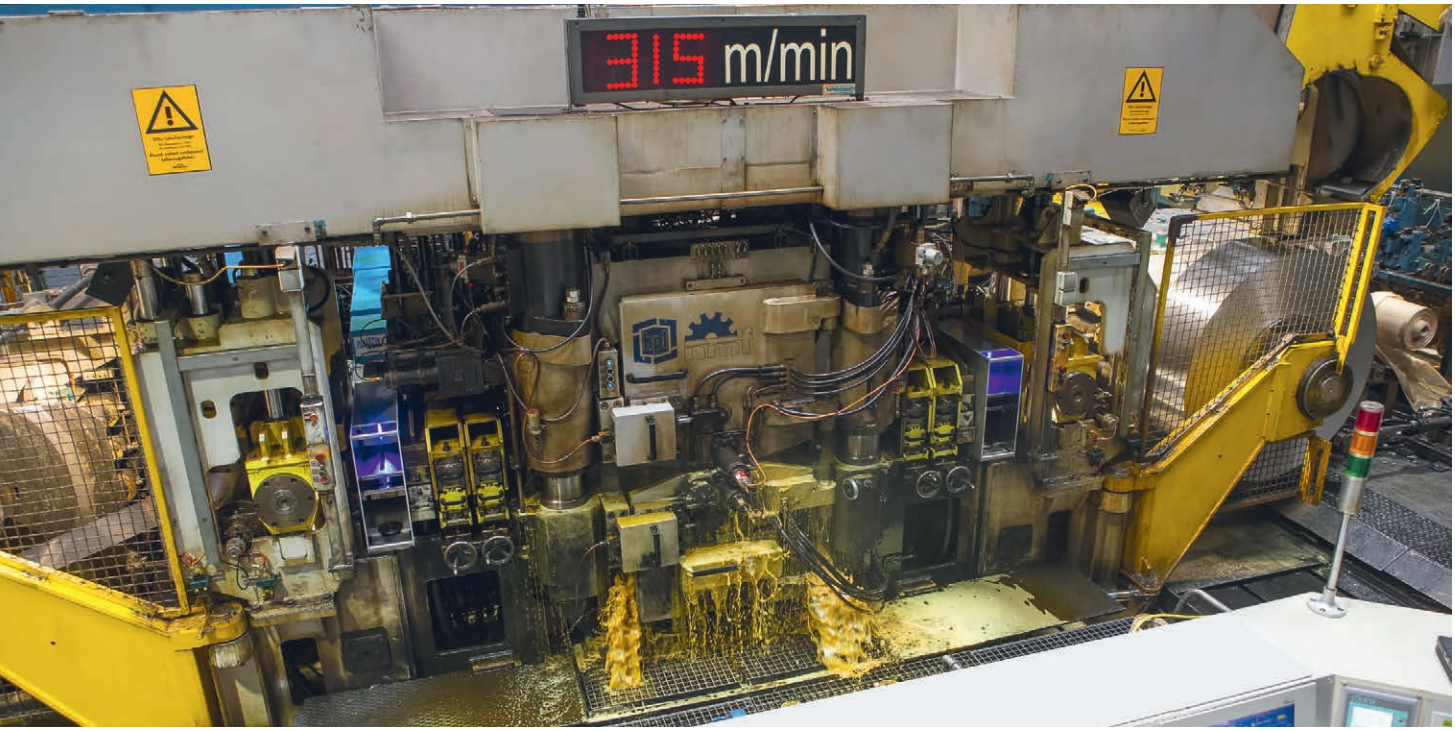
Internet-PDF aus „MPT International“ (2016), Heft 6, Seite 42–44.



The 20-roll mill stand at the Hagen-Hohenlimburg site of BWS with the two thickness measuring systems (blue indicator lights) installed

Lasers – the cost-effective alternative to radiometric and tactile thickness measurements

The new "VTLG" thickness measurement system has passed the acid test: under the extreme conditions of a 20-roll cold rolling mill, it most reliably measures the strip thickness in the immediate vicinity of the roll gap. Despite high strip temperatures and dense oil mist, it achieves a measuring precision of ± 1 µm.

At its Hagen-Hohenlimburg, Germany, works, Philipp Boecker + Wender Stahl GmbH & Co. KG (BWS) produces high-quality strip of stainless and special steel grades in widths of up to 400 mm on a precision cold rolling mill. The product spectrum includes strip in thicknesses ranging from 4 mm down to 50 µm, on request even down to 20 µm. BWS operates a 20-roll mill stand for cold rolling.

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The company makes products that require the highest of precision also in terms of strip thickness. For example, for rupture discs or roller springs, the customers demand compliance with a thickness tolerance of just a few micrometres. Also strip for medical products must comply with very tight tolerances, e.g. ± 2 µm for 50 µm thick strip. The precision of the thickness measurement therefore has to be ±1 µm.

The goal: precise, cost-effective thickness measurement

For decades BWS has been using tactile thickness measuring systems from Vollmer at all of its rolling stands and in its levelling lines to ensure such accuracy, as those systems reliably achieve the required precision. However, the mechanically operating devices in use at the cold rolling stand were getting close to their economic lifetime and demanded a great deal of maintenance. Furthermore, the diamonds were occasionally leaving undesired marks on the delicate surfaces, for example, of thin strip made of nickel or titanium alloys. As the systems could not be traversed across the width of the strip, it was not possible either to measure the shape – for example, the taper – of the incoming stock.

Therefore, after decades of successful operation, the time had become ripe

to consider an upgrade of the thickness measuring system. Instead of a complete modernization, BWS decided in favour of another future-oriented alternative.

It was clear from the outset that a contact-free technology had to be chosen. The variants isotopic, X-ray and laser technology were compared. However, the decision was quickly made in favour of the optical method, as it functions independently of the alloy. Other arguments in favour of an optical system were the lower costs of investment and operation as well as the lower safety precautions to be taken.

Challenging conditions

However, the prevailing conditions in the mill posed an obstacle for the installation of a laser-based system, as the installation space was very limited. The only possible installation location was on each side of the roll gap between the oil strippers and the shapemeter rolls – i.e. at exactly the same positions as the existing tactile thickness measuring systems. Just 200 mm in the rolling direction were available for the installation.

Furthermore, the dense oil mist arising from the up to 80°C hot strip being rolled at speeds of up to 650 m/min severely obstructs the view of the strip surface. Additionally, the high ambient temperature in the vicinity of the roll gap had to be coped with. Due to the confined space, it was difficult to effectively shield the measuring systems from the outside.

Vollmer therefore suggested the installation of the new "VTLG" optical thickness measuring system that had already proved effective in other works, but under significantly less challenging conditions. At BWS, Vollmer wanted to prove that the new system would function just as precisely and reliably under extreme conditions.

First, one VTLG system was installed on one side of the mill stand, replacing a tactile system. The tactile measuring system on the other side remained in operation for the time being and measured the strip thickness twice at each pass during that test phase. The results were compared with the values measured by the optical system. After a few optimization measures, the VTLG functioned so reliably that also the second tactile system was removed and replaced with a laser system. A few days after the installation, the second system was ready for operation at the required precision. Since June 2016, both systems have been integrated into the highly dynamic thickness control system of the rolling stand.

First experience

The results show that the systems consistently and reliably achieve the demanded precision even under the extreme conditions prevailing in the immediate vicinity of the oil strippers. The systems provide precise measurements at the high strip speed and under the conditions of high temperatures and the resulting dense oil mist. Since their installation, both systems have functioned trouble-free; there have been no unscheduled standstills of the cold rolling mill caused by the thickness measuring systems.

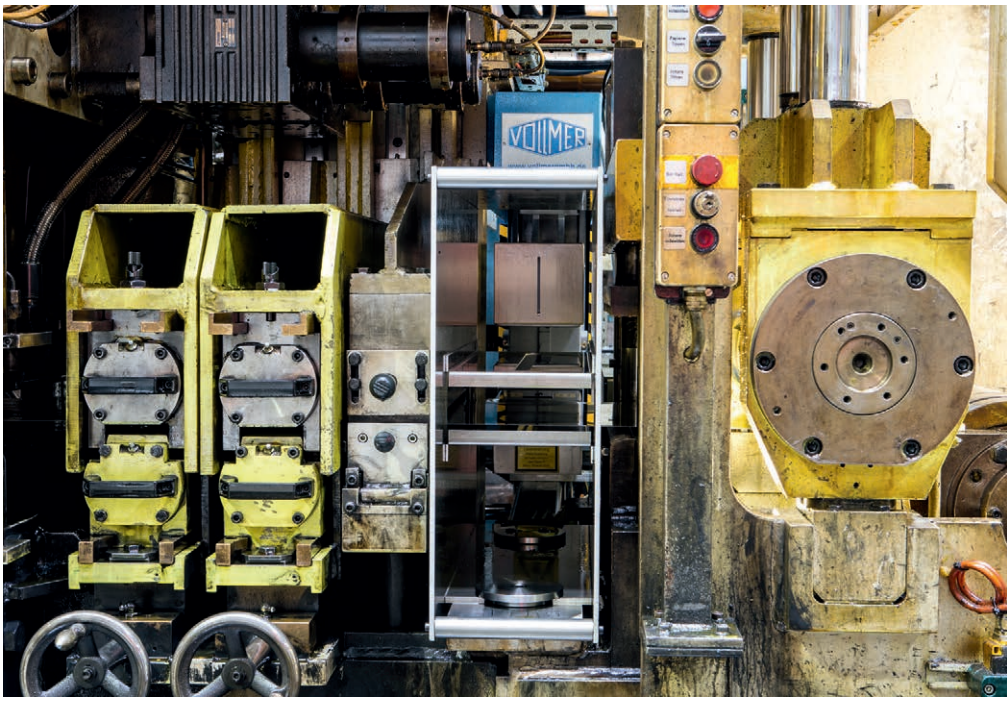
The changeover from the tactile to the optical technology was easy. No modifications to the mill stand had been necessary. The installation space that the tactile systems had taken up proved to be sufficient for the optical systems. As all the systems have the same interface to the process control system, it had not been necessary to modify the control system.

The automatic calibration of the system before each pass has proved highly efficient. It gives the line operators the certainty that the thickness measuring system is functioning reliably with each individual strip.

At the start of each pass, the VTLG now also measures the thickness distribution transversely to the rolling direction by moving the measuring frame across the whole width of the strip, so that any camber of the starting material can be corrected during rolling. Such measurement was not possible with the tactile systems.

While the current thickness is permanently shown on displays, the dedicated Vollmer software also generates a thickness profile over the strip length and width.

The systems require minimum service and maintenance. The optical components are so well protected that maintenance is limited to just cleaning twice a week the optical components accessible from the outside. This provides significantly higher availability of the cold rolling mill compared to the situation with the tactile systems installed.



C-frame of the VTLG system in parking position at the drive side of the mill stand (all pictures by courtesy of Vollmer)

The technology in detail

The new VTLG strip thickness gauge operates on the principle of laser triangulation. It is characterized by a very sturdy design. Although it contains optical components, it can be installed in the mill stand in the immediate vicinity of the roll gap. Even under such tough conditions, it achieves very high

Only 200 mm length are required for the installation of the thickness measuring system

precision. The VTLG thus opens up completely new possibilities for quick and precise thickness control and for quality assurance. With an internal scanning rate of 50 kHz, the scalable analogue output provides the input signal for high-speed thickness control within milliseconds.

VTLG uses an absolute measuring technique to measure the strip thickness, i.e. the measurement is not influenced in any way by the material properties. The measurement is contact-free and from a safe distance. With a measuring accuracy of ± 1 µm, it achieves the same precision as tactile and radiometric gauges.

Vollmer offers the system for different measuring ranges, from a minimum thickness of 0.015 up to a maximum of 12.0 mm. With an air gap of the C-frame of 125 or 285 mm, the sensors are positioned at a safe distance from the strip. Depending on the gauge type, the measuring depth is between 400 and 1,200 mm. The space requirement in rolling direction lies between 160 and 200 mm, depending on the measuring range.

The VTLG is not only suitable for measurements in the rolling stand – it is equally suitable for use in pickling lines, the finishing shop, edge milling machines or slitting lines.

Four design features contribute to the high precision of the systems: temperature stabilization of the measuring frame, automatic calibration checks before each strip pass, air purging systems and synchronicity of the measurements.

The thermal expansion of the C-frame is compensated by means of an intelligent temperature management system. This ensures that the measurement of the strip thickness – in the rolling stand, at the exit of an annealing line or within the pickling line – is just as accurate as a measurement in an air conditioned measuring room. Furthermore, before each strip pass, the system checks whether it has been correctly set using a calibration standard integrated into the C-frame. At the start of the measurement, the C-frame moves automatically into the line, on its way measuring the thickness of four integrated standard gauging blocks representing the thickness spectrum of the rolling stand. The VTLG thus constantly monitors itself, automatically making any corrections as necessary.

The fact that the two sensors operate absolutely synchronously contributes significantly to the high precision of the system. The VTLG eliminates the influence of the strip movement during the measurement.

Air purging systems ensure reliable operation even under the rough environmental conditions in the rolling stand. Both the entry and exit windows of the transmitting and receiving lenses and the beam path are constantly flushed with clean air so that vapours or mists from rolling do not affect the measurement.

The lasers conform to laser protection class 3B. This means that in most cases no additional occupational health and safety measures are necessary.

The system has all common interfaces for communication with the line control systems: PROFINET, PROFIBUS, hardware interface or TCP/IP. Operation via a touch panel is convenient and intuitive. Extensive diagnostic functions support the operator.

Conclusion

With a precision of ± 1 µm, the VTLG meets the measuring requirements in cold rolling, including those applicable to thin strips having to satisfy extremely tight thickness tolerances. The experience at BWS has shown that even under very rough ambient conditions the optical system is definitely an adequate replacement for the tactile systems used before. And what is more, it operates fully independently of the alloy, protects the surface of the strip, allows the thickness profile to be measured transversely to the rolling direction and significantly reduces the maintenance effort, thus increasing the availability of the mill stand. ■