GLASS SERVICE

COLLECTION OF ABSTRACTS

17th INTERNATIONAL SEMINAR
ON FURNACE DESIGN

June 18 - 19, 2025
Wellness Hotel Horal
Velke Karlovice
Czechia

COLLECTION OF ABSTRACTS

17th International Seminar
on Furnace Design – Operation & Process Simulation

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Wellness Hotel Horal I Velke Karlovice
Czechia

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CONTENTS

ABSTRACTS OF PAPERS

AGC Glass Europe & Americas Decarbonization Initiatives Towards Low Carbon Products …. **1**
Fabrice Fasilow

"The Secret of Getting Ahead Is Getting Started"
How Science and Industry Converge to Resolve Issues Facing the Global Glass Industry ……... **2**
Steve Whettingsteel, Malte Sander

Glass Futures: A Research and Collaboration Platform for Glass Industry Decarbonisation ….. **3**
Dave Fordham

Decarbonisation, the Road Ahead May Be Bumpy! ……..……...…… **4**
Stuart Hakes

Net-Zero Glass Production: Only a Dream? ……..…… **5**
Malte Sander

Numerical Modelling of a Continuous Glass Tank Furnace for Glass Industry ……...……..…… **6**
Shivam Swarnakar, Jeetendra Sehgal

Simulations, Reduced Models & Alternative Fuels to Improve Productivity and Sustainability in Glass Fiber Manufacturing …..……...…….. **7**
Ashreet Mishra, Alex Lohse, Ravi Arora, Bruno A. Purnode, Etienne Roux, Rino Fabris
Shrikar Chakravarti, Kelly Tian, Victor Hernandez

Where Does the Glass Industry Stand in AI ……..… **8**
John Page

CFD Modelling As a Multi-Purpose Tool to Aid Furnace Efficiency and Emissions …….. **9**
Matthew Rivers

Numerical Modeling of Regenerators in Hybrid Glass Furnaces:
Optimizing For Decarbonization ……...……. **10**
Canalp Kulahli

Zero CO_2 Project and Hybrid Furnaces ……. **11**
Dorothee Ullrich

Recent Advances in CFD Simulations of Industrial Furnaces:
Improved Simulation of Batch Melting in Cold-Top Melters and Validated Bubbler Modeling ….. **12**
Miroslav Trochta, Tomáš Krobot, Jiří Brada

Hybrid Furnaces and Batch Carryover:
Lab Studies and CFD Modeling for Improved Tank Design ……. **13**
Wolf Kuhn, Syntia Metchueng Kamden, Christian Räbiger

Experiences from the Design & Operation of an All-Electric Glass Melting Furnace **14**
Harald Zimmermann, Weniamin Yusim, Tobias Helling, Florian Reischl, Lars Biennek
Wolfram Wintzer

Horizon Europe Project H2GLASS:
Outcomes of the First Campaigns of Industrial Scale H2 Combustion Trials Performed in a Container Glass Melting Furnace of Steklarna Hrastnik **15**
Simone Tiozzo, Damiano Marchese, Tilen Sever, Gorazd Krese, Giuseppe Fragapane, P. Wang

Hydrogen Combustion Experiences in Glass Industry **16**
Ernesto Cattaneo

FlammaTec Further Contributions to CO_2 Reduction in Glass Production by Optimization of Firing **17**
Andreas Birle

Decarbonization Through AI-Powered Batch Monitoring and Model-Based Predictive Control for Electric and Gas-Fired Furnaces **18**
Robert Procházka, Erik Muijsenberg

Regenerator Design Optimization and Monitoring Solutions to Maximize and Maintain Furnace Energy Efficiency **19**
Mohamed Lazrak, Fabiano Rodrigues, Tomáš Denk, Miroslav Trochta, Tomáš Krobot

Refractory Corrosion During Industrial and Waste Glass Melting: Development of Corrosion Rate Model Based on Advanced Dynamic Corrosion Tests **20**
Radek Pezl, Jaroslav Kloužek, Petra Cincibusová, Šárka Msallamová, Pavel Hrma, Albert A. Kruger
Richard Pokorný

GLASS SERVICE, SEFPRO & Crystalex – Throat Corrosion Simulation **21**
Miroslav Polák, Michel Gaubil, Maxime Simon, Jiří Kruml

Tank Monitoring System to Maximize Furnace Lifetime and Avoid Major Safety Events **22**
Hugo Hiel-Beraud, Fabiano Rodrigues

Oxy-Fuel Furnaces – How Does This Influence the Flue Gas Treatment **23**
Matthias Hagen

Using of Modelling Tools Driving the Implementation of DiluJet® Swing Fh Oxy-Fuel Burners at the Refiner and Forehearths of Three Production Furnaces Previously Air-Fuel Fired **24**
Joaquín de Diego, Tuur de Preter, Masashi Yamaguchi, Yoshiyuki Hagihara

Heraeus' Innovative DPH Alloys:
Revolutionizing Glass Production with Enhanced Performance and Sustainability **25**
Tim Rackensperger

CFD-Simulation with Star CCM+ **26**
Andreas Hanninger

The Decarbonisation Pathway for Used Glass **27**
Steve Whettingsteel

ABSTRACTS OF PAPERS

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AGC GLASS EUROPE & AMERICAS DECARBONIZATION INITIATIVES TOWARDS LOW CARBON PRODUCTS

Fabrice Fasilow
AGC Glass Europe & Americas Scope 1 Sustainability Manager*

Abstract:

AGC Glass Europe and Americas (AGEA) is part of the AGC group, one of the global leader in Architectural and Automotive glass company. AGC's commitment is to be GHG net zero in 2050 with a milestone in 2030 of 30% reduction on scope 1, 2 and 3 versus 2019 emissions.

This is why AGEA is evaluating, developing and implementing several decarbonization technologies to reach the 2030 challenge as AGEA doesn't believe in a unique and general decarbonization solution. Effectively AGEA believes more in a solution toolkit which is applied depending on the local conditions in terms of energy prices, energy country mix, availability of infrastructures, raw material sourcing and national or European financial support.

Among the decarbonization technologies, it can mentioned the electrical boosting deployment, the hybrid electrical/oxygen fired furnace (as the on-going "Volta" project), cullet increase from new cullet sources, renewable electricity, CCS,…

By applying already today effective decarbonization solutions, AGC is able to offer to the market its "Low Carbon Glass".

The carbon footprint of the "Low Carbon glass" like other AGC glass products can be easily computed from the "AGC Glass configurator" where on-line Environmental Product Declarations (EPD's) can be automatically generated from any glass product configuration.

* 29 years experience in AGC Glass Europe with a background on melting processes development, new technologies assessment, melting technologies benchmarking, global projects coordination aiming to improve glass melting processes, melting energy performances and direct CO_2 emissions reduction

"THE SECRET OF GETTING AHEAD IS GETTING STARTED"

HOW SCIENCE AND INDUSTRY CONVERGE TO RESOLVE ISSUES FACING THE GLOBAL GLASS INDUSTRY

Steve Whettingsteel, Krysteline Technologies Ltd
Malte Sander, GLASS SERVICE, a.s.

Abstract:

The glass industry is committed to achieving carbon neutrality by 2050. However, the high-energy, high-temperature melting process presents significant challenges in finding effective solutions. In addition to unresolved technical issues, new legislations and regulations further increase the pressure on the global glass industry.

Looking at the status quo we believe the glass industry will have major issues to justify its global impact and compete with alternative materials. Finding a solution for the glass industry is a matter of years rather than decades. Therefore, we must focus glass research into the development of new sustainable and scalable technologies.

As a first step, we must gain a scientific and unbiased understanding of the current situation and circumstances. This will enable the glass community to advocate strongly for fair legislation and effectively assess the impact of new technologies and alternative product flows. Such an approach will help ensure that the industry moves forward in a sustainable and equitable manner.

This presentation will scratch the surface of the glass world, bringing together industrial interests and scientific solutions.

GLASS FUTURES: A RESEARCH AND COLLABORATION PLATFORM FOR GLASS INDUSTRY DECARBONISATION

Dave Fordham
Glass Futures Ltd, UK

Abstract:

The glass industry needs a step-change in technology if it is to achieve net-zero. This involves high risk R&D at a large/industrially-relevant scale. Glass Futures is a not-for-profit research organisation, built by its members from across the global glass industry to do exactly this, at a Centre of Excellence being built in St Helens, UK. The remit of the organisation is to enable its members from across the glass supply chain and beyond to collaborate in areas which affect all parties, with a particular focus on decarbonisation of the glass-making process and its upstream and downstream activities.

At the heart of the new Glass Futures' facility is a 30 tonnes/day pilot-scale glass furnace, due to be commissioned in spring 2025. The facility has been designed to enable the industry to develop and trial new technologies at an industrially relevant scale, without risk to their commercial manufacturing assets, thus providing increased confidence for manufacturers looking to invest in low-carbon technologies such as alternative fuels, CCUS technologies and new raw materials.

In this presentation, the authors will provide an overview of the new Glass Futures facility. The initial programme of pilot-scale trials focusing around low-carbon energy sources (biofuels, electric boost, hydrogen) will be highlighted. In addition, some of the key research work conducted by Glass Futures and partners in this area will be discussed.

DECARBONISATION, THE ROAD AHEAD MAY BE BUMPY!

Stuart Hakes
FIC UK Limited

Abstract:

The presentation will briefly review the decarbonisation pathways in the Glass Industry but then take a deeper look into what that means in reality. The ramifications for the industry are important going forward so realistic expectations are essential for future planning.

NET-ZERO GLASS PRODUCTION: ONLY A DREAM?

Malte Sander
GLASS SERVICE, a.s.

Abstract:

Over the past century, the glass industry has greatly reduced the energy needed to produce one metric ton of glass, from 20 GJ to just 3 GJ. However, further improvements are limited by thermodynamic constraints, as the energy required to transform raw materials into glass through high-temperature processes sets a lower boundary. For example, melting a container glass batch with 50% cullet requires about 2.2 GJ/t, even under ideal conditions without energy losses. Even if it were possible to melt glass without any losses, direct carbon emissions from combustion processes and indirect emissions from electricity generation still cause significant carbon emissions.

As renewable energy sources such as wind, solar, and tidal power become more cost-effective, they offer a promising path for decarbonizing glass production. However, the variability in renewable energy availability poses a challenge for the glass industry, as glass melting requires a continuous and stable energy supply. To achieve net-zero emissions and remain competitive with alternative materials (e.g., PET and aluminum), the industry must adopt innovative furnace designs capable of handling variable energy inputs.

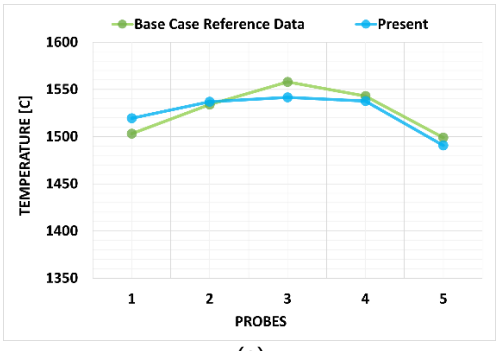
In this context, Glass Service provides its advanced Glass Furnace Model - a computational fluid dynamics software to support the industry and help today’s brilliant technologists to revolutionize the industrial glass melting process.

NUMERICAL MODELLING OF A CONTINUOUS GLASS TANK FURNACE FOR GLASS INDUSTRY

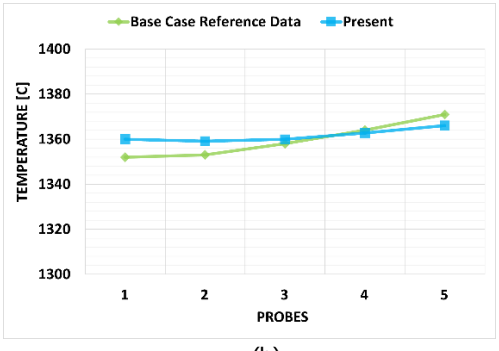
Dr. Shivam Swarnakar, Dr. Jeetendra Sehgal
B.L. Kheruka Research and Development Center, Borosil Renewables Ltd.

Abstract:

This work discusses the methodology employed for conducting numerical simulations of a continuous glass tank furnace with a capacity of 500+ tons per day, using the commercially available Computational Fluid Dynamics (CFD) toolkit Ansys Fluent. The simulation assumes a steady state and treats the working fluid as incompressible. The CFD model is structured into two distinct parts: the furnace combustion model and the glass tank flow model. In the furnace combustion model, the combustion of furnace fuel is simulated using a partially premixed combustion model, and heat transfer within the furnace is modelled accounting for conduction, convection, and radiation modes. The heat flux obtained from the furnace combustion model serves as an input for the glass tank flow model. In the glass tank flow model, molten glass is treated as the fluid, and all three modes of heat transfer, i.e., conduction, convection, and radiation, are considered. Within the glass tank, various convection currents develop, which play a crucial role in the effective mixing and refining of the glass. Verification of furnace combustion (Figure 1(a)) and glass tank (Figure 1(b)) models are done against base case reference data. The current findings demonstrate good agreement with base case reference data, with deviations typically not exceeding 1%.



(a)



(b)

Figure 1: Verification of temperature at various probe locations on the furnace crown (a) and the bottom of the glass tank (b)

SIMULATIONS, REDUCED MODELS & ALTERNATIVE FUELS TO IMPROVE PRODUCTIVITY AND SUSTAINABILITY IN GLASS FIBER MANUFACTURING

Ashreet Mishra, Alex Lohse, Ravi Arora, Bruno A. Purnode, Etienne Roux*, Rino Fabris*
Owens Corning, Granville, USA,
* Chambery, France

Shrikar Chakravarti, Kelly Tian, Victor Hernandez
Linde R&D center, USA

Abstract:

With the focus on productivity, decarbonization and automation, there are major opportunities to increase efficiencies in the glass manufacturing industry. But a first step in developing such initiatives starts with good insights of the process and the need to provide timely responses. This includes the development and installation of new sensors and controls schemes that add new insights to the process, but also the development of modeling techniques for fundamental understanding. With ever increasing computing power and more sophisticated mathematical methods, numerical simulation has become a daily use in many processing industries. The glass industry has used those techniques, and this paper reviews the practices involved in the mathematical modeling of transport processes in the glass fiber making sector.

Validation of the models is a challenging step and often rely on new sensor and measurement technologies. Those advanced models also provide the basis for simulation-based Digital Twins to be developed. Those provide rapid insights in the process and a selection of results is presented to illustrate practical applications of modeling in design and operations.

We also cover the development of using hydrogen to decarbonize glass manufacturing operations. We will present an extensive effort focused on experiments and lab testing in state-of-the art facilities at Linde. As part of this initiative, flame behaviour, its impact on the burner and heat transfer were evaluated with new measurement methods. Those sensing techniques, along with simulations allowed us to understand the fundamentals of hydrogen combustion for glass fiber manufacturing.

WHERE DOES THE GLASS INDUSTRY STAND IN AI

John Page
Cardinal

Abstract:

In a recent webinar the readiness of the Glass Industry for Artificial Intelligence (AI) was raised. Presentations were given to generate interest and establish the current state of AI in the industry. In summary the use of Machine Learning to first model and develop a supervisory system of the process is emerging, but process control based on AI remains years away. The conclusions were that the Glass Industry is not ready due to a lack of knowledge of AI.

I disagree with this conclusion because it insinuates that an extensive knowledge of AI is required before it can be utilized in our industry. Computational Fluid Dynamics (CFD) and Model Predictive Control Systems (MPC) such as ESIII are examples of systems that prove our industry already uses Machine Learning, a subset of AI. In 1995 AFG invested in CFD and in1998 Line 1 at Greenland TN began using ESII based on MPC control. In both cases, I had no knowledge of AI, just a belief in the potential and a company willing to invest.

This presentation includes a case study using CFD, addressing a common type of distortion found in the Float Glass Industry. By combining modeling results and process data operating limits were established. Although not what most would consider AI, it demonstrates the value of data analysis and model development, the platform for Machine Learning.

CFD MODELLING AS A MULTI-PURPOSE TOOL TO AID FURNACE EFFICIENCY AND EMISSIONS

Matthew Rivers
Fives Stein Ltd.

Abstract:

CFD modelling continues to be a valuable multi-purpose tool for a range of customer requirements, and it is important to be able to assist our customers with their performance and emission targets as part of continuous efforts to combat climate change.

The versatility of CFD modelling and image processing tools allow us to respond to feedback and investigate specific areas of a furnace to indicate the behaviour of glass in a furnace and locate the sources of potential issues that may affect production.

CFD modelling is an important part of the design process of the latest generation of all-electric furnaces. We can simulate a variety of furnace types and configurations, allowing comparisons and recommendations on the best development route.

Future developments into larger electric melting solutions, either by increasing the size of existing all-electric melter designs or by repurposing existing furnace designs to use electric boosting, start with a CFD model as a feasibility study.

We are also able to advise our customers on additional boosting and increased hybridisation of their existing furnaces. The ease at which we can run variations is increasingly useful for predicting the performance of a wide range of input parameters, allowing us to build a complete process for increasing the share of electrical boosting input.

NUMERICAL MODELING OF REGENERATORS IN HYBRID GLASS FURNACES: OPTIMIZING FOR DECARBONIZATION

Canalp Kulahli
Şişecam Science and Technology Center, Turkey

Abstract:

The glass industry has traditionally been a significant contributor to carbon emissions due to the high-temperature requirements of the glass melting process. In recent years, transformative changes aimed at reducing the carbon footprint and moving towards carbon neutrality have been initiated in glass production. Among the emerging solutions are alternative technologies such as hydrogen combustion and electric melting, with hybrid furnaces with a high share of electricity increasingly being adopted as part of broader decarbonization efforts in the industry. As new technologies are implemented, it is crucial to thoroughly assess the compatibility of associated subsystems, such as regenerators, within the production process to ensure successful integration.

In this project, a comprehensive numerical model was developed to investigate the flow and temperature distributions in regenerators under conditions of reduced gas flow rates resulting from the high electricity share in hybrid furnaces. This model was designed to support the development of efficient, cost-effective, and durable regenerators in response to the industry's shift towards decarbonization.

The simulation results are analyzed in terms of flow and temperature distributions, and values for total transferred heat and logarithmic mean temperature difference are obtained. Simulations were conducted across various operational and design parameters, yielding correlations between the overall heat transfer coefficient, Number of Transfer Units (NTU), gas velocities, and geometric configurations.

ZERO CO_2 PROJECT AND HYBRID FURNACES

Dorothee Ullrich
Horn Glass Industries

Abstract:

With the aim of producing glass with the lowest CO_2 production as possible, the zero CO_2 project was founded, with the participants IPGR, RWTH Aachen, HORN Glass Industries and Wiegand Glas. With this project, the challenges of melting nearly CO_2 free glass are tested in a real operating furnace with 6 t/d in Aachen, which was set in operation in October 2024. The furnace was modelled beforehand with the main operating conditions. The electric power supply is in the range from 20 to 80 %, supplied by bottom electrodes. The oxyfuel fired furnace should be operated with natural gas as well as hydrogen, which has a different effect on the energy demand. In addition, CO_2 free batch should be tested as well as normal batch.

With hybrid furnaces, the more unstable costs of the electric power supply can be compensated. In the second part of the presentation, the modelling of a hybrid furnace concept with 420 t/d and 30 % to 70% electric energy is shown. For the modelling study, the two firing concepts of recuperative and oxyfuel combustion are compared. The furnace geometry will be discussed as well as the arrangement of the melting electrodes and barrier electrodes and the distribution of the electric power supply.

RECENT ADVANCES IN CFD SIMULATIONS OF INDUSTRIAL FURNACES: IMPROVED SIMULATION OF BATCH MELTING IN COLD-TOP MELTERS AND VALIDATED BUBBLER MODELING

Miroslav Trochta, Tomáš Krobot, Jiří Brada
GLASS SERVICE, a.s.

Abstract:

Accurate simulation of industrial glass furnaces is critical for optimizing energy efficiency and ensuring high-quality glass production. This presentation introduces two recent advancements in Glass Services' Glass Furnace Model CFD software:

Firstly, we present a novel strategy for simulating batch melting dynamics in cold-top all-electric furnaces. Traditional CFD approaches have struggled to capture the complexity of batch melting, gas generation, and the intricate heat transfer processes between batch materials and molten glass. Our new model incorporates a comprehensive representation of batch physics and integrates an active control strategy for energy input and batch charging, essential for stable furnace operation.

Secondly, we introduce a newly developed CFD model for bubblers. This advanced bubbler model is based on detailed simulations of bubble behavior using the Lattice Boltzmann Method (LBM). We are rigorously validating our bubbler model against experimental data obtained from a physical model, ensuring accurate representation of bubbler-induced flow fields.

HYBRID FURNACES AND BATCH CARRYOVER: LAB STUDIES AND CFD MODELING FOR IMPROVED TANK DESIGN

Wolf Kuhn[1], Syntia Metchueng Kamden[1], Christian Räbiger[2]
[1]Fives Stein
[2]CelSian

Abstract:

Hybrid melting requires a significant reduction of the combustion temperatures in the batch melting zone. This leads to delayed glazing of the batch surface. Combustion gases still sweeping over the unglazed batch pick up carry over dust and risk contaminating the whole combustion space. Ideally, the carry-over dust is directly extracted into the flue gas outlets of a hybrid oxy or hybrid recuperative tank. However, this is not achievable with conventional combustion space designs.

The talk reviews the means for experimental and CFD modeling of the carry-over dust from batch blankets. Lab experiments show how batch granulometry and decrepitation have a major impact on the release of dust into the flue gas. Particle tracing based on lab experiments allows for a quantification of the carry-over contamination in the flue gasses.

CFD modeling demonstrates how flue gas convection of the combustion space dominates the way carry-over dust is evacuated or recirculated in the combustion space. The thermo-convection of the flue gases in the batch area is largely responsible for this recirculation of the carry-over dust. The Richardson number allows us to characterize the intensity of the thermos-convection – and gives a clear indication of the required design to avoid the recirculation effect. A combustion design is proposed that suppresses the recirculation of the flue gas in the batch charging zone and leads to an almost ideal evacuation of carry-over dust even for large areas of the unglazed batch surface.

EXPERIENCES FROM THE DESIGN & OPERATION OF AN ALL-ELECTRIC GLASS MELTING FURNACE

H. Zimmermann[1*], W. Yusim[1], T. Helling[1], F. Reischl[1], L. Biennek[2], W. Wintzer[2]
[1] TH Deggendorf - TAZ Spiegelau
[2] HORN Glass Industries AG

Abstract:

The Technology Application Centre Spiegelau (TAZ), founded in 2012 and operated in cooperation with the University of Bayreuth, is responsible for melting and forming molten glass at the Deggendorf Institute of Technology (THD).

One of the main areas of research and development at the TAZ is the development, construction and operation of all-electric glass melting furnaces in close cooperation with industry.

Since the end of 2021, the TAZ team has been building and operating the third all-electric furnace, labelled α-Melter 2.0, which is a previous development in the BMBF-funded GreenGlass4.0 project. The initial operation and refractories of this furnace are supported by HEINZ-GLAS to answer some scientific questions related to their own furnace development programme.

The presentation will describe the construction of the current melter and the measures that were necessary to be able to work on the research questions of the company Heinz-Glas. Some of the results of the test campaign will also be discussed.

When we talk about glass quality, it seems easy to measure it. This may be true in the case of an industrial furnace feeding a glass production that results in verifiable glass products. In the case of a semi-industrial laboratory furnace with a melting capacity of 150 kg/d, producing a thin glass thread, it becomes more complicated because the manual production of the glass samples has many effects on its quality. Part of the solution is therefore to count the bubbles manually every hour and, in parallel, to develop a camera-based automatic bubble counting system, including automatic pull-rate detection.

A second seemingly simple problem is temperature measurement in an all-electric furnace, particularly at the point where the highest (fining) temperatures are expected. To solve this problem, the method of calculating temperature by measuring resistance has been demonstrated.

One of the most important parameters in electrically heated furnaces is the thickness of the cold top layer. Until now, this has been done manually in the industry using an iron rod. During the presentation different methods will be discussed.

HORIZON EUROPE PROJECT H2GLASS: OUTCOMES OF THE FIRST CAMPAIGNS OF INDUSTRIAL SCALE H2 COMBUSTION TRIALS PERFORMED IN A CONTAINER GLASS MELTING FURNACE OF STEKLARNA HRASTNIK

S. Tiozzo, D. Marchese, Stazione Sperimentale del Vetro Scpa (Italy)
T. Sever, G. Krese, Steklarna Hrastnik (Slovenia)
G. Fragapane, P. Wang, SINTEF Manufacturing (Norway)

Abstract:

Within the framework of the Horizon Europe H2GLASS Project, from the 20th November to the 1st December 2023, several days of experimental campaigns of preliminary H2 combustion trials took place in the industrial demonstrator site of Steklarna Hrastnik. The tests were carried out on an oxy-fuel fired furnace producing high quality flint glass for the manufacture of premium beverage containers, and were aimed at assessing the impact of the combustion of various H2/Natural Gas blends on the gaseous emissions, on glass quality and on the energy transfer by flames to the melt and raw materials.

The trials involved feeding different couples of burners (out of 6 total) at a time with fuel mixtures ranging from 0% to 100%, H2, that is experimenting combustion configurations where H2 accounted for up to the 60% in volume of the total fuel input, thus contributing up to 33% of the total power required for glass melting, which translates into an equivalent up to 33% reduction in direct combustion CO_2 emissions.

During the trials, SSV carried out simultaneous multi-parametric measurements in several points of the furnace system, deploying its MCM – Multipoint Continuous Monitoring approach for glass furnace behavior characterization. This presentation will highlight the main results and evidences gathered from these on-site measurements, providing a first assessment of the impact of increasing H2 concentrations in fuel on combustion, emissions and production of the studied furnace.

HYDROGEN COMBUSTION EXPERIENCES IN GLASS INDUSTRY

Ernesto Cattaneo
STARA GLASS

Abstract:

Among all the possible ways to decarbonize the glass sector, it is certainly interesting to approach the utilization of hydrogen as a fuel. Stara Glass is involved in the Horizon H2-GLASS project, within which it is in the process of developing its oxy and regenerative burners for any mixture of hydrogen and natural gas. The lecture describes the project advancements on hydrogen testing in real furnaces, burner development and the impact of this alternative combustion on furnace design.

FLAMMATEC FURTHER CONTRIBUTIONS TO CO_2 REDUCTION IN GLASS PRODUCTION BY OPTIMIZATION OF FIRING

A Status Report on Optimization Activities in Oxy-Fuel and Air-Fuel Combustion

Dipl. Ing. Andreas Birle
FlammaTec Germany GmbH

Abstract:

The target of a low or zero CO_2 emission in glass production will lead to high or full use of direct electric heating. The long path to this target is characterized by a high demand of flexible and efficient solutions for the remaining top fire requirements adaptable to existing furnaces and new melting concepts.

Flammatec has developed a Carbonfree Oxygen-Gas burner flexible in use of pure Hydrogen, pure Natural gas and mixtures of those. The efficiency of oxyfuel technology requires a flat combustion arrangement which is another field of FlammaTec development.

The large number of current running air -fuel regenerative furnaces are still worth to be optimized. Based on the successful Free Jet Gas injector concept, FlammaTec has developed a unique flat gas injector for regenerative furnaces. The improved heat transfer area compared to tube type nozzle has positive effects on energy consumption and NO_x emissions and as well on reduced maintenance requirement due to lower number of injectors.

DECARBONIZATION THROUGH AI-POWERED BATCH MONITORING AND MODEL-BASED PREDICTIVE CONTROL FOR ELECTRIC AND GAS-FIRED FURNACES

Robert Procházka, Erik Muijsenberg
GLASS SERVICE, a.s.

Abstract:

Batch and cullet melting represent the initial stages of the glass melting process. The stability of this process, influenced by factors such as pull, cullet level, glass color, raw material variations, rheological behavior, and the batch charger, is crucial for ensuring optimal glass quality in gas-fired furnaces. The potential instability necessitates continuous 24-hour monitoring and potential corrective control to minimize quality issues. Additionally, the increasing electric boosting levels resulting from the decarbonization process have the capacity to alter glass convection loops, displacing batch downstream in the process.

In cold top melting furnaces, the thickness of the batch plays a pivotal role in insulating the hot glass melt and minimizing heat loss. However, variations in pull and cullet can significantly impact batch thickness. Until now, there has been a lack of systems capable of measuring the actual batch thickness or height and incorporating this parameter into automatic model-based predictive furnace control.

This paper will present the latest developments and results for both gas-fired and cold top electric melters.

Figure 1. Batch cover over a Hybrid melter using more than 55% electric boosting (LMFV France).

REGENERATOR DESIGN OPTIMIZATION AND MONITORING SOLUTIONS TO MAXIMIZE AND MAINTAIN FURNACE ENERGY EFFICIENCY

Mohamed Lazrak[1], Fabiano Rodrigues[1], Tomáš Denk[2], Miroslav Trochta[2], Tomáš Krobot[2]
[1]SEFPRO, France
[2]GLASS SERVICE, a.s., Czech Republic

Abstract:

Reducing the carbon footprint of the inherently energy-intensive glass making process is a major challenge. It will require a progressive technology transition, starting from incremental improvements of existing technologies, and heading towards groundbreaking innovation in the long term.

As far as existing technologies are concerned, regenerative furnaces have already made substantial contributions to energy savings in the glass industry. Nevertheless, ongoing efforts by SEFPRO and Glass Service suggest that there is still room for additional reduction in fuel consumption, and hence in CO_2 emissions, thanks to the design optimization of high-performance Cruciforms®-based regenerators with the aid of advanced numerical models.

In the first part, this presentation will address the construction of a foundational parameter library for Darcy porous wall approximation, encompassing various Cruciforms shapes. The library can be utilized for models that seamlessly integrate regenerators with the furnace into a comprehensive and accurate simulation.

Then, we will discuss how checkerpack designs can be fine-tuned to maximize both energy efficiency and durability, based on furnace and regenerator engineering and operating conditions. Concrete examples will illustrate optimized solutions obtained by combining specific Cruciforms geometries, a proper selection of electrofused materials and the implementation of innovative monitoring solutions to maintain regenerator's thermal performance at the highest level throughout the furnace lifetime.

REFRACTORY CORROSION DURING INDUSTRIAL AND WASTE GLASS MELTING: DEVELOPMENT OF CORROSION RATE MODEL BASED ON ADVANCED DYNAMIC CORROSION TESTS

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Abstract:

Refractory materials used as linings in melting and vitrification furnaces are critical components of the glass industry. To maintain high product quality and ensure the long lifespan of melting equipment, these materials must withstand the extreme conditions present in melting furnaces, including high temperatures, mechanical stress, and chemical interactions with the glass melt. This experimental and modelling work focuses on developing a corrosion rate model for refractory materials as a function of temperature, melt flow rate, and glass composition. In the experimental part, we describe an improved “Merry Go Round” dynamic corrosion test setup, commonly used in glass industry. By changing the shape of the rotating refractory samples from cylinders to thin slices, we were able to measure both subsurface and melt-line (neck/groove) corrosion with high precision, avoiding issues related to asymmetrical corrosion profiles caused by the differences in the flow velocity at the inner and outer part of the refractory sample. The shape of our coupons also allows the estimation of diffusion coefficients for the dissolving refractory components. The results presented in this work, obtained for high-chromium fusion cast refractory, are used to develop corrosion models based on diffusion-controlled refractory dissolution, which will be later coupled with computational fluid dynamics (CFD) models of nuclear waste glass melters. This coupling will allow to simulate the effects of melter processing conditions (temperature, melt convection rate, frequency of pouring cycles) and the waste glass composition on the corrosion of high-chromia refractory within the whole waste glass melter.

GLASS SERVICE, SEFPRO & CRYSTALEX – THROAT CORROSION SIMULATION

Miroslav Polák[1*], Michel Gaubil[2], Maxime Simon[2], Jiří Kruml[3]
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Abstract:

GLASS SERVICE (GS) became part of the SEFPRO in 2024. This connection is beneficial as it enhances the efforts to find the best solutions for optimizing customer's furnaces (geometry, operational parameters and also used refractories).

A collaboration between GS and SEFPRO on a throat corrosion simulation will be shown in this presentation. The real project of CRYSTALEX (tableware glass manufacturer from Czechia) is used. The GFM (Glass Furnace Model) is used in this case for calculating the temperature and velocity distribution in the vicinity of throat blocks. These results are then used as boundary conditions for SEFPRO's corrosion model. An iterative approach is used to simulate time steps representing the corrosion of throat. Results of the simulations are compared with the real measurements from CRYSTALEX after certain time of production.

Target of this cooperation is to prolong the lifetime of the glass furnace and thus help decreasing the costs and increase the sustainability of the production.

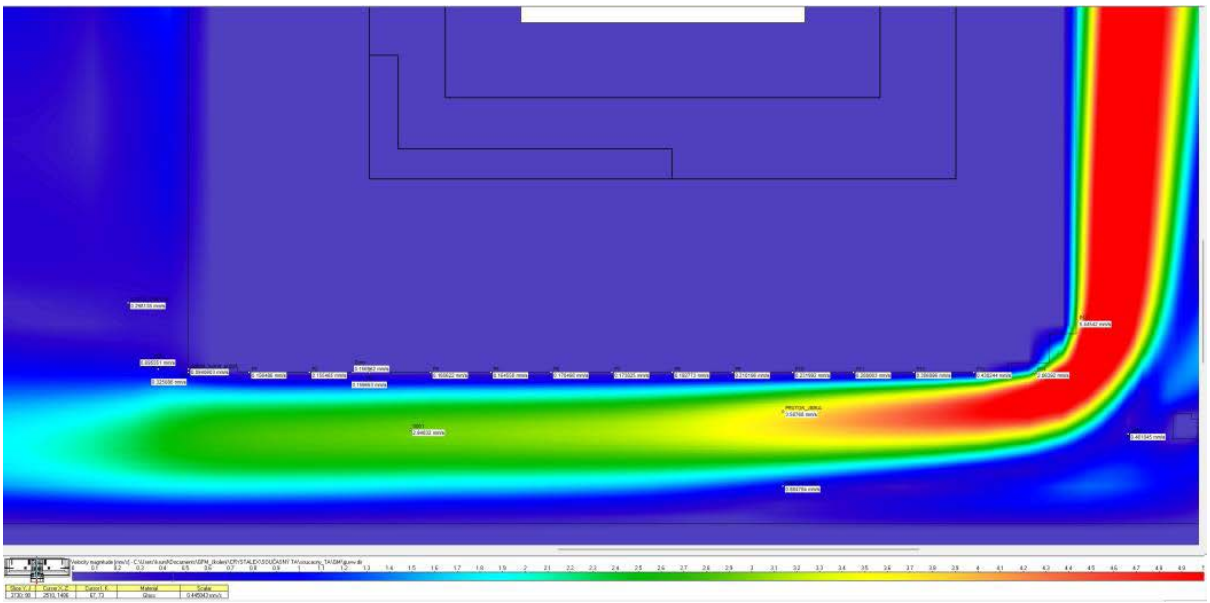

Figure 1. Velocity distribution in the vicinity of throat refractories

TANK MONITORING SYSTEM TO MAXIMIZE FURNACE LIFETIME AND AVOID MAJOR SAFETY EVENTS

Hugo Hiel-Beraud, Fabiano Rodrigues
SEFPRO

Abstract:

Reducing the carbon footprint of the inherently energy-intensive glass making process is a major challenge. It will require a progressive technology transition, starting from incremental improvements of existing technologies, and heading towards groundbreaking innovation in the long term.

Hybrid and Electrical furnace technologies are progressively being adopted as the first step along this journey toward decarbonation. Nevertheless, these new technologies bring many technical challenges, refractories corrosion in the melting zone being among the most critical ones. New corrosion profiles and kinetics will be experienced, hence requiring adjustments in material selection, melt tank design and furnace maintenance.

In the first part, this presentation will address the benefits of SEFPRO GUARD® Tank monitoring system to tackle these new challenges. The development history of the solution will be explained, as wells as the advantages it provides today. Then, we will discuss how this tool can be used to assess the corrosion profile of refractory blocks and follow operating trends, allowing to fine tune furnace operation accounting for the new indicators available.

OXY-FUEL FURNACES – HOW DOES THIS INFLUENCE THE FLUE GAS TREATMENT

Dipl. Ing (FH) Matthias Hagen
DÜRR Systems AG

Abstract:

Oxy-fuel furnaces will help to reduce the energy consumption of a furnace. Before glass manufacturers decide for this solution, they should have a bigger view on the overall concept and which effects this will have on energy level of the flue gases and the flue gas treatment itself.

As the flue gas temperature will increase dramatically a usage of this energy is the preferred solution. But how could this energy be used and what happens if no usage is possible and a cooling is required to achieve the acceptable temperature for the flue gas treatment?

The paper will explain different scenarios and show two recently realized solutions. Finally this will lead to a guideline for decision makers to be considered prior the selection of a new furnace.

USING OF MODELLING TOOLS DRIVING THE IMPLEMENTATION OF DILUJET® SWING FH OXY-FUEL BURNERS AT THE REFINER AND FOREHEARTHS OF THREE PRODUCTION FURNACES PREVIOUSLY AIR-FUEL FIRED

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Abstract:

Decarbonization strategies are linked to the reduction of fossil fuels use together with the modelling of the implementation of new oxy-combustion technologies revamping old air-fuel fired refiners and forehearths.

Refiner + Forehearths are responsible of 6 to 45% of the total energy consumption on a glass production plant (pending of the kind of glass produced). Decarbonization strategies are linked to the reduction of fossil fuels, and the implementation of well stablish oxy-combustion technologies at the refiner and forehearths is helping to reduce CO_2 footprint to existing without the necessity to demolish it before the end of the campaign.

Modeling helped decide where to implement oxy-fuel burners in order to maintain glass production and quality while drastically reducing natural gas consumptions and greatly reducing CO_2 emissions at the site; responding to the demands of customers and consumers while increasing profitability for shareholders.

Firstly will be described how the auto inducted swing technology works. Later we will describe how we used Modelling Technology to decide where to implement self-induced oscillation oxy-fuel burners at the Refiner & forehearths and finally we will show the results on energy reduction obtained at the customers.

Figure 1. DiluJet Swing FH

HERAEUS' INNOVATIVE DPH ALLOYS: REVOLUTIONIZING GLASS PRODUCTION WITH ENHANCED PERFORMANCE AND SUSTAINABILITY

Tim Rackensperger
Heraeus Precious Metals

Abstract:

Glass plays a crucial role in various sectors, from construction to electronics and lifestyle applications. High-quality specialty glasses require significant amounts of precious metals, primarily platinum and rhodium. To meet increasingly demanding customer requirements such as higher durability, improved optical properties and higher heat resistance, manufacturers must innovate, leading to better and more efficient glass production processes, including the use of precious metal tools and alloys.

One such innovation is the use of Oxide Dispersion Strengthened (ODS) precious metal alloys. These alloys, composed of a metal matrix and fine particles of an insoluble phase, exhibit exceptional mechanical properties, especially creep strength at high temperatures. Consequently, ODS alloys are used in various applications in the glass industry.

The advantages of Heraeus ODS alloys, called DPH in glass production include enhanced heat resistance, improved efficiency, and extended tool lifespan. Modern Pt DPH alloys can fully replace Rhodium, because being very expensive and detrimental for certain glass compositions.

Additionally, reduced precious metal content contributes to CO_2 reduction taking into consideration that precious metal mining is an energy-intensive process.

Recent innovations in this field include DPH Strong and DPH Flex. DPH Strong offers unrivaled creep resistance, while DPH-Flex combines high creep resistance with high ductility.

CFD-SIMULATION WITH STAR CCM+

Andreas Hanninger
TH Deggendorf – TAZ Spiegelau

Abstract:

The simulation of electrical glass melting furnaces represents a considerable challenge, as it requires the complex modeling of fluid flows and heat transfer, and demands either the use of general CFD programs or specialized solutions. For this task, highly specialized modeling programs with their own libraries have proven effective in practice, raising the question of whether modern CFD simulation programs can be effectively utilized for simulating electrical glass melting furnaces.

Within the framework of a PhD project, it is being investigated whether Siemens' CFD simulation program Star CCM+ is suitable as a modeling tool in this specific context.

The presentation demonstrates the complete setup of a CFD simulation using Star CCM+ and addresses both the methodological and practical challenges involved in developing the model. The basis of the simulation is a simplified model of an experimental furnace at TAZ Spiegelau, which particularly shows the temperature distribution and flow conditions within the electrical melting furnace.

The obtained results are compared and discussed with experimental measurements to verify the validity of the simulation. Finally, a comprehensive evaluation of the simulation is carried out, highlighting the potential for further work and model expansion.

THE DECARBONISATION PATHWAY FOR USED GLASS

Steve Whettingsteel
Krysteline Technologies Ltd, UK

Abstract:

Glass recycling must evolve to support a more viable low carbon approach. Sustainable low CO_2 solutions for all glass entering a recycling facility are required for the long-term viability of the glass industry, respecting and monetising all glass equally. Innovation and progressive thinking are developing a clearer strategy for glass recycling, one focused on low CO_2 and the recycling of all types of glass including containers, automotive, flat glass, pharmaceutical and photovoltaic (PV) cells.

We consider how a more inclusive CO_2 strategy with cooperation with academic research facilities and small businesses will impact the recycling landscape by facilitating the discovery and development of ultra-low CO_2 products for current and emerging markets. We will review how location of glass and facilities effects the viability of use, and look at the complexities and market dynamics required to establish a fair and logical national and international approach of glass decarbonisation. Resolving to determine a strategy based on CO_2 instead of tonnage, and considering CO_2 at every stage from conception along its journey through distribution, filling, packaging, distribution, waste collection, processing at an MRF, transport to beneficiation. To be legislated in a logical way, to mandate change, and motivate policies based on location, available markets, and of course CO_2.