

## OPTIMIZED HYDROGEL FOR APPLICATION AS REPAIRING AGENTS IN CEMENT BASED PRODUCTS

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### ABSTRACT

Cracking is an intrinsic property of reinforced concrete which, however, provides a dangerous pathway through which water, ions or gases can reach and damage the steel reinforcement in cementitious based products. If possible to block these cracks in anyway, the problem would be solved. So, the main goal of the work here presented is to develop a concrete containing intelligent systems based on hydrogels which block microcracks when water enters through them.

Hydrogels are swelling materials able to absorb and retain big amounts of water without dissolving their structure, a property which could be profitable to seal cracks without using any catalyst. [1] The self-healing mechanism provided by hydrogels, which is totally innovative, is mainly associated to their ability to increase volume and can be activated by physico-chemical stimuli such as humidity, pH or salt concentrations. In addition, hydrogels present the advantage with respect to other self-healing systems of being non-expensive, non-toxic and easy to chemically modify.

The extraordinary swelling capacity of hydrogels is highly dependent on the alkalinity and ionic content of solutions, a fact which has been widely used for sensing purposes mainly related with biomedical applications. As a consequence, up to date most of developed hydrogels display swelling abilities sensitive to typical human body parameters, such as acidic pH of stomach. On the contrary, little examples are reported in literature related with hydrogels able to significantly swell in alkaline media, which is the typical pH of cementitious mixtures.

Here we present preliminary studies on an acrylic hydrogel specifically formulated to display improved swelling properties at alkaline pH for application into cementitious materials. In particular, tests have been performed to determine the swelling ratios of the hydrogel in the pH range 9-13 and also using synthetic pore solutions simulating real pore composition in concrete samples ( $[\text{NaOH}] = 0.01 \text{ mol/L} + [\text{Ca}(\text{OH})_2] = 0.002 \text{ mol/L}$ ). At the pH of cement mortars (pH 13), the hydrogel structures used to be in a collapse state which slowly turns into the swell one when pH decreases due to the ingress of water and dissolution of  $\text{CO}_2$ , filling the empty volume left by microcracks. Figure 1 depicts the swelling degree at pHs 13 and 9 for the developed hydrogel measured in solutions simulating real pore composition. The volume increase from pH 14 to pH 9 of 670 a.u. is expected to have a sealing effect in concrete microcracks avoiding ingress of water that promote corrosion processes of steel reinforcements.

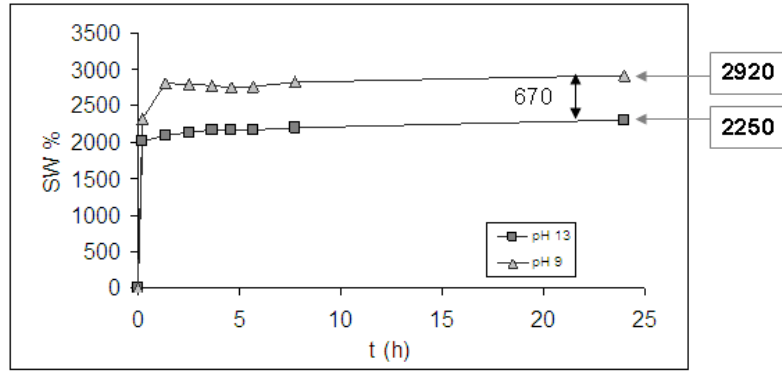


Figure 1: Swelling kinetics for developed hydrogel at pH 13 and 9 buffered solutions (A) and pH 13 and 9 solutions with ionic strength simulating the concrete pore.

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#### REFERENCES

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