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Performance of hydrous iron oxide for dissolved organic phosphorus adsorption from wastewater at various pH

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One of the main objectives of wastewater engineering is achieving lower P concentration to prevent eutrophication. Most of P removal technologies aim to remove P as orthophosphate (POP) by transforming this form of soluble P into particulate forms followed by solid separation processes. However, to reach more stringent P limits, other forms of P must also be removed, such as dissolved organic phosphorus (DOP) which becomes more relevant in secondary and tertiary effluents [1]. Amorphous ferric hydroxides have a demonstrated good ability to uptake POP, but their removal performance for DOP is not reported. This work is part of the development of a new model to predict the kinetic and stoichiometric processes of hydrous iron oxide or ferrihydrite (HFO) precipitation with combined adsorption and co-precipitation of POP and DOP. This model will be combined with chemical equilibriums and physical precipitation reactions in order to complement the model developed by Hauduc et al. [2] to describe chemical P removal using ferric chloride.

The effectiveness of synthesized HFO for the removal of DOP (as phytic acid) as a pH function (4.0, 5.25 and 6.5) was evaluated. Adsorption represents one important removal pathway of DOP using ferric chloride at the evaluated pHs: e.g, at pH=6.5, at least 44% of total DOP removal (83%) was removed by adsorption with the experimental conditions used in jar tests (molar ratio Fe/DOP=1; rapid mix, flocculation and sedimentation times of 5, 15 and 30 min with velocity gradient of 400, 30 and 0 s^{-1} respectively).

Table 1 summarizes maximum adsorption capacities (Q_e). The results showed that maximum DOP adsorption was at pH 4.0. FTIR and SEM-EDS analysis were performed to reveal the bonding nature between DOP and HFO and to elucidate the underlying adsorption mechanisms. Apparently, DOP (as phytate) is adsorbed through binuclear and double bidentate bridging.

Table 1. Q_e of DOP for synthesized HFO. Experimental conditions: synthetic wastewater, adsorbent dosage ($g \cdot L^{-1}$); initial DOP concentration ($mg \cdot L^{-1}$).

Adsorbent (pH)	Q_e	Experimental conditions (30 °C)	Adsorption kinetics
HFO (4.0 ± 0.1)	1.88 ± 0.12 $mg\text{-}DOP \cdot g^{-1}$	2.5; 10; 30	Pseudo-first-order with fast (r^2 = 0.999) and low (r^2 = 0.999) stages
HFO (5.25 ± 0.1)	1.24 ± 0.03 $mg\text{-}DOP \cdot g^{-1}$		Pseudo-second-order (r^2=0.999)
HFO (6.5 ± 0.1)	1.40 ± 0.05 $mg\text{-}DOP \cdot g^{-1}$		Pseudo-second-order (r^2=0.993)

References

1. Gu, A.Z., Liu, L., Neethling, J.B., Stensel, H.D., Murthy, S. (2011). Treatability and fate of various phosphorus fractions in different wastewater treatment processes. *Water Science & Technology*, 63(4), 804-810.
2. Hauduc, H., Takács, I., Smith, S., Szabó, A., Murthy, S., Daigger, G. T., Sperandio, M. (2015). A dynamic physicochemical model for chemical phosphorus removal. *Water Research*, 73, 157-170.