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REAL-TIME INTELLIGENCE FROM LIQUID METALS

Uncover endless business optimization opportunities while accelerating your digital transformation journey. Redefine the way elemental analysis of metals is done along the value chain, deploying DTE's breakthrough innovation associated to Industry 4.0 technologies.



DTE IREAS

INTELLIGENT REAL-TIME ELEMENTAL ANALYSIS SYSTEM

Maximize value, safety, sustainability, and efficiency with real-time intelligence from liquid metals generated by a machine learning-based cloud platform -DTE's metals production ecosystem- and chemical composition analysis based on DTE's LP-LIBS™ technology from a network of elemental analyzers.



Streamline decision making

Breaking value chain silos with accurate real time information

Increase return on capital

Optimizing production assets' use and performance

Decrease energy consumption

Applying real-time and forward-looking process control

Fine-tune alloying process

Visualizing the melt dynamic of alloying elements

Maximize quality and traceability

Monitoring the liquid metal along the production line

Increase throughput

Using real time product information and process control

Optimize production planning

Leveraging metal intelligence along the value chain

Increase operators safety

Using fully automated liquid metal analyzers

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Real-time intelligence from liquid metals

D. Areces, DT Equipment ehf



Combining real-time chemical composition analysis from liquid metals with an artificial intelligence-based cloud platform helps to optimize operation efficiency, sustainability and safety along the value chain in aluminium manufacturing

DT Equipment ehf (DTE) combines real-time chemical composition analysis from liquid metals with a machine learning based cloud platform to maximize value, operation efficiency, sustainability and safety by optimizing the aluminium manufacturing's value chain and executing forward-looking process control and business management.

At DTE, we believe that breakthrough innovation and constant technological evolution open doors to new value creation possibilities, efficiency and sustainability. Since our inception, we have focused our innovation efforts on bringing technologies to market to solve evident, well-defined problems that our customers have and provide them with solutions that deliver a beneficial business outcome. Whenever we do that, we do it thinking of the overall business challenge in front of us, from having excellent products that perform as expected in a rugged industrial environment to ensuring that the solution provides the business outcome sought out by our customers.

This article's essence is about how DTE, through breakthrough disruptive innovation and the use of Industry 4.0 technologies, has brought to the market a solution that redefines the way metals – in this case, aluminium – are produced.

Redefining the approach to maximize productivity in the aluminium industry

For how long have we thought about the process improvements we would deploy if we could measure liquid metals' chemical composition? And what about if we could do it 'in-line', in real-time? And what if we could have that information available to us, in digital format, available across the operations, along the value chain? And if that information was provided to us in the form of actionable reasoning intelligence, so we could make decisions, not only based upon historical input but more importantly based upon predictive insights?

Considering all this, how much operation efficiency could we gain? How much value could we bring to the business? Should we begin to consider, once again, the things that we dreamed about for years?

Well, yes. We all have to think again about bringing back the ideas we had but could not implement because the technology was not available or did not work correctly in a demanding industrial environment. With a new frame of mind, we have to start thinking about uncovering additional value based on the new possibilities offered by the breakthrough innovation described in this article.

We have to start thinking about new ways to balance the sustainability equation – econ-

omy, people, and safety – considering that now we can leverage on the current Industry 4.0 technologies. Smart manufacturing allows us to access data and, more importantly, actionable information and intelligence to make decisions with a holistic mindset, breaking silos within functional operations and across the value chain.

We have to start thinking again because DTE has brought to the market a solution that redefines how to run operations and drive the business. The solution is real-time intelligence from liquid metals, combining chemical composition analysis of molten metals with an machine learning-based cloud platform.

DTE's solution: real-time intelligence from liquid metals

DTE, a leader in real-time business and operational intelligence from liquid metals, has brought to the market a solution that combines real-time chemical composition analysis of liquid metals with an ML-based cloud platform, the foundation of a metals production eco-system. DTE's solution maximizes value, operation efficiency, sustainability and safety by optimizing the vertical functional operations along the complete horizontal value chain.

Breakthrough innovation and digital technologies: DTE's solution, which leverages many of the multiple technologies of Industry 4.0 – from laser optics and digital spectroscopy to cybersecurity, machine learning and a cloud platform – not only covers the whole lifecycle of an industrial operation but also benefits from the company's organizational behaviour and process knowledge capabilities. It also aims to provide tangible business value along the value chain generated by an eco-system defined by the cloud platform's network effect.

DTE has made it possible not only to measure, in real-time, molten aluminium, through the so-called technology *Liquid-Phase-Laser-Induced Breakdown Spectroscopy (LP-LIBS)* but also to extract the most business value out of the actionable intelligence derived from DTE's elemental analyzers.

Three significant elements enable plenty of opportunities to maximize operation efficiency, sustainability, safety and overall value to the business, summarized in the concept of 'faster, better products to market', with

‘better’ not only considering the customer benefits but also the manufacturing efficiency.

The first element is the possibility of measuring chemical composition from liquid metals in less than a minute and making that information instantaneously available to the business systems.

The second is the ability to execute forward-looking or prescriptive process control and business management – thanks to the availability of the information in real-time and the predictive insights capabilities of machine learning.

The third one is the convergence of vertical (operational units) and horizontal (value chain) optimization, one of the digital transformation pillars in industry segments – enabled by the same Industry 4.0 technologies capabilities highlighted before.

High-level benefits generated by real-time intelligence from liquid metals: The value that the new technology brings to the metals industry is vast and goes from point value – value-focused in a particular part of the process – to an all-across optimization, from suppliers to customers, from the plant floor to the trading desks. We summarize it as ‘faster, better products to market’.

Next, a summarized high-level list of values that have been discussed and verified with stakeholders in the aluminium business. In a more detailed document available upon request, we have also monetized the impact of these values. However, deploying LP-LIBS technology provides different benefits to different customers, based on their level of technological and financial evolution.

The benefits are the following:

- Having more meaningful and actionable data, immediately available, from the core element in the process – in this case, the flowing product being manufactured: molten aluminium – in the form of intelligent information not only improves the decision-making process but also increases a company’s valuation considering that data is a new asset class.
- There is an overall increase in the ‘return on capital employed’ driven by improved production planning – defined by the finished product being demanded and therefore manufactured – and the knowledge of the product status along the value chain.
- Real-time, frequent, chemical composition

analysis from liquid metal provides detailed information about the melt dynamics which enables fine-tuning of the alloying process

- Increasing the chemical composition analysis frequency (faster, in more points along the value chain) increases the availability, quality and traceability of the manufactured product.
- Greenhouse gas emissions and energy consumption are reduced because processes governed by time, volume or experience due to the limitations of the current chemical composition analysis technology will be controlled by real-time information to be controlled; an example of this is the treatment of alloys in the furnaces.
- More, faster and more accurate data offers the possibility to generate better predictive insights and therefore execute predictive maintenance, avoiding significant process and safety challenges. An example is the case of sudden electrolysis pot bursts.
- The cost of analyzing chemical composition (people, associated assets, consumables and others) decrease, considering the apparent differences of analyzing liquid metal in-situ versus analyzing a solid in a remote or nearby laboratory.
- Safety is increased as operators no longer have to sample and cast liquid metal and do not have to walk through the plant to carry samples to the labs.

The solution: DTE’s intelligence from liquid metals solution includes three major components:

- Connected, real-time elemental analysis.
- A metals production eco-system that enables a network effect, whose engine is DTE’s ML-based cloud platform.

- A comprehensive set of digital elemental analysis services, including field, change management and business optimization services, among others.

These three components are described, at a high level, in the following sections.

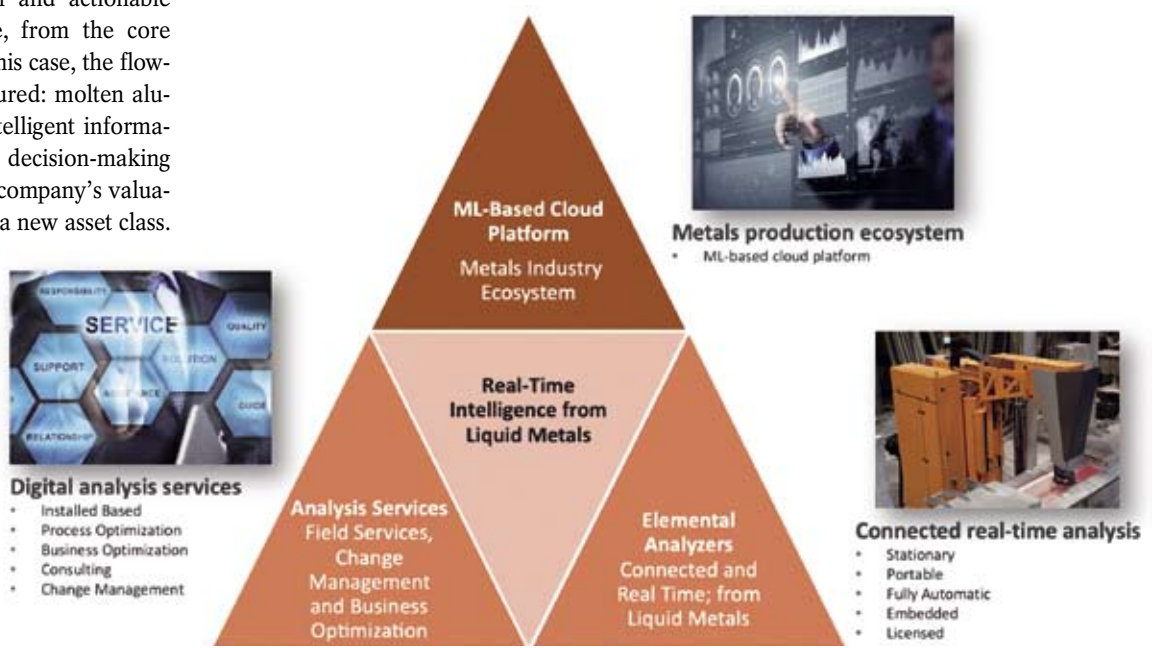
LP-LIBS elemental analyzers

While frequent and reliable chemical analysis of a metal or alloy is the critical success factor for efficient process control in primary and secondary aluminium smelters, for a sustainable and profitable business ‘control’ the processing and management of that information in the context of all the other production variables is imperative. Here is where IT/ OT integration plays a critical role.

The cornerstone of DTE’s solution is its portfolio of ‘connected’ elemental analyzers, which allow measuring, in real-time, the chemical composition of liquid metals, processing the data and sending the information to DTE’s machine learning-based cloud platform.

The complete range of elemental analyzers covers applications in every one of the main process steps in primary or secondary aluminium manufacturing that require chemical composition analysis: the potroom, the crucible, the furnaces, the casters and the launders.

Considering that connectivity is essential for IoT devices, DTE’s elemental analyzers offer 4G, WiFi and Bluetooth communication technology, which is used to connect to DTE’s cloud platform and portable devices carried by operators. →





DTE's Portable Elemental Analyzer EA-1000

As reported in DTE's research paper *Accurate Real-Time Elemental (LIBS) Analysis of Molten Aluminium and Aluminium Alloys* [1], LIBS analysis of aluminium and aluminium alloys in their molten state is, for most of the investigated elements, superior to conventional laboratory analysis of solid process samples. Furthermore, LIBS measurements can provide an unprecedented level of detail about melt dynamics in real-time.

LP-LIBS technology has demonstrated, so far, in laboratories and on the plant floor that in terms of accuracy, measurement to measurement repeatability, stability and real-time measurement, it can perform better than the current technologies used.

Besides, and as stated in the research report *Automated Chemical Analysis of Liquid Aluminium for Process Control* [2], a fully automatic LIBS-based analysis of chemical composition from liquid primary aluminium gives a good representation of melt chemistry. In many cases, this analysis shows improved internal consistency of measurement results compared to laboratory analysis of process samples.

On top of this, the online analysis provides rapid results (measuring time typically less than 1 minute), improves worker safety and eliminates the risk of human error. The LIBS analyzer can run largely unattended for weeks or months and is ideal for continuous process control where fast and secure feedback is required.

Comparable chemical composition performance and accuracy derived from tests performed with DTE's fully automatic stationary analyzers has been obtained from portable analyzers in different lab and field tests.

DTE's metals production eco-system

For any business to deliver profitable and sustainable business growth, the processing and management of the business level information in the context of all the other variables, along with the integration of this information to the operational technology levels (the 'process') is imperative.

DTE's AI-based cloud platform is the component of the solution that enables profitable and sustainable growth by transforming real-time chemical composition analysis from the liquid metal into actionable intelligence and integrating IT and OT.

While the elemental analyzers installed in a plant provide accurate, timely and precise trace and alloying elements information, the

cloud platform converts this data into actionable information, consolidates it, puts it in context, monetizes it, and provides a holistic view of the value chain.

The cloud platform is also the engine behind DTE's metals production eco-system, a 'virtual business place', driving value of the collaboration among suppliers, customers, partners and the market. The eco-system streamlines the value chain all along – internally between operational units, and externally with suppliers, customers and partners – and also allows a vertical optimization thanks to the data transparency, from the plant floor to the business levels and the trading markets.

The benefits: DTE's cloud platform turns the essential information that it may be found out in a smelter's operation – the chemical composition of the final product in its different stages of production – into a concrete business outcome.

In summary, DTE's cloud platform:

- Converts chemical composition information from the liquid metal into actionable intelligence in real time
- Makes data an even more valuable asset with a dual role, to optimize operations and to increase a company's valuation – through a centralized data governance hub
- Maximizes cybersecurity and optimizes data management and device connectivity by leveraging the power of Amazon Web Services
- Provides a single version of the truth across the entire operation, through its set of dashboards or cockpits
- Provides visibility across the value chain, which allows to break operational silos and not only work inefficiencies within functional



DTE's Stationary Elemental Analyzer EA-2000 performing chemical composition analysis at the launder

units but also along the value chain

- Combines operational and business information – integration of IT and OT – to monetize the impact of decisions at every level to provide a clear understanding that small improvements (most of the time) deliver significant gains to organizations
- Provides information about future events or values of the most critical business variables through its predictive insight's capabilities to enable forward-looking (manual or automatic) decision and control capabilities
- Enables the network effect, creating a collaboration, self-growing and self-learning ecosystem.

DTE's digital analysis services

As part of the 'Intelligence from Liquid Metals' solution, DTE offers digital analysis services that leverage remote connectivity and DTE's ML-based cloud platform. To highlight a few:

Field services to the installed base, which are in general services to 'keep the operation running'.

Business optimization services that lever-

age the collaboration between man and machine or between human and artificial intelligence. Business optimization services are all about consulting services based upon historical information and predictive insights, allowing forward-looking decisions.

Change management services, associated with supporting the significant personnel transformation that need to occur when bringing digital technologies to the manufacturing environment. Through a proactive engagement – before, during and after the technological evolution based on business variables – and leveraging the Human Resources function as one of the most important business partners, the organizational DNA must be adapted to maximize the benefits brought by digital technologies. This service ensures that plant personnel and business managers understand the value of their proactivity, their decisions and their use of digital technologies.

Conclusion

This article highlights how DTE, through its 'real-time intelligence from liquid metals' solution, maximizes value creation, safety,

sustainability and efficiency for aluminium producing customers.

DTE's 'real-time intelligence from liquid metals' solution is a breakthrough innovation based on LP-LIBS (Liquid-Phase-Laser-Induced Breakdown Spectroscopy) technology used to analyze in real time the chemical composition of molten metals, combined with complementary Industry 4.0 technologies, most notably machine learning, connectivity and cloud services.

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Save energy and increase cell life

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Aluminium smelters are often challenged by high energy prices and to some extent a short cell lifetime. There are many factors controlling the reduction cell lifetime, e.g. lining material quality (cathodes, barrier and insulation materials, etc.), lining material installation, cell commissioning and operation. The most important properties of lining materials are thermal conductivity and stability, chemical resistance and mechanical strength. Some properties commonly work against each other, e.g. a low thermal conductivity usually goes with low chemical resistance and low mechanical strength. Skamol Group has developed a new class of material, which combines these properties at a new level. The new product is an insulating barrier board called SkamoAlu Barrier LE.

Innovation at Skamol

Skamol Group is constantly developing new solutions to meet the challenges faced by the



SkamoAlu Barrier LE is an insulating barrier board with a density of 1,400 kg/m³

primary aluminium industry. SkamoAlu Barrier LE is a new material class which combines a low thermal conductivity, non-wettable surface, high mechanical strength and high chemical resistance towards cryolitic melt and sodium vapour.

Saving energy

External tests conducted according to ASTM C-201/182 in years 2019 and 2020 on Ska-

moAlu Barrier LE show, that the thermal conductivity is 0.4 to 0.5 W m⁻¹ K⁻¹ (300 to 800 °C), which is 40 to 50% lower than the traditional, dense alumina-silicate refractory materials which are commonly used as a barrier lining against the electrolyte. This superior insulation performance coexists with high chemical resistance and high strength.

The low thermal conductivity of SkamoAlu Barrier LE is due to its low density and to its phase composition. The low thermal con-