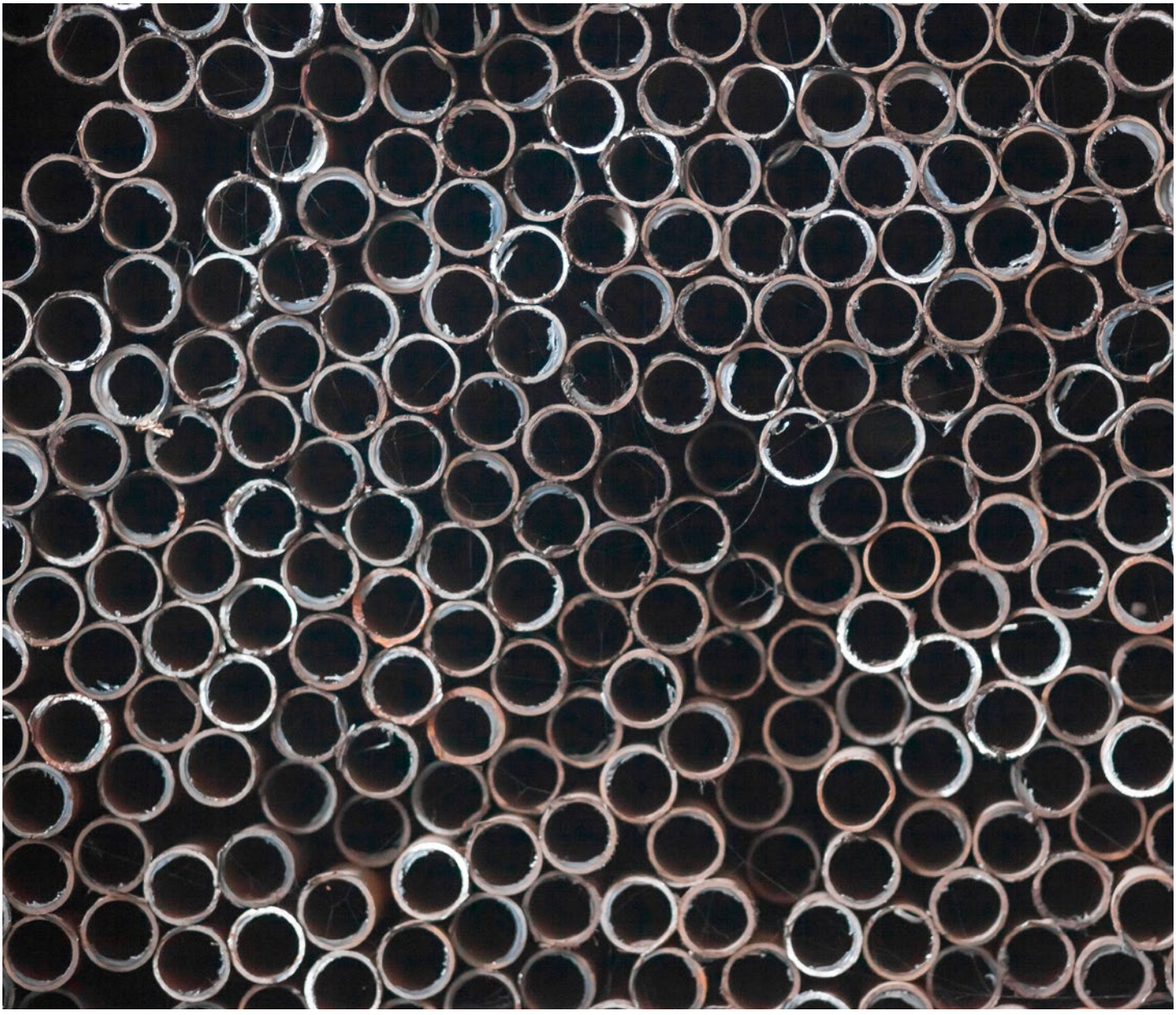
OLYMPUS

The Metal Manufacturing Cycle

From Raw Materials to Finished Products with Continuous Recycling



The Metal Manufacturing Cycle

From Raw Materials to Finished Products with Continuous Recycling

The modern metal manufacturing cycle relies on recycled materials. Even when manufacturing metals from ores, recycled metals are added to reduce the environmental burden. Typically, metal produced by remelting and refining scrap metal is both more energy efficient and economical. One tool that is central to this process is the handheld X-ray fluorescence (XRF) analyzer.

The Olympus Vanta™ XRF analyzer enables you to get lab-quality material chemistry results where and when you need them. Combined with strong, global support and easy-to-follow tutorial videos, you can begin benefitting from the information XRF provides right away by making sure your team fully understands the measurement results, as well as how to export and integrate data.

This e-book will explore the modern metal manufacturing process and explain how handheld XRF analyzers can improve your process at every step.

Contents

Scrap Recycling

Readily check scrap metal quality prior to furnace charging.

The advantages of using scrap metal for metal manufacturing include both energy and environmental benefits. However, manufacturers must ensure that the scrap supplier is trustworthy and the quality of the scrap metal is consistent. The material quality is checked by verifying furnace-ready scrap shipments from suppliers prior to stock piling or furnace feeding.

Handheld X-ray fluorescence (XRF) analyzers provide a user-friendly method to verify the quality and consistency of each shipment of scrap without needing to send large samples to the laboratory for preparation and testing.

Raw Materials: Iron and Steel

Iron ore pellets are ready to be loaded for DRI production.

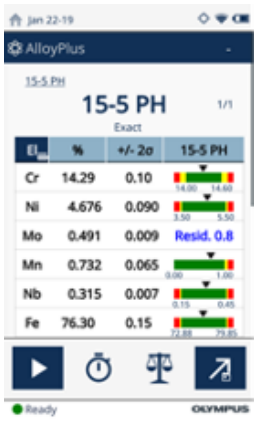
The raw materials used in an iron and steel plant, including iron ore, limestone, coal, coke, and direct reduced iron (DRI), can be easily tested for grade control and to help ensure an ideal chemical analysis balance of all raw materials entering the steel-making process.

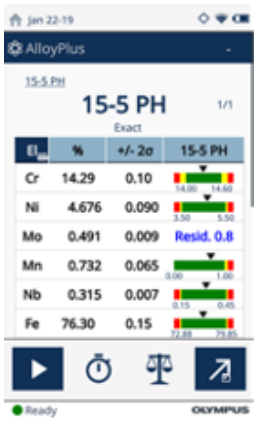
Using XRF analyzers for grade control to minimize tramp elements, such as copper (Cu) and lead (Pb), helps ensure steel quality, process efficiency, and environmental control.

Many parts of the world must control levels of copper, largely contained within scrap metal, in many steel grades. The Vanta™ analyzer can be configured to include calibrations for all raw materials entering the plant.

Steelmaking Materials

Slag analysis is important to help ensure the correct heat endpoint and cleanliness in finished steel products.





Stainless steel analyses clearly show that the two samples meet the alloy specifications within the ranges shown with a green bar. Also note the residual elements displayed.

Controlling the furnace process is critical to achieve a high-grade steel product. Knowing the material chemistry is important to help eliminate any surprises in the melt bath. Our Vanta™ XRF analyzer enables rapid chemistry of the bath sample with minimal preparation. This can save considerable time at the furnace since it is the heat endpoint.

Critical elemental residuals reduce the risk of nonmetallic inclusions in the finished products, so manufacturers can benefit from an XRF analyzer that clearly displays this information. With the Vanta analyzer, it is easy to see the alloying elements and the residuals in a single measurement. Screen display options include the placement of critical elements or residuals on top of the element list. The easy-to-read range bars help you avoid unforeseen endpoint analysis in the finished heat.

At the same time, the slag analysis is often a good marker to aid the endpoint control. Vanta XRF analyzers that have slag analysis enabled can be used on the furnace floor to provide elemental analysis, which can help ensure the required basicity. With its excellent light element detection, the Vanta VMR model can provide oxide and basicity on its clear screen display.

Consistent readings can be achieved by using rapid repeat measurements. Further preparation of the slag sample by grinding and placing it in a sample cup will produce results with a single measurement.

Steel Slag

Data Regression and Verification

The examples below compare the XRF results from testing steel slag samples with a Vanta™ handheld XRF analyzer with the results from testing the same sample in a lab. The closely similar results demonstrate how the Vanta XRF analyzer can provide lab-quality results in the field for faster decision-making.

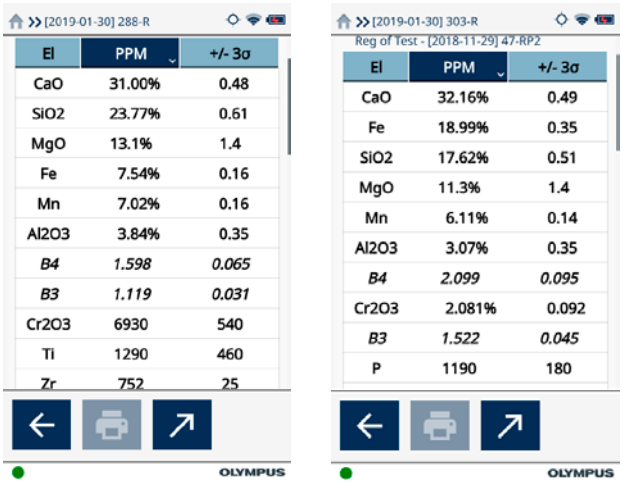
Vanta analyzer screenshot of slag analysis taken after test completion (15 seconds low energy beam, 20 seconds total test time).

Aluminum Oxide (Al_2O_3) Lab	Calcium Oxide (CaO) Lab	Magnesium Oxide (MgO) Lab	Chromium Oxide (Cr_2O_3) Lab	Silicon Dioxide (SiO_2) Lab	Iron (Fe) Lab
7.22	41.89	16.01	0.39	24.64	2.03

Lab analysis of the same sample above closely matches the results from the Vanta analyzer.

Use In-Process

- The Vanta analyzer can calculate basicity ratios in real-time
  - Example: B3: $CaO/(SiO_2+Al_2O_3)$
  - Example: B4: $(CaO+MgO)/(SiO_2+Al_2O_3)$
- The analyzer's software offers a feature that uses live results to calculate the basicity ratios



Slag analyses showing oxides and basicity values calculated using the pseudo element function.

Slag Analysis

Slag analysis is important to help ensure the correct heat endpoint and cleanliness in finished steel products.

The slag analysis is as important as making the correct alloy grade. Rapid assessment of the slag near the heat endpoint can help ensure that the heat at tapping is achieved and time is not lost waiting for slag analyses.

On the furnace floor, taking an immersion slag sample at that point enables operators to use Vanta™ analyzers to rapidly determine the chemistry. Sample prep is easy, as it only needs to be crushed to ensure reliable measurements. Typically, the best practice is to take an average of several readings. The Vanta analyzer displays the average elemental and oxide readings, and ratios such as basicity can also be displayed.

Alternatively, operators can also grind the sample and place it in a sample cup for measurement. Either way, the results can be easily transferred to the dynamic heat calculation.

The Vanta analyzer can be used as a handheld solution or positioned in a Vanta Work Station on the furnace floor or within the control room area.

Continuous Casting

Billets exit the continuous caster ready to transfer for shipping or the rolling mill. Vanta analyzers in handheld, robotic, or in-line applications are ideal for rapid heat verification.

At the continuous caster, samples of metals, slag, and powder taken from the tundish and molds can be analyzed quickly with the Vanta XRF analyzer.

The analysis and condition of the slags and powders are controlled to provide a manganese sulfide (MnS) and aluminum oxide (Al_2O_3) inclusion-free slab for rolling and to confirm the final product quality, such as when manufacturing API 5L pipe steels. The powdered fluxes are controlled to ensure correct lubrication in the mold.

Semifinished Products

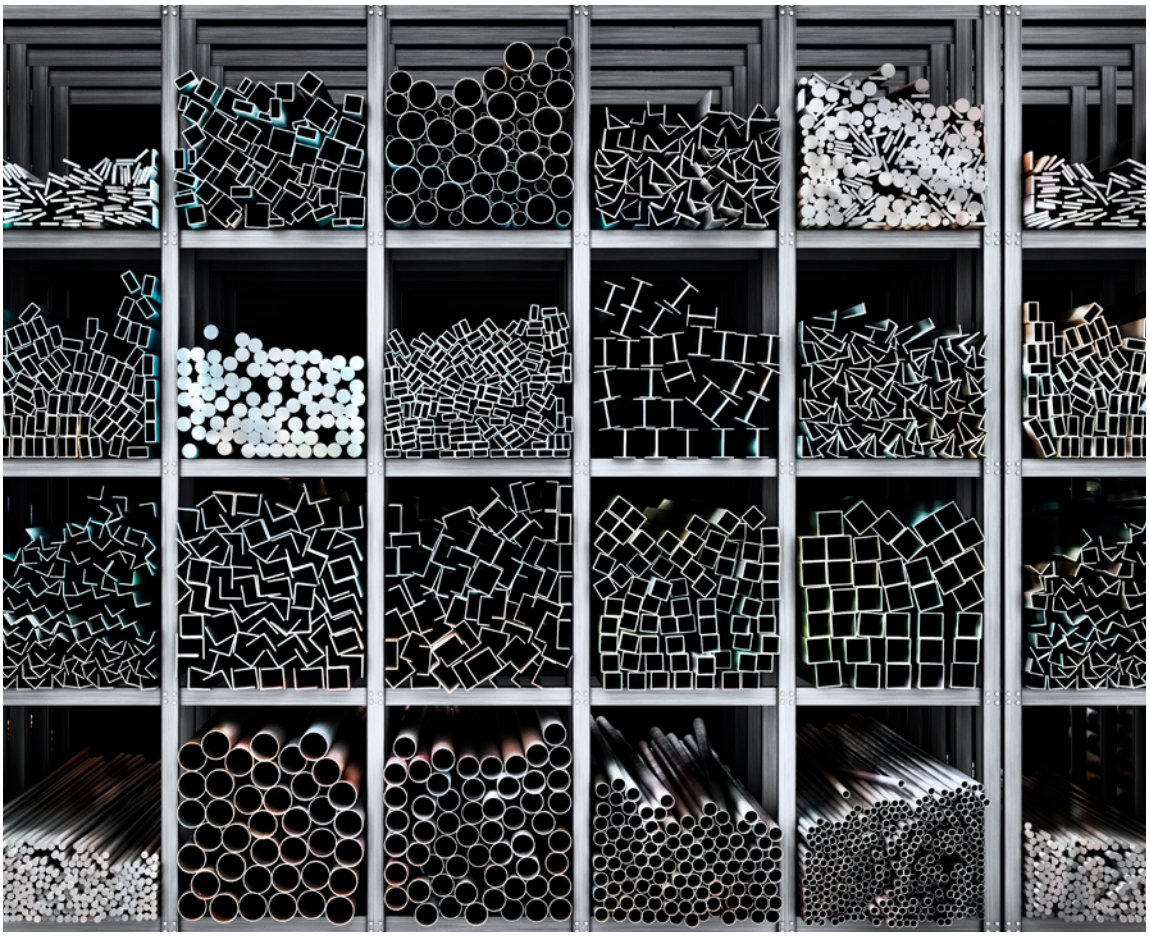
Steel plate in the yard will be verified prior to shipment.

Verification of heat chemistry with the Vanta™ analyzer enables full traceability of semifinished product lots, which are either further processed within the mill or shipped to customer facilities for processing. Semifinished products include:

- Ingots, slabs, and billets
- Plates and sheets
- Rods and bars
- Tubes and pipes

Vanta analyzers in handheld, robotic, or in-line applications are ideal for rapid verification of heat chemistry and can be fully integrated to help ensure the correct product is released. Our Vanta Connect API provides easy integration of the analyzers into most existing control systems, enabling 100% inspection to help eliminate the risks of product mix-ups.

Quality Assurance/Quality Control (QA/QC)



Metal stockists hold and process many alloy types. Knowing a sample is the correct alloy upon arrival, throughout processing, and at shipping helps to ensure the correct heat is delivered to the customer.

As 100% alloy heat verification in the ERP system becomes essential across industries, Vanta handheld and in-line XRF analyzers can quickly and accurately identify the heat chemistry of alloys.

For instance, you can easily scan barcodes to ensure that the analyzer is set up to match the alloy heat chemistry. You can also send the analyzer data to the ERP system, which can be used to release customers' purchases.

Other Vanta™ analyzer features that can improve the manufacturing QA/QC process include:

- Optional sample and panoramic cameras, user-defined input fields, connectivity features, and extensive data reporting capabilities maximize the speed and efficiency of industrial goods processing
- User-friendly software enables operators to make inspections with minimal training
- Touch-screen display is clear, bright, and readable in any light
- Intuitive user interface is easy to navigate
- Customizable display: choose features and functions for the main screen
- Data export is simple via USB flash drive, wireless LAN, or Bluetooth®
- Unique username and password login for each user
- Ergonomic buttons and an industrial-grade, push-button joystick make it easy to navigate the system with gloved hands

Fabrication

Fabrication of complex assemblies for industrial uses requires alloy verification at each step of the process.

Incoming goods inspection must be performed before any fabrication operation that transforms a piece of semifinished steel into a final component. The goods are normally tagged to a heat or batch number, as well as the relevant material test report (MTR) that includes the chemical composition.

Inspectors can use Vanta XRF analyzers to determine that the goods meet the chemistry of the MTR. These checks help them discover steel grade issues before the material is accepted into the fabrication plant.

Typically, similar checks are made at each part of the process to avoid material mix-ups. The Vanta™ analyzer offers modern data capabilities, such as a barcode reader and easily configured data transfer, to help ensure continued traceability throughout the facility. For repetitive analysis tasks, the Vanta series can be automated with in-line and robotic configurations. Olympus' API makes these setups easy to install and configure in manufacturing environments.

If you are welding, cutting, machining, forming, and assembling, Vanta analyzers meet material verification needs. For instance, testing welding materials such as weld wire or rods prior to the welding process will help you avoid costly mix-ups.

Post-welding testing with either a weld mask or collimation helps to ensure that the correct materials are used for the weld and ultimately lowers the risk of in-service failures. Thoroughly testing the parent materials both pre- and post-weld further adds to the QA/QC procedures.

Positive Material Identification

The Vanta analyzer is fast and easy to use on-site for PMI.

When fabricated components, such as valves, arrive at a power plant or an oil refinery, they must be immediately inspected in the warehouse or laydown yard to meet the purchase specification for acceptance. Rugged, lightweight, and field-portable, the Vanta™ XRF analyzer is the ideal tool for these positive material identification (PMI) procedures. When 100% inspection is required, an in-line or robotized XRF analyzer may be appropriate.

During construction, where many components are assembled, on-site testing must be performed to API RP 578 standards. Operators can use the Vanta analyzer to test the components, then transfer its data to a plant piping and instrumentation diagram (P&ID) for confirmation and recordkeeping. The Vanta XRF analyzer can also link wirelessly to remote offices, where data can be reviewed and reported, while operators continue their inspections.

Many existing facilities in the field have operated for long periods and, due to changing operational conditions in these aging facilities, there is a need to implement retroactive PMI testing as part of a safety procedure.

Conclusion

This e-book is designed to give you a foundational understanding of the metal manufacturing cycle and how handheld XRF analyzers can assist in all process steps. To learn more about Vanta™ XRF analyzers and how to get the most out of your instrument, contact your local Olympus representative or visit us online at www.olympus-ims.com.

www.olympus-ims.com

OLYMPUS

OLYMPUS CORPORATION OF THE AMERICAS
48 Woerd Avenue, Waltham, MA 02453, USA, Tel.: (1) 781-419-3900
110 Magellan Circle, Webster TX, 77598, USA, Tel.: (1) 281-922-9300
OLYMPUS NDT CANADA INC.
3415, rue Pierre-Ardouin, Québec (Québec) G1P 0B3, Tel.: (1) 418-872-1155

For inquiries - contact
www.olympus-ims.com/contact-us

Metals_eBook_202011 • Printed in the USA • P/N: 920-589-EN Rev. A