

Course syllabus

Department of Civil Engineering, Indian Institute of Technology Madras

CE6040- Cement Chemistry

Credit Distribution: C:9 L:3 T:0 P:0 E:0 O:6 TH:0

Course Type: Theory

Description: Objective: To provide detailed understanding of the chemistry and microstructure of cements
Learning Outcome: To enable students to perform independent research on topics related to cement chemistry.

Course Content:

1. Overview of cement manufacture, and structure of Portland cement phases Introduction to phase equilibria, kinetics, and crystal structure Properties of calcium silicates and calcium aluminates Clinker phase equilibria Manufacture of Portland cement.

2. Chemical reactions in Portland cement system Hydration of calcium silicates and structure of hydrates Thermodynamics and kinetics of calcium silicate hydration, Hydration of aluminates, ferrite, and sulfate phases Hydration of Portland cement and blended cements Influence of mineral and chemical admixtures (including grinding aids) on Portland cement hydration.

3. Properties of hydrated Portland cement Fresh paste structure and properties Colloidal behavior and rheology Hardened paste. Sulfoaluminate-belite cement Calcium aluminate cement Magnesium-based cement Alkali-activated binder.

5. Chemistry of concrete deterioration Concrete structure and properties Permeability and diffusivity.

4. Chemistry of special cements Calcium microstructure Alkali-silica reaction Sulfate attack.

Text Books: Cement Chemistry, H.F.W. Taylor, 2nd Edition, Thomas Telford, 1997.

Reference Books:

1. Introduction to Colloid & Surface Chemistry, Duncan J. Shaw, 4th Edition, Butterworth, 1992.

2. Lea's Chemistry of Cement and Concrete, Peter C. Hewlett, 4th Edition, Elsevier Science & Technology Books, 2004.

3. Special Inorganic Cements, Ivan Odler, E&FN Spon (Taylor & Francis Group), 2000.

4. Alkali activated materials: state-of-the-art report, RILEM TC 224-AAM (Vol. 13), J. L. Provis and J.S. Van Deventer, Eds., Springer Science & Business Media, 2013.

5. Lothenbach, B. and Winnefeld, F., 2006. Thermodynamic modelling of the hydration of Portland cement. Cement and Concrete Research, 36(2), pp.209-226.

6. Gartner, E.M. and Macphee, D.E., 2011. A physico-chemical basis for novel cementitious binders. Cement and Concrete Research, 41(7), pp.736-749.

7. Gartner, E.M. and Jennings, H.M., 1987. Thermodynamics of calcium silicate hydrates and their solutions. Journal of the American Ceramic Society, 70(10), pp.743-749.

8. Bullard, J.W., Jennings, H.M., Livingston, R.A., Nonat, A., Scherer, G.W., Schweitzer, J.S., Scrivener, K.L. and Thomas, J.J., 2011. Mechanisms of cement hydration. *Cement and Concrete Research*, 41(12), pp.1208-1223.

9. Lothenbach, B., Scrivener, K. and Hooton, R.D., 2011. Supplementary cementitious materials. *Cement and Concrete Research*, 41(12), pp.1244-1256.

Prerequisites: Nil