Corrosion Inhibition of Concrete Rebars by Sodium Molybdate

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Reinforced concrete is the most widely used construction material in the world. The carbon steel rebars that increase the tensile strength of concrete are initially protected from corrosion by the highly alkaline pore solution environment. However, chloride ingress and carbonation by atmospheric carbon dioxide results in increased susceptibility to both localised and general corrosion. Application of corrosion inhibitors represents the simplest and least expensive method for rehabilitation of existing buildings and corrosion prevention of new buildings. In this work, sodium molybdate has been tested as a corrosion inhibitor for protection against general corrosion and localised corrosion. Electrochemical results show that molybdate can prevent passivity breakdown under open-circuit conditions in both carbonated and non-carbonated simulated concrete pore solutions contaminated with chloride at levels much lower than traditional nitrite inhibitors. As long as calcium ions are present, a calcium molybdate film is precipitated on the steel surface that results in a reduction of the effective surface area available for oxygen reduction, thus reducing the general corrosion rate by up to 60%. Potentiodynamic polarisation experiments show that molybdate both increases the pitting potential and retards pit propagation rates. Repeat polarisation experiments in chloride-contaminated pH 12.5 pore solutions show that the pitting potential in the second scan is higher than that in the first scan and can even exceed the oxygen evolution potential when the molybdate concentration exceeds a critical limit. Both EDX and EIS support a pore-plugging mechanism where the incorporation of molybdate into the rust cover after the initial pitting damage reduces the permeability of the pit cover and allows the pit to be repassivated more easily.