Refractory behavior in case of glass melting process change – few examples

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German Chamber of Commerce and Industry

Von der IHK öffentlich bestellter Sachverständiger
für die Glasindustrie, feuerfeste Stoffe und Bindemittel

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Introduction

The change in glass melting process:
cannot be really avoided

The change:
can be major and minor

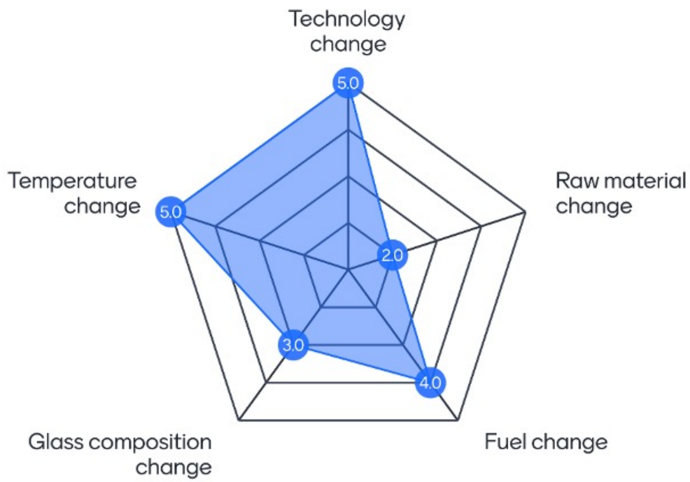
The influence on refractories:
in most of the cases huge

Results from a workshop

Which melting process change is most critical for refractories

Results from a workshop

Which melting process change is most critical for refractories



Change in:	Examples:
Raw materials	Fine cullet
	Batch preheating
	Impurity in raw materials
Glass composition	Boron
Fuel	Solid fuel (pet coke)
	Gas ← → oil
	Biofuel
	Energy distribution on different ports
Temperature	Increasing melter temperaure
	Decreasing melter temperature
Technology	Oxyfuel / Oxyful boosting
	Reducing atmophere
	Hybrid
	Hydrogen firing

Change in:	Examples:	Cases in this presentation:
Raw materials	Fine cullet	
	Batch preheating	
	Impurity in raw materials	X
Glass composition	Boron	
Fuel	Solid fuel (pet coke)	
	Gas ← → oil	
	Biofuel	
	Energy distribution on different ports	X
Temperature	Increasing melter temperaure	
	Decreasing melter temperature	X
Technology	Oxyfuel / Oxyful boosting	
	Reducing atmophere	
	Hybrid	X
	Hydrogen firing	

- One furnace uses oxyful firing
- The process change has caused decreasing the gas amount on few burners
- After a time of period the process changed back

- However the flame not straight any more (downwards directed)
- Consequence: more carryover, more Na-evapouration

- Looking for the reasons
- Problem solved after replacing the burner block
- The firing happend inside of the burner block during the period of low gas amount

- The customer changed few furnace parameters: bubbling amount, burner setting…
- Foam formation become stronger
- Higher melting temperature needed
  → more corrosion on refractories
  → dripping on silica crown started
- Change back of the process parameter: no improvement reached

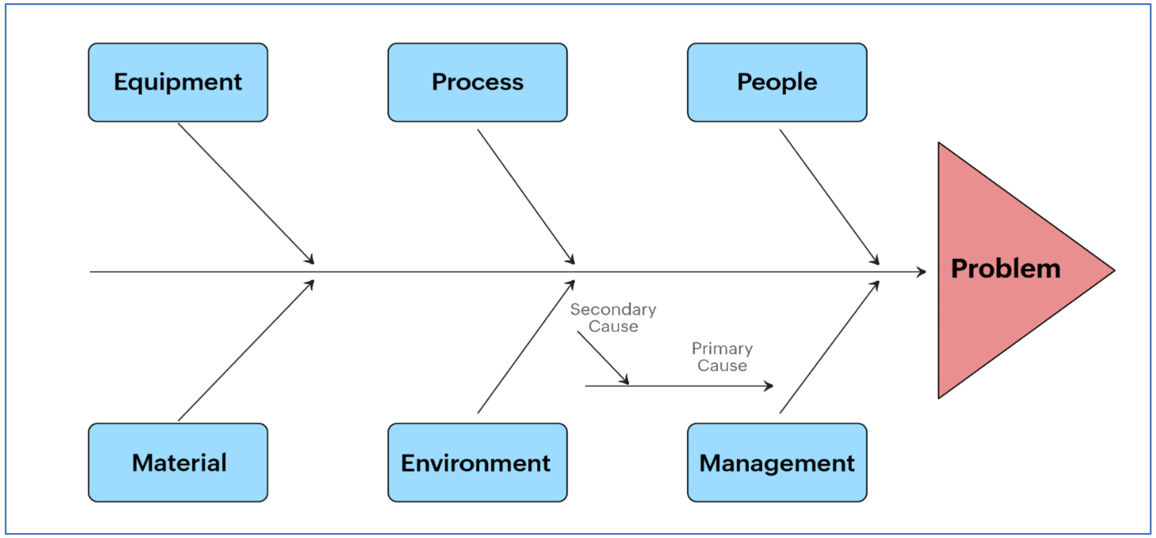
Systematic analysis:

Kepner-Tregoe analysis

		IS	IS NOT
What	Identify:	What thing IS having the problem?	What similar thing IS NOT having the problem?
Where	Location:	Where IS this problem happening?	Where else could this pmblem be happening, but IS NOT?
When	Timing:	When IS the problem first observed?	When else could it be first observed, but IS NOT?
Extent	Magnitude:	How many of tile thing are being affected?	How many ,could be affected, but are not?

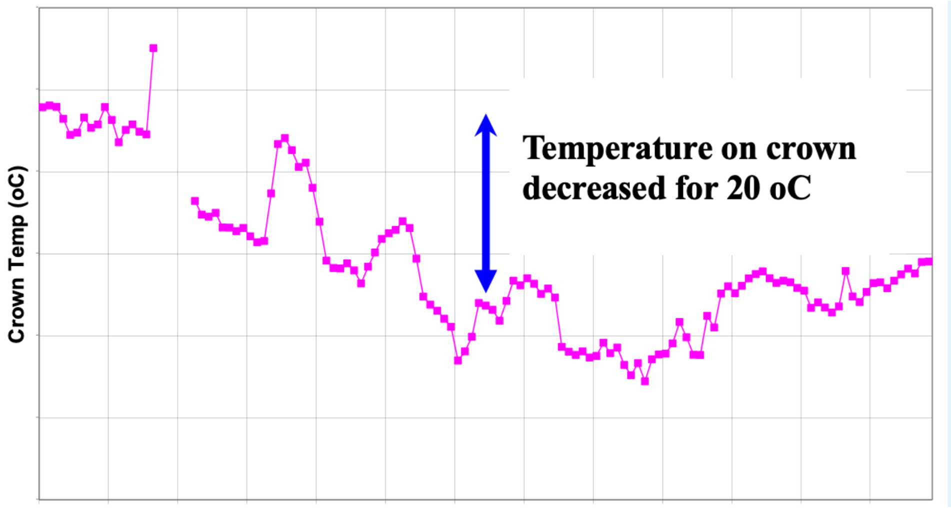
Systematic analysis:

Ishikawa diagram



- According to Ishikawa diagram: impurity in one raw material could be the reason

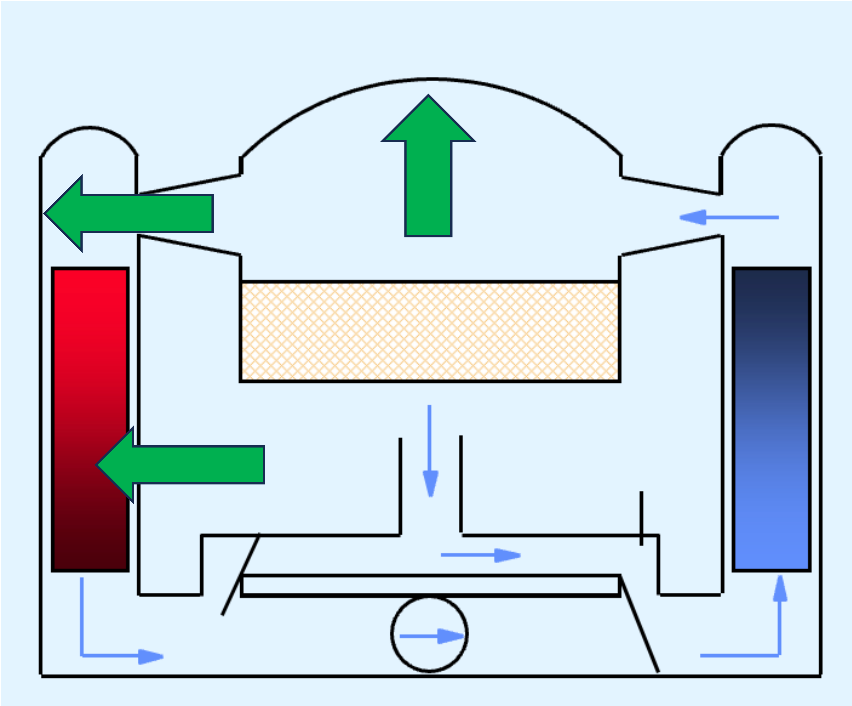
- The melting test in lab confirmed the „problem maker“ is the impurity of one raw material
- Use right raw material
- Foam become thinner



- Melter temperature lower again

For one regenerative furnace, during a time period the melter temperature is lowered

- For melter: temperature went down, more silica corrosion and dripping happened



- For regenerator chamber: the formation of nepheline on mullite wall and crown, peeling happens during coming back to higher temperature

- For regenerator checker: the condensation zone moved to higher position, these bricks are not foreseen resistant to sulfate attack. More corrosion

Concerns for using „hybrid technology“ during discussion with glass makers:

Refractories: how is the behaviour during the 80 ←→ 20% energy change?

crown/superstructure:
silica

Behaviour during 80 ←→ 20% energy change?

tridymite ←→ cristobalite change

cristobalite ←→ tridymite change

crown/superstructure:
fc AZS

Formation of nepheline

Behaviour during 80 ←→ 20% energy change?

Concerns for using „hybrid technology“ during discussion with glass makers:

Refractories: how is the behaviour during the 80 ←→ 20% energy change?

FMEA ANALYSIS

Attention: this table is only for exercise with FMEA, it is not the technical analysis for real cases!

1. Identify		2. Classify					3. Take action	4. Action results			
Item	Failure mode	Effect(s) of potential failure	Severity	Occurrence likelihood	Detection	RPN (Risk priority no.)	Recommended action(s)	Severity	Occurrence	Detection	RPN (Risk priority no.)
Silica crown	Heavy corrosion	Short lifetime	8	5	1	**40**	Slower change?	8	2	1	16
	Dripping	Glass defects	6	2	1	12					
	Expansion/ Shrinkage	Crown movement	6	1	1	6					
AZS crown	Peeling	Glass defects	6	5	1	**30**	Slower change?	6	1	1	6
							Cullet don't come back to furnace				
	Expansion/ Shrinkage	Crown movement	6	8	1	**48**	take care on bolts	6	1	1	6
	Corrosion	Short lifetime	8	1	1	8					

Conclusion

Behaviour of refractories can be influenced by melting process change.

Making analyses before (and during/after) the change can help to minimize the negative effects.

Thank you for your attention

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