

Cold rolling of stainless steel strip

Optical thickness measurement proves itself in dense mist of rolling oil

The “VTLG” laser-optical thickness measuring system from Vollmer has replaced an X-ray gauge at the Dillenburg cold strip mill of Outokumpu. It now simplifies the production processes due to the material independence of the method. Despite the extremely dense rolling oil mist, it operates with μm accuracy.

The Outokumpu Works in Dillenburg, Germany, is a modern cold rolling mill that produces predominantly stainless steel strip. The material satisfies the highest demands on surface quality – for example, as a façade cladding in architecture.

The starting material that is between 2.5 and 6.0 mm thick and comes from the Group’s plants in Finland and Sweden, is rolled to a thickness between 0.15 and 4.0 mm and then annealed, pickled, slit and cut to length according to customer requirements.

For over 20 years, a radiometric thickness gauge was in operation on the “Sundwig 1350” 20-high cold rolling mill (figure 1). However, the supply of spare parts for this system was no longer assured. Since it is not possible to roll without precise thickness measurement, a defect would have jeopardised the supply security of the entire plant.

Furthermore, operation of the X-ray measuring system involved a great deal of work: Measurement of the thickness is influenced by the material properties of the strips, so that the parameters for each

new alloy had to be entered into the measuring device. In some cases, this meant that the rolling of coils of new materials had to be postponed until the correction factors from the alloy analysis had been input into the radiometric gauge.

Challenging boundary conditions

During the search for an alternative, the project team contacted Vollmer, as the “VTLG” laser-optical thickness gauge had already proven itself in dozens of plants and had significantly reduced the maintenance costs there.

However, multi-roll stands usually produce more rolling oil mist than cold rolling with two-high or four-high stands, and even more so with stainless steel, as the forces involved are particularly high. With a strip speed of up to 880 m/min and high deformation values, a particularly dense oil mist develops at the roll gap on the mill in Dillenburg (figure 2).

In addition, the surface of the 3D bright annealed material that represents the majority of the plant’s product spectrum is highly reflective. Furthermore, the installation space was very limited, because the mill has a particularly compact design in order to keep the distance between the two coilers – and thus the non-rolled areas – as short as possible.

Overall, the Outokumpu project team had concerns about whether optical measurement could function absolutely reliably and provide accurate results under these conditions.

The project

The specialists from Vollmer, however, were very confident that the VTLG laser-optical thickness measuring system would also work reliably on the Dillenburg



Figure 1. The “Sundwig 1350” 20-high cold rolling mill at the Dillenburg works. The VTLG can be recognised from the light blue indicator light on the mill to the right of the control panel (Picture: Wolfram Schroll / Vollmer GmbH)

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mill. They therefore proposed to initially install a system on only one side of the mill (**figure 3**). In the unlikely event that it did not prove itself, they would replace it with an X-ray gauge from their own production. This created a win-win situation for both sides.

Outokumpu had the possibility of returning to the X-ray technology at any time, and Vollmer had the opportunity to prove that the system works reliably even under the most difficult conditions. The X-ray system on the other side of the mill stand remained in operation for the time being.

The substructure of the existing X-ray gauge could continue to be used for the installation of the VTLG (**figure 4**). Only very minor modifications were required to the mill proper. Vollmer adopted the hardware interfaces to the superordinate systems one-to-one, and only the content of the telegrams was adapted. No constructional measures were necessary with regard to laser protection either.

Thanks to the good preparation on both sides, dismantling of the old gauge and installation and commissioning of the new system were completed on schedule in three days, despite the difficult installation situation. The VTLG went into operation on 20 August 2019.

The technology in detail

The VTLG strip thickness gauge operates on the principle of laser triangulation. It is particularly characterised by its sturdy design: Although it contains optical components, it can be installed in the mill in the immediate vicinity of the roll gap. Even under such tough conditions, it achieves a very high 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 80 kHz, the scalable analog output provides a signal for the high-speed thickness control within milliseconds.

VTLG measures the absolute thickness of the strip without being influenced by the material properties, but contact-free and from a safe distance. With a measuring accuracy of $\pm 1 \mu\text{m}$, it achieves the same precision as tactile and X-ray gauges.

Vollmer offers different measuring ranges from 0.015 to 12.0 mm thickness. With an air gap of the C-frame of 135 or 205 mm, the sensors are positioned at a safe

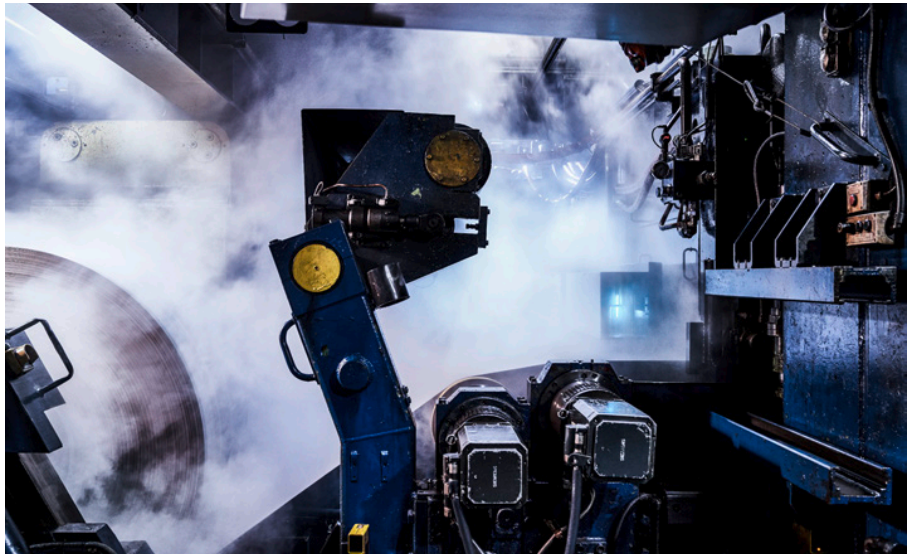


Figure 2. Even dense oil mist does not affect the measuring precision of the VTLG (Picture: Wolfram Schroll / Vollmer GmbH)

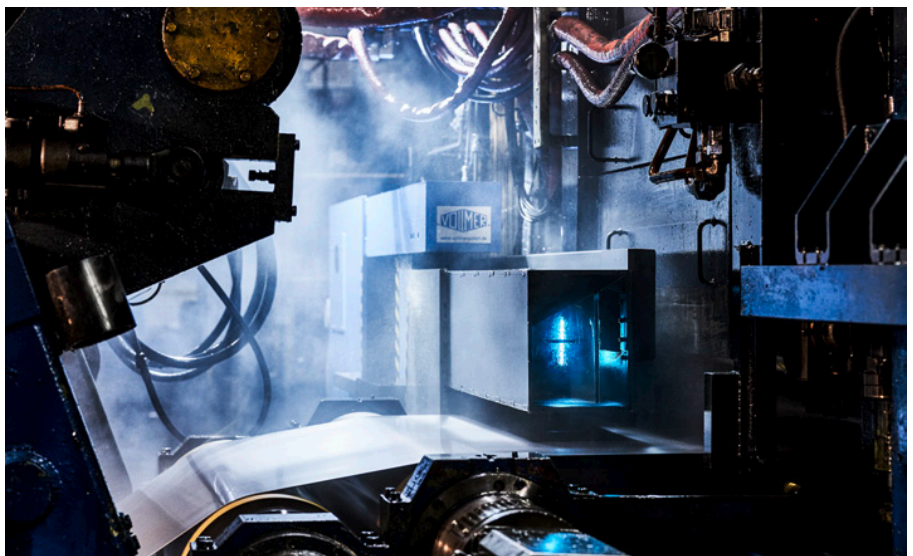


Figure 3. The VTLG is installed just a few centimetres from the roll gap (Picture: Wolfram Schroll / Vollmer GmbH)

distance from the strip. The measuring depth lies between 400 and 1200 mm, depending on the gauge type. The space requirement in rolling direction lies between 170 and 200 mm, depending on the measuring range.

The VTLG is not only suitable for measurement in the mill – it is equally suitable for use on the annealing line, in the finishing shop, on strip millers or in shear lines.

Four design features contribute to the high precision of the system: The temperature stabilisation of the measuring frame, the automatic check of the calibration before each strip, the air cleaning systems

and the synchronicity of the upper and lower laser sensor.

- Vollmer compensates the thermal expansion of the C-frame by means of an intelligent temperature management system. This ensures that the measurement of the strip thickness in the mill, at the exit from a furnace line or on the annealing line is just as accurate as in an air conditioned laboratory.
- Furthermore, the system checks its adjustment using a calibration normal integrated into the C frame before each strip pass: At the start of the measurement, the C-frame moves automatically



Figure 4. The C-frame of the VTLG in parking position (Picture: Wolfram Schroll / Vollmer GmbH)

into the line and on its way there measures the thickness of four captive DAkkS-certified gauge blocks representing the thickness spectrum of the mill. The VTLG thus constantly monitors itself and makes any necessary corrections automatically.

- The fact that the two sensors operate absolutely synchronously contributes significantly to the high precision of the system. VTLG eliminates the influence of the strip movement during the measurement.
- Air cleaning systems ensure reliable operation even under the rough environmental conditions in the mill: 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 the mill 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 the common interfaces for communication with the line controller: PROFINET, PROFIBUS, hardware interface or TCP/IP. Operation via a touch panel is simple and intuitive, while extensive diagnostic functions support the operator.

Initial experience

From the first strip that was rolled slowly, the system functioned with the specified precision. The rolling speed could already

be increased to 880 m/min with the second coil. Even the then very pronounced development of oil mist did not influence the measurement results in any way: The VTLG achieved the required measuring accuracy in the μm range under all the operating conditions.

The acceptance by the mill operators was immediately very high, as the gauge functioned reliably right from the start.

Since commissioning, the laser thickness measuring system has operated reliably, and it has not been responsible for any production downtimes – an important aspect considering that it is not possible to roll without thickness measurement.

By contrast with the X-ray method, laser-optical measurement offers high flexibility during rolling thanks to its independence from the material properties: Even grades whose analysis is not yet available can be rolled immediately on arrival in the works. Particularly against the background of the fact that more and more new materials are being developed, the VTLG also has clear advantages in this respect compared with radiometric measurement.

Operation is limited to moving the C-frame in and out. The current strip thickness is displayed numerically, and the supplementary VGraph software from Vollmer shows the thickness profile over the strip length.

Automatic calibration of the system before each pass has also proven to be effective: Before a new strip is threaded in, the VTLG moves a DAkkS-certified set of gauge blocks into the measuring range fully

automatically and thus adjusts itself automatically. This gives the operators the certainty that the thickness measuring system is functioning reliably at each individual strip.

Very little maintenance is required: The inside of the C-frame is so well protected that it is limited to cleaning the optical components accessible from the outside every few days. It can be performed by the operating personnel at any time without the radiation protection officer having to give his approval.

In summary

With the precision in the μm range, the VTLG meets the demands of cold rolling even for thin strips that have to satisfy very tight thickness tolerances. The application in Dillenburg has proven that the optical system offers significant advantages over the radiometric gauges generally used to date, even under tough operating conditions: It operates completely independently of the alloy, significantly reduces maintenance work and thus increases the availability of the mill.

In view of the good experience, Outokumpu placed the order for the installation of the system on the second side of the mill just a few weeks after commissioning of the first system. It is also planned that the other mill in the works should be fitted with the laser-optical thickness gauges.

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