Università degli Studi di Napoli

“ Federico II ”

Department of Hydraulic, Geotechnical and Environmental Engineering

Stevens Institute of Technology

Center for Environmental Systems


Master thesis in Environmental Engineering

ABSTRACT

# *Removal of organic contaminants using zero valent iron: treatment of wastewaters from Insensitive Munitions Explosives (IMX) manufacture*


Supervisors :

Prof. Massimiliano Fabbricino

Prof. Xiaoguang Meng

Author :

Amalia Terracciano

Matr. M 67/59



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# ABSTRACT

The aim of the present work was to study the applicability of Zero-Valent Iron (Fe0) to treat wastewater produced by Insesitive Munition Explosives (IMX) manufacture. The study included batch tests, column tests and field tests aimed at investigating the potentiality of the treatment for NTO, NQ, DNAN and RDX removal, mainly focalized on process optimization in terms of operative conditions. The last part of the study was dedicated, instead, to the evaluation of best options for iron removal from treated wastewater.

Results of batch tests are summarized in Figures 3.1-3.4.

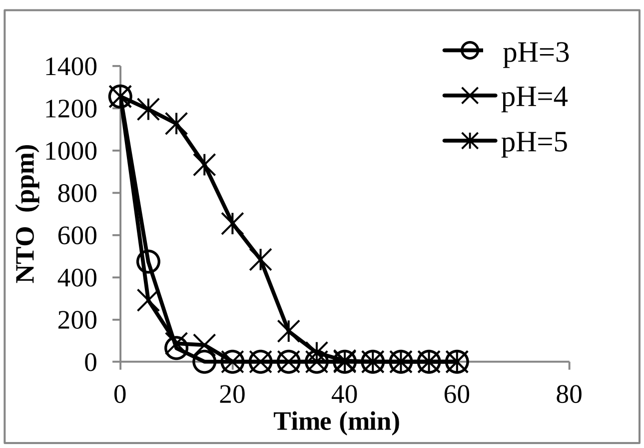


***Fig 3.1*** *NTO concentration vs time for Batch 1,2,3*

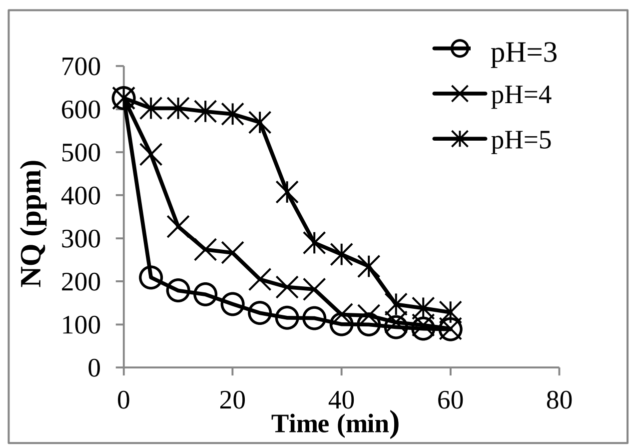


***Fig 3.2*** *NQ concentration vs time for Batch 1,2,3*

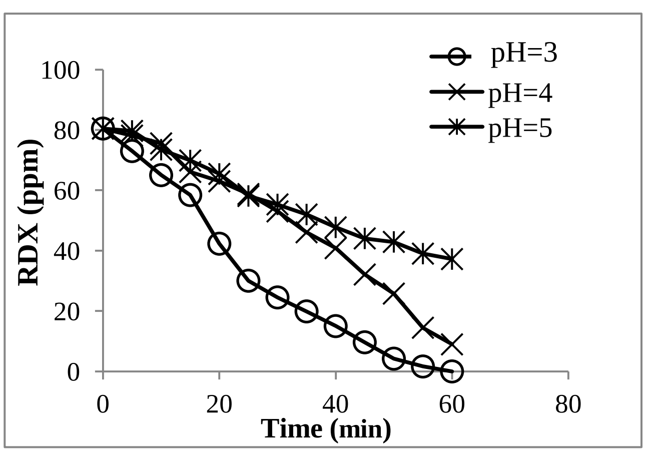


***Fig 3.3*** *RDX concentration vs time for Batch 1,2,3*

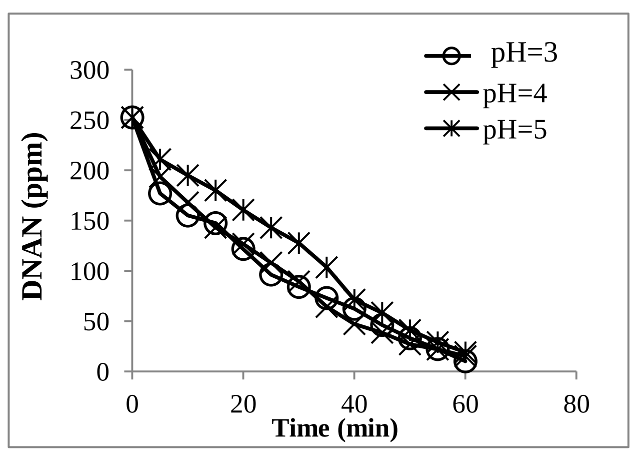


***Fig 3.4*** *DNAN concentration vs time for Batch 1,2,3*

As showed, DNAN, RDX and NTO were easily removed at pH 3 even if the reaction rate was different for the three compounds: the degradation of NTO was clearly more rapid than the degradation of RDX and DNAN, whose removal was not reached within one hour. On the contrary NQ was only partially removed: the reaction rate was more rapid for pH 3 than pH 4 and 5, but in all cases the percentage of degradation was below 60%.

Column tests confirmed some of the previous results, and allowed to individuate the principal operative parameters to be used for full scale applications.

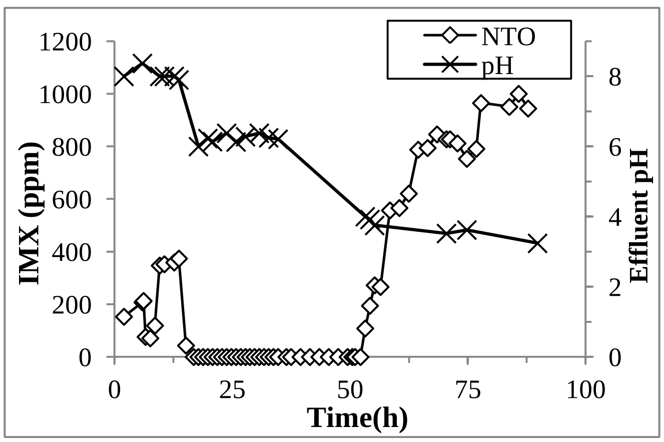


***Fig 3.5*** *Column 1, NTO and effluent pH vs time*

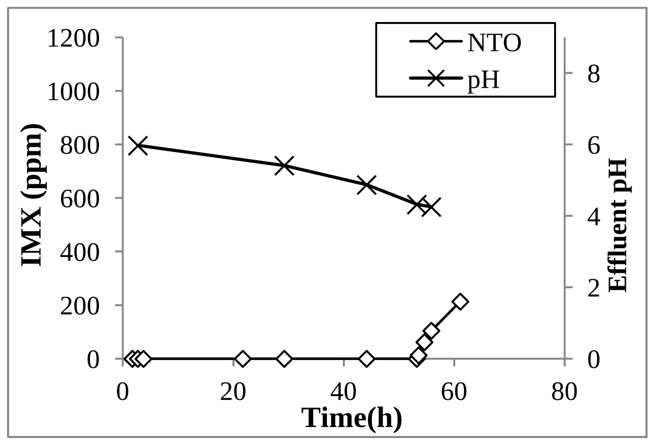


***Fig 3.6*** *Column 2, NTO and effluent pH vs time*

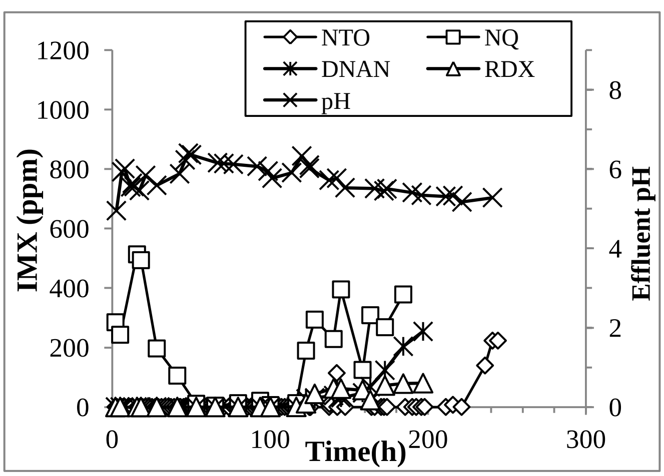


***Fig 3.7*** *Column 3, IMX and pH effluent vs time*

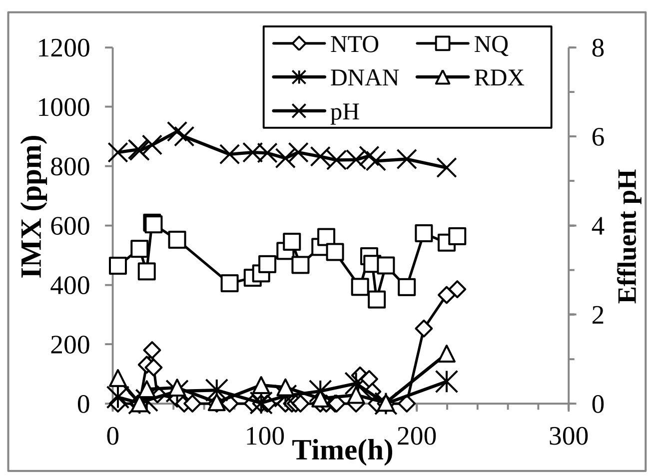


***Fig 3.9*** *Column 4, IMX and pH effluent vs time*

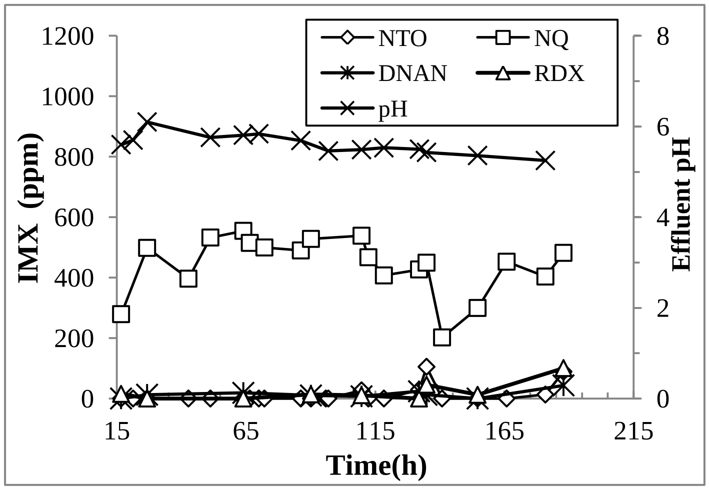


***Fig 3.10*** *Column 5, IMX and pH effluent vs time*

As it can be deduced from Figures 3.5-3.10 the ZVI showed a good efficiency in terms of NTO, DNAN and RDX removal, with an EBCT of 1 hour. NQ removal was once more limited.

Field test was characterized by varying values of EBCT and influent pH value (Figures 3.13 and 3.14).

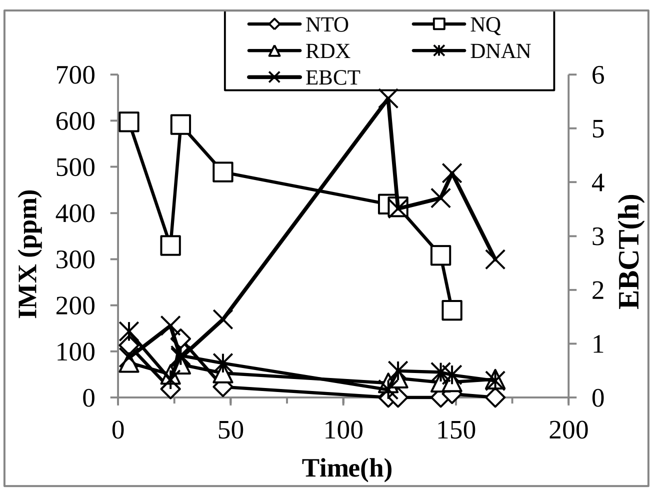


***Fig 3.13*** *Field Column, IMX and EBCT vs time*

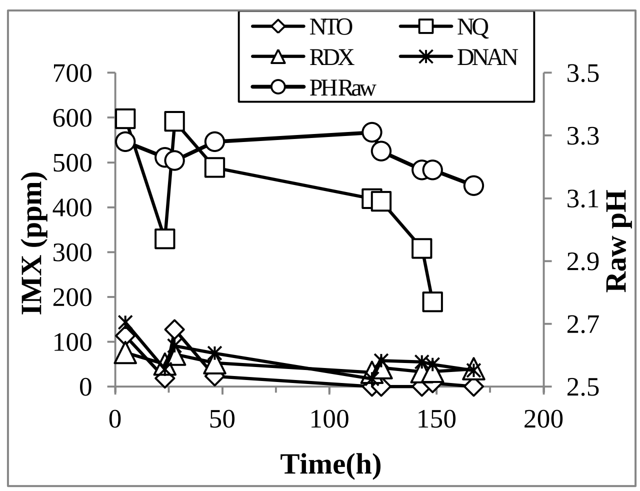


***Fig 3.14*** *Field Column, IMX and Raw pH vs time*

Obtained results were used to repeat lab test to optimize process performances (Figures 3.16-3.23).

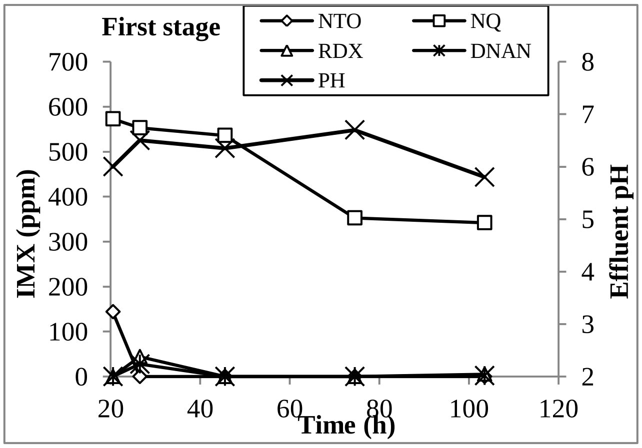


***Fig 3.16*** *First stage column, IMX and effluent pH vs time*

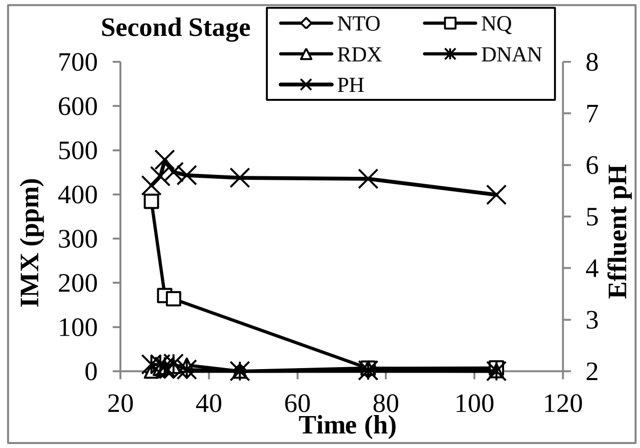


***Fig 3.17*** *Second stage column, IMX and effluent pH vs time*

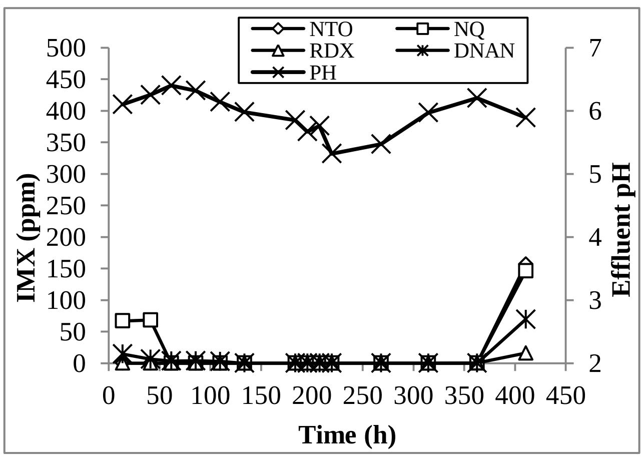


***Fig 3.18*** *Column 1(i) , IMX and effluent pH vs time*

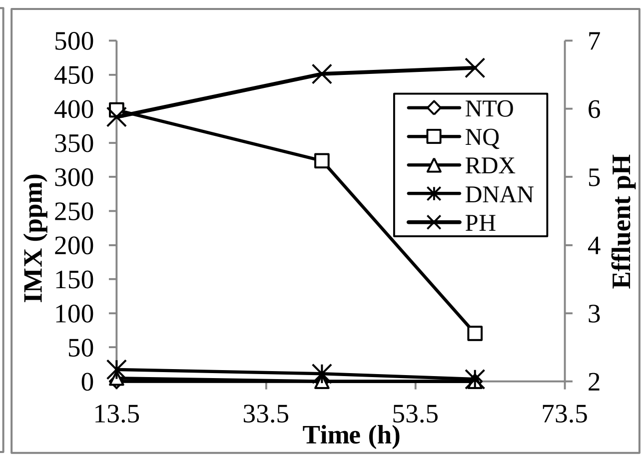


***Fig 3.19*** *Column 2(i) , IMX and effluent pH vs time*

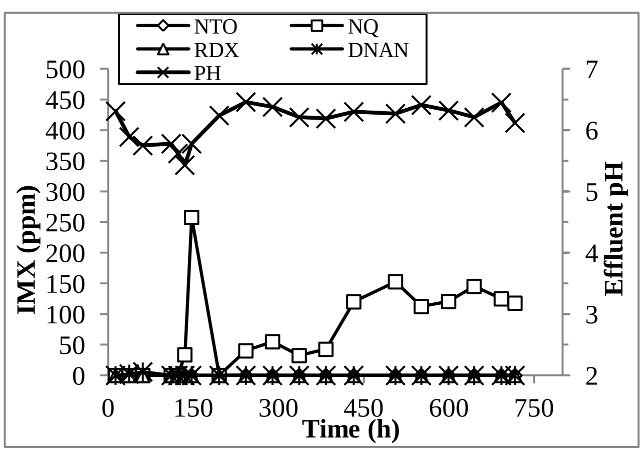


***Fig 3.20*** *Column 3(i) , IMX and effluent pH vs time*

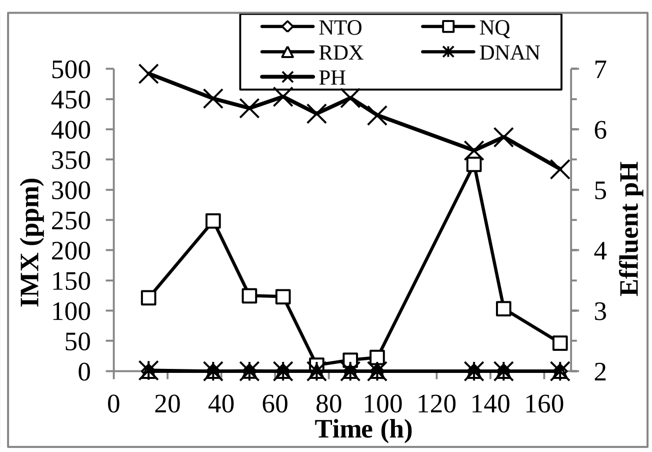


***Fig 3.21*** *Column 4(i), IMX and effluent pH vs time*

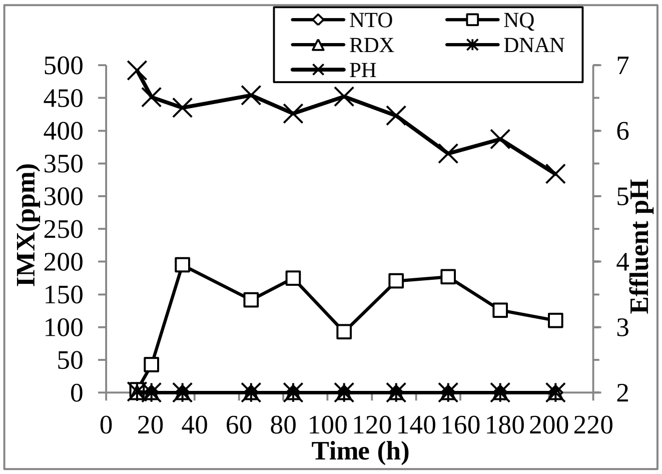


***Fig 3.22*** *Column 5(i), IMX and effluent pH vs time*

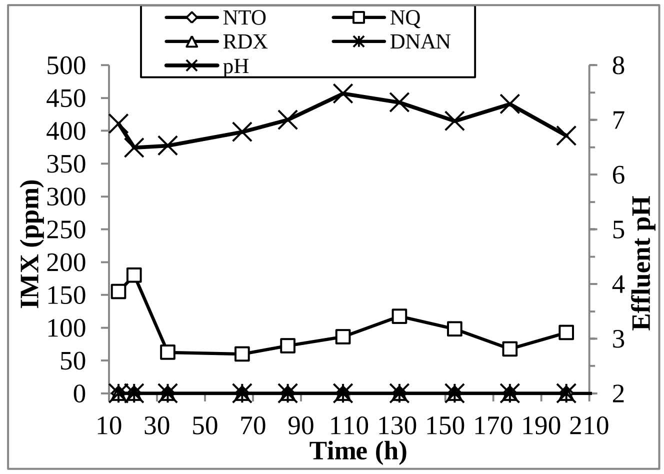


***Fig 3.23*** *Column 6(i), IMX and effluent pH vs time*

Results of iron removal tests are finally reported in Figures(3.24-3.26). Aeration (Test A) showed a very low efficiency for iron removal. The water had a light clarity after the treatment, but still a heavy red color, index of a high concentration of ferric ions ($Fe^{3+}$). Combined use of calcium oxide and aeration (Test B) allowed to improved the final efficiency. The samples showed a greater clarity after the treatment but the color was still yellow, sign of a significant persistency of soluble iron. Final oxidation with Sodium Hypochlorite (Test C) allowed to obtain a good removal of iron.

***Fig 3.24*** *Test A, aeration treatment*

***Fig 3.25*** *Test B, Calcium Oxide*

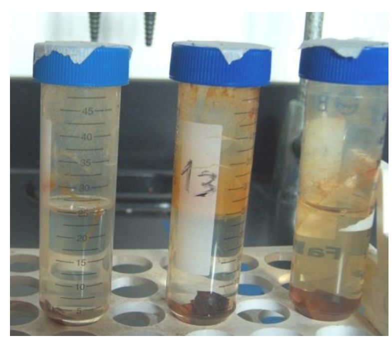

***Fig 3.26*** *Test C, NaClO*

The optimal dosage of solution was found to be about 2,5 ml of solution for 20 ml of water (Figure 3.27)

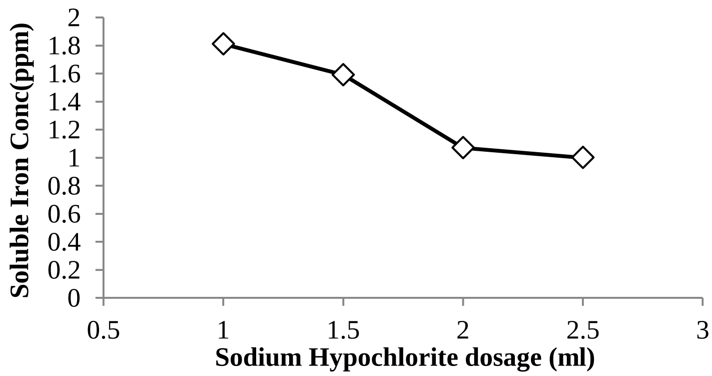


***Fig 3.27*** *Soluble iron concentration (ppm) vs NaClO dosage (ml)*