Inline measurement of rolling emulsion concentrations at Wickeder Westfalenstahl

Whereas in the past the composition and concentration of rolling emulsions in cold rolling used to be largely neglected, today they are considered as decisive process parameters. However, due to the lack of real-time measuring techniques, precise dosing of concentrate and water was not possible in the past. But at Wickeder Westfalenstahl GmbH a technology has been introduced which now enables rolling emulsion concentrations to be measured inline. The technique has been successfully field tested in daily routines.

The extremely exacting demands on rolled products call for increasingly better performing rolling emulsions. Rolling emulsions can only perform reliably if their concentration is measured and regulated speedily and with a very high degree of precision.

In cold strip rolling, variations in the concentration of the rolling emulsion may cause problems during rolling or in the downstream processes. If the concentration is too high, the oil film is too thick. This leads to excessive lubrication, cooling problems during rolling and problems during annealing. Too low a concentration causes excessive abrasion due to insufficient lubrication, affects strip surface wetting and impairs corrosion protection. In both cases, residues may contaminate the surface of the rolled strip.

Variations in the concentration are caused by the – unavoidable – evaporation of water which requires new water to be added, by influences due to foreign oil and due to dragged out emulsion. Such variations are compensated by the addition of concentrate to replenish the components of the emulsion.

For correct online dosing the currently prevailing concentration must be known. Traditionally, the composition of the emulsion used to be determined by means of acid cleavage, a chemical analysis which could take up to 10 hours. Even if accelerated by the addition of cleavage agents, three to four hours would always elapse until the results are available. Hence, fast, real-time reaction during rolling was not possible with that procedure.

The results were a "sawtooth" behaviour of the concentration about the desired value and much uncertainty about the proper quantities of water and concentrate to be added. Timely, reliable measuring data were not available. Therefore the rolling result was dependent on the judgment of individual operators.

At Wickeder Westfalenstahl this problem was very salient in the production of shadow mask material. This material calls for the concentration of the rolling emulsion to be kept within an exceptionally narrow tolerance range. In some cases, flaws due to wrong concentrations would only show in the downstream production stages, sometimes not until after annealing.

Process reliability through inline measurement

The production management set itself the goal to make the production process more predictable and reliable by eliminating the uncertainty factor "concentration measurement". The objective was to keep the concentration within very tight tolerances in order to be able to run the production process with constant cooling and lubrication parameters. Another objective was to establish an automatic concentrate dosing procedure to make the process independent of human judgments.

The only feasible way to control the dosing process was to close the time gap elapsing until the results from the chemical analysis are available. This was only achievable by measuring the concentration in real time. Tests conducted in the past with different techniques had not been successful.

However, close collaboration between the mill operator, the manufacturer of the rolling oil concentrate and the provider of the sensor technology recently brought about a solution which has already passed its field testing under routine operating conditions. SPL (Steel Process Lubricants) Group of Houghton Deutschland, specialists in process fluids technology for rolling mill applications and manufacturer of the rolling oil concentrate used at Wickeder, suggested that the concentration should be measured inline with ultrasonic technology from SensoTech. SensoTech technology had already proved reliable as concentration measurement systems in

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Figure 1.
LiquiSonic sensor and controller

Figure 2.
LiquiSonic sensor installed on the feeding line of a plant unit

pickling, coating and purification baths in various industries. The installation on the CVC 6-high reversing mill at Wickeder Westfalenstahl in early 2005 was, however, the first steel industry application. Since then it has successfully proved its worth and reliability in a rolling mill under routine operating conditions.

A LiquiSonic sensor from SensoTech performs inline measurements of the rolling emulsion concentration in the main oil feeding line of the mill stand. The installed sensor measures the sonic speed of the emulsion by high-precision measurement of the interval between transmission and echo-return. From this the concentration is derived.

Measurement accuracy is up to 0.05 % abs. LiquiSonic sensors can be installed in existing pipelines, without requiring a steadied section. The sensors feature a controller for validating and displaying the measured data **(figure 1)**. The data is output via standard interfaces. In addition to these functions, the controller performs permanent self-monitoring of the sensor.

The technique is functional irrespective of the colour, transparency or conductivity of the medium. It is even capable of measuring conductivity and the pH value. The sensor is temperature compensated and maintenance-free.

LiquiSonic sensors are generally offered as pipe or immersion sensors to be installed in the main oil feeding line of the mill stand **(figure 2)** or in a bypass of the emulsion tank.

As the Wickeder rolling mill alternately uses two different tanks with very different degrees of contamination, Houghton thoroughly examined the total contamination of the emulsion by analyzing the dissolved components and determining the particle sizes of the undissolved fraction. Also SensoTech conducted comprehensive preliminary tests on the temperature and pressure behaviour of the emulsion.

Operating experience

It did not take very long for the newly installed equipment to provide visible results: thanks to the inline measurement both the surface quality and the cleanness of the rolled product has been improved. Manual addition is much more precise than before, because at any time measured values of the currently prevailing concentration are available.

In addition to enhanced process reliability and quality, the introduction of the new equipment also provides major cost advantages: the emulsion is used longer, because the replacement of part of the emulsion – which in the past often had to be done “on spec” – can now be avoided.

The productivity of the mill stand has markedly improved due to shorter set-up and downtimes. Laboratory costs are lower because now only one analysis per week is required, instead of seven as in the past.

And even a further goal has already been achieved, namely the complete and gap-free documentation of the measured concentration values as required by current quality and QM standards.

To date experience with the system in practical operation has shown that the sensors do not contaminate and that they work reliably also under the conditions of routine rolling practice.

After these first achievements, the second logical step to be tackled is the automatic, closed-loop dosing of rolling oil concentrate and water. It is already being discussed how product-specific presetting of the concentration can be realized. This would enable the concentration to be adjusted optimally for each product. ■