Chapter VI

Summary

The objective of the present thesis was to study the relation between the composition and chemical durability of man made mineral fibres. The other purpose was to compare the corrosion rate of simple sample geometry (chip glass) with results previously obtained from fibres. Finally, the effect of CO_2, phosphate, binder, and a buffer solution at pH 5 was also studied. On the theoretical side, this required data preparation in terms of speciation of the glassy phase, speciation of the aqueous species and formulation of the reaction equations for the use in a predictive model. On the experimental side, tests were designed for chip and fibre samples with Gamble's solution, Gamble's solution saturated with N_2, phosphate free solution, buffer solution at pH 5 and Gamble's solution test with sample coated binder, with surface area / leachant volume s = 0.1 cm^{-1}. Experimentation required much preparation, such as :

- fabrication of crucibles
- melting of glasses
- cutting and etching of samples
- calibration and control of the heating chamber (better than 37 ± 1°C long term)
- establishing a system for pH and CO_2 partial pressure control.

During the experiments, pH and temperature were re-checked every 2 days.

The results show a relation between the dissolution Gibbs free energy and the corrosion rate. The experimental results were used to modify the predictive model. By this, some deeper understanding on the details of the corrosion process were gained. The condition $s = 0.1\ cm^{-1}$ indeed fulfilled the assumption of infinite dilution in most case. In these cases, the corrosion rates and the Gibbs free energies were related by the slope 1 / RT. For very high G values, the solution could not be considered as infinitely diluted. In this case (e.g., slag in Gamble's solution), the actual G value was estimated by assuming the formation of precipitates (C-S-H and C-A-H phases). A similar scenario was valid for the corrosion of samples covered with a binder : there, a local increase of pH and local precipitation were assumed. Finally, in the moderately acid range, a clear correlation between corrosion rate and G only occured when depletion of boron and alkali was assumed.

All glasses were slightly more stable in CO_2 (5%) saturated Gamble's solution than in N_2 saturated one. At pH 5, the basic basalt and slag glass assumed very high corrosion rates, whereas the borosilicate fibre JM became very durable. The latter finding is explained by the depletion of alkali and boron converting the surface into a high silica alumina glass. Finally, binder boosts the corrosion of glass free of MgO while it retards the corrosion of glass containing MgO. Examples of this behavior have been found with fibre experiments before.

An essential outcome of the study is seen in the fact, that the same durability sequence is found as previously measured in flow experiments with fibres. The latter data are systematically lower by a

factor of 4, indicating that such experiments (even under flow condition) model the case of infinite dilution less well than a static chip test with $s = 0.1\ cm^{-1}$. So the stay times of the fibres were usually overestimated.