

CelSian Academy

# Glass Technology training courses 2022

Introductory | Advanced | In-company

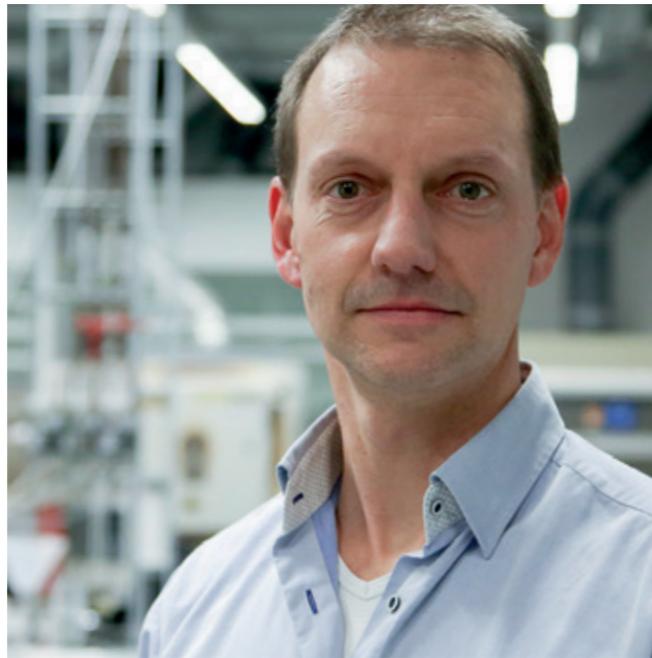


 CelSian



# This is CelSian

Originating from the TNO Glass Group and based on many years of experience of glass making at Philips, CelSian is an independent company. From 2012 CelSian's focus is on improving product quality and process efficiency for glass manufacturers over the whole world. Our proprietary software models, unique experimental facilities and industrial sensor systems are used by our customers to optimize glass melting processes while minimizing costs for end users and environment.



# CelSian Academy

The CelSian Academy is based on a 30+ years history of research, development, and application within the industrial glass production environment. Drawing on this experience, our leading experts cover the challenges of today's glass production when training you and your colleagues to help improve your business.

## Glass Technology Training Course

It all started back in the 1990s. A group of glass experts started the open glass technology training for the worldwide glass industry. Since then, we have educated more than 2000 people globally. Many different training formats have been developed covering numerous aspects of glass products and glass production. The courses are given by glass experts in a modern, hands-on and interactive way to meet the specific needs of the trainees.

### What we offer:

- General Glass Technology course
- Topic specific introductory and advanced training
- Glass type specific training (float, e-glass, glass wool, container glass, etc.)
- Open enrolment and in-company tailor-made courses
- Webinar-based training sessions
- E-learning modules



## Training courses 2022

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We continuously develop our training portfolio and extra courses might be proposed during the year. For updates, please check [www.celsian.nl](http://www.celsian.nl), our LinkedIn-page, or send us an email to become part of our mailing list.

### Training methods

We offer a blended learning approach by mixing e-learning, lectures, open discussions and questions, exercises, and case studies in teams or individually. Our training courses are given in English by default. In customized set-up we also offer Chinese, Dutch, French, German and Italian languages. The number of participants per course is between 10 and 25 to maximize your learning experience. Participants always receive the presentations and a training certificate.

### Participants

We welcome employees of all glass-making companies and suppliers. Whether you work in glass production (batch, furnace, and melting), quality and control, research and development, technical support, or for a refractory, raw materials, gas, sensor supplier, a furnace designer and builder, we have relevant content for you.

As a consequence of the global Covid-19 pandemic, traveling can be uncertain. This logo applied on a training indicates that an online access can be offered or that the training may be fully given online.



### Level of seniority

We offer different types of training depending on your experience in the glass industry:

- **Introductory** courses are meant for novice to advanced beginners who would like to improve their understanding and apply the knowledge during practical cases
- **Advanced** courses are dedicated to advanced beginners and skilled professionals willing to deepen their knowledge and to understand the topic in detail

The general glass technology training is very comprehensive and suitable for all technical people in relation with the glass industry, from novices searching for a broad overview to competent professionals willing to refresh or deepen their understanding on some topics.

### Terms, conditions and discounts

CelSian reserves the right to cancel up to two weeks prior to the training, proposing new dates or refunds.

Learning requires a lot of energy so we always provide drinks, lunch and some dinners during multiple day trainings. Training costs do not include accommodation, travelling, tax and duties.

Are you registering as a group? You are entitled to a 15% discount on all courses: for 5 registrations, the 6th participant can join for free.

Cancellation fees apply. 1 week before training 50%; no show, full price. In case of an unexpected event, we are happy to look for rescheduling or voucher options.

# Raw materials and melting

## Introductory training



duration  
1 1/2 days

date  
March 9 - 10

location  
Eindhoven,  
The Netherlands



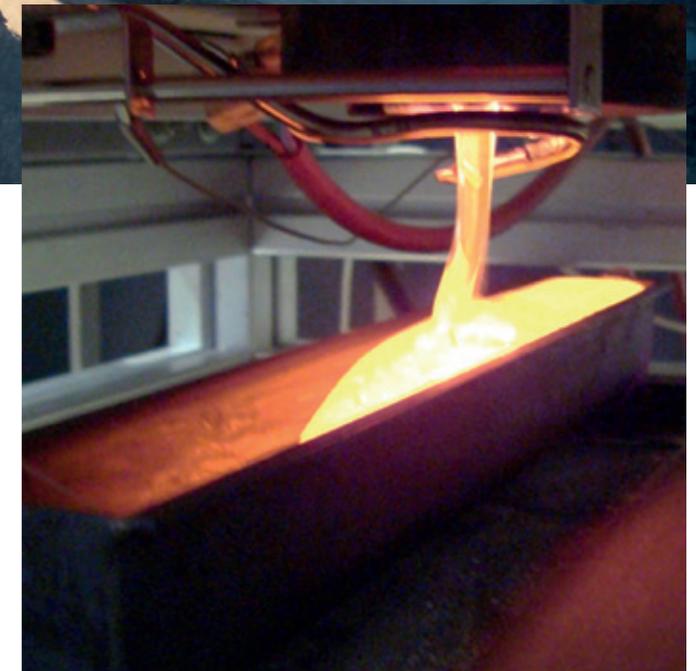
Raw material selection is the first step of the glass making process and may influence the complete production. The compromise between many economic, process and product requirements is explained during the course. The homogeneity of the batch will have an impact on the melting and final product quality so technologies to avoid segregation are described. Parameters to enhance the batch-to-melt conversion are also presented.

### After the training

- You have a clear understanding of the main criteria for raw material selection.
- You can optimize your raw materials according to the specification of your process and products regarding redox, energy consumption, emissions, melting rate.
- You can solve problems related to segregation and batch handling.
- In the context of concerns about emissions and energy consumption, you have ideas on innovative alternatives for current raw materials.

### Contents

- Characteristics of the classical raw materials used in the glass industry : chemical composition, grain sizes
- Batch handling, segregation and charging methods
- Cullet applications, market and processing
- Benefits and drawbacks related to the use of recycled cullet
- Influence of raw materials on glass redox and quality
- Batch composition and melting energy
- Melting reactions and kinetics



### Investment

Training costs € 1450 per participant. When onsite, price includes 2 lunches and 1 dinner. It excludes the living cost of the participants, tax and duties.

The 6th participant from the same company can join for free.

# Glass melting technologies

## Introductory training

duration  
2 days

date  
March 16 - 17

location  
United Kingdom



This training provides an eminent overview of the key process steps involved in converting raw materials into a glass melt ready to be delivered to the forming process. The general description of glass production enables trainees who desire generic knowledge of glass melting to understand the challenges of glass production.

At the end of the training, you will have a clear view of the main challenges in glass production and how they are linked to raw materials, furnace design, and process settings.

### After the training

- You have a clear overview how raw materials affect melting, energy consumption, glass quality and furnace lifetime.
- You understand the link between energy consumption (& CO<sub>2</sub> emission) with fuel source, furnace design and operation.
- You know how emissions can be minimized by primary and secondary measures.
- You are able to pinpoint critical furnace conditions and process settings that affect furnace lifetime.
- You can define industrial measures to improve on glass quality and yield.

### Contents

- Production line for different glass types and products
- Furnace configuration: end port, cross-fired, oxygen-fired, electric melters
- A glass furnace is a chemical reactor
- Glass quality : fining process
- Raw materials, recycling and carry-over
- Regenerators and recuperators
- Evaporation, condensation
- Refractory types, properties and challenges
- Energy consumption of glass furnaces
- Environmental aspects and emissions



### Investment

Training costs € 1950 per participant. When onsite, price includes 2 lunches and 1 dinner. It excludes the living cost of the participants, tax and duties.

The 6th participant from the same company can join for free.

# Glass defect diagnosis

## Introductory training

duration  
1 day

date  
March 22

location  
Eindhoven,  
The Netherlands



Product quality is vital in glass production. This short course focuses on the identification of solid and gaseous defects in glass, diagnosis of the problem and solving it at root cause. An overview is given of the potential sources of various defects and the available analytical techniques. Examples of defects (from container, tableware and flat glass) will be shown and the participants will be given the chance to analyze the defects themselves. Bubble diagnosis will be explained using case studies.

### After the training

- You have an overview of common glass defects.
- You know the approach for efficient defect analysis.
- You are able to diagnose bubble problems and know how to solve these.
- You have knowledge of additional tools available to help diagnose more complicated defect cases (e.g. lab studies, CFD modelling).

### Contents

- Explanation of solid defect sources (raw materials, recycling cullet, refractory, melting & fining processes)
- Characteristics of common defects (stones, devitrification, knots, cords, bubbles)
- Hands-on identification of solid inclusions
- Explanation of sources of bubbles and seeds
- Diagnosis and solution of bubble problems using case histories



### Investment

Training costs € 950 per participant. When onsite, price includes a lunch and refreshments. It excludes the living cost of the participants, tax and duties.

The 6th participant from the same company can join for free.

# Annealing, Tempering

## Introductory training

duration  
1 day

date  
March 24

location  
Eindhoven,  
The Netherlands



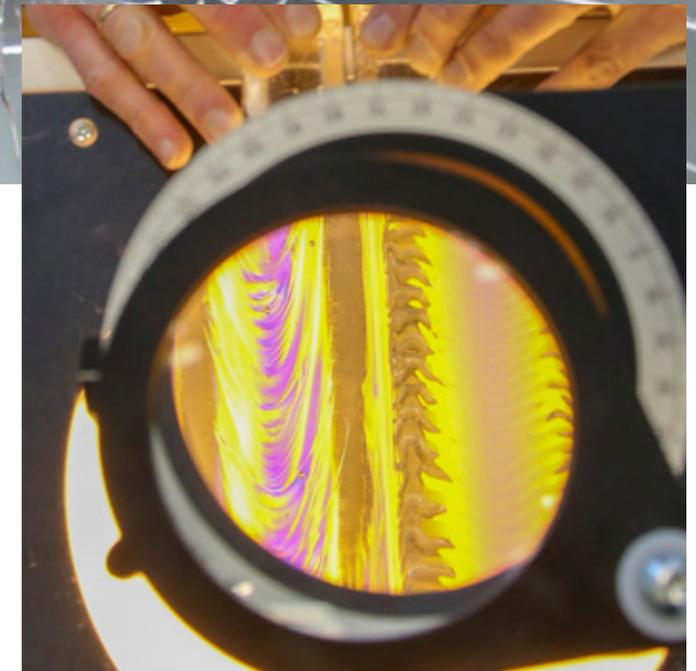
The mechanical properties of glass are of vital importance for many applications. Bottles must withstand internal pressure; architectural and automotive glazing must break in a safe way; ovenware must endure brutal temperature shocks; plane windshields must resist high-speed collisions with birds. This training provides key information to understand the ways to improve the strength of glass products.

### After the training

- You know why different glass types have different properties.
- You understand why it is important to take care of the surface of glass products.
- You can estimate the thermal shock resistance of a glass piece.
- You can calculate a theoretical annealing schedule to optimize glass relaxation.
- You understand how tempering plays with stress and improves the mechanical resistance of glass.

### Contents

- Glass composition (soda-lime, borosilicate, crystal) and atomic structure
- From structure to Young's modulus and thermal expansion coefficient
- The key role of glass surface condition
- Thermal shock resistance
- Relaxing stress : annealing
- Tailoring stress : heat strengthening and tempering
- Special glasses and chemical tempering



### Investment

Training costs € 950 per participant. When onsite, price includes a lunch and refreshments. It excludes the living cost of the participants, tax and duties.

The 6th participant from the same company can join for free.

# Redox, fining and glass quality

## Advanced training

duration  
2 days

date  
March 29 - 30 and  
September 13 - 14

location  
Eindhoven,  
The Netherlands



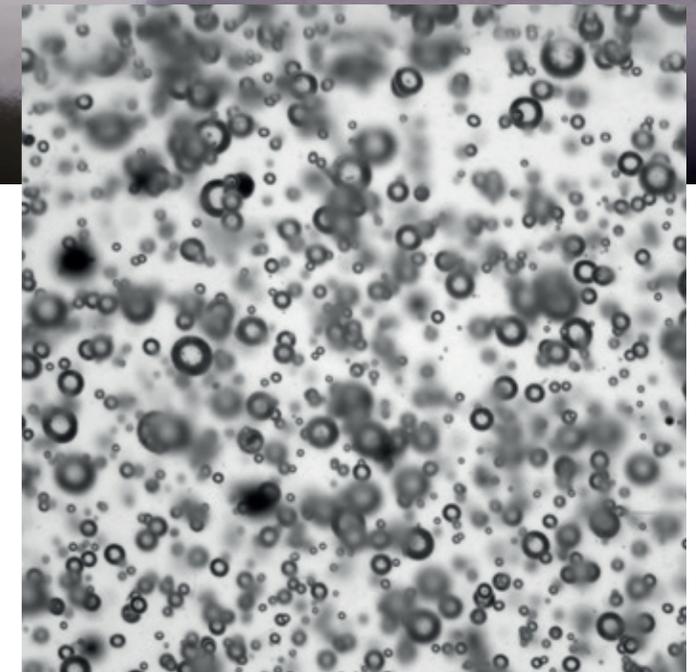
You know that redox is a key element of glass production and that its consequences can be perceived all along the production chain. You want to understand how redox influences the melting and fining process in relation to foaming, seeds defects and colour variations. You will be able to diagnose better redox related issues and to find solutions faster.

### After the training

- You can quantify the redox of a batch, melt and glass.
- You realize what are the optimum fining conditions for your glass production.
- You can perform faster troubleshooting and relate process or quality problems (foaming, energy consumption, colour, seeds, bubbles) to redox issues.

### Contents

- Introduction and definition of redox:
  - Batch redox number
  - Relations with oxygen partial pressure and temperature
  - Optical measurements on the glass
- Glass colour : transition elements, amber chromophore, reduced green, decolouration
- Radiative heat transfer
- Sulphur solubility in the melt
- Fining principle and mechanisms
- Mechanisms and root causes of foaming
- Air-fuel versus oxy-fuel furnaces
- Cullet and redox control
- Seeds and bubbles : identifying the origin
- Case study brought by participants or from our archives



### Investment

Training costs € 1950 per participant. When onsite, price includes 2 lunches and 1 dinner. It excludes the living cost of the participants, tax and duties.

The 6th participant from the same company can join for free.

# Electric systems for glass melting

## Introductory training

duration  
2 days

date  
April 28 - 29 and  
September 6 - 7

location  
Eindhoven,  
The Netherlands



Electricity will play a major role in the ongoing energy transition to reduce CO<sub>2</sub> emissions. Although electric melting of glass is an old technology, many aspects have to be considered to create an efficient system that is suitable for each specific glass production. This training focuses on supply and hardware, from the electrical grid down to the electrodes and beyond, to provide you with a pragmatic level of understanding of the whole system.

### After the training

- You understand the many advantages of electrical boosting.
- You have a clear overview of what needs to be considered to increase the electric share in your energy mix.
- You know how to choose the proper electrical system for your specific production, from the choice of the right transformer to the choice of the electrode density and control system.
- You know how to prevent and follow the electrode corrosion and how to shift the electrodes.

### Contents

- Purpose of electrical boosting, from sustainability to flexibility
- Melting zone, barrier and throat boosting
- Electrode material, types, holder and cooling systems
- Positioning of electrodes
- Selecting the correct type of transformer, cables and busbars
- Granularity, efficiency and types of control systems



### Investment

Training costs € 1950 per participant. When onsite, price includes 2 lunches and 1 dinner. It excludes the living cost of the participants, tax and duties.

The 6th participant from the same company can join for free.

# Burners, combustion and NOx emissions

## Introductory training

duration  
1 1/2 days

date  
May 17 - 18

location  
United Kingdom



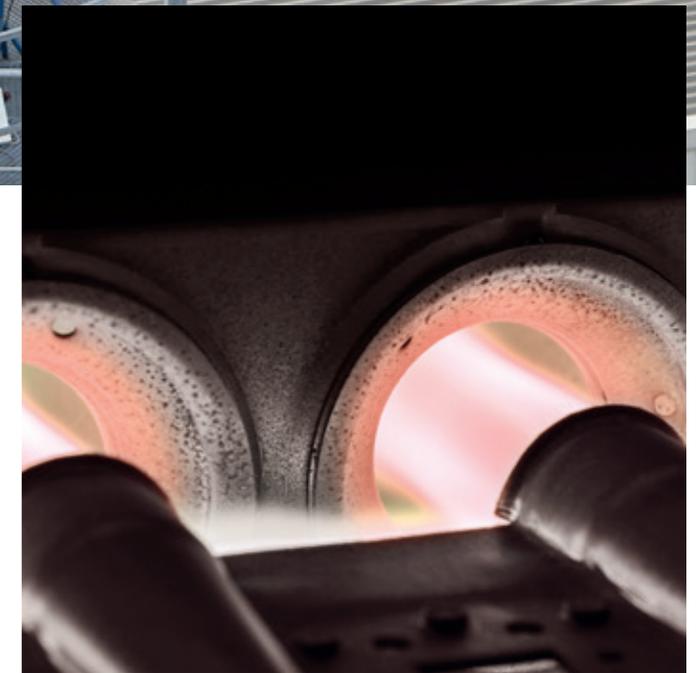
Fossil fuel combustion is a key element affecting glass furnace emissions and energy consumption. Combustion settings and burner types influence heat transfer and formation of aggressive and pollution such as NOx. In addition to explaining the various mechanisms responsible for pollution, the course will explain how to reduce emissions both from the perspective of primary (process-integrated) and secondary (end-of-pipe) techniques.

### After the training

- You realize the mutual interaction between batch components & combustion atmosphere on one hand and glass quality & furnace lifetime on the other hand.
- You are trained to find industrially feasible emission limits for different glass and furnace type.
- You are familiar with techniques to reduce emissions.
- You can diagnose causes of emissions and define measure to reduce them.

### Contents

- Combustion mechanisms
- Emissions sources and legislation
- Glass furnace energy balance
- Radiation and heat transfer
- NOx formation
- Burner types
- Staged combustion
- Carry-over and evaporation
- Impact of combustion on redox
- Combustion monitoring & control
- Abatement technologies



### Investment

Training costs € 1450 per participant. When onsite, price includes 2 lunches and 1 dinner. It excludes the living cost of the participants, tax and duties.

The 6th participant from the same company can join for free.

# General glass technology training

duration  
5 days

date  
June 20 - 24  
October 3 - 7

location  
Detroit area, US  
Eindhoven, The Netherlands



The training course is an excellent introduction for new entrants to the glass industry and a perfect refresher for more experienced ones. This course contains a global overview of key glass making technologies from raw materials till the glass forming process. At the end of the training, you will have a clear view of the industrial glass production process, understanding of the current and future challenges, and plenty of ideas to optimize your process. This comprehensive course was developed in cooperation with the National Committee of the Dutch glass industry (NCNG).

## After the training

- You can improve various glass properties by tuning their composition and optimizing raw materials.
- You know how to react when redox-based issues occur and impact heat transfer, fining, foaming and colour of the glass.
- You recognize solid and gaseous defects, you know their origin and have ideas to solve a crisis.
- You can select process design and operation parameters to achieve emission reduction, energy savings and improve sustainability of glass production.

## Contents

The topics covered are listed below. A visit to a glass factory is generally organized during one afternoon.

- Glass and melt composition, structure, properties
- Raw materials
- Batch processing
- Carry-over
- Recycling
- Melting and kinetics
- Redox, colour and heat transfer
- Fining and foaming
- Annealing, tempering
- Furnace types, design and control
- Combustion

- Evaporation
- Refractories
- Energy efficiency
- Emission
- Glass defects

Participants will receive a comprehensive textbook (about 800 pages) on industrial glass technologies.

## Investment

Training costs € 2950 per participant. When onsite, price includes 5 lunches and 2 dinners. It excludes the living cost of the participants, tax and duties.

The 6th participant from the same company can join for free.

# Heat transfer in glass melting furnaces

## Advanced training

duration  
1 day

date  
October 13

location  
Eindhoven,  
The Netherlands



This training describes the fundamentals of heat transfer mechanisms in the combustion space, batch blanket and glass melt. It focusses on radiative heat transfer in glass melts depending on the presence of the colouring ions and the redox state of the melt. The effects of new, emerging, sustainable furnace technologies, like hydrogen combustion and full electric melting on the heat transfer mechanisms are elucidated.

### After the training

- You can estimate the effect of raw material nature and preparation on the heat penetration in the batch blanket.
- You can estimate the effect of glass chemistry, colour and redox on radiative heat transfer in the glass melt.
- You can estimate the effects of furnace design on convective heat transfer with help of characteristic dimensionless numbers.

### Contents

- Heat transfer in the combustion space:
  - Flame emissivity
  - Effect of soot
  - H<sub>2</sub>-rich flames
- Heat penetration in batch:
  - In flame furnaces
  - In electric cold-top furnaces
  - Effect of cullet type and content
- Heat transfer in glass melt
  - Radiative heat transfer using a new model for predicting thermal radiation conductivity
  - Convection in fuel-fired and electric cold top tanks.



### Investment

Training costs € 950 per participant. When onsite, price includes a lunch and refreshments. It excludes the living cost of the participants, tax and duties.

The 6th participant from the same company can join for free.

# Sustainability and energy savings

## Introductory training

duration  
2 days

date  
October 18 - 19

location  
Eindhoven,  
The Netherlands



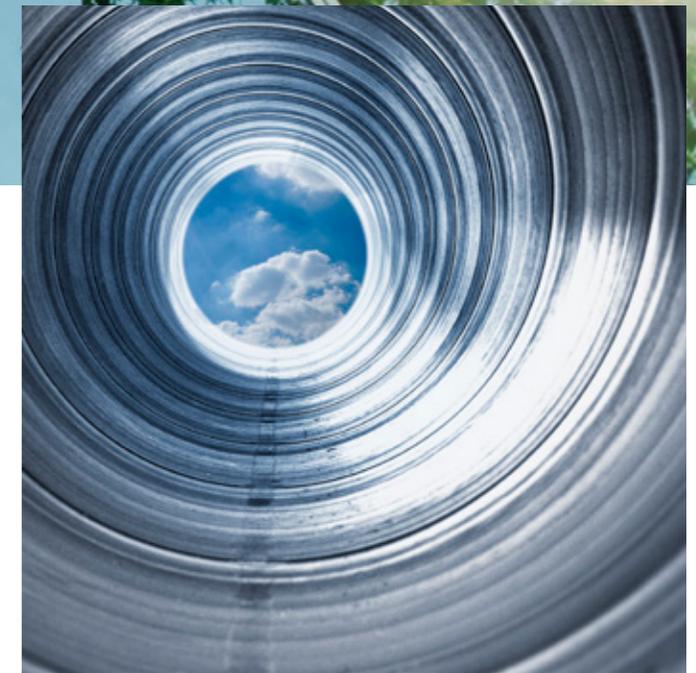
Complying with sustainability targets derived from the Paris climate agreement means that the glass industry is looking at options to lower CO<sub>2</sub> emissions and improve energy efficiency. We will discuss the various options (both for short and longer-term) from the perspective of efficiency, technology readiness and potential side-effects.

### After the training

- You have a clear overview of different decarbonisation routes and methods to improve on energy efficiency.
- You can distinguish between short-term and long-term options to improve sustainability of glass production.
- You understand the technological challenges to switch to sustainable fuels, modified furnace designs, and alternative raw materials.
- You are aware of non-technical issues of converting into CO<sub>2</sub>-free glass production.

### Contents

- Options for CO<sub>2</sub> emission reduction
- Energy consumption (benchmarking) and CO<sub>2</sub> emission (direct and indirect) of glass production
- Alternative sustainable fuels and their implication on glass quality, energy consumption, emissions, and furnace lifetime
- Influence of the furnace design on energy consumption and CO<sub>2</sub> emission
- Raw material selection and impact on CO<sub>2</sub> footprint
- Waste heat recovery
- CO<sub>2</sub> capture and utilization



### Investment

Training costs € 1950 per participant. When onsite, price includes 2 lunches and 1 dinner. It excludes the living cost of the participants, tax and duties.

The 6th participant from the same company can join for free.

# Refractory selection, maintenance and related defects

## Introductory training



duration  
2 days

date  
November 15 - 16

location  
Eindhoven,  
The Netherlands



The refractory materials used in industrial melting furnaces are a huge investment for the glass manufacturer. Choosing the correct refractories is key in improving the furnace lifetime, reducing the energy costs and reducing the refractory related defects. The course will provide you with insight into why different parts of the furnace, including melter, refiner, working end/forehearth channels and regenerator chambers, require different refractory types with specific chemistry and properties. The course will also provide you with some maintenance techniques that can be used to increase the furnace lifetime and reduce the risk of refractory failures.

### After the training

- You have an overview of chemistry and properties of refractory types for the different parts of furnaces and the purpose of their use.
- You understand the corrosion mechanisms of refractories in contact with the glass melt, in the superstructure/crown and in the regenerators.
- You have knowledge of techniques for testing, monitoring and controlling the thickness of refractory walls.
- You understand the defect types that can originate from different refractories in the furnace.
- You will have some techniques for preventive and corrective maintenance of the furnace structure.

### Contents

- Key refractories, requirements and properties
- Interaction mechanisms of refractories in contact with the glass melt and in contact with flue gases
- Exercises on:
  - Refractory selection for different furnace parts
  - Thermal insulation of refractory walls
- Refractory testing and on-line monitoring techniques
- Preventive maintenance of furnace structure
- Corrective maintenance and hot repair of furnace structure
- Identifying and understanding refractory related solid defects and cords
- Exercises on:
  - Refractory defect identification
  - Technique for furnace maintenance



### Investment

Training costs € 1950 per participant. When onsite, price includes 2 lunches and 1 dinner. It excludes the living cost of the participants, tax and duties.

The 6th participant from the same company can join for free.

# Float glass melting and forming

## Introductory training

duration  
2 days

date  
November 8 - 9

location  
Eindhoven,  
The Netherlands



The training is dedicated to everyone in float glass production who needs a high-level understanding of the melting and forming processes of float glass. A general overview will be given of the main characteristics of float glass production focusing on the melting and forming operation, with the defects related to these processes also described.

### After the training

- You will have an understanding of relevant float glass properties and their importance in the melting and forming process.
- You will understand the melting characteristics inside the furnace and the link with good dissolution of particles and fining.
- You will have knowledge of some combustion parameters and the link with glass quality, furnace lifetime, energy consumption and emissions of your process.
- You will have knowledge of the float glass forming process and some important parameters.
- You will have knowledge of the float bath chemistry and how it correlates with float bath defects.

### Contents

- Float glass properties
- Melting, fining and homogenization
- Combustion and emissions
- Furnace operation
- Energy consumption
- Interactive session on some float glass melting parameters
- Furnace operation and defects
- Float glass forming basics
- Float bath chemistry
- Float bath related defects



### Investment

Training costs € 1950 per participant. When onsite, price includes 2 lunches and 1 dinner. It excludes the living cost of the participants, tax and duties.

The 6th participant from the same company can join for free.

# In-company training courses



duration  
To your needs

date  
Your wish

location  
Your place



For all companies willing to train a number of employees at once, we can propose customized in-company training.

All courses can be given at a location of your choice. Modules can be combined to tailor a course for your team. Content can be customized to match your glass-related learning goals. Applications and examples are chosen according to your production type. The nature and level of content is adapted to your team.



Besides the worldwide acknowledged and well-known open 5 day glass technology training, custom-made (in time, content and format) courses have been developed and provided across the globe serving the entire glass industry.



# Your trainers



Corinne Claireaux  
🇫🇷

Corinne Claireaux studied glass and materials chemistry in Rennes and obtained her PhD from the Sorbonne University in Paris in 2014. She worked as an internal trainer and R&D project leader for Saint-Gobain, improving or developing new glass formulations for different businesses and products (float, glass wool, glass-ceramics). She joined CelSian as a glass scientist and trainer in 2019.



René Meuleman  
🇳🇱🇬🇧🇩🇪

René Meuleman started his career in the glass industry in 1968 as an employee of Vereenigde Glasfabrieken, later BSN and Owens-Illinois. He built a broad experience in the design and development of electronic quality equipment for container glass manufacturing and was involved in the implementation of their first-generation electrical furnace boosting systems, PLC and DCS systems, as well as electronic timing systems for IS-machines. In 2007 he joined the Eurotherm by Schneider Electric group where he became responsible for the technical and commercial glass business development focusing on the automation and electrification of the glass industry. He started at CelSian in early 2021.

*To support container glass production and optimization, we have trained teams of operational managers for many companies, both in Europe and in America.*



Johan Lotter  
🇬🇧🇳🇦

Johan Lotter obtained a master's degree in chemical engineering from the University of the Witwatersrand. He worked at PFG building glass as a furnace engineer, technical expert, and manager of the technical department of two plants. He developed a large experience in raw materials, melting and floating process and defect analysis. He is now working as a CFD Engineer and trainer at CelSian.



Neil Simpson  
🇬🇧

Neil Simpson graduated in Energy Engineering from Edinburgh Napier University. He developed burners for the glass industry with Laidlaw Drew and BOC, was a glass industry specialist at Eclipse and became an independent consultant in 2014. With over 20 published patent applications Neil is a Chartered Engineer and Fellow of the Society of Glass Technology. He became a CelSian registered trainer in 2015 and has organised multiple UK based courses since.



Penny Mason  
🇳🇱🇬🇧

Penny Mason studied Glass Science and Technology at Sheffield University. She worked in development and process improvement for TV and lighting glass applications at Philips. She joined CelSian in 2012 concentrating on glass melting projects in the lab. As a consultant, researcher and trainer, she loves the challenge to apply experimental work to assist manufacturers in improving their performance while decreasing their environmental footprint.

# Your trainers



Mathi Rongen

Mathi Rongen studied Applied Physics at Hogeschool Eindhoven. He started working at Philips Research Laboratories as research engineer and developed measurement set-ups for thermo-physical properties of silica glasses. In 1996 he joined Philips as development engineer responsible for improving the glass quality of TV and Lighting glass using CFD Glass Furnace Modeling. In 2006 he joined TNO Glass Group as R&D project manager. He is now senior consultant at CelSian, with a focus on executing melting trials and other customer projects in our laboratory.

*We have developed specific training courses related to reinforcement fibre and glass wool production.*



Oscar Verheijen

Oscar Verheijen obtained his PhD from Eindhoven Technical University before joining TNO as a R&D project manager and business development manager of sustainable technologies. He is now R&D and training team leader at CelSian, Board member of the GlassTrend, member of the steering committee of the Dutch Glass Industry (NCNG) and represents the NCNG at European level.

*We have successfully applied different formats to train operational and R&D teams of major glass producers but also in smaller entities.*



Yongguo Wu

Yongguo Wu was educated in China (BSc & MSc) and USA (PhD & MBA) and is fluent in bilingual Chinese and English. Dr Wu has more than 35 years experience in glass industry worldwide. He started working in a flat glass manufacturer and taught glass furnace classes in China before going to USA for further studies at Case Western Reserve University. He worked at various functions rising to senior management roles from OI, Johns Manville, AGY, and Frazier-Simplex before founding the US-based technical service and solution provider, ICEON Glasstech.



Sjoerd Stelwagen

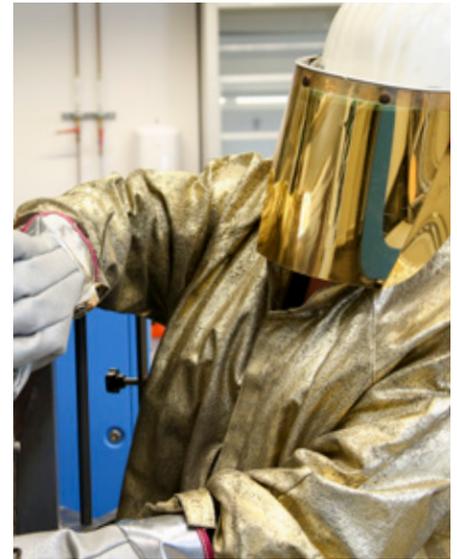
Sjoerd Stelwagen studied Chemical Engineering at Eindhoven University of Technology. Directly after his study he started as a Technical Specialist at the Furnace department of Ardagh Glass in Dongen, The Netherlands, where he later became Batch and Furnace Manager. He then evolved as EHS manager for the Benelux plants. With more than 16 years of practical glass making experience, he joined Celsian in 2021 to work as a project manager and trainer.



Improve glass quality



Optimize melting process



Extend furnace lifetime

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