Glass Batch CO_2 and Cullet Energy Saving

Process CO_2 released from carbonate raw materials per tonne of glass, and the melting energy and CO_2 saved by a share of cullet.

Method: Carbonate decomposition stoichiometry and cullet energy rule

Input parameters

Unit system: SI

Parameter	Value	Unit
Na_2O in the glass (from soda ash)	13.000	%
CaO in the glass (from limestone)	10.000	%
MgO in the glass (from dolomite or magnesite)	3.0000	%
Cullet share of the batch	30.000	%
Melting energy with no cullet (per kg of glass)	5.5000	MJ/kg
Energy saved per unit cullet share (0.25 means 2.5 % per 10 %)	25.000	%
Fuel CO_2 per GJ of melting energy	56.100	kg/GJ

Calculated results

Parameter	Value	Unit
Process CO_2 per kg of glass	142.48	kg/t
Melting energy with the cullet	5.0875	MJ/kg
Energy saved	7.5000	%
Total CO_2 per kg of glass, process plus fuel	427.89	kg/t
Total CO_2 per kg of glass with no cullet	512.10	kg/t

Notes for this case

• Soda ash, limestone and dolomite release CO_2 as they melt: each kg of Na_2O, CaO or MgO in the glass came with 44/62, 44/56 or 44/40 kg of CO_2. Cullet (recycled glass) has already lost its CO_2 and needs less energy to melt, about 2.5–3 % less per 10 % of cullet. Both savings scale with the cullet share. CO_2 is shown in kg per tonne of glass and energy in MJ/kg (equal to GJ per tonne); fuel CO_2 uses the emission factor of the furnace fuel (56 kg/GJ for natural gas).

Formula and method

$$CO_{2,proc} = (1 - f_c)\left(x_{Na_2O}\frac{44}{62} + x_{CaO}\frac{44}{56} + x_{MgO}\frac{44}{40}\right), \quad E = E_0(1 - k f_c)$$

Variables

x_{Na_2O}	Na_2O in the glass (from soda ash)	-
x_{CaO}	CaO in the glass (from limestone)	-
x_{MgO}	MgO in the glass (from dolomite or magnesite)	-
f_c	Cullet share of the batch	-
E_0	Melting energy with no cullet (per kg of glass)	J/kg
k	Energy saved per unit cullet share (0.25 means 2.5 % per 10 %)	-
e_f	Fuel CO_2 per GJ of melting energy	kg/J
$CO_{2,proc}$	Process CO_2 per kg of glass	kg/kg
E	Melting energy with the cullet	J/kg
ΔE	Energy saved	-
$CO_{2,tot}$	Total CO_2 per kg of glass, process plus fuel	kg/kg

$CO_{2,0}$	Total CO_2 per kg of glass with no cullet	kg/kg

Method and standards

Glass batch CO_2.

Assumptions and limits

- All alkali and alkaline-earth oxides from carbonates; linear cullet effect.

References

Carbonate decomposition stoichiometry and cullet energy rule

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/chemical/ceramics-glass/glass-batch-co2-cullet

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Reopens the calculator with the inputs of this report.