Calcium peroxide modified Fenton oxidation as treatment technology for pesticide contaminated groundwater

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Introduction and scope of study

Fenton oxidation is the process between H_2O_2 and Fe(II)/Fe(III) to produce reactive hydroxyl radicals (1). However, for in-situ chemical oxidation, the H_2O_2 utilization efficiency is low due to instability in the subsurface.

This project concerns the possibility to use solid CaO_2 as reactant for production of H_2O_2 and its use in a modified Fenton process (2).

$$H_2O_2(l) + Fe(II) \rightarrow Fe(III) + OH^{\bullet} + OH^{-} \quad (1)$$

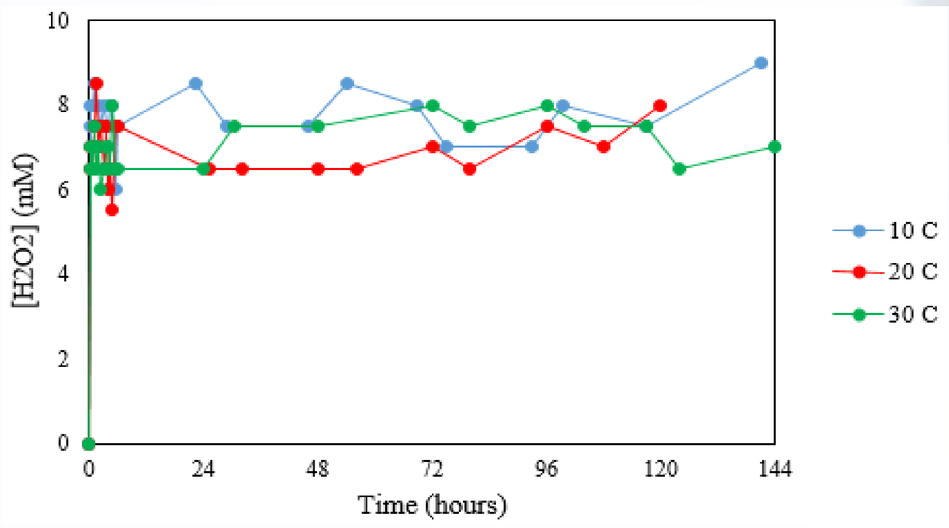
$$CaO_2(s) + 2H_2O \rightarrow H_2O_2 + Ca(OH)_2 \quad (2)$$

Objectives

- Evaluate the yield of H_2O_2 from CaO_2 and the time required for dissolution at different temperatures and pH-values.
- Use 4-Nitroso-N,N-dimethylaniline (RNO) as hydroxyl radical probe compound in order to confirm the progress of the Fenton oxidation process (batch studies)
- Use pesticides (MCPA and MCPP) to demonstrate the potential of the technology (batch studies)

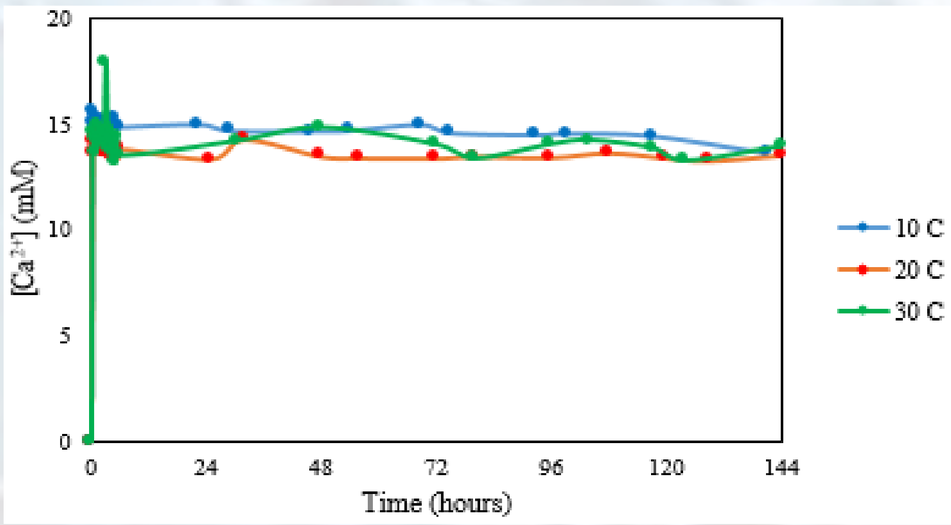
Preliminary results

Fig 1: Yield of H_2O_2 from CaO_2 at pH 3 at 10, 20 and 30 °C



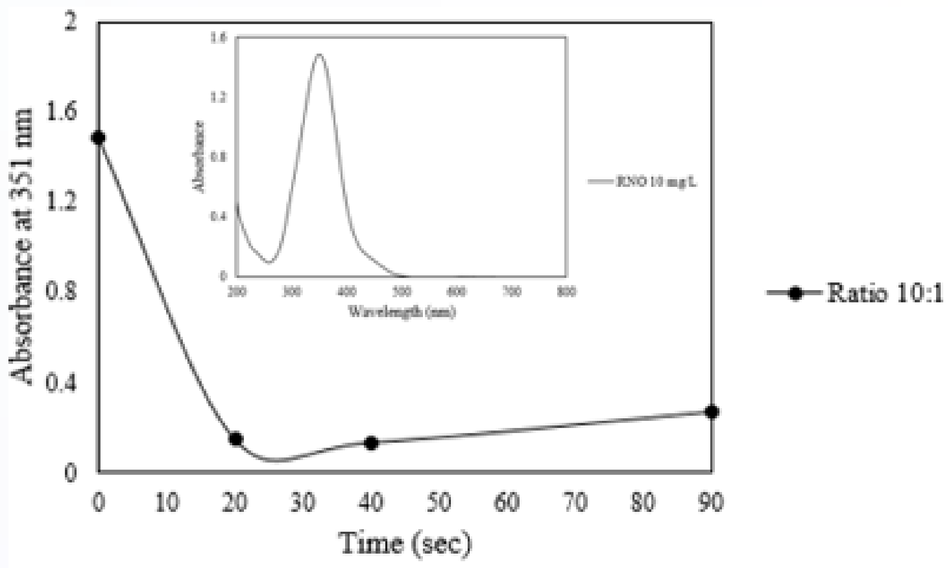
A drastically increase in H_2O_2 concentration was obtained after 15 min of experiments.

Fig 2: Concentrations of Ca^{2+} at pH 3 at 10, 20 and 30 °C



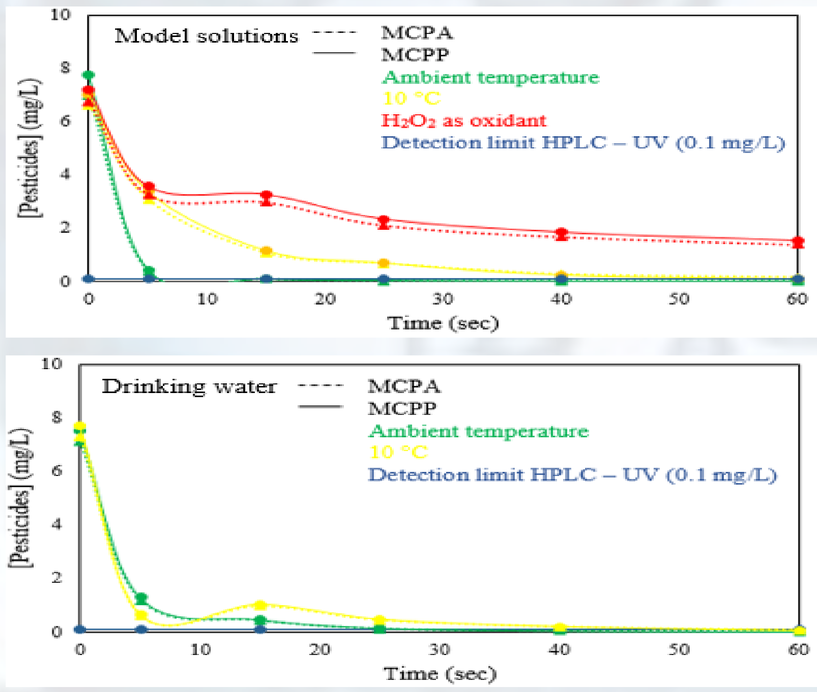
At pH 3, $Ca(OH)_2$ in (2) dissolved to Ca^{2+} and OH^{-}. For pH 6 and 8 significantly lower concentrations of Ca^{2+} were obtained

Fig 3: Bleaching performance of RNO in a 10:1 molar ratio of CaO_2: $FeSO_4$



The absorbance at 351 nm increases with time indicating intermediates in the reaction mechanism. RNO was bleached after 90 seconds of experiment.

Fig 4: Degradation of pesticides at ambient temperature and 10 °C with both CaO_2 (s) and H_2O_2 (l) as oxidants



The degradation efficiency was greatest using CaO_2 as oxidant. When using H_2O_2, the detection limit was never reached.

Future work

- Develop the technology into a column based polishing technology targeting the pesticides

Conclusion

Based on preliminary batch studies, solid CaO_2 is considered useful as oxidant in modified Fenton oxidation process.