivery performance, products are being rolled in smaller and smaller batch sizes. The mill may never reach a steady-state before the next product is rolled. Many coils are produced under "transient" conditions, leading to quality problems in terms of the surface, and excessive profile variations.

Flexible rolling

In an ideal world, a hot mill would be able to roll any product on demand, no matter what it had just rolled. There would be no need to schedule products in groups: the batch size would be a single ingot! But such flexibility must not be at the expense of productivity: the system must produce at least as many good tonnes per hour as were historically achieved with large batch sizes of a single product.

Sounds great. But is it feasible?



So why are hot mills so inflexible?

Why do hot mills so dislike change? Each transition from one ingot to the next is an event, which could perturb the system from steady-state. Scheduling the sequence of ingots through the mill is designed to minimise these transitions. For example:

- Delays or hold-ups between ingots cause large variations in profile, because work rolls cool during the delay. Some mills compensate for a known forthcoming delay by adding a small delay between coils in the current sequence.
- Width changes between ingots can also generate large profile variations: most mills schedule to roll increasingly narrower ingots in a campaign.
- Alloy changes can cause small profile fluctuations. Far more seriously, they can destabilise the coating which builds up on the work rolls, causing surface quality issues. This is notably a problem moving from high magnesium alloys to purer alloys.

Totally flexible rolling

In recent years, there have been two interesting developments in rolling technology, which if combined, could lead to more flexible hot rolling.

Hot edge sprays

The first is the advent of hot edge sprays in cold rolling. Work rolls get hot during rolling: coolant is sprayed on them, keeping their steady-state temperature typically 20 or 30°C hotter than the coolant. There is usually a rapid variation in temperature near the strip edge, hence the roll diameter changes rapidly in this region (rolls expand when hot). This leads to a common strip flatness defect called "tight-edge".

Many companies have developed hot edge sprays, to apply hot coolant (heatant?!) outside the strip edge. The work roll diameter doesn't then change so rapidly and the tight edge problem is eliminated.

A similar variation in work roll diameter occurs in hot rolling, causing profile variation during a width change. So hot edge sprays, so successful in cold rolling, could be developed for hot rolling. But why stop there? Why not have a whole bank of hot sprays across the work roll? These could be switched on during delays (whilst switching off the normal coolant sprays!), keeping the work rolls at their steady-state temperature. So that has solved the problem of profile transients...



In situ casting of clad ingots

The second development potentially relates to surface quality. A number of recent patents claim to cast DC ingots with surfaces of a different alloy. Starting with Kaiser (1986), Matzner (1995), Alcoa's simultaneous multi-alloy continuous casting, SMACC (2003) and now Novelis's Fusion (2004), the target has been to separate the product surface requirements from bulk mechanical properties. It is sometimes difficult (or impossible) for one alloy to meet both needs. The aim is to replace notoriously inefficient hot mill cladding (a theme discussed in a previous issue).



Fusion ingot (Novelis)

The surface quality problem in hot rolling occurs because of the change in alloy composition in contact with the work rolls. But what if all ingots had the same surface composition? If all ingots had the same surface cladding, there would be no variation in surface quality. The cladding should be a commercial purity alloy, also providing improved product formability and corrosion performance. The only product adversely affected by this would be can body stock, which should be left unclad, and run on dedicated mills.

So developing hot edge sprays to be cross-width hot sprays, coupled with all ingots being clad-cast with a pure alloy surface would allow ingots to be rolled in any order on the hot mill. Total flexibility, combined with improved product properties, and improved throughput... *too good to be true?!*

This "what if" scenario has been brought to you by **tsc**, to help relieve us of the here and now, and promote thinking and innovation within the industry.

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