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Contents

4  IMS Measuring Systems – The Advantages
5  Optical Measuring Systems – Perfect Geometry
6  Slab and Heavy Plate
8  Hot and Cold Strip
10 Strip Refinement
11 Tubes
12 Test and Calibration Equipment
13 Technologies and Components
14 Use of Optical and Radiometric Measuring Technology
IMS Measuring Systems – The Advantages

The optical measuring systems from IMS are:

- **compact**
  They need little space and are easy to integrate into existing lines.

- **low maintenance**
  They are encapsulated and air-conditioned appropriately for the harsh environmental conditions – the basis for top availability with long lifetimes and large maintenance intervals.

- **traceable**
  They are quick and easy to check regarding their measuring accuracy – customer quality assurance requirements can be met to an optimum.

IMS works permanently on developing its measuring methods further and adapting them to customer wishes. You therefore always receive products matching the latest state of the art.

Measuring systems from IMS help you to produce efficiently and deliver perfect and fully documented quality.

**They stand out for their:**

- high availability
- long life over decades requirements.
One of the critical quality criteria for sheet, plate and tube production is compliance with the required dimensions for slabs, strips, plates and tubes.

This material property must be guaranteed constantly throughout the complete production process – from continuous casting plant through hot and cold rolling mill and refining line to dressing and straightening line and inspection line.

IMS delivers optical measuring systems that measure and document the relevant parameters precisely and reliably even in extreme environmental conditions and constantly changing material position.

The optical measuring systems from IMS measure:

- **quickly**
  The measurement is made online. The results are available immediately – the higher-level process control system can react immediately

- **accurately**
  They measure every single product completely – the basis for comprehensive documentation and complete traceability.

- **without physical contact**
  They measure from a safe distance without physical contact with the material.
Optical Measuring Technology –
Slab and Heavy Plate

Slab
Installed at the exit of a continuous casting plant, optical systems deliver exact information on the cross-section and external contour of the slabs. The measured results are used firstly for precision control of the continuous casting plant. Secondly, the data transfer to the hot strip or heavy plate mill delivers important information for the downstream equipment.

Exact measurement of the slab geometry enables optimisation of furnace charging and its pilot control for every single slab.

The information on the external contour is also used to protect the other equipment, for example the furnace in the case of strong turn-up/turn-down or strong sag. The geometry values are used to derive the weight and identity, which in turn serves added safety in the entry to the furnace through clear identification of the slabs.

Heavy Plate
If there are optical measuring systems installed behind the finishing stand, they serve adjustment of the stand. Additional measurement of the edge profile and outline shape of the plates ensures best-possible use of the material through optimum control of the trimming shear.

The systems also measure the head and foot shape. These values are used to optimise the crop length, thereby using the savings potential in cropping.

Optical width measurement on the finished product ensures that all plates leave the plant with the right dimensions.

The TopPlan system has enabled total control of the height matrix of the plates for the first time. The system measures the complete topology of the plates and is considerably more accurate and faster than manual measurement. The system is used for online measurement of flatness and levelness behind the hot or cold leveller and quickly delivers precise and objective information on additional straightening of individual plates.

It is used in dressing and straightening lines and at inspection lines for cold plates in combination with width and length measuring systems to provide complete documentation of the properties of the finished plates.
High-resolution, positionable cameras are usually used for measurement of the width. They are driven over the edges of the material automatically by linear units.

Stereoscopic measuring systems with fixed cameras are used to measure slabs or behind the finishing stand of hot strip mills because this method allows automatic correction of height position and material thickness.

Depending on the application, the systems use backlighting, the characteristic radiation of the material or the backscattered light of a line laser.

The material thickness is measured, depending on requirements, radiometrically or by the laser triangulation or laser-light section method. The cross profiles (crown and wedge) are also determined. Systems that scan the complete width of the material also measure the height of the turn-up/turn-down.

The thickness measuring system from IMS works so accurately that it also detects accumulations of scale on the surface of the slab at the exit from the continuous casting plant.

The scale can then be removed in time – cold points are avoided.

The shape of the edges is measured with light section systems mounted on the sides of the roller table. Triangulation sensors, also mounted on the sides of the roller table, determine the sabre and the position of the material on the roller table.

Through correlation of the length using laser Doppler velocimeters, the individual measured values are used to calculate the length profiles for width, thickness and edge shape, as a result of which the complete external contour is known.

The TopPlan system captures the complete topology of the surface of heavy plate. It projects a line pattern on to the surface of the material, which is then filmed by matrix cameras.
Optical Measuring Technology – Hot and Cold Strip

**Hot Strip**

The width of the **pre-strip** is regulated at the edger by the optical width measuring system. The systems also measure the head and foot shape in the last pass; these values are used to control the cropping shears. This makes it possible to use the savings potential in cropping and enables optimum control of the finishing line. The systems also capture the edge contour for optimum trimming.

In **hot strip mills** optical systems measure behind the finishing train or in front of the coiler and deliver quality information on width, edge cracks and holes directly. In this way exact geometrical information is available for further processing, enabling immediate decisions on further use and processing. If, for example, edge cracks are detected, the further production stages are run at slower speed, thereby avoiding breaking of the strip.

A TopPlan system installed behind the finishing train measures the flatness and captures edge and middle waviness. The measured values are sent to the higher-level profile and flatness control, where they are used to control adjustment and bending of the work rolls of the last stand. A second system at the coiler shows the influence of the cooling section on flatness.

This results in plane-parallel products without crown, ripple, turn-up/turn-down or twisting.

**Cold Strip**

Optical measuring systems measure the geometry of the strip in all lines through which the cold strip runs – for example, pickling lines, lines for inorganic or organic coating, inspection and recoiling lines as well as slitting and cut-to-length lines. They capture width, strip contour, crossbow and strip position and use these values, for example, for exact centreline control and clean winding up of the coils.

Other systems detect edge cracks and holes. In this way they deliver the information needed for optimum trimming of the strips and prevent defective strips from being delivered.

In pickling lines TopPlan systems capture the complete topology of the strips and ensure that the levelers can work with optimal settings.

In slitting lines the optical width and cross contour measuring systems ensure that the required width of the individual strips is kept to precisely, even if the strip is slightly arched. The flatness of highly reflective material can also be measured. The reflective system TopPlan Reflect is available for this.
Traversable, high-resolution cameras that follow the strip edge automatically are usually used for width measurement on slabs and cold strip: the range of movement here is limited and no height correction is necessary. In this way the high resolution of the cameras is used optimally. In certain cases fixed cameras are used.

Stereoscopic measuring systems are usually used to measure pre-strip and behind the finishing train because they allow automatic compensation of the thickness of the slabs and height position of the strip and because the crop shape can be determined. Traversable systems are also possible.

The strip position is derived from the width measurement and any side shift corrected. The system also determines the strip contour (residual curvature/sabre). Many systems also optionally detect edge cracks. IMS offers additional systems for detection of holes of any size.

The TopPlan systems for hot strip work similarly to those for heavy plate. They measure before the coiler and thereby also detect the height of the turn-up/turn-down.

Temperature, length and speed are detected by sensors integrated in the measuring systems. In this way the optical systems from IMS capture multiple measured values in a compact measuring frame. The sabre can also be determined using additional edge-detection sensors.
In the strip refinement line optical measuring systems first measure the same parameters as on the cold strip: width, strip position in the line, holes and edge cracks, thus supplying comprehensive information for further processing.

Apart from the optical measuring systems already described, the following additional optical measuring systems from IMS are also used in strip refinement lines:

- residual fat/thin oil film measurement on black plate (measuring method: ellipsometry)
- oil film measurement on sheet (measuring method: infrared spectroscopy in MIR range)
- pre-/after-treatment measurement, lacquer coat measurement (measuring method: UV-VIS measurement with IMSpect)

Ellipsometry

The ellipsometer method is used for the following applications:

- measurement of thin oil films in tinplate production
- residual fat measurement behind rolling lines
- film measurement after annealing and cleaning processes.

Ellipsometry – a non-destructive and non-contact optical measuring technique – is based on the fact that polarised light changes its polarisation state on reflection from a surface. The wave amplitude and phase of the components parallel and vertical to the plane of incidence are generally changed differently. The elliptically polarised, reflected light is examined for its polarisation state by polarising elements.

The optical constants, i.e., the complex refractive index of a material, can be determined from the ellipsometric values measured and then the coat thickness and refractive index of surface coatings with other models.

IMSpect

The optical measuring system IMSpect is used in coating lines, e.g., electrolytic, hot-dip galvanising and lacquering lines. It measures the coat thickness of pre-/after-treatments such as chromates, titanium/zirconium compounds and chromium-free pre-treatments as well as lacquer coat thicknesses. Other coating materials can also be measured after suitable investigation. The measuring system is further able to detect colour differences between current production and a reference sample.

Infrared Spectroscopy in MIR Range

Pre-lube and dry-lube oils are mainly used for corrosion protection and simultaneously offer good forming properties for later processing steps.

Using an interferometer, spectra in the MIR range are filmed and analysed. With the help of a calibration curve, it is possible to measure the film thicknesses of different oils and waxes on various surfaces (sheet uncoated or galvanised or lacquered) on the top and bottom strip sides.
In tube production optical measuring systems from IMS measure the ovality and external contour, length, position on the roller table as well as speed and temperature of shells, hollow blooms and finished tubes. As separate systems they ensure optimum output and document quality.

They further support the radiometric measuring systems from IMS for measurement of wall thickness, contour and eccentricity by supplying support values for radiometric wall thickness measurement.

Rolling technologies in the production of seamless steel tubes – such as individually adjustable rollers in three-roller stands in PQF mills or adjustable end stands in stretch reducing mills – require suitable and cost-efficient measuring systems in order to meet the stricter demands for transparency in the rolling process and maximum accuracy in measurement.

For high-resolution diameter profile measurement, IMS offers a system that delivers a distortion-free picture of the external tube profile. The system is usually equipped with 18 or 24 high-precision laser triangulation sensors arranged in a circle around the tube circumference and all synchronised with each other. Every sensor measures the distance to the tube and a computer program then reconstructs the external contour within a few milliseconds. This measuring configuration offers especially high benefits in combination with a radiometric multichannel wall thickness measuring system. To this end IMS has integrated all sensors for measurement of the geometric parameters on hot tube in a compact measuring frame.

For measurements in hot strip applications the sensors are mounted on a water-cooled protective ring and behind protective doors with heat protection shields. Pressure blowers protect the sensors from soiling.

Optical Measuring Technology – Tubes
With its quality management, the industry places high demands on the measuring systems used in production lines for monitoring purposes. All measured parameters must be traceable to accepted standards. Traceability of the parameters is effected with standards (calibration bodies). They are certified by accredited institutes.

**IMS Calibration Bodies**
- Measuring systems and measuring equipment are monitored for quality assurance purposes.
- The calibration bodies are designed, dimensioned and fabricated project-specifically by IMS.
- The measuring systems from IMS allow easy and time-saving checking and calibration.
- The calibration bodies are optimised for safe handling, low weight and high availability over the lifetime of the measuring system.

**Width Measuring System**
Width measuring systems with line scan cameras are calibrated with the help of a slit collimator. The exact dimensions of the slits and their arrangement are measured over the complete measuring range and stored in the measuring system.

**TopPlan**
The flatness measuring systems are calibrated with a flat reference plate and a calibration body. Only one measurement at a few points in the measuring field is necessary for height measurement of the complete system.

**LasCon**
Laser measuring systems for detection of contours are calibrated with a three-dimensional body. The arrangement of area scan camera to line lasers is ascertained and the width and height measurement in the complete measuring volume determined.

**Tube Geometry**
The external profile and tube position are obtained from multiple, circularly arranged distance measurements by the laser triangulation method. The complete measuring field is determined by rotating calibration bodies with different diameters.
New technologies are being developed and applied continuously in industrial measuring technology. Performance, reliability and high lifetime of the components determine whether they are used.

**Width Measuring System**
Compared to conventional light technology, the influence of extraneous light is reduced further and maintenance requirements minimised in width measuring systems with LED backlight sources.

**TopPlan**
A specially developed projector with LED technology is optionally used for the TopPlan flatness measuring system. The high luminous power is only used during the measuring phase for image acquisition. The lifetime and light intensity of the LEDs used are many times higher than in conventional illuminants.

**Image Transfer**
Within the framework of continuous further development the transmission routes between camera and analyser are also optimised. An example of this are the line and area scan cameras used by IMS for optical measuring systems with their Gigabit Ethernet (GigE) interfaces.
Use of Optical and Radiometric Measuring Technology

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<th>Feature</th>
<th>Slab</th>
<th>Heavy plate</th>
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<th>Cold strip</th>
<th>Strip treatment</th>
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