Coolant management in aluminium flat rolled product manufacturing

Within the aluminium industry's Flat Rolled Product (FRP) sector, proper management of the rolling mill's coolant of choice plays an important role in maintaining product quality and controlling costs. **By Ed Brownlee***

Whether the coolant is being used in a hot mill or a cold mill, whether its formulation is emulsion-based or oil-based, the coolant's reprocessing system must ultimately minimise particulate and mill lubricant contamination and maintain additive levels. Adding to this challenge is the move by many FRP manufacturers toward stringent zero-waste policies.

FRP producers have several options for controlling contamination. This article will discuss these options and how they affect the rolling mill's operation, product quality, environmental impact and overall cost.

Coolant in rolling operations

Hot mills typically use an emulsion-based coolant consisting of 5% to 8% oil-based concentrate in water. Although cold mills can also use an emulsion-based product, oil-based coolant is the more common choice. Coolants contain several essential additives, which are used primarily for their load-bearing properties, and are often the most expensive component of the coolant formulation.

Coolant plays a critical role in the operation of every rolling mill and serves three main functions. First, it removes the heat generated during rolling by the friction of the rolls themselves, as well as the internal friction created by the working of the aluminum. Second, the coolant acts as a lubricant, controlling both the heat generation and the overall product finish. And third, coolant flushes debris away from the sheet.

During rolling operations, the coolant becomes contaminated with machinery lubricants, hydraulic fluids, water, metallic soaps, metal fines and other debris. These contaminants must be controlled for the coolant to be effective. Two technologies

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are used to control contamination: Distillation and filtration.

Distillation

Distillation is the best option for controlling contamination caused by mill lubes, which are the machinery lubricants and hydraulic fluids that leak into the system during operation. Distillation is also used to control contamination by metallic soaps created by the reaction between metallic fines and fatty acid additives. Distillation also aids in the removal of metal fines, oxides and debris. A dehydration step is often included in the process to remove residual water from the coolant prior to distillation.

During distillation, the coolant is heated under vacuum in order to lower its boiling point. Base oil and additive vapour leave the evaporator vessel, passing through a condenser. Then, after condensing to liquid, the clean coolant is returned to the rolling mill's clean oil tank. Concentrated contaminants and some un-recovered coolant that remain behind in the evaporator are periodically purged to a waste tank.

Several different companies manufacture off-the-shelf vacuum distillation systems. These are typically sold as skid-mounted, turnkey systems lacking the customisation needed to meet a customer's specific recovery and throughput requirements. Without such customisation, the distillation process is often inefficient and more likely to send too much base oil and additive out with the waste stream.

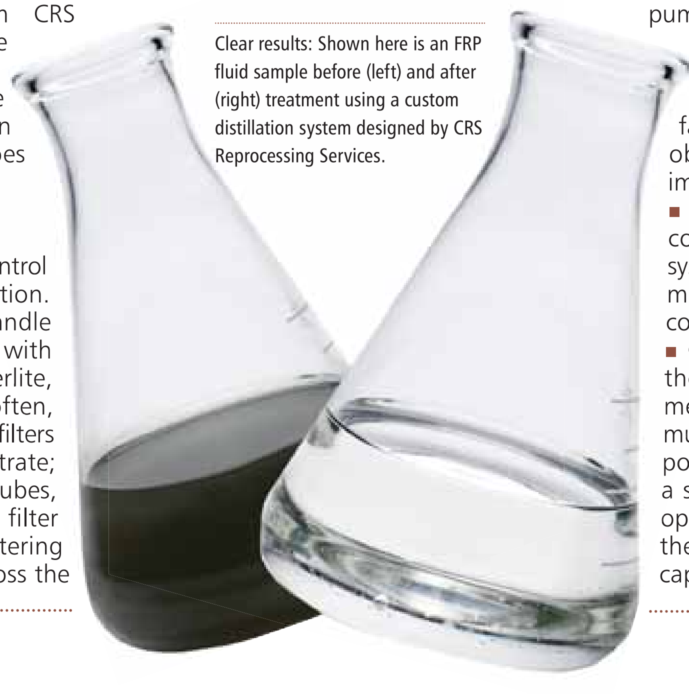
Some rolling mills use full-flow distillation to treat their entire coolant system. Fines, oxides and debris are removed along with the mill lubes and soaps, eliminating the need for a filtration system. For most rolling mills, however, the volume of coolant is so large that full-flow distillation is not practical. Those operators can benefit from CRS Reprocessing Services' expertise in calculating the optimal percentage of coolant volume requiring treatment by distillation before the remainder undergoes filtration.

Filtration

Filtration is a method used to control particulate contamination. Historically, stack filters or candle filters are employed in tandem with a filtering aid such as perlite, cellulose or, most often, diatomaceous earth (DE). Stack filters use paper as the filtration substrate; candle filters use porous steel tubes, arranged vertically inside the filter housing. In both cases, the filtering aid forms a boundary layer across the substrate where the filtration actually occurs. The final micron rating is dependent upon the grade of filtering aid used.

Eventually, the filtering aid becomes "full" and loses flow capacity, and, therefore, loses its ability to clean the coolant. At that point, the spent filtering aid is replaced with fresh material, and the process repeats. Ultimately, the filtration process creates a significant amount of waste in the form of spent DE saturated with coolant.

With more than 20 years of service experience designing, installing, maintaining and operating distillation systems that meet each customer's specific needs, CRS Reprocessing Services knows how to maximise the throughput and recovery of expensive additives, thereby ensuring quality and minimising waste.



Clear results: Shown here is an FRP fluid sample before (left) and after (right) treatment using a custom distillation system designed by CRS Reprocessing Services.

Recently, CRS Reprocessing Services developed a repeatable proprietary cross-flow membrane filtration technology that is capable of removing particulate without the need for filtering aids.

Choice of coolant management systems

When choosing a coolant management system, the manufacturer must look at all the factors contributing to product quality and cost of ownership. The following list highlights some key concerns:

- Raw material usage – The spent DE used in most filtration systems, as well as base oil and additives that are lost through inefficient processes must be replaced.
- Coolant recovery – In a problem tied to the cost of raw material usage, poorly designed distillation systems send too much coolant out with the waste stream. While no distillation system is 100% efficient, a custom-designed system can minimise base oil and additive losses through the bottoms. Coolant loss is also an issue in filtration systems using DE, which lose coolant with each indexing cycle.
- Quality – The dirt load for DE stack filters along with ineffective off-the-shelf distillation units can impact the efficiency of the reprocessing system and – more important – potentially impact downstream product quality. The improvements to downstream product quality that are made possible by better coolant have great value and should not be overlooked.
- Waste costs – Filtration systems that index too often, distillation systems with poor recovery rates, and spent DE all have an impact on waste treatment costs.
- Utility costs – Inefficient distillation systems waste power. The pumping power required by filtration systems makes electrical costs add up quickly. In fact, pumping requirements for all the various systems must be taken into account.
- HSE – Use of DE inhibits the facility's compliance with zero waste objectives and contributes to the impact of dust particulate.
- Labour and maintenance costs – All costs associated with operating the system and maintaining the equipment must be calculated, along with the costs associated with mill downtime.
- Capital costs – The price of an off-the-shelf system that may or may not meet specific operating requirements must be evaluated in comparison to the potential cost savings of working with a service provider that owns, designs, operates and maintains the equipment, thereby freeing the manufacturer's capital for other projects. ■