Increasing the Melting Ability of Glass Batch by Batch Modification

International Conference on Applied Physics and Material Applications (ICAPMA2013) 20-22 February 2013

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Abstract

The soda-lime glass with the composition of 74SiO2·18Na2O·6CaO·
B2O3·Al2O3 thermodynamically requires the exploited heat of 557 kW/t of
glass to transform raw materials into glass. The objective of this
project is to modify the soda-lime glass batch by using wollastonite
instead of limestone and pyrophyllite instead of aluminum hydroxide.
The exploited heat of the batch with wollastonite is reduced to 546
kW/t of glass while the batch with wollastonite and pyrophyllite is
decreased to 550 kW/t of glass. According to Batch-Free Time testing,
it is found that the melting ability of both modified batches is higher than
of the original batch, while the properties of glass are slightly changed.
This implies that the modified batch requires a lower melting energy than
the original batch.

Introduction

Glass melting requires a high energy to transform batch to glass. There
are many researches that study on the reduction of the glass
melting energy. Our previous studies of batch modification found that
using wollastonite (CaSiO3) instead of limestone (CaCO3) and using
feldspar (KAlSiO4) and pyrophyllite (Al4SiO9(OH)2) instead of alumina in a
glass batch showed the possibility of lowering the melting energy. In this
project, the batch modification of soda-lime glass is studied by using
wollastonite instead of limestone and pyrophyllite instead of aluminum
hydroxide in the same batch.

Objective

The batch modification of soda-lime glass is studied by using
wollastonite instead of limestone and pyrophyllite instead of aluminum
hydroxide.

Procedure

Batch Modification

| Batch-Free Time | Melted collet with 0.1%CO2 at 1400 °C, 1 hr |
| Batch 100 g | hold at 30, 50, 70 min |
| Annealed at 550 °C | Melt at 1500 °C, 2 hr |
| Annealed at 550 °C | XRD |
| Viscosity | COE |
| Color measurement | XRD |

Acknowledgements

This study is a part of the study of batch-to-melt conversion analysis method
for improving energy efficiency funding and supporting by Department of Science
Service.

Result

Fig. 1a and 1b show the images of the batch containing some particles on the
surface a) before and b) after image analyzing using imageJ program. Fig. 2 exhibits the
percentage of unmelted area on the glass surface relative to the dwelling time. It shows
that batch B and C are dissolved easier than batch A at 50 min, which most of raw
materials are melted. According to the XRD result in Fig. 3 it is found that the
remaining particles are silica. Table 1 shows the chemical composition of the resulting glasses. The result shows that Glass B and C has slightly different compositions from Glass A.

| Table 1. Chemical composition of glasses. | Composition [weight %] |
| Na2O | MgO | Al2O3 | B2O3 | SiO2 | K2O | CaO | TiO2 | Fe2O3 | SO3 |
| Glass A | 18.59 | - | 0.86 | 0.75 | 74.05 | 0.05 | 5.65 | - | 0.03 | 0.02 |
| Glass B | 17.98 | 0.25 | 0.84 | 0.83 | 74.23 | 0.05 | 5.75 | 0.01 | 0.04 | 0.02 |
| Glass C | 18.90 | 0.22 | 0.70 | 0.78 | 74.39 | 0.05 | 4.90 | 0.02 | 0.04 | 0.02 |

Fig. 4 presents the results of viscosity and thermal expansion. It shows that the
viscosity and thermal expansion of Glass A, B, C are quite similar. However, the viscosity
curves are slightly different, i.e. most of characteristic point of Glass B and C are lower
than A.

| Table 2. Calculated glasses color in CIE L* a* b* system |
| Glass | L* | a* | b* |
| A | 94.17 | -0.43 | 0.45 |
| B | 92.98 | -0.43 | 0.58 |
| C | 93.14 | -0.46 | 0.77 |

Conclusions

The batch modification of soda-lime glass by using wollastonite instead of limestone and
pyrophyllite instead of aluminum hydroxide shows a potential to reduce the melting energy. The
glass produced from the modified batch contains similar chemical and thermal properties to the
original batch. Unfortunately, the modified batches produce the glass with a little greenish
comparing to the original due to higher concentration of iron oxide. However, it is still in the range
that can be controlled by decolorizing or reducing agent.