39th ASEAN GLASS CONFERENCE of AFGM

“Driving Growth in Traditional and New Markets "

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HORN
GLASS INDUSTRIES
INNOVATION ENGINEERED IN GERMANY

Glass Conditioning in Distributor and Forehearths

HORN Solutions for Future Production demands

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Distributor + Forehearths

1. Tasks / Purpose of Distributor and Forehearth
2. History
3. Dimensioning/Conception
4. Examples
5. Glass conditioning
6. Job change
7. Conclusion

Distributor + Forehearth

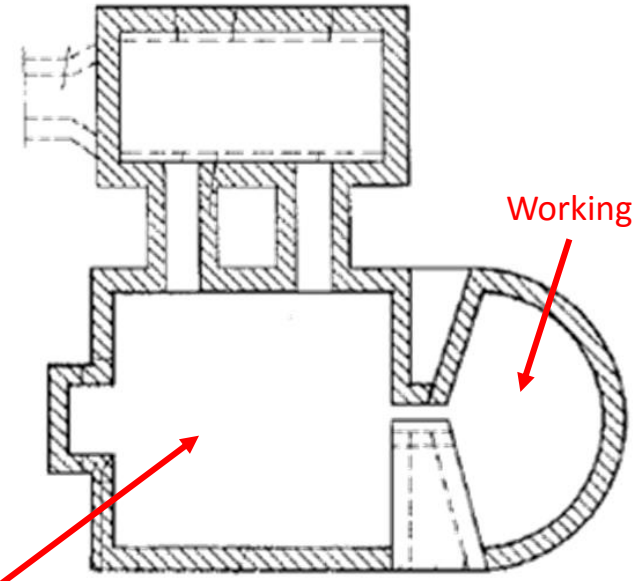
1. Purpose of Distributor / Forehearth

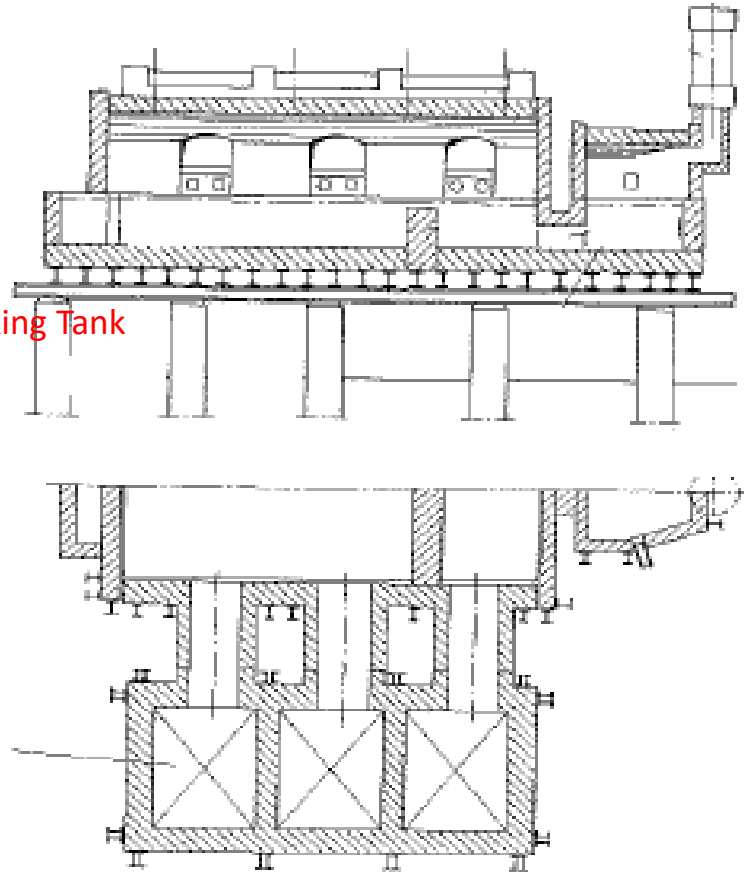
<u>Working End / Working Tank / “Glass Conditioning”:</u>

- Link between Furnace and Manufacturing
- Cooling of the Glass Melt / Adjustment of Temperatures / Viscosities for different Articles
- Transport of molten Glass
- Thermal Homogeneity
  -> production process
- Different glass colours, if necessary (Coloring FH)

Distributor + Forehearth

2. History / Working End



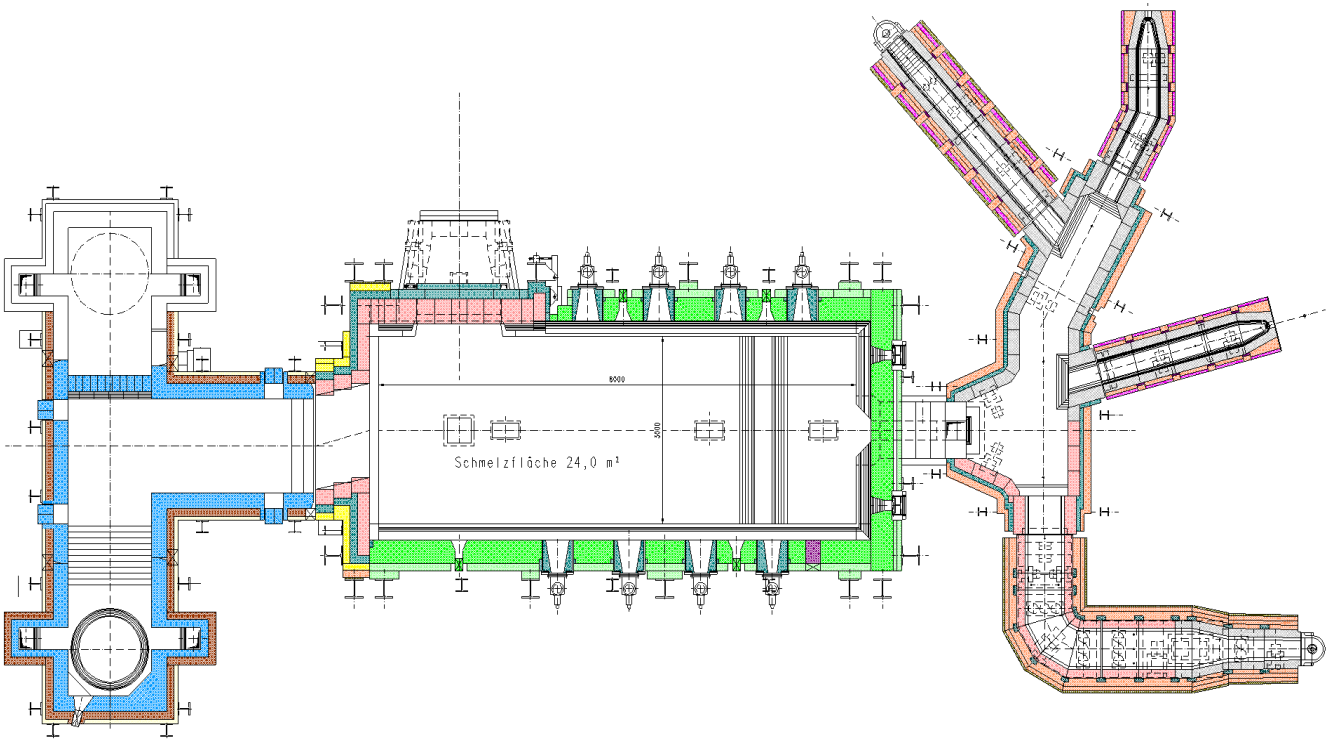


(Quelle: Trier ´Glasschmelzöfen´ Springer-Verlag 1984)

Distributor + Forehearth

2. History: `Development` to Distributor

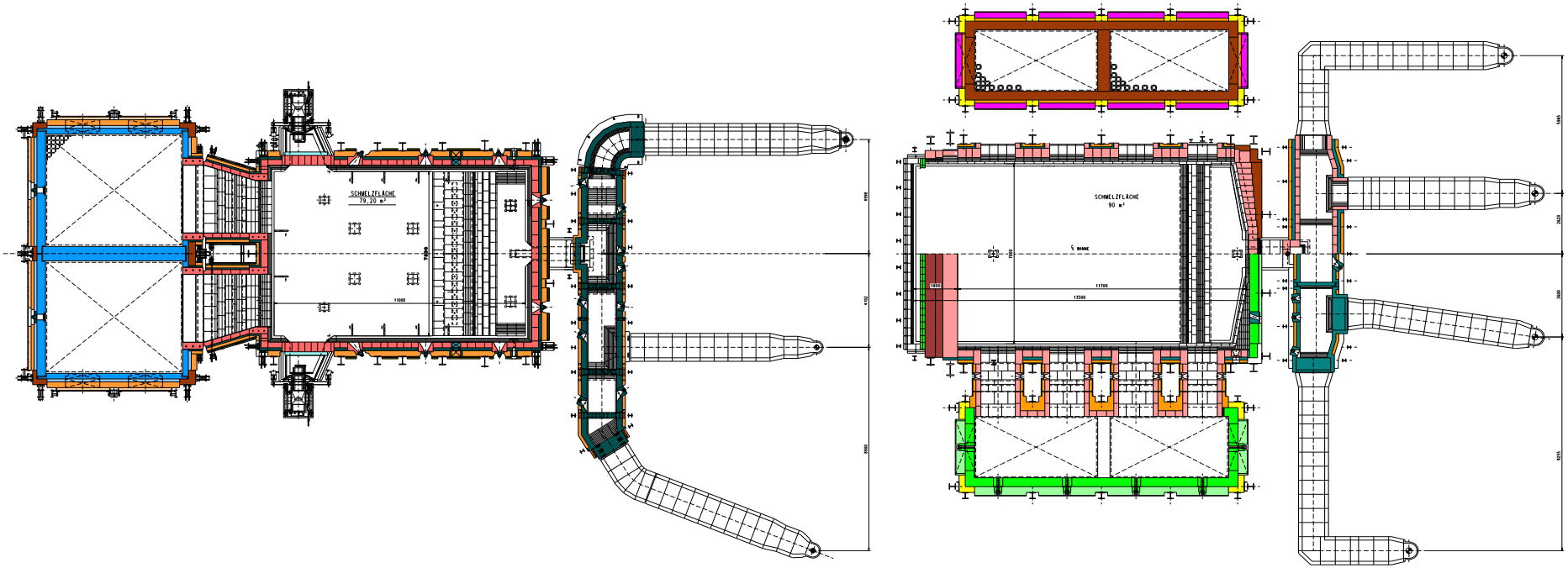
Started in the 1980s, most common since 1990s



Distributor adapted to on site conditions / forming machine configuration/ -type (Tableware)

Distributor + Forehearth

2. History: `Development` to Distributor



Distributor for large container furnaces (Example Container)

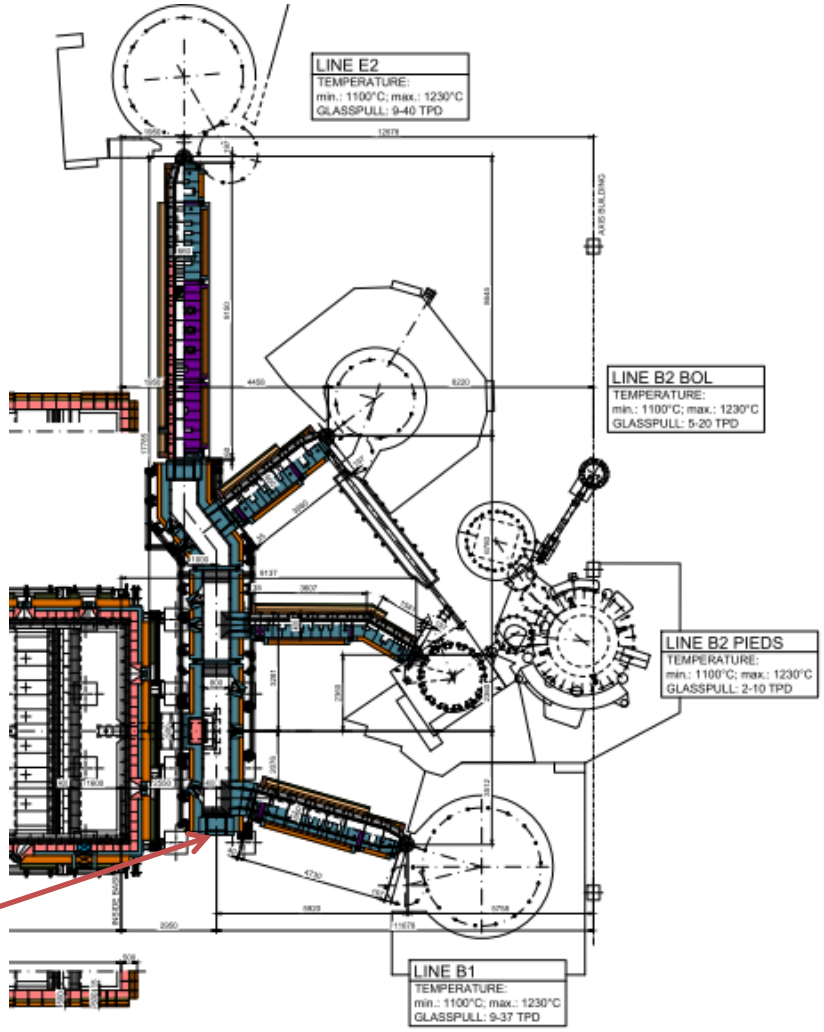
Distributor + Forehearth

2. History: `Development` to Distributor

Distributor for Table Ware Furnaces

Gob point layout according existing Building

With additional connection block for future expansion



Distributor + Forehearth

3. Dimensioning / conception of Distributor and Forehearths

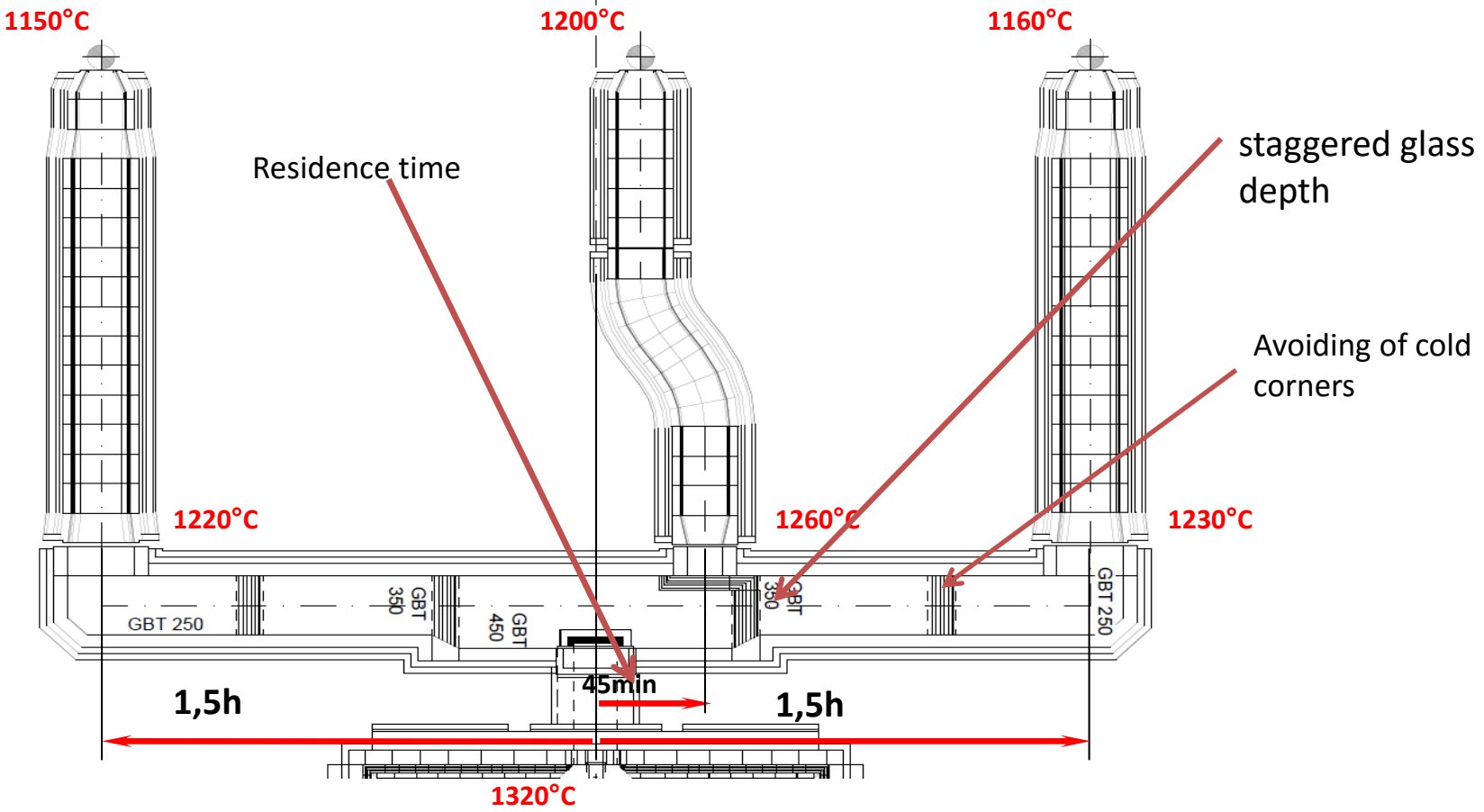
Basic Questions:

- Every Distributor / Forehearth is a special and individual Equipment
- Has to be developped according to customer´s special requirements
- Questions to be asked and answered:

. Plant layout, Gob point position
. Greenfield project
. Restrictions (reuse of Equipment / Support Structure)
. Glass Color of furnace (Flint, Amber, Green)
. Pull range
. Temperature range
. Gob weight range
. Machine speed range
. Glass Color change required
. Kind of production (weight sensibility, NNPB, high speed)
. Special glasses (Borosilicate / Opal / Fiber) need special solutions

Distributor + Forehearth

3. Dimensioning / conception of Distributor
Basic temperature requirements



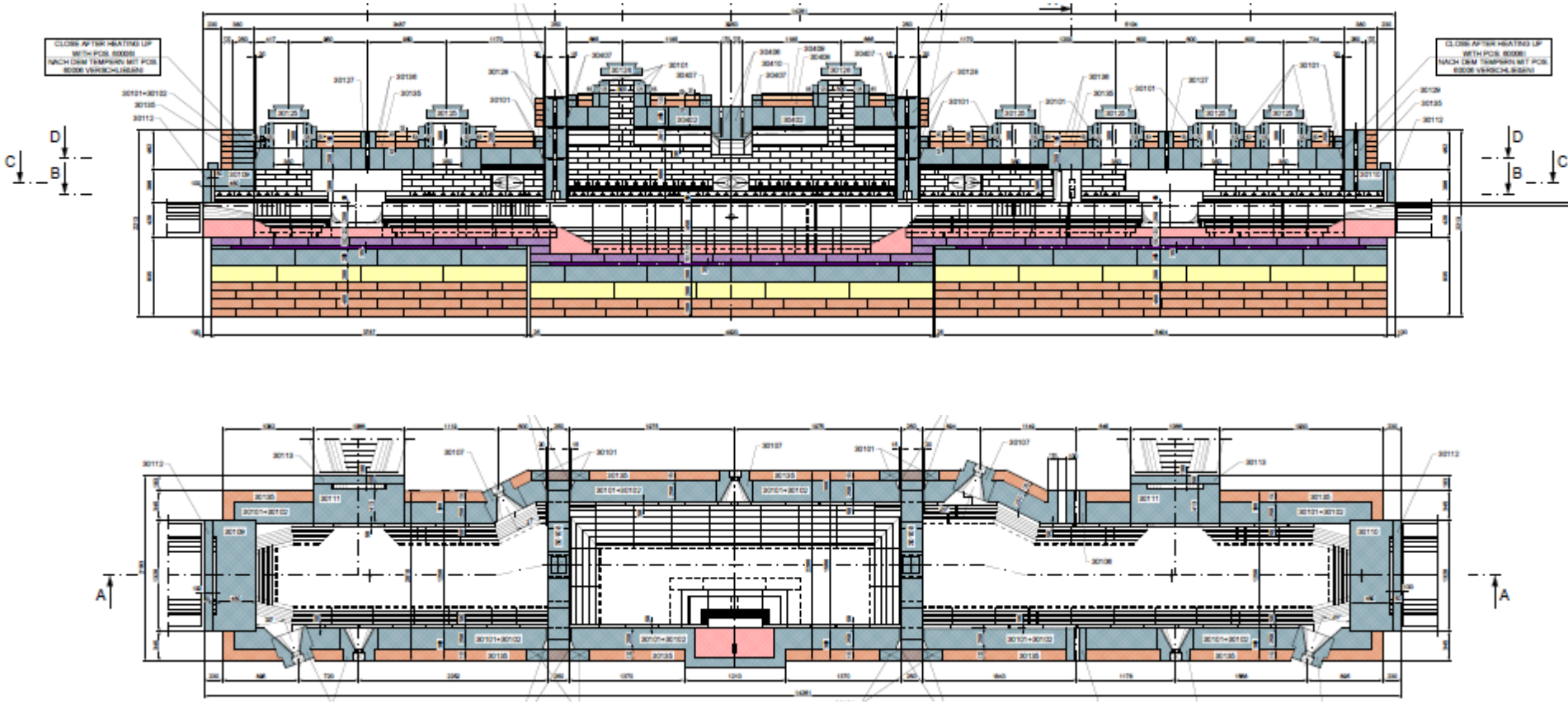
Main criteria:

- Depth, according to glass colour
- Residence time of the glass

Flint: *up to 600mm*
Green: *max. 450mm*
Amber: *max. 450mm*

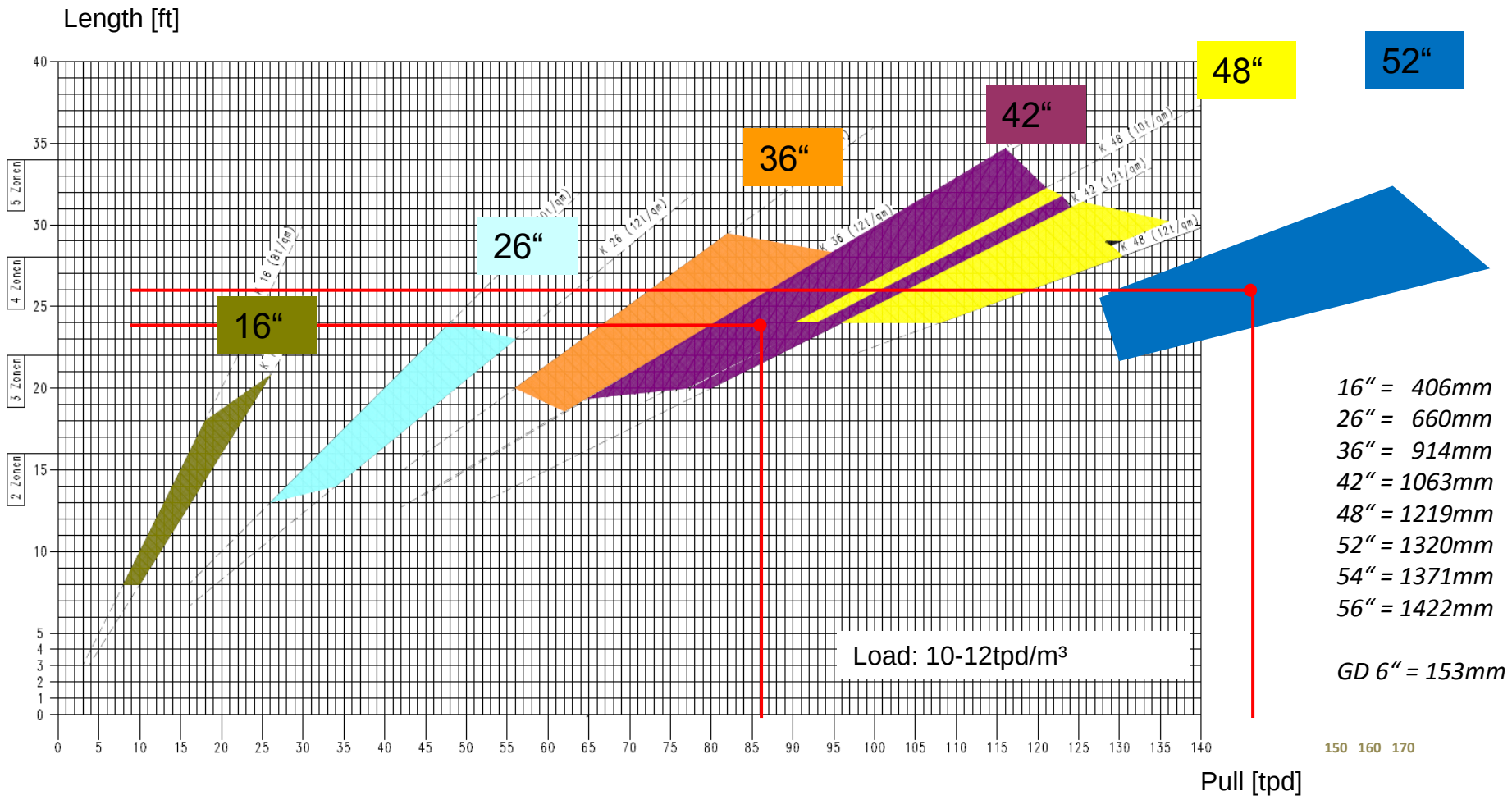
Distributor + Forehearth

3. Dimensioning / conception of Distributor



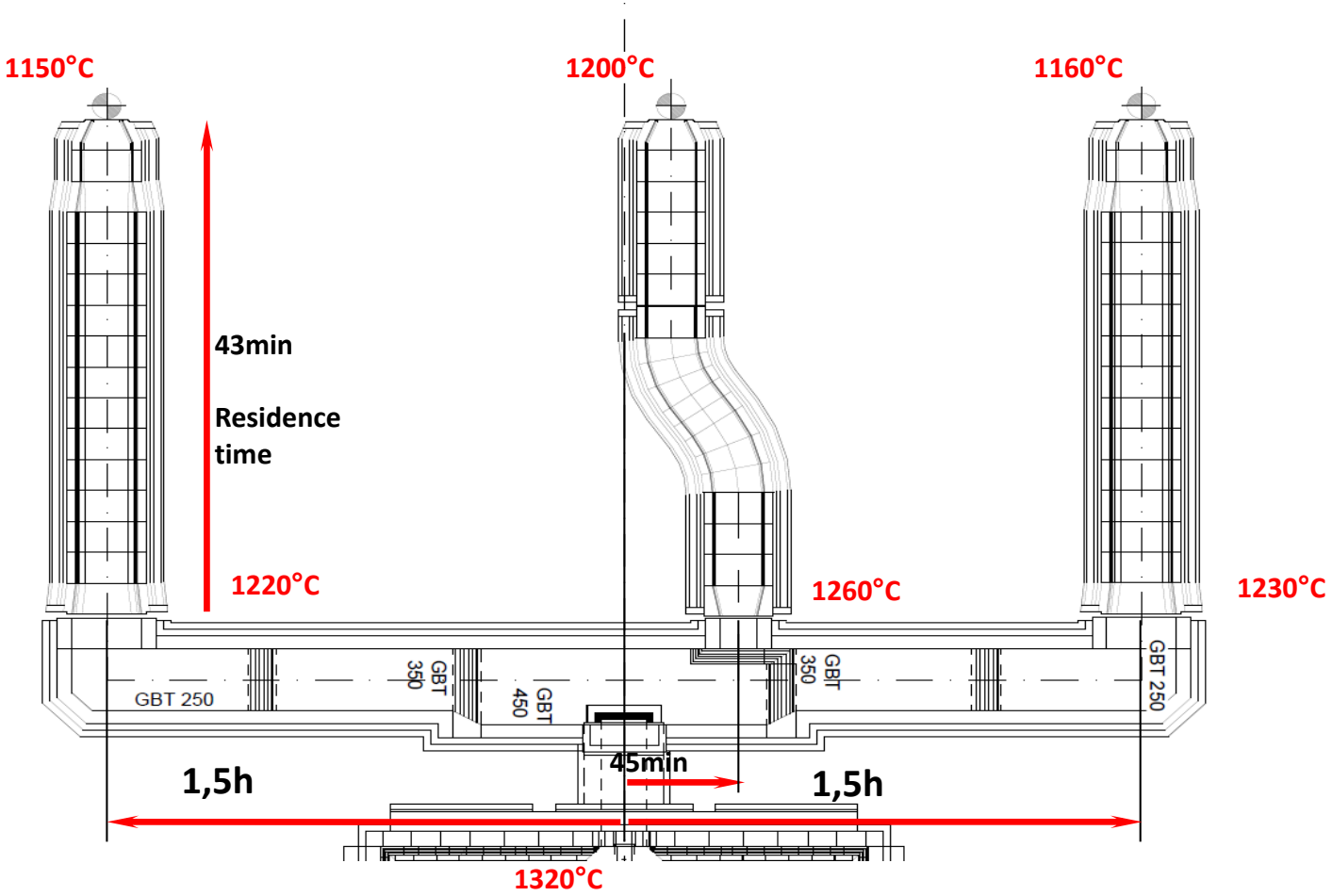
Distributor + Forehearth

3. Dimensioning / conception of Channel blocks



Distributor + Forehearth

3. Dimensioning / conception of Distributor / Forehearth



Main criteria:

- Depthd, according to glasscolour
- Width, according residence time of glass

Depth generally 153mm / 6inch (10 " for CFH)

Distributor + Forehearth

3. Dimensioning / conception of Distributor / Forehearth

Step 1:

Selection / Definition of basic geometrical data when considering:

- Total Pull / pull per forehearth
- Gob point restrictions / existing gob points etc

Step 2:

Selection of Distributor and Forehearth Refractories

- AZS fused cast
- Fused Alumina
- Bonded Alumina
- Sillimanite
- Zircon Mullite
- High Grade Insulation

- Glass Chemistry
- Glass Temperatures
- Glass Quality
- Refractory wear
- etc

Distributor + Forehearth

3. Conception of Superstructure

Step 3:

Selection of Superstructure details:

- Heating equipment
- Cooling equipment (direct / indirect superstructure cooling, indirect bottom cooling)
- large radiation flap / super large radiation flap
- Small waste gas opening
- CORA (Gas- Air mixing / Regulation station)
- Single Burner row
- Double Burner row
- Design-Elements (bath depth)

Distributor + Forehearth

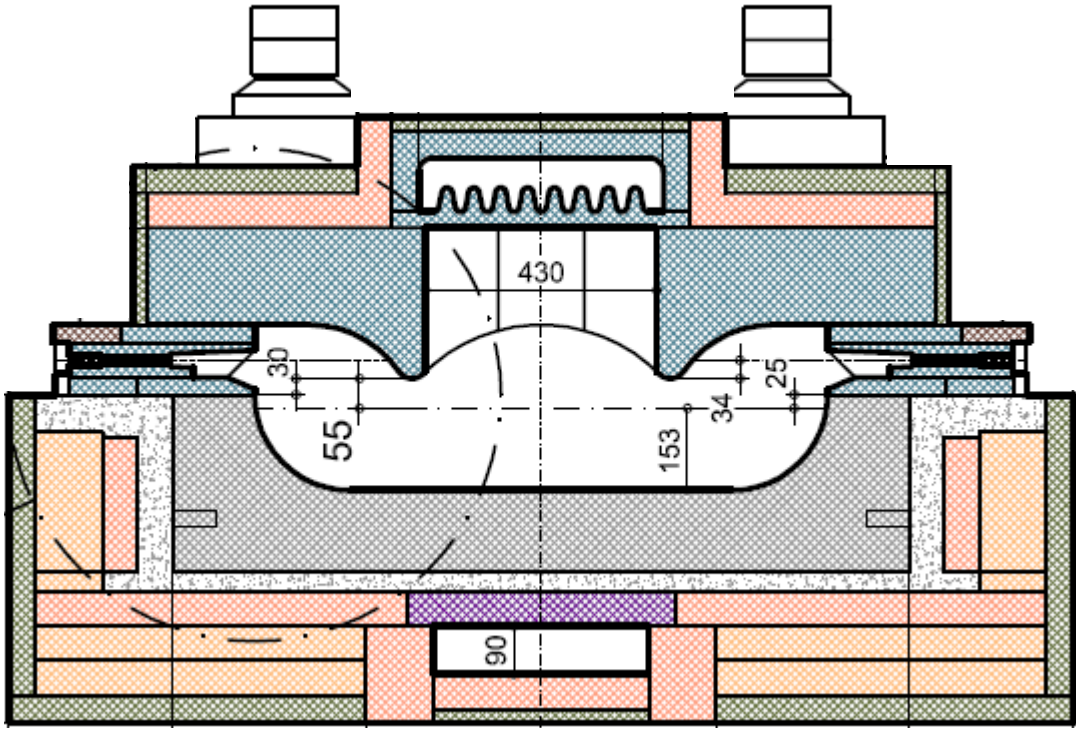
4. Examples: Cross section through FCMB Forehearth (forced indirect air cooling multi burner; Series 300)

- Small to medium Container
- Table ware

- 178 radius for avoiding cold corners
- Semi high superstructure
- Possibility of indirect superstructure cooling, if nessessary
- Manual or automatic chimney / radiation flap

Distributor + Forehearth

4. Examples: Cross section through GCS 301 Forehearth (Container, High Pull, Highly Flexible)

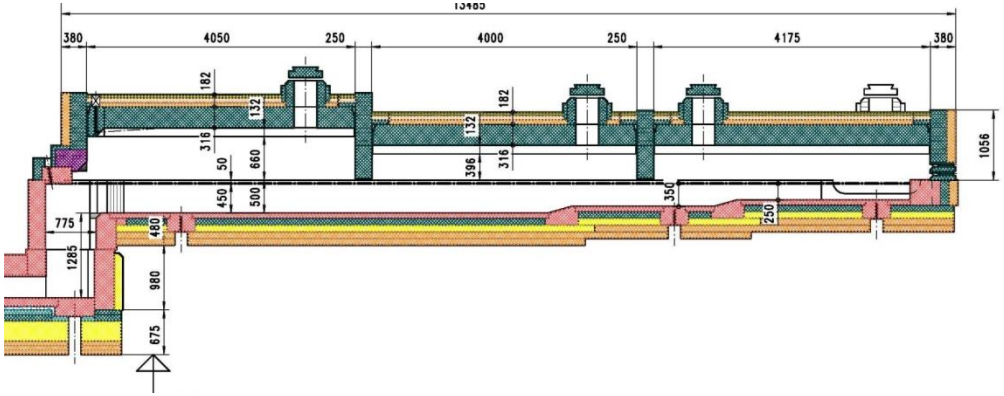


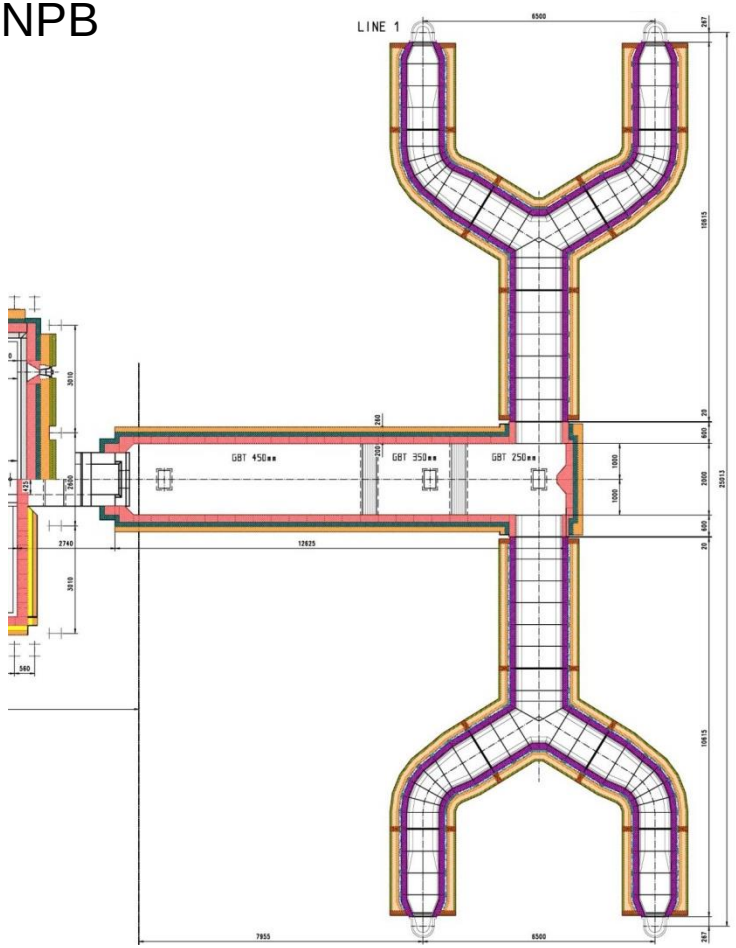
- High Pull Container
- 178 radius for avoiding cold corners
- lower superstructure
- Height according to the temperature requirements
- Profiled superstructure for heating the corners and cooling the center
- Possibility of indirect superstructure cooling, if nessessary
- Manual or automatic chimney / radiation flap
- Possibility of bottom cooling

Distributor + Forehearth

4. Examples: Special Arrangement for High Speed Container production (hardly no job change)

IS – Tandem Machines for NNPB





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4. Examples: Coloring Forehearth

… for cosmetics

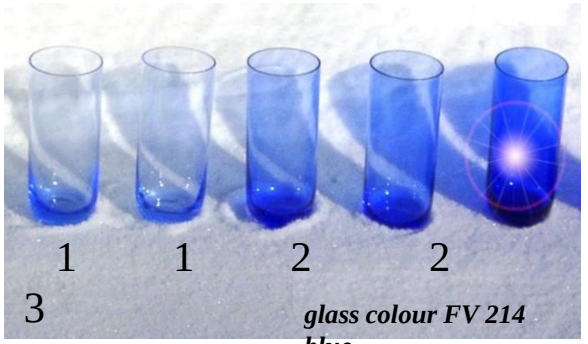
grading step 1 – 7

(smoke blue to dark blue)

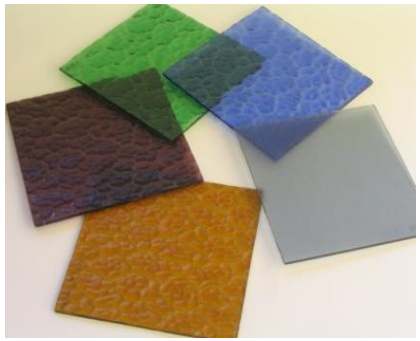
…for cristall glass

grading step 1 – 3

(light blue to dark blue)



… for figured



… for containers

… for table ware

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4. “The Stage is set”

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5. Glass Conditioning in Operation Conditions

What is glass conditioning?

Glass conditioning is the procedure to form proper gobs with target

to achieve the utmost temperature homogeneity

– not only – in a single gob,

but in a number of neighboured gobs, coming from 1 spout

Distributor + Forehearth

5. Glass conditioning

„Pre“-Conditioning in Distributor

Tools:

1. Heating system
2. Chimneys
3. Indirect Cooling
4. Direct Cooling

Final conditioning in Forehearth

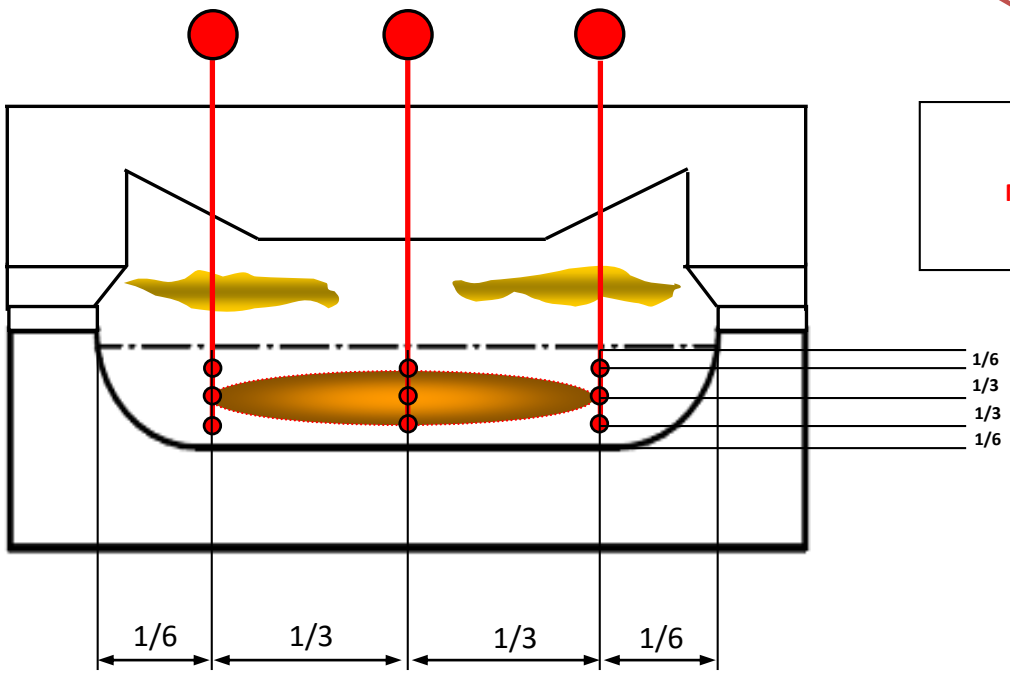
Tools:

1. Heating system
2. Chimneys
3. Radiation openings
4. Indirect Cooling (Superstructure / Bottom)
5. Direct Cooling
6. Stirrers in EQZ
7. Booster in Equalizing Zone

Distributor + Forehearth

5. Glass Conditioning Final Target

Thermocouple arrangement in EQZ



Efficiency
100%

	L	M	R
U	1171	1171	1171
M	1171	1171	1171
L	1171	1171	1171

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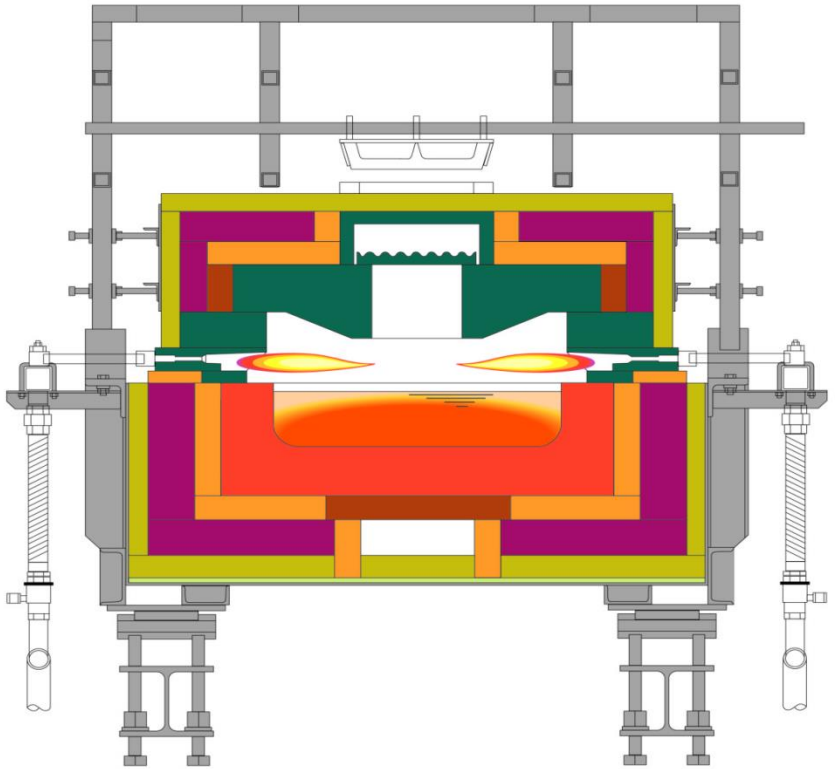
5. Glass conditioning GCS 300

Glass conditioning: Charging state of Forehearth (FH)

Low pull



At low pull…..
glass carries low amount of energy

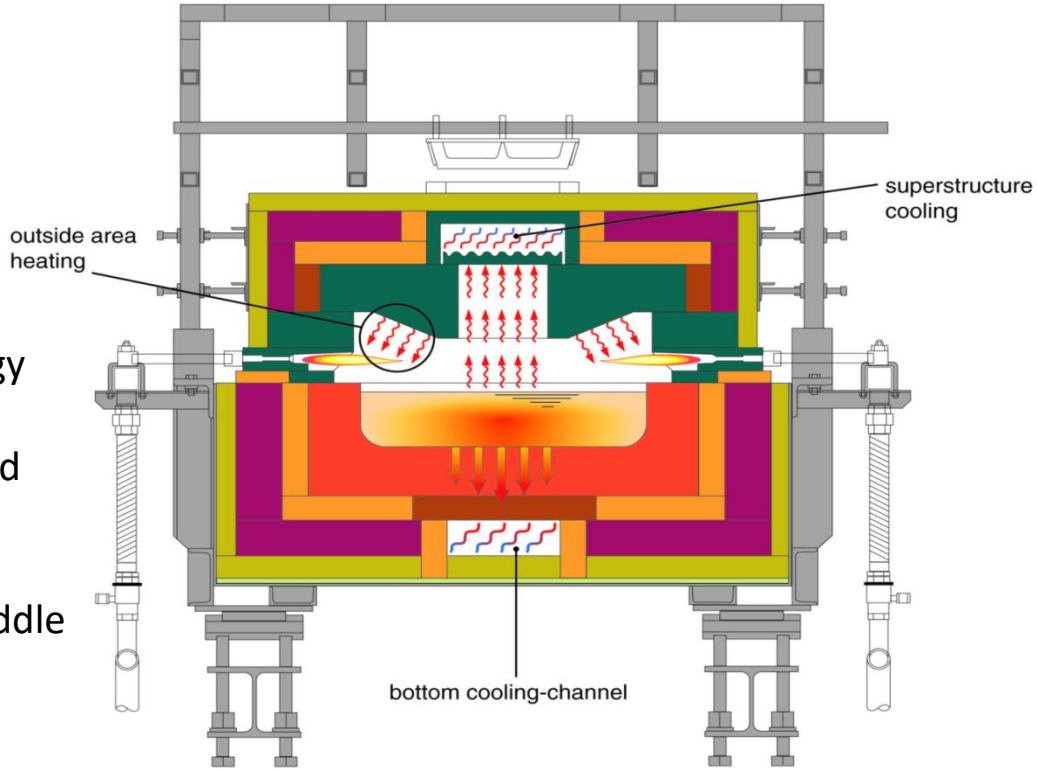
- high premix pressure
- long flames
- no cooling
- keep temperature
- reduce heat loss

Distributor + Forehearth

5. Glass conditioning GCS 300

Glass conditioning: Charging state of Forehearth (FH)

High pull

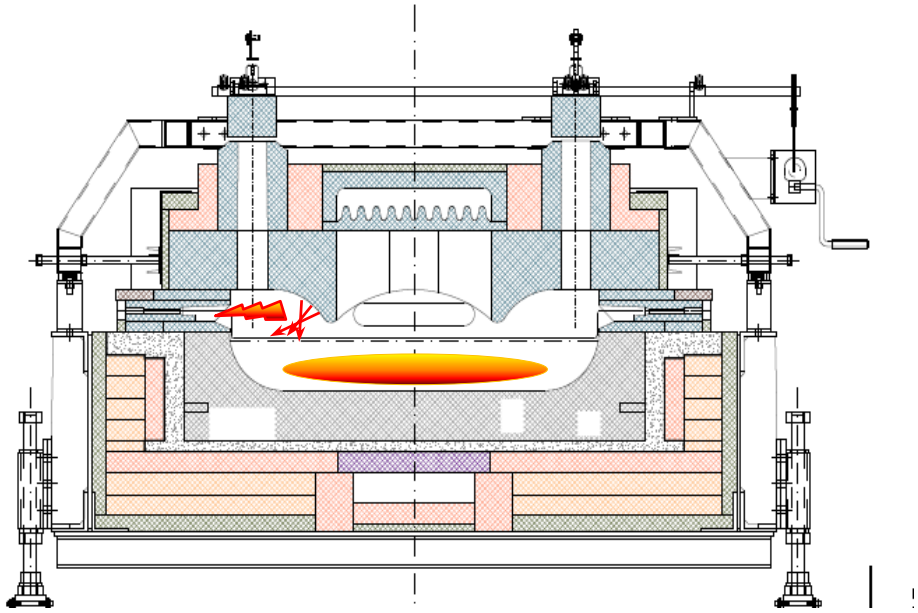


At high pull……
glass carries high amount of energy

- Usually low temperatures needed
- low premix pressure
- short flames
- take out the energy from the middle
- add energy in the outer areas
- maybe forced cooling necessary

Distributor + Forehearth

5. Glass conditioning GCS 301

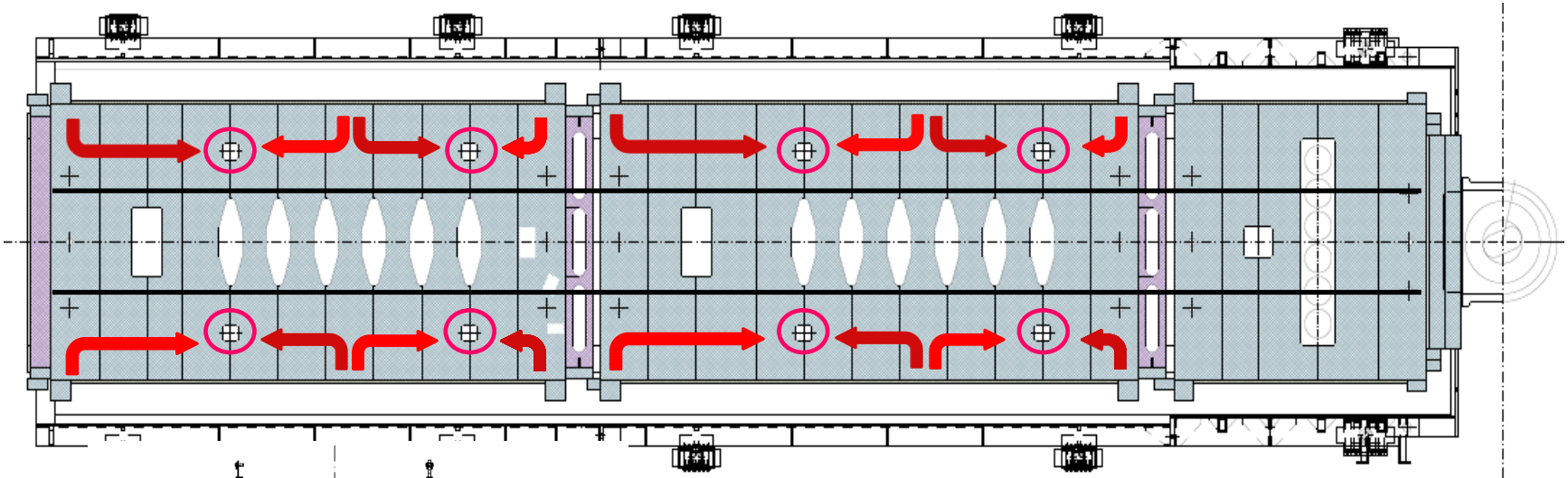


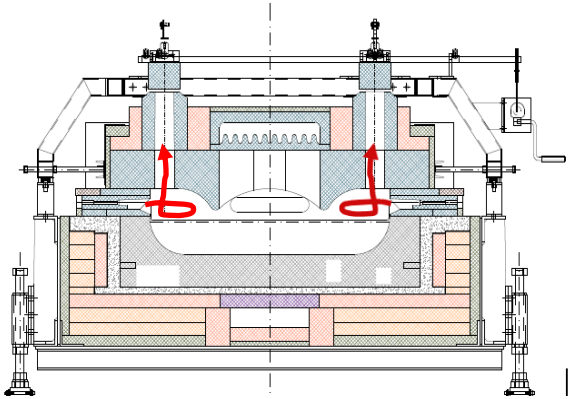
Roof blocks with concave surfaces, in order to generate a counter radiation in boundary area of forehearth.
Areal division of lateral heating zones to centreline

Distributor + Forehearth

5. Glass conditioning

Chimneys (waste gas)





Lateral alignment of chimneys – „connected“ to outer sector

-> enable to „draw“ the hot wastegas along outer sector of Forehearth, in order to heat the outer sector separately.

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5. Glass conditioning

Chimneys (waste gas)

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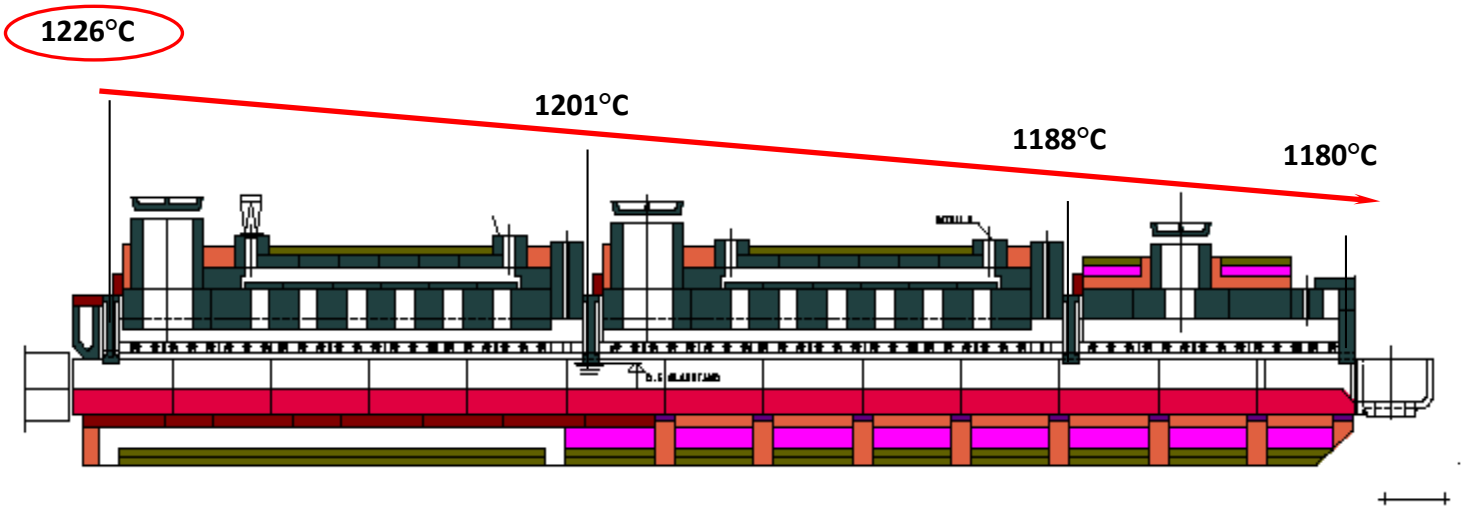
5. Glass conditioning

Ideal Temperature profile in forehearth



Longitudinal view of a Forehearth with 3 Zones and example for a ´falling´ temperature profile

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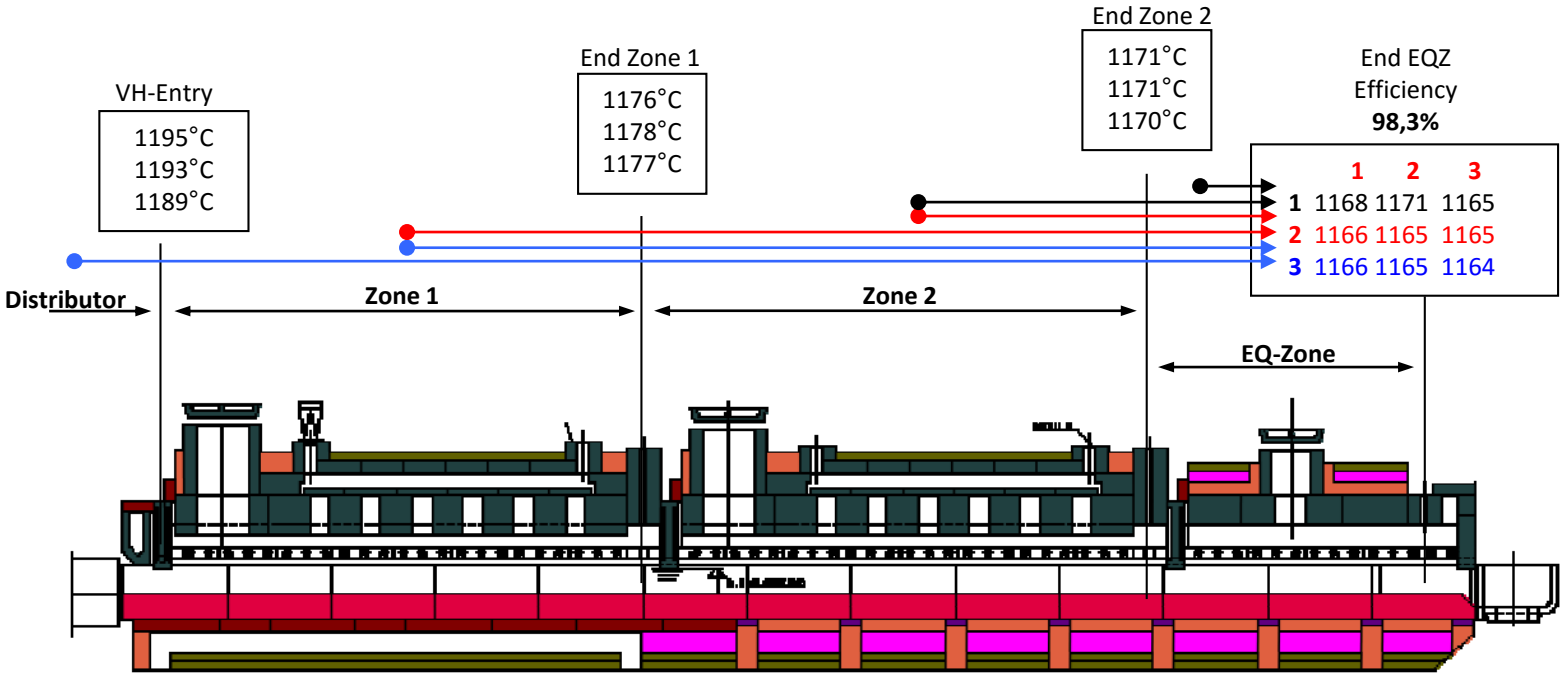
5. Glass conditioning

Heating system: Impact of single zones on efficiency



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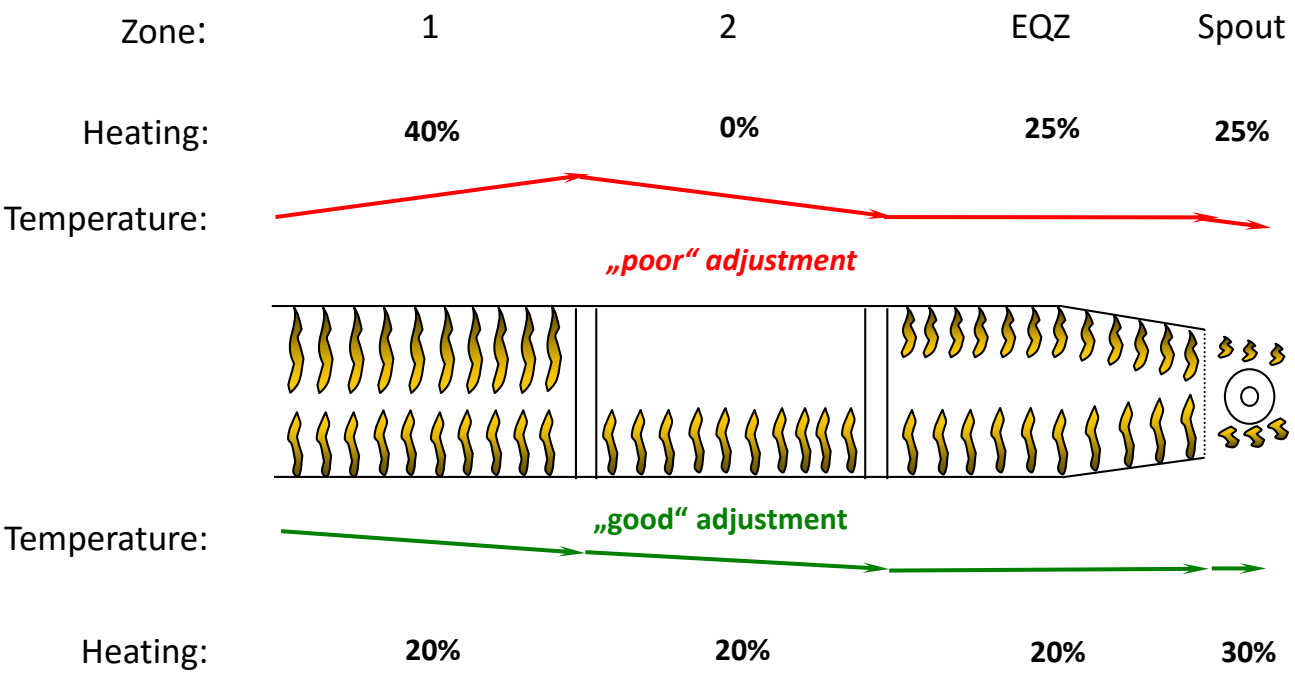
5. Glass conditioning

Temperature profile / heating profile in forehearth (in reality?)



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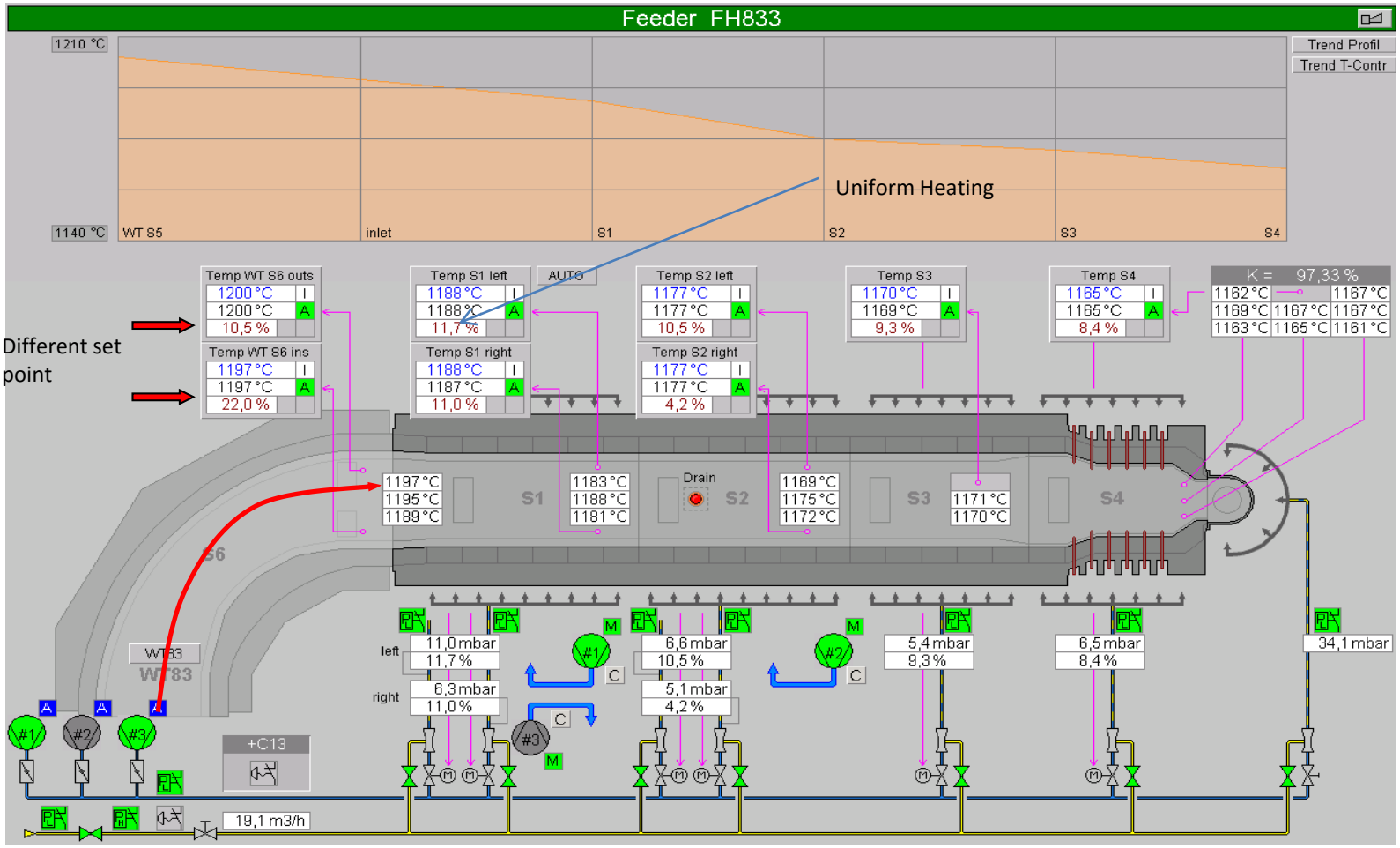
5. Glass conditioning

Heating system: Right/Left-Control of single zones



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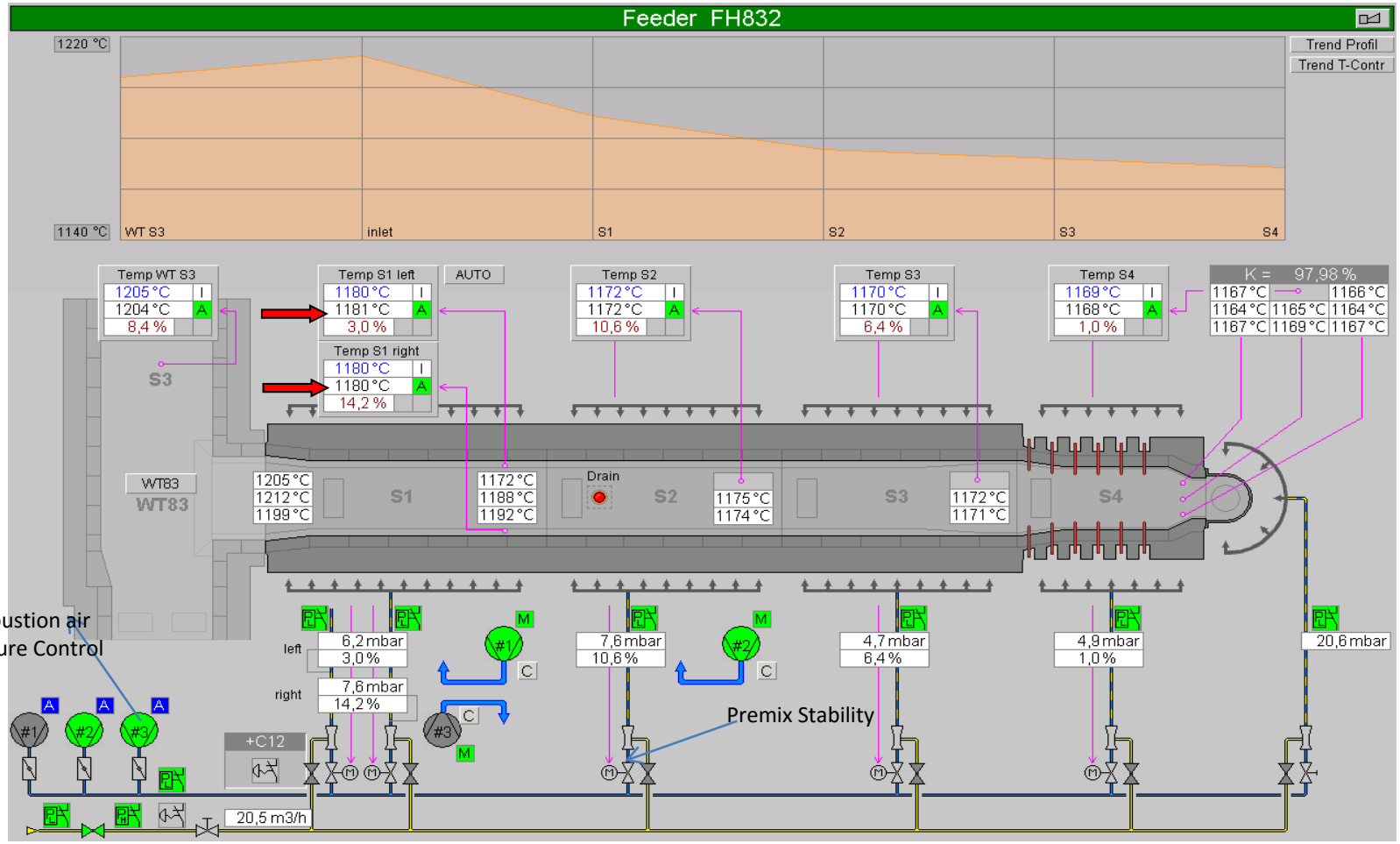
5. Glass conditioning

Heating system: Right/Left-Control of single zones



Combustion air
Pressure Control

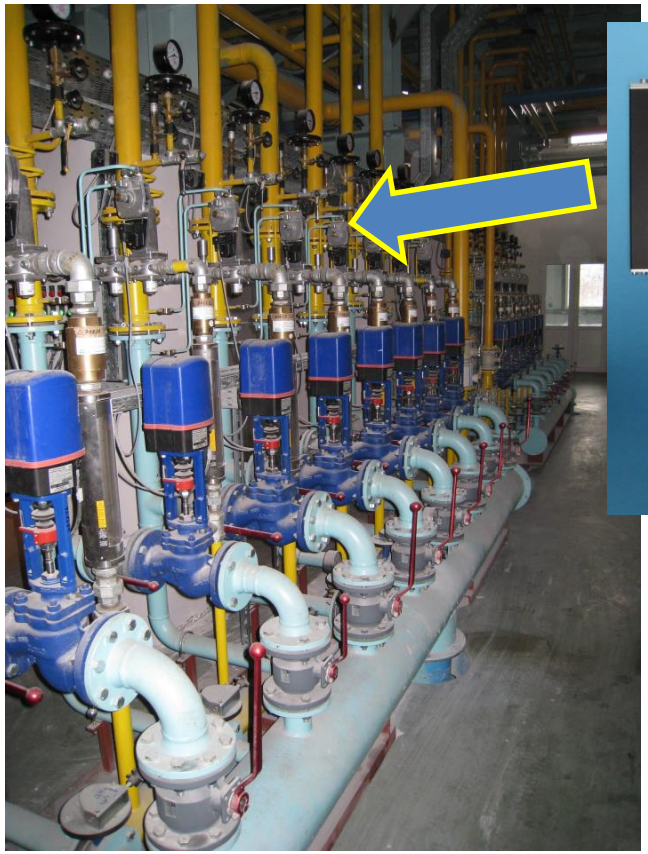
Distributor + Forehearth

5. Glass conditioning

Conventional ´Pencil-Burner´ and CORA Premix-Station

Can be equipped with Oxygen control for constant Gas-Air ratio

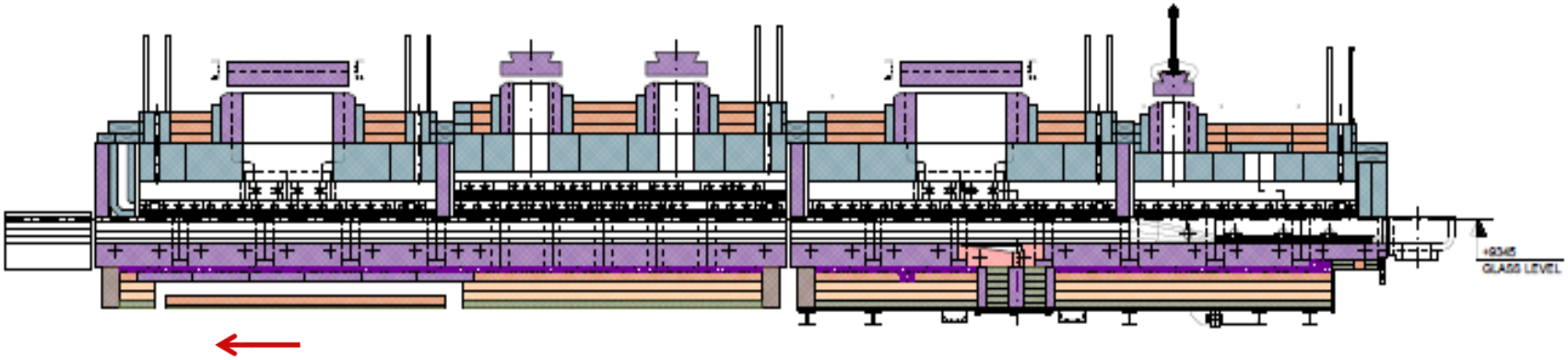
(for highly sensible glass types)

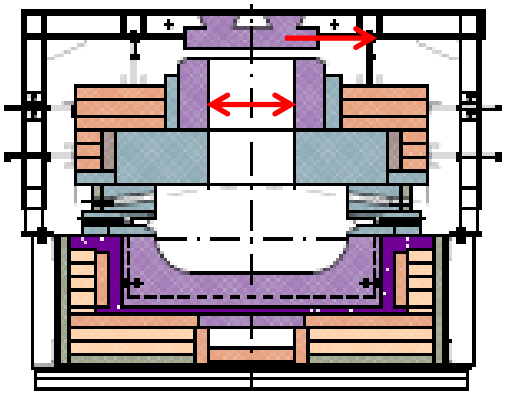


Distributor + Forehearth

5. Glass conditioning

Radiation openings





Width of radiation opening is 1/3rd of channel width

Length -> according to requirement

Damper opens sideways to release heat radiation from centreline in a defined width.

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5. Glass conditioning

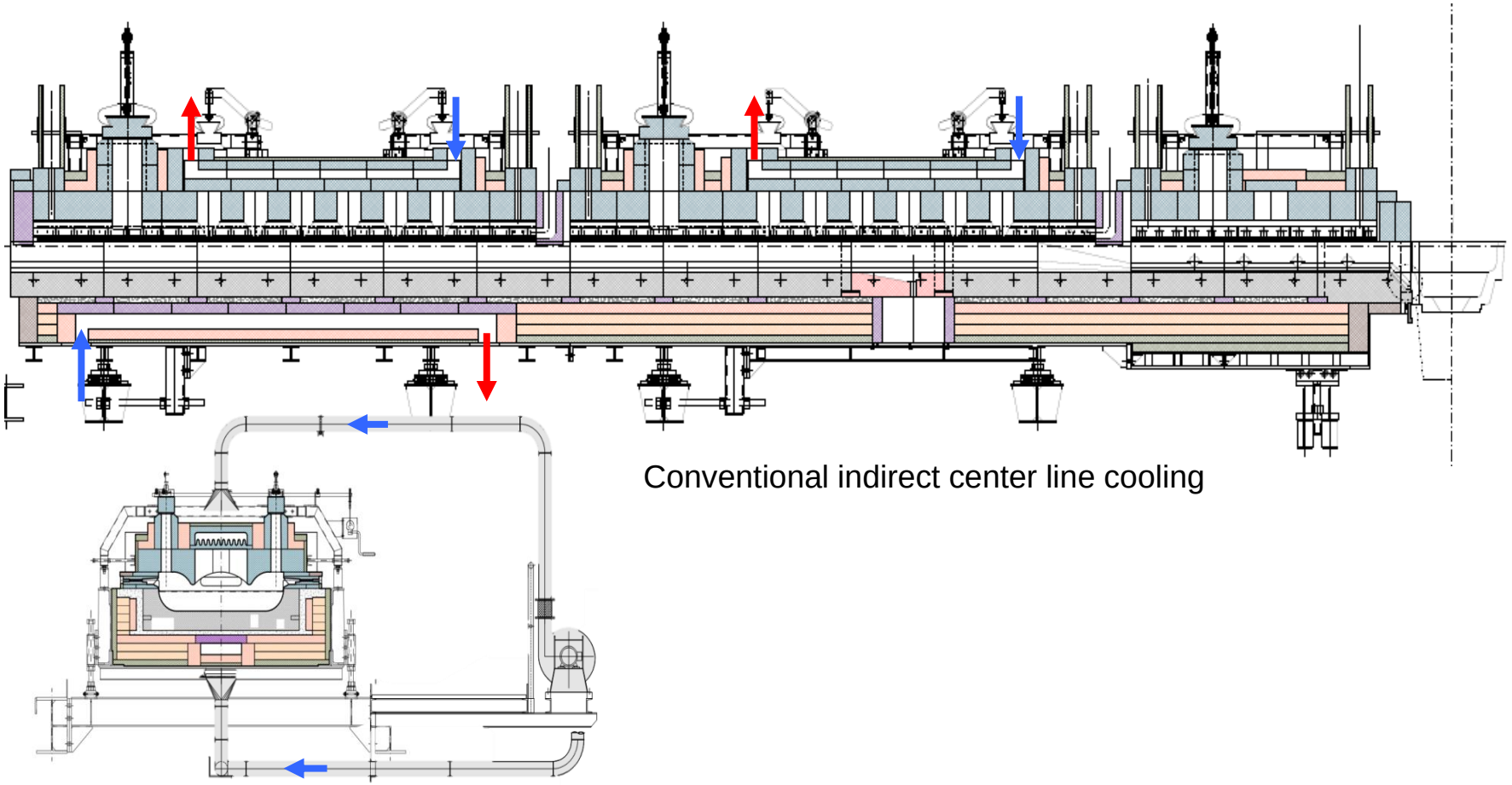
Radiation openings

(Quelle: HORN/Gerresheimer AG)

Distributor + Forehearth

5. Glass conditioning

Indirect cooling

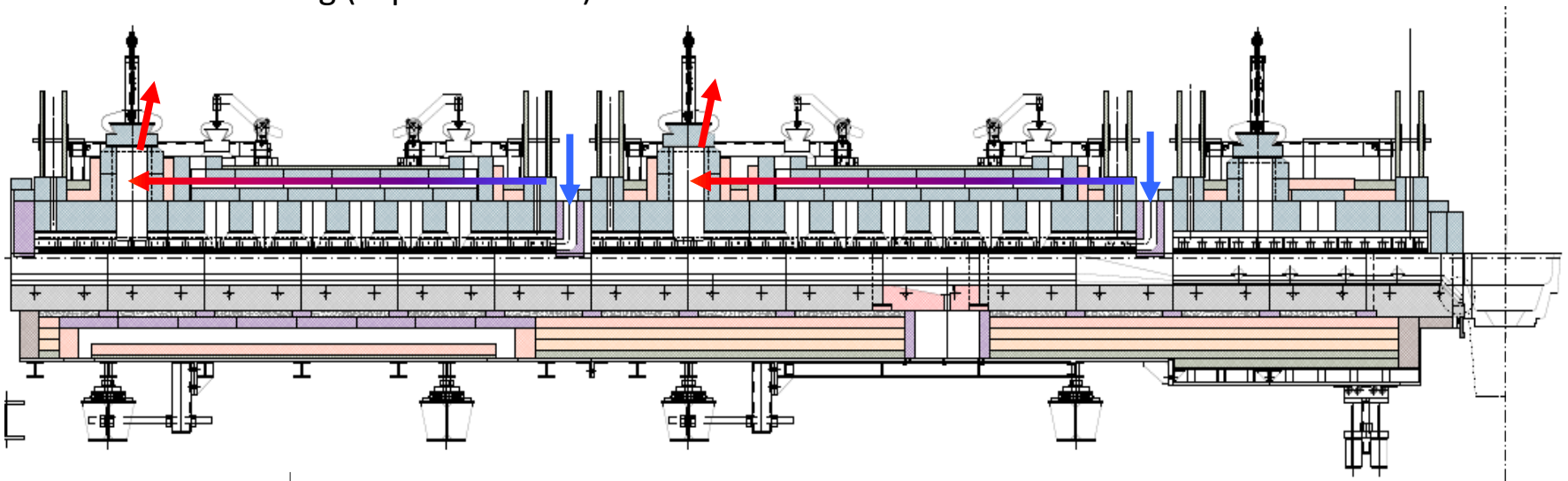


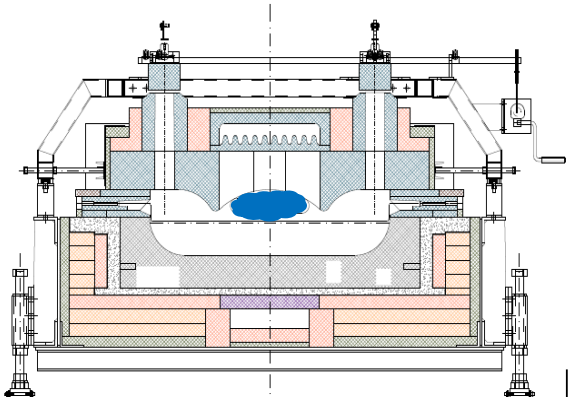
Conventional indirect center line cooling

Distributor + Forehearth

5. Glass conditioning

Direct cooling (superstructure)





Direct cooling air is introduced via a mantle block against Glass flow direction. (Direction can be changed, due to customer requirement)

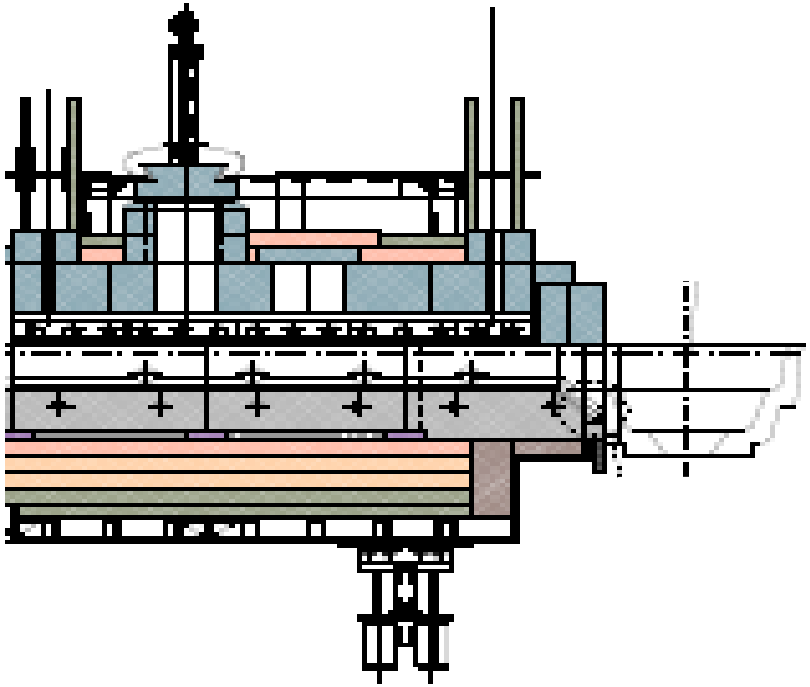
Air can be guided by setting of chimney- and/or radiation opening dampers

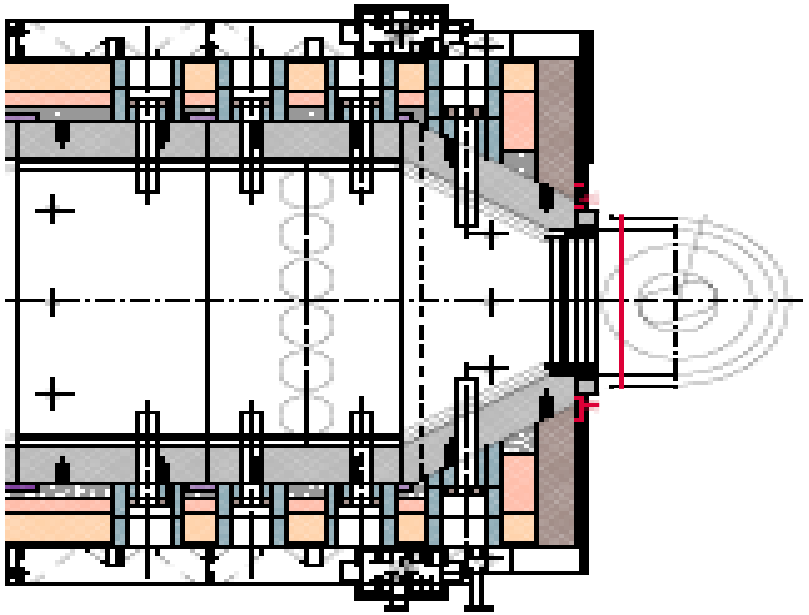
Preferred use during job changes and/or to ensure “positive pressure”

Distributor + Forehearth

5. Glass conditioning (Container Glass Example)

Stirrer



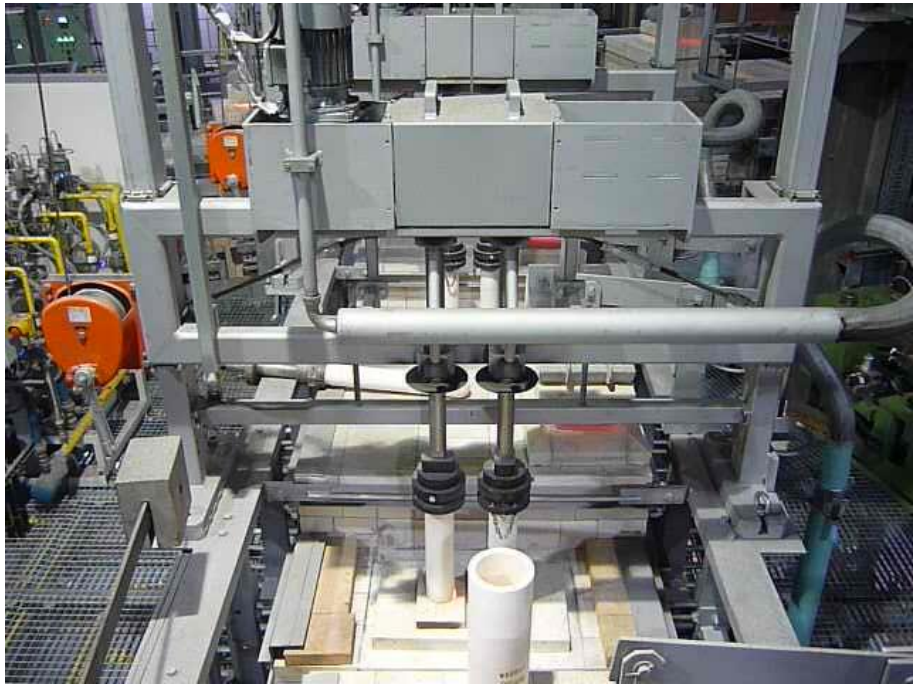


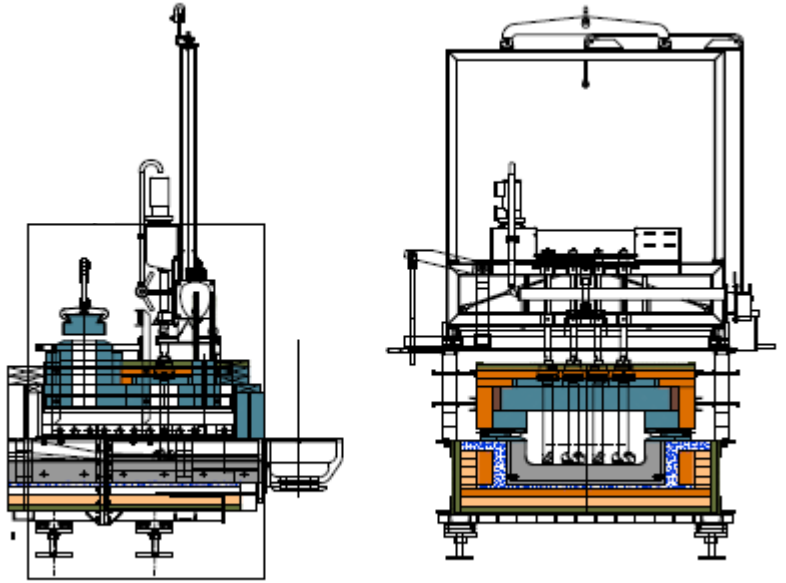
Equalizing zone for application of stirrers and boosting

Distributor + Forehearth

5. Glass conditioning (Table ware example)

Stirrer





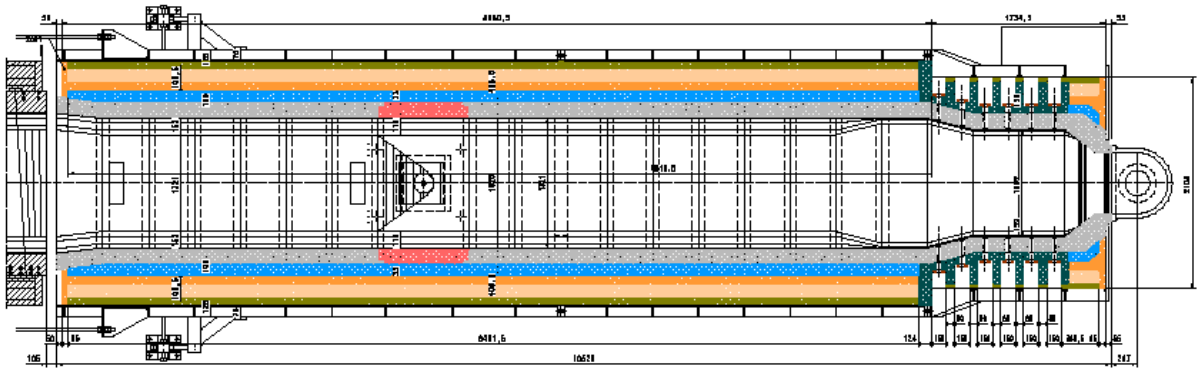
Distributor + Forehearth

5. Glass conditioning

EQZ-Boosting

By means of electrical boosting accurate tuning at the end of forehearth is possible.

It is an efficient tool for heating side and bottom glass layers in order to achieve homogenous glass temperature at exit of EQZ.



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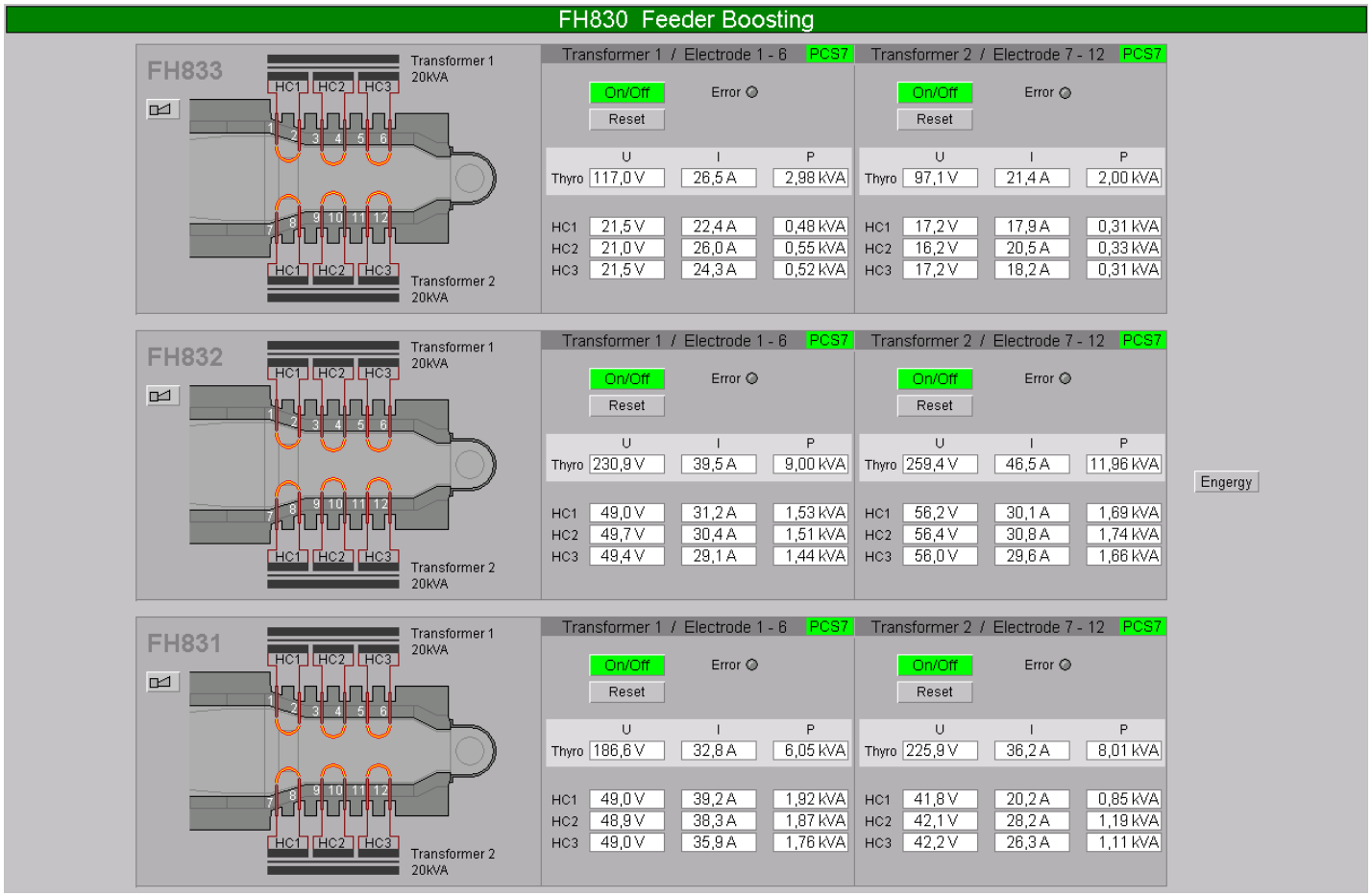
5. Glass conditioning

EQZ-Boosting



Distributor + Forehearth

6. Job changes

How to adjust DIST/FH Operations

6.1 Furnace — Increase / Decrease Energy 3-4 hrs before (or more)

6.2 Timing between Furnace - Machine

→ - Change of orifice ring ?
Who does WHAT and WHEN?

- 30 min before job change, furnace operator
- should focus on forehearth (or who is responsible)

- 15 min before job change, **temp.-controler in MAN-mode**

Focus on forehearth

Distributor + Forehearth

6. Job changes

6.3 Pull increase > 20 tpd

→ - 10 min before, decrease gas manually 2-5 % in each zone, incl. Spout
- Observe the temperatures
- Focus on forehearth
- Gob temperature ?

6.4 Communication between Furnace - Machine

→ - Gob temperature in- or decrease ?
- If orifice-ring has to be changed,
- Plunger/Tube adjusted ?

Distributor + Forehearth

6. Job changes

6.5 Higher gob temperature

→ - Wait until constant pull !!!
- Observe the temperatures

focus on - Forehearth
- Equalizing-Zone temperature
- Spout temperature

- If all temperatures are constant,
set the current temperature as SETPOINT
and take the controller back to AUTO-mode

Distributor + Forehearth

6. Job changes

6.6 Adjusting gob temperature

If gob temperature is too low,
increase the complete profile – from EQZ to the distributor

or

If gob temperature is too high,
decrease the complete profile – from EQZ to the distributor

Distributor + Forehearth

7. Conclusion

- Distributor and forehearths are the utmost important link between furnace and production machine
- Must be highly flexible and capable to deliver the correct amount of glass with correct, well defined proerties and viscosity
- We have several „adjustment screws“ to get good thermal and chemical homogenity
- Dist. and FH adjustment is highly complicated and needs a lot of experience and skill
- HORN FH can meet the increasing customers´demands in flexibility and reliability.

THANK YOU FOR YOUR ATTENTION!

HORN GLASS INDUSTRIES