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# EFFECT OF ACTIVATING SOLUTION ON THE SYNTHESIS AND PROPERTIES OF POROUS Fe-Si-Ca-RICH INORGANIC POLYMERS

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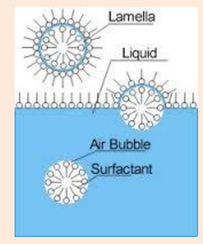
## Abstract

This paper investigates the effect of the activating solution molar ratio and water content on the foaming process and final foam properties, such as porosity, pore structure and mechanical strength, of inorganic polymers (IP). A synthetic Fe-Si-Ca based slag, resembling the chemical composition of slags from non-ferrous metals' production, was used. The slag was produced synthetically and was water granulated, resulting in a highly amorphous structure (> 93 wt.%), and thus, a promising precursor for IP. In order to synthesize an inorganic polymer, the slag was activated with sodium silicate activating solutions, having the $SiO_2/Na_2O$ molar ratio varying between 1.4 and 2.0, and the water content being 65 or 75 wt.%. Foaming was achieved by the oxidation of aluminium metal in the alkaline environment, liberating $H_2$ gas, and the subsequent gas entrapment. The temperature of the environment during foaming was kept at 20 °C and it was controlled by having all the installation inside a water tank with controlled temperature. The process was analysed by image analysis, enabling the description of foaming kinetics, as well as by rheology and calorimetry tests. The porosity and pore structure of end-microstructure was studied by means of electron microscopy, computed X-ray tomography and water absorption tests. The data reveal the interrelation between process and end-properties and describe how the process can be controlled towards the desirable microstructure.

## Synthesis of porous IP



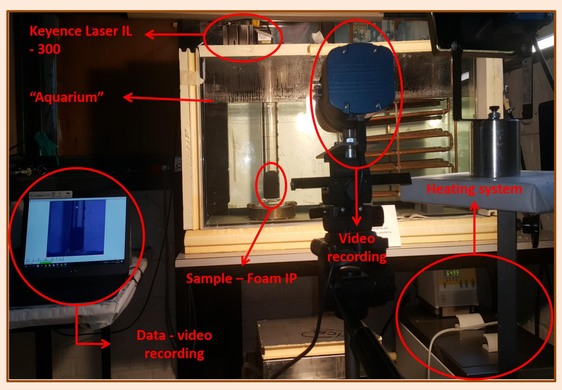

| FeO [wt%] | $SiO_2$ [wt%] | CaO [wt%] | $Al_2O_3$ [wt%] | MgO [wt%] | Others [wt%] |
|---|---|---|---|---|---|
| 41 | 36 | 13 | 6 | 2 | 2 |

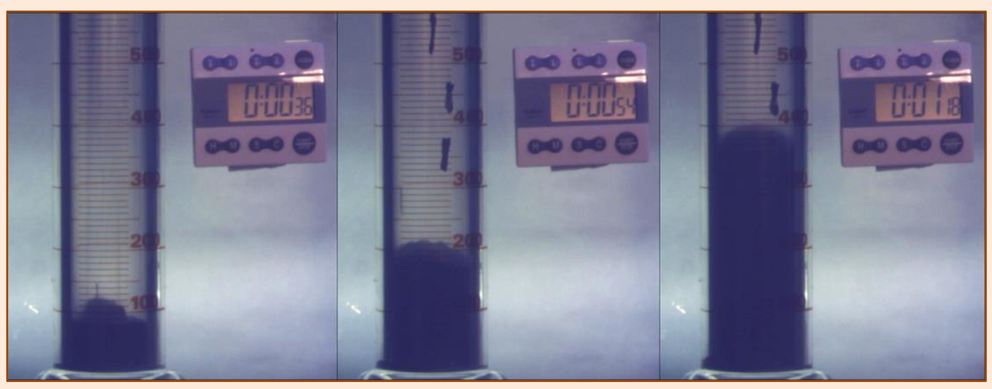
| $SiO_2/Na_2O$ [molar ratio] | $H_2O$ [wt%] |
|---|---|
| 1.4 – 2.0 | 65 - 75 |

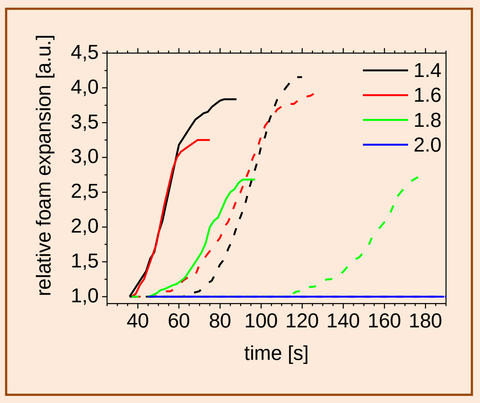
| Al [wt%] |
|---|
| 0.3 |

| Surfactant [ml/100g] |
|---|
| 0.02 |

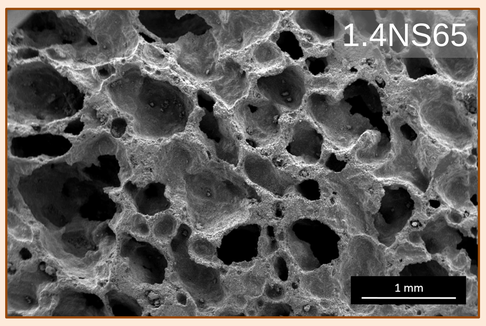
## Experimental setup

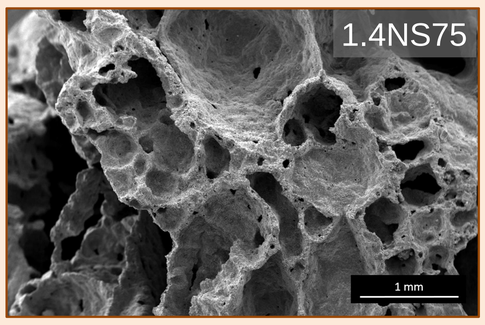





## Foam structure




| | Compressive strength [MPa] | Density [g/cm³] | Porosity [%] |
|---|---|---|---|
| 1.4NS65 | 1.98 ± 0.4 | 0.81 ± 0.01 | 65 |
| 1.6NS65 | 1.29 ± 0.2 | 0.65 ± 0.02 | 75 |
| 1.8NS65 | 0.91 ± 0.5 | 0.58 ± 0.04 | 77 |
| 1.4NS75 | 0.33 ± 0.14 | 0.59 ± 0.01 | 82 |
| 1.6NS75 | 0.29 ± 0.05 | 0.50 ± 0.01 | 84 |
| 1.8NS75 | 0.15 ± 0.04 | 0.47 ± 0.01 | 83 |

## Conclusions

The obtained results indicated that the higher water content in the solutions resulted in delayed foam initiation, but higher volumetric expansion. The increased $SiO_2/Na_2O$ ratio for the same $H_2O$ level, showed a negative effect on the foam expansion. However, due to the improved foam stability, the lightest foam was synthesised from activating solution with high $SiO_2/Na_2O$ ratio (1.8) and high water content (75 wt.%).

## Acknowledgement

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