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The Landscape of (North) American Foundries

Griffin Patterson

Application Specialist – Foundries HarbisonWalker International, a member of Calderys CALDERYS MEET 2024

26-27 September 2024

State of the market



Number of Companies



Number of Facilities

(Excluding Art Foundries and Educational Foundries)



• Private equities, consolidations and closures are making the market smaller

State of the market



Q1 How have your company's sales trended over the last 90 days?



Q2 What is your business outlook for the next 12 months?



- Private equities, consolidations and closures are making the market smaller
- Business outlook is generally stagnant

State of the market





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Private equities,

market smaller

were highest.

largest challenge

consolidations and

Business outlook is

generally stagnant

closures are making the

Post-covid, labor issues

Insufficient orders is the

Internal vs external refractory work





Probably common knowledge

Internal (handled by foundry workers)

- Ladles
- Launders and troughs
- Spout repairs
- Coreless furnaces
- Electric Arc Furnaces

External (handled by C/Is)

- Cupola maintenance (exceptions apply)
- Holding furnaces
- Heat treat furnaces
- Precast and turnaround programs

Refractory path to market





Direct to customer

Most common with larger foundries (larger orders, more acclimated with project management)

Typically, best pricing for customers

Relies on good internal refractory installation knowledge or relationship with installer



Distribution

Required by smaller foundries, as it can be difficult to put a truck together

Distributors supply more than just refractories

Distributors often have helpful knowledge of the industry, as they are industry specific



Contractor installer

More suitable for larger jobs, due to experience with project management and refractory outages

Prefers to handle labor and material sales

Utilizes highly skilled refractory installers and has resources for complex installation considerations (dry-out, staging, anchors)

What is a C/I (Contractor/Installer)





♥

Third party refractory/construction company that works with end users to:

- Organize material supply
- Warehouse and distribute material
- Provide recommendations for refractory improvement
- Install material during major outages
- **<u>Does not</u>** manufacture refractory materials

♥

C/I Network is a group of signed partners in industry with the common goal of working directly with a refractory manufacturer to improve service, performance and reliability for mutual growth

- Measure of loyalty
- History of proven performance
- Expectation of market needs

HWI – C/I network partnership





♥

HWI is aligned with the most experienced refractory installation professionals

Deep, collaborative partnership to bring value to our collective end customers

Extension of the HWI team and sales efforts – a multiplier for reach

Synergistic relationship: 1 + 1 > 2

- Logistics and material availability
- Application knowledge
- Service packages
- Rich industrial market experiences
- Local customer knowledge and experience
- Rapid response to customer emergencies
- Day to day understanding of production and maintenance processes
- Deep expertise in HWI refractory installation => entire portfolio brick + monolithic



C/I network







C/I technical support



♥

Refractory training and continuous education

- Exclusive annual refractory fundamentals training at HWI's Advanced Technology and Research Center
- Tailored training events/meetings for C/Is focused on products, installation techniques, solutions for specific markets and customers
 - Training seminars
 - Product demonstrations



C/I technical support





Premier access to analytical services and product support

Post-mortem analysis

- Failure analysis
- Microscopic and mineralogical analysis

Performance testing

- Molten metal testing
- Salt and flux analysis
- Slag analysis

Continuous education to enhance the value to our customers



C/I innovation



C/I's are a key component of product development at HWI

- C/I Installation Hands-on experience, detailed knowledge. They have seen a lot!
- HWI's product technology and refractory science experience. *They know a lot!*
- Optimization of Designs Key feedback to product designers. They use the product
- C/I Early product adopters. Promoting use as a competitive advantage
- This partnership drives creative, useful refractory solutions for many industries







Fostering deep collaboration to drive *mutual growth* and success

Partners vs customers

"Signed C/Is" vs "Unsigned C/Is"

Three main components of loyalty program – "Signed C/Is":



Loyalty Program Incentive → Annual rebate credit* for targets achieved

Performance expectations:

- Minimum annual revenue target

 \$X for incumbents; \$4X for new entrants
- Engagement expectations

 to drive collaboration and enable new business opportunities

Benefits:

- **Preferred Pricing** tier for loyalty program participants
- Target-based annual **rebate**
- Additional benefits for results above target

Precast and turnaround programs





Foundries utilize refractory installers to take decommissioned ladles and replace refractory, ensuring that foundry has adequate supply of usable ladles

- Higher refractory performance
- Geographically sensitive



So why are contractor Installers doing this and not the refractory supplier?

Distribution vs. installation



All C/Is handle some aspect of installation work (cupola relines, holding furnace relines)

• Labor with or without material sales

In the foundry market, a large subset of C/Is also handle distribution

- More suitable for smaller foundries
- Less service oriented, more logistics oriented

HWI also has its own distribution centers, but foundries almost entirely prefer foundry distributors

- Better knowledge
- Better relationships
- The ability to supply more than just refractories



75% of foundries in the US are small businesses with under 100 employees

Installation vs. material sales



Contractor/Installers prefer to offer turnkey solutions with material sales and installation offered as a single bid

- Better control of timeline
- Better control of material quality
- Margin added on both material and labor

Some C/Is are more labor focused with low logistical overheard and do better on installation without material sales Utilizing Contractor/Installers for turnkey solutions reduces outage complexity and enables corrective measures to require only one point of contact should an issue arise.

• Union foundries require unionized contractor/installers

Plann ing and	Material Ordering	Pre-Shutdown	Shutdown	Maintenance and	Post-Maintenance	Restart and	Continuous
Schedu ling	and Logistics	Activities	Execution	Reline Work	Activities	Monitoring	Improvement
Timeline Resource Allocation Risk Assessment Coordination	 Material selection Warehousing Staging Arranging freight 	 Inventory Management Equipment Inspection Documentation Communication 	 Decommissioning Isolation Cleaning Disassembly 	 Inspection Tearout Installation Quality Control 	 Reassembly Testing Calibration Documentation 	 Dryout Monitoring Adjustments Process feedback 	• Review • Lessons Learned • Updates • Training

Market trends in foundry shutdowns



♥

As industrial data systems get more user friendly and consolidations drive improved efficiencies, end users are becoming more capable with their own logistics

- Shutdown expectations are being planned years in advance
- Purchasing teams are capable of organizing material handling, delivery and warehousing
- Economic factors are driving need to cut costs on contractor contributions
 - Operating expenses have gone up ~40% over the last 10 years

•

C/Is who handle material supply and installation are regularly losing out to labor only contractors

• Labor only contractors do not partner with material suppliers

HWI is looking into a distribution model similar to the contractor/installer network

- Rebates
- Targets
- Pricing tiers

ModuResearch Technology Foundry Consultants

Current challenges in the foundry industry

Solutions for optimal green sand and perfect castings



ModuResearch Technology

Foundry Consultants





ModuResearch Technology Foundry Consultants

Agenda

Company Challenges Systems for solutions

Company



ModuResearch Technology Foundry Consultants

- Founded in 1976
- Developer of foundry specialized technology
- We are the innovation leader for moisture control systems in foundries
- Own R&D laboratory for measurement technology
- ISO 9001 certified; ISO 14001 in process



Business Branches



ModuResearch Technology

Foundry Consultants

Products & Services

- Two product lines
- Software solutions
- Maintenance

Sand Plant Consulting

- Detecting insufficiencies
- Identifying optimization potentials
- Provide recommendations for action
- Modernization of "dumb" equipment



ModuResearch Technology

Foundry Consultants

Challenges





Technology

Foundry Consultants

It is our goal to provide customers with automated solutions to solve their problems.





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ModuResearch Technology

Foundry Consultants

for Solutions

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Systems

Product Lines



Professional Line

- Basic Needs
- Fixed System Layout
- Reliable Technology
- Plug & Play

Expert Line

- High-End-System
- Modular Systems
- Tailor Made Solution
- Guaranteed Values

Professional Line



ModuResearch Technology Foundry Consultants

- New measurement technology
- Easy set-up and installation Plug & Play
- More economical than comparable systems



Professional Line

BlackBoxSystem



ModuResearch Technology Foundry Consultants

- New model release end of 2024
- Standard technology installed at the conveyor belt in front of the aggregate
- Material and temperature monitoring
- Water addition depending on moisture, temperature and material level





Technology Foundry Consultants

- Modular connected system for the sand plant
- Measurement within the process (in the mixer; cooler; at the molding machine)
- Automated multiple water dosing depending on moisture, temperature and material
- High precision (Measurements are taken over 1000 times per second)





Module 1 Module 2 **MIXER-SYSTEM COOLER-SYSTEM** for all mixer-types for all cooler types SANDPLANT Module 3 Module 4 SANDLAB **MiPro Suite 19** online laboratory MES

Technology Foundry Consultants



Multicooler

11

Fluidbed-Cooler

MMM

100001300

AT AND AND AND AND AND AND AND

ME

Batchtype-Cooler

Cool Drum

Module 2 COOLER-Systems

Quelle: © disagroup.com

Michenfelder

MFASUREMENT & CONTROL SYSTEMS

ModuResearch Technology

> Foundry Consultants

Module 3

SANDLAB Online sand laboratory

Basics

- Compactability
- Compressive Strength
- Action 2024





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Further options

- Shear Strength
- Deformability
- Gas permability
- Moisture
- Temperature
- Active Bentonite (calculated)
- Springback Effect


Module 4 MiPro | PROMA*V/S®*



ModuResearch Technology Foundry Consultants



- Quality Assurance System
- Process Data Management
- Real-Time Control
- Two Versions available

FoMaSys® MiPro





FoMaSys® PROMAL//S®









ModuResearch Technology

- Process Management and Visualization
- Total Quality Control
- Silo/Bunker Simulation
- Material Tracking
- Sand Time Machine (Endless Data Loop)

Material Tracking

2.

3.

4.



What's next?



Technology





ModuResearch Technology Foundry Consultants

Formstoffberechnung Erfassung Verbrauchsdaten Bilanderungen Produk	torapian Model Datenbark			_			
Bianurummer Verbrauchsnummer Modeliname	Von	58	Esen/Sand-Verhältnis	Kernsandzulauf Neusandzul	lauf Auffrischungsgrad Bentonit	verbrauch G48-Verbrauch Senton	t Verschieftaal
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Auffrechung 15 lag / 105lag Fe Genetich 068-Antel 40 % GRittentunk 2000 lag Plastigetentunk 2000			Model Kaon Fice For Kerr Sole Auff ge	wiefte Kathen igesen / Kasten : 000 and / Kasten : 000 and / Kasten : 000 ente Kasten ter Sall 000 % ischung Sall 000 kg / 101	kg Bedarf Genod kg Bedarf Genod kg Bedarf Benton kg Fe	kg /Kaden kg /Katen tpur kg /Kaden	
Benchmer >>		iç/der					

- Data need to be used
- Moulding Material Balance
- Model based

Michenfelder PROMAVIS® [Test_Micomp5]



📇 🙀 😿 😜 Michenfelder [System] Anlage störungsfrei

Mischdynamik Drucker Labor Kühler1 Kühler2 Datenbank Korrelation Sandlab1 Mischer Uni Mischer1 Formsand





Forr		twerte Fo	ormsand-So	ollwerte	Validation	Korrektur						
Nu	immer	Datum	Uhrzeit	Mischer	Charge	Altsandgruppe	Altsandfeuchte	Linie	Feuchte	Verdichtbarkeit	Druckfestigkeit	Normierte Dr 🔺
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	2	25.09.2024	11:56:54	1	2	1	0	1	3	38	22	
4												
	K 🛛 🖣		Ak	tuell								

R&D Projects

Big Data Smart Data

- Use of the generated "Industry 4.0" data
- Our system is specialized in ("Moulding Sand 4.0")
- Makes processes visible
- Creation of know-how and safeguarding of the process

Foundry Supervisor

- Artificial Intelligence (AI)
- Self-optimizing technology
- Advice or process control
- Know-How Transfer and Knowledge Protection









Foundry Supervisor



Foundry Consultants

Foundry Supervisor Coal Dust **Digital Foundry** Bentonite Water Waage Module 1 ME ME **MIXER** Module 3 - SANDLAB Mouldi ng San d Mouldi ng Line

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Refractory concepts for Energy Savings

Tommy Rydholm & Henrik Ohlsson

26-27 September 2024





AGENDA



Limitations of a lining concept



Case Study – First step



Case study – Second step



Ways forward & Conclusions



01 Limitations





The Limitations

The limitations of a lining concept:

- Lining thickness
- Material properties: maximum user temperature, insulating properties
- Safety layer: freezing point melted iron approximately 1,150°C degrees

The problems with the right hand example:

- The hotface lining is pretty thin
- The maximum user temperature of the insulating material is exceeded.
- The freezing point is not in the safety layer









Energy concepts for ladles



Different solutions for ladles

- Hotface in CALDE® MIX FLASH A 55 MD.
- > This material has greater insulating properties than regular hotface materials. The problem with this solution is that the lifetime of the lining is significantly lower than a normal hotface material. Generally, this is not a good solution from a financial point of view.
 - A prefab ladle solves the problem with a safety layer
- It generally improves the insulation as well, but also decreases the thickness of the hotface. Since the ladle is dried out upon delivery additional energy savings is done. To get really good insulating solutions you need a thick lining though, so you can use several layers for the lining.
 - A lid is always a good improvement in case that does not exist.



02 Case study – Step 1



Case study: holding furnace at SKF Mekan - Step 1

The original concept was a simple lining with hot face, insulating/safety layer, ceramic fibre.

- As a first step we introduced a concept with a **hot face, safety layer, insulating layer, ceramic fibre**. This is a concept that is quite common and well proven.
- Theoretical heat transfer calculations was made
- Theoretical energy saving calculations was made
- The new concept was slightly more expensive, mainly due to longer installation time







Calculations - Step 1



What was made:

- A change in the wall of the furnace
- A heat calculation regarding how that changes the theoretical temperatures in the wall. The outside temperature decreased from 224°C degrees to 200°C
- A change in the bottom of the furnace and the lining of the lid
- A theoretical calculation of the energy savings



Wall concept comparison





Energy saving calculations - Step 1



- The theoretical energy saving is **106 MWh/year**
- 3 years furnace lifetime expectancy
- Once the concept was adapted the measured energy savings did meet the expectations
- When it was time for the next lining of the furnace the customer wanted us to develop the concept further to provide even more energy savings

	OLD CONCEPT (inside area)				
Part of lining	Heat loss/m2 (inside) (W/m2)	Area (inside)	Heatloss		
Wall	3190	17	54230		
Bottom	2418	6,3	15233,4		
Lid	2367	6,3	14912,1		
Other 1			0		
Other 2			0		
Total heatloss/hour			84375,5		
	NEW CONCEPT (inside area)				
Part of lining	Heat loss/m2 (inside) (W/m2)	Area (inside)	Heatloss		
Wall	2767	17	47039		
Bottom	2017	6,3	12707,1		
Lid	1977	6,3	12455,1		
Other 1			0		
Other 2			0		
Total heatloss/hour			72201,2		
Energy savings /hour (kW/h)					
iotai running time of object per year (nours)					
Total energysaving/year for object (kWh)					



03 Case study – Step 2



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MEET 2024

Case study: holding furnace at SKF Mekan - Step 2

The second step was to use high insulating microporous material for insulation in the walls and the lid.

- To protect the microporous during gunning of refractory insulation material, ceramic fibre was put on the microporous material
- Theoretical heat transfer calculations was made
- Theoretical energy saving calculations was made
- The new concept was more expensive due to higher material costs and a more complex installation





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Calculations - Step 2



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What was made:

- Furnace wall changed.
- A heat calculation regarding how that changes the theoretical temperatures in the wall. The outside temperature decreased from 200°C degrees to 175°C degrees
- Lid change
- The concept for the bottom remained the same
- A theoretical calculation of the energy savings based on these heat calculations





150

440 mm

177

outside *C

Wall concept comparison





Energy saving calculations - Step 2



- The theoretical energy saving is another **108 MWh/year**
- Together, these two steps provides a theoretical energy saving compared to the original lining with over 200 MWh/year

	OLD CONCEPT (inside area)				
Part of lining	Heat loss/m2 (inside) (W/m2)	Area (inside)	Heatloss		
Wall	2767	17	47039		
Bottom	2017	6,3	12707,1		
Lid	1977	6,3	12455,1		
Other 1			0		
Other 2			0		
Total heatloss/hour			72201,2		
	NEW CONCEPT (inside area)				
Part of lining	Heat loss/m2 (inside) (W/m2)	Area (inside)	Heatloss		
Wall	2150	17	36550		
Bottom	2017	6,3	12707,1		
Lid	1679	6,3	10577,7		
Other 1			0		
Other 2			0		
Total heatloss/hour			59834,8		
Energy savings /hour (kW/h)					
Total running time of object per year (hours)					
Total energysaving/year for object (kWh)					



04 Ways forward & Conclusions CALDERYS MEET 2024



Possible ways to move forward



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Our European colleagues are testing new installation methods as well, and by utilizing the Calderys network, it is possible to develop these concepts further

For example, Calderys Germany has developed a different concept for lids to improve the insulation. By using a refractory insulating material with better insulation properties, but high enough user temperature to withstand the higher temperature.

This means avoiding the complex installation of the microporous in the lid, but getting even better insulating properties. A lid insulated with this concept provides an additional saving of 28 MWh/year*



Case study conclusions



With our two steps we have made a theoretical energy saving of 214 MWh/year. With an energy price of 0,10 €/kWh this means a saving of 21,400 €/year and a saving of 64,200€ during the full lifetime of the furnace.

- After a new lid concept, this would increase the savings in the example above to **24,200 €/year** and to **72,600€** during the furnace lifetime
- This would also mean a **considerable reduction** of the CO2 footprint

Total savings/year with todays concept

	OLD CONCEPT (inside area)				
Part of lining	Heat loss/m2 (inside) (W/m2)	Area (inside)	Heatloss		
Wall	3190	17	54230		
Bottom	2418	6,3	15233,4		
Lid	2367	6,3	14912,1		
Other 1			0		
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Other 1			0		
Other 2			0		
Total heatloss/hour			59834,8		
Energy savings /hour (kW/h)					
iotai running time of object per year (nours)					
Total energysaving/year for object (kWb)					

Total savings/year with todays concept and improved lid

	OLD CONCEPT (inside area)				
Part of lining	Heat loss/m2 (inside) (W/m2)	Area (inside)	Heatloss		
Wall	3190	17	54230		
Bottom	2418	6,3	15233,4		
Lid	2367	6,3	14912,1		
Other 1			0		
Other 2			0		
Total heatloss/hour			84375,5		
		-			
	NEW CONCEPT (inside area)				
Part of lining	Heat loss/m2 (inside) (W/m2)	Area (inside)	Heatloss		
Wall	2150	17	36550		
Bottom	2017	6,3	12707,1		
Lid	1179	6,3	7427,7		
Other 1			0		
Other 2			0		
Total heatloss/hour			56684,8		
Energy savings /hour (kW/h)					
Total running time of object per year (hours)					
Total energysaving/year for object (kWh)					





Thank you for your attention



CALDERYS $\mathsf{VEE} \mathbf{2024}$



Decarbonization in the foundry

A complex and challenging topic Oleg Podobed, Robert Siebrecht, Frank Siegrist

26-27 September 2024





Why does it matter?





The reduction of CO₂ in the air is a topic that our generation must tackle.







Introduction **Example in NRW (Germany)** 06 01 02 **Scopes Ambitions** 07 **Breakthrough technologies** 03 Energy 04 Decarbonization 05



01 Introduction





Introduction



- Since the Paris Agreement, there has been a growing sense of urgency on reducing carbon emissions so that we can limit global warming within safe limits.
- To enable companies to credibly track and report their emissions, the Greenhouse Gas Protocol (GHGP) provides a framework of scope-categories which define the different kinds of emissions generated in a company's operations and value chains.
- Foundries already produce Near Net Shape products transferring metal scrap into the castings and using Green Molding Sand technology, dye casting or chill molds with very low materials consumption. Recycling is coming to accelerate the way to the climate neutrality.




















Understanding scope 1, 2 and 3 emissions

Graphic by Stacy Smedley, 2021





Diving deeper into the scopes

CALDERY

Scope 1 and 2 (summary)

In contrast, scope 1 and 2 emissions have a more narrow focus

• Scope 1 emissions are the company's direct emissions from sources it owns or controls, such as combustion of fuels in boilers and company owned or controlled vehicles, or emissions from industrial processes and onsite manufacturing



• Scope 2 emissions are indirect emissions associated with the organization's consumption of purchased electricity, steam, heating and cooling





Diving deeper into the scopes



Scope 3 (summary)

Scope 3 emissions include indirect emissions from a company's value chain such as emissions from

- Transport and the distribution of goods and services
- Waste generation
- Business travel
- Employees' commuting
- Use and disposal of products
- Investments made by the organization



The standard breaks scope 3 emissions down into 15 categories, helping businesses identify the areas in which they can have the greatest impact and quickest wins in terms of reducing GHG emissions, while also creating a level playing field that supports partnerships and collaboration.









Foundry map in the North Rhine-Westphalia region, Germany









Foundry facts Germany (East and West)

Around 550 mostly medium sized companies (150 Iron foundries) and 4,5 Mio tons of good castings.

Total CO₂ emissions (from energy)

- 55 % Iron foundries
- 35 % Light alloys foundries (Al, Mg)
- 10 % steel foundries
- 5 % Copper alloys foundries

Foundries (in TWh)	Coke	Electricity	Natural gas	Oil	Total
Iron	1,8	2,6	1,0	<0,1	5,4
Steel	0	0,4	0,4	<0,1	0,8
Light alloys	0	1,5	2,2	<0,1	3,7
Copper alloys	0	0,2	0,1	<0,1	0,3
TOTAL	1,8	4,7	3,7	0,1	10,3



Foundry map in Germany



Germany's energy sources and changes from 2010



Through the electrification – increase of electricity demand by 1 TWh and the lower emissions from electricity mix (higher portion of renewable energy)

- the CO₂ footprint went down from 750 g CO₂ per kWh to 400 g CO₂ per kWh
- Cheap and available natural gas increase by 1 TWh
- Coke consumption went down from 300 000 t/year to 100 000 t/year
- Still > 40 cupolas (hot-cold wind) in operation
- Ongoing substitution by inductive ovens



Decarbonization and defosilization. Targets?



According to German Federal Climate Protection Regulation:



CO₂ Reduction Target for 2030 is 37 % compared to 2020

Means no need for full substitution of fossil energy sources. Only 2045 all processes should become CO₂ neutral or balanced $\mathbf{\vee}$

Till 2040 the reduction of 88 % (compared to 2020) is targeted.

-88 %

>

The compensation of nonavoidable emissions is still allowed, means the operation of fossil fueled equipment, but will get more and more expensive and finally non-reasonable.

MEET 20



Decarbonization and defosilization. Targets?



Which targets are **OUR** real targets?





Foundry challenges and perspectives





- Higher efficiency of energy use and corresponding material efficiency and climate protection are main challenges for EMEA area
- We need clear regulation to keep competitiveness and reduce the risk of invests
- > As a classic supply industry we are in the **global competition** staying under the price and margin



03 Breakthrough technologies CALDERYS



Foundry challenges and perspectives



Breakthrough-technologies from the 4 years evaluation project InnoGuss

Breakthrough-technologies are those allowed a significant reduction of Greenhouse emissions:

- Use of Green Energy/Green Electricity
- Biomass ("Biocoke" for cupola)
- Hydrogen vs. natural gas
- Further Electrification (even of thermal processes)
- CCUs (Carbon Capture and Utilization)





If there is no chance to change the technology - use green power!

DIHAG Groupe in Germany did the power purchase agreement with GETEC ENERGIE for 2024 and 2025 using wind energy from wind energy parcs in North Germany.

 GC
 Using of power purchase agreements, we ensure our way to climate neutrality

 Christian Luke CEO of DIHAG

Green electricity



First contact







- > Energy producer is your **first contact** for Green Energy.
- They have harder targets for decarbonization 61 % CO₂ savings till 2030 compared to 2020

For the foundries with high degree of electrification there is a chance to buy Green Electricity on top of physical energy purchase or just pay a surcharge for the renewable energy supply (financial support) for labeling.









Energy saving or utilization



Inside the foundry

In foundries, there is considerable waste heat potential in the melting process, the cooling sections as well as in the heat treatment or the compressed air compressors, which can be used in other production areas. Solar thermal energy can be used in remote sanitary areas.



In principle, foundries should check whether it is possible to generate their own electricity with photovoltaic rooftop or groundmounted systems or to participate in neighboring hydroelectric power plants and wind turbines.

Collected from near-surface geothermal energy systems for heating and cooling, Coating free cores/additives. Foundries with high natural gas requirements can switch to bionatural gas/biomethane, which is produced from biogenic materials.

- Typically, only around 10% of renewable biomethane from biogenic residues is added to the natural gas supply and a contribution is made to the construction of new renewable energy systems.
- There are currently no major electrolysis capacities in Germany to produce so-called "green hydrogen" that would enable foundries to purchase it.



Energy saving or utilization



Fondium and Maggie - connected by energy

Maggie uses the "waste" heat from Fondium Singen



FONDIUM



- 11 000 tons less CO₂ per year or 50 GWh energy per year
- 5 Mio Invest
- 20 % compensation from federal government



Cupola and Biocoke



From the idea to reality

The idea/experience:

Use of Biocoke in South America for steel industry

Challenge:

Biocoke is (usually) a powder but we need briquettes as coke as a supportive function in the shaft (high temperature strength of briquettes)

Binder and briquetting plants in Europe are required

Max. reported substitution is 20%.

However, the technology is a "transition technology" as no climate neutrality possible.

The ongoing EU Renewable Energy Directive III intends that the thermal convention is the last step for biogenic energy source.

The pyrolyzes of biomass for Biocoke is not allowed and also not reasonable in this particular case.





Hydrogen



Integral part of almost all organic chemical substances

Hydrogen pretends to become a solution for climate neutrality, BUT only as a combination of:

Produced through water electrolyses using green energy and using its higher energy density with high flame temperature with savings of **0,61 kg CO₂ per m³ of hydrogen** Calorific value of Hydrogen is only 10,8 MJ/m³ means **only 30 % of natural gas** (~36 MJ/m³)

3-3,5 x high volume flow is needed for the same heat impact

The level of technology readiness is TR9 (9 years of further research are needed)!

- No distribution pipes network
- No production capacity, low demand (non-ferrous melting shops)
- Water?









Recycling of green molding sand, refractories

Despite of available recycling technologies, experience and even technical benefits around 8 mio. tons of foundry sand (waste sand/returned sand) are going to the landfill every year (only EU).

The target for the recycling quote could be up to 90 % with corresponding reduction of CO₂ for transportation and processing of the sand and resource conservation of silica sand.





05 Decarbonization









Costs development CO₂ (according to nET – natinal emissions trading)

Price development 2021 - 2026

adjustment according to BEHG amendment 2022



Costs for Certificates is a result from "offer and request".

From 10 Euro in March 2018 to 100 Euro in 2022.



Costs reduction for CO₂



Basics on the way to CO₂ neutrality

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Step1

- Improvement of performance (f.E. productivity)
- Less time and energy for holding of molten metals
- Reduction of scrap
- Substitution of energy carriers

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Step 2

 Reduction of emissions in the process with follow up and control according EMAS, DIN EN ISO 14001:2015 und DIN EN ISO 50001:2018





European Commission

Step 3

 (\bullet)

- Compensation of emissions (Carbon Offsetting)
- Further options are available within EU-ETS (EU Emissions trading system).
 <u>https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets_en</u>



CO₂ costs



CO₂ compensation by payment

Microsoft became climate negative in 2023.

and until 2050 they would remove the coal from the atmosphere that the company released since its foundation in 1975.





CO₂ – Management



Carbon footprint calculation



There are several ways of voluntary compensation via certified project developers (CRM carbon reduction management)

- Voluntary Carbon Standard (VCS) or Gold Standard
- Natural Forest Standard (NFS)
- REDD+ (Reducing Emissions from Deforestation and Forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries)



CO₂ – Management



Greenhause reduction rates

Mineral Oil Companies within Greenhouse reduction rates **imported Biodiesel from China** (with mostly false declaration)

12.000 t 1.000.000 t In the year 2022 In the year 2023

The real origin of Chinese **Biodiesel is palm oil from** Indonesia, which contributed to the jungle destruction.

At the same time, the EU Paid 4 500 000 Euro compensation for **Upstream Emissions Projects to** Mineral **Oil Companies**

On top of global planet destruction:

Biodiesel is very cheap compared to local Biogas and Biodiesel producers, which arms the economy of the local actors.

We can and will not destroy the Blackforest!





CO₂ – Management



4,1 Mio. Ha

In 2022 we lost 4,1 Mio. Ha tropical rainforest for the production of Palmoil, "Bio Diesel", Biocoke.



Which translates into the release of 2,7 Gigatons of CO_2 . This is the equivalent of the full emissions from fossil sources in India per year!

*source: (World Resource Institute)



Examples CCS (Carbone Capture and Storage)

Fly with CO_2

ALIGN-CCUS & TAKE-OFF

Use CO₂ as a raw material to reduce CO₂ emissions "ALIGN-CCUS" und "TAKE-OFF".

- Stage 1: win Dimethylether (DME) from CO₂, Water and Electricity
- Stage 2: produce aircraft fuel from DME



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06 Examples in NRW (Germany) CALDERYS



Examples CCUs



Cement

CLEANKER

Catch the CO₂ from Cement production process by use of Calcium-Looping-Process and make it useful for further utilization (Association of German Cement producers)



Examples CCUs



Thyssenkrupp project

Carbon2Chem

Reduce the CO₂ Emissions from steel production through the transformation of CO₂ gas to chemicals (as a raw material)













Transportation



Ways of Emissions reduction (also within Calderys)

"Road transport is an area where organizations can also make big changes to their carbon footprint because most freight is still distributed using trucks, ships, and trains powered by fossil fuels," "Shifting to suppliers and logistics companies **using renewable diesel or battery-powered transport would be a great first step** for these businesses." **ETS2:** buildings, road transport and additional sectors – new additional platform of EU ETS





Summary

Follow up recommendations







Thank you for your attention



CALDERYS $\mathsf{VEE} \mathbf{2024}$



CALDERYS $\mathsf{VEE} \mathbf{2024}$


CALDE® Fast Dry Range

Thomas Höjer

26-27 September 2024





The dry-out of refractories present some challenges

Refractories need dry-out before they can protect any equipment

- There is a period of **unavailability** of the furnace due to the necessary drying time
- Frequently, the pressure to deliver production impacts the maintenance process. If not done properly, it increases risks of **unplanned downtime**

Existing solutions for castables refractories for fast dryout come with inherent disadvantages

- Existing solutions for fast dry is able to be used for repair purposes only
- Challenge to have innovative solutions that is available across multiple sites globally without delays

Dry-out explosion poses safety hazards to customer personnel and operations





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Background & information why





CALDERYS MEET 2024

Background & information why





Dry-out? Is that really needed...?





Our solution: CALDE® Fast Dry (FD) Range





The CALDE[®] FD are **cement-bonded monolithics**. They are used to line the furnaces of Aluminum and Cement producers, Boilers operators and **any industry** using monolithics for their furnaces.

CALDE[®] FD products reduces customer furnace downtime and improves safety on their site. These monolithics are **engineered to remove free water efficiently** from the lining without compromising product performance.

No additional equipment and tools are required.

The CALDE[®] FD range **increases safety**, and **availability** of customer's furnace while **reducing carbon footprint** thanks to an efficient dry-out process.

It is published in the proceedings of UNITECR'23



What does the CALDE® FD Range bring you?

during dry out process





no additional safety hazards



Why work with Calderys







Why choose the CALDE® FD Range?

Detailed presentation of the differentiators



No second component

• No additional second component needed for job site installation. So no additional planning required for extra purchase, extra storage; no additional steps required during installation.

High Green Strength

 CALDE[®] FD products still **delivers standard** setting time that allows for quick removal of formwork, hence no need for additional wait before installation can proceed to dry out.

Full Furnace can be designed with FD materials

• CALDE[®] FD technology allows for the **full furnace lining** to be designed with fast dry materials without compromising on performance or cost of ownership.



Versatility in installation techniques

• CALDE[®] FD technology available for **all available product ranges** for different installation needs vibrocast, self-flow, spraycast, (dry gunning).

)Easy to adjust

• CALDE[®] FD technology allows for **easy adaptation** to extreme climate conditions on job site installations.



CALDE® FD Products



Savings of more than 72 hours to reach 1,200°C





CALDE® FD refractory performance



Remains as effective as the original CALDE® Range



Abrasion value of 3.8 cc for FD version of 85% alumina LCC castable Alkali cup test results for 50% alumina LCC castable



Alkali cup test results for FD version of 50% alumina LCC castable



Dry-out progress in standard castables



Water loss progression and internal pressure development vs. temperature increase as per the dry-out curve for standard castables.

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Keep in mind internal cement hydrates releasing chemically bonded water at elevated temperatures too.

The "key" is higher permeability without increased porosity = FD.





Temperature Increase as per dry-out curve for CALDE® FD products





No build up in Internal Pressure in this sample

Efficient dry-out: **80%** of internal water is removed in less than 15 hours. With standard castable, this is taking approximately 33 hours



Our solutions for the channel holding furnace

Products tailored to the hot face:

- CALDE® CAST UT 94 for steel alloys
- CALDE® CAST UB or CALDE® CAST LT 98 L as standard castable solution for iron alloys
- CALDE® MIX BC 90 Z R or CALDE® MIX SA 68 S as DVM
 Options
- CALDE® CAST UB 75 S or CALDE® CAST LA 50 SZ for non-ferrous alloys







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Our solutions for the pouring furnace

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Products tailored to the hot face:

- CALDE® CAST UT 94 for iron and steel alloys
- CALDE® CAST UB or CALDE® CAST LT 98 L as standard castable solution for iron alloys
- CALDE® MIX BC 90 Z R or MIX SA 58 MD as DVM options
- CALDE® CAST UB 75 S or CALDE® CAST LA 50 SZ for nonferrous alloys







Our solutions for cupolas



Products tailored to the melt contact:

- **CALDE® CAST G 7 P** as standard castable solution
- **CALDE® CAST G NC 66S24 QD** as quick-drying alternative for hearth and syphon box
- **CALDE® SOL CAST G C 68S22 2CP** as sol-bonded alternative for syphon box or slag outlet
- **CALDE® RAM G C 60S18** as ramming option
- CALDE® RAM G B 64S10 for manhole
- **CALDE® GUN G C 65S25** for gunning repairs







Our solutions for ladles



Products tailored to the hot face:

- CALDE® CAST UB, CALDE® CAST LB 84 G10 as standard solutions
- **CALDE® CAST NB 82 QD** as quick-drying castable already
- **CALDE® CAST LX 58 MD** as temperature shock resistant
- alternative, also available as sol-based CALDE® SOL CAST M 60 2CP quick-drying castable already
- CALDE® RAM PF 55 as ramming option
- **CALDE® FLOW AZ** as self-flowing option
- CALDE® MIX FLASH A 55 as exothermic DVM option for instant use







A full range of CALDE® FD products at your disposal



Available in all other cement-bonded castables already offered by Calderys





Thank you for your attention

