NATIONAL INSTITUTE OF RESEARCH AND DEVELOPMENT FOR INDUSTRIAL ECOLOGY

ECOIND

EXCELLENCE IN RESEARCH AND ENVIRONMENTAL SERVICES

National Research and Development Institute for Industrial Ecology-ECOIND

INTERNATIONAL SYMPOSIUM „THE ENVIRONMENT AND THE INDUSTRY" 2023

SIMI

REMOVAL OF HCH AND DDX FROM HISTORICAL POLLUTED SOILS BY ZEROVALENT IRON TECHNOLOGY

Mihai Stefanescu, Costel Bumbac, Ionut Cristea

National Research and Development Institute for Industrial Ecology - ECOIND, 57-73 Drumul Podu Dâmboviței, district 6, 06052, Bucharest, mihai.stefanescu@incdecoind.ro, Romania

Introduction

Many countries have environmental problems because of ex industrial production of HCH and DDT. Romania is one of them after decades since the production was stopped. For each tone of lindane 8-12 tons of HCH-residuals were produced and there are 5-10 million tons of HCH-waste which still exist around the world. Fortunately, there are some ways to reuse these waste in industrial processes but in many cases the HCH isomers are still disposed into inadequate landfills. Conventional treatments for organochlorine-contaminated soils include excavation and incineration, thermal desorption, microwave-enhanced thermal treatment, supercritical fluid extraction and biological treatment. Among these treatment technologies, bioremediation was more cost-effective and less destructive. This paper work emphasized the efficiency of zerovalent iron treatment in case of two different polluted soil samples, from two Romanian locations having HCH and DDX historical pollution.

Materials and methods

The experiments of soil treatment using ZVI method were performed in the following conditions:

- There were tested 9 specific operating conditions for each contact time
- There were tested 2 types particle size of iron: GH200F 465 µm, GH50F 215 µm
- Each experimental test was performed for 4 different period of time
- Brown bottles were used and orbital shaker
- Soil samples were dried, grinded and sieved. Finally, particle size was below 1.5 mm.
- Each bottle contains 50 g of dried soil and 150 ml of water

We performed soil tests with iron (two grinding size) - three doses, with iron and acetic acid (two doses for each dose of iron and for each type of grinding iron size).

Table 1 Experimental parameters

Test no.	Contact times (days)	Fe doses (% weight to w.s.)	Acetic acid doses (%volume/weight)
1	7;14;21;28	1	-
2	7;14;21;28	2	-
3	7;14;21;28	5	-
4	7;14;21;28	1	0.5
5	7;14;21;28	1	1
6	7;14;21;28	2	0.5
7	7;14;21;28	2	1
8	7;14;21;28	5	0.5
9	7;14;21;28	5	1

Initial organochlorinated concentrations in soil sample were as following:

- **Location A** samples: αHCH-3643 µg/kg d.w., βHCH-5223 µg/kg d.w., γHCH-4377 µg/kg d.w., δHCH-1988 µg/kg d.w., ΣHCH = 15231 µg/kg d.w., DDE-79.4 µg/kg d.w., DDD-86.8 µg/kg d.w., DDT-97.3 µg/kg d.w., ΣDDX = 263.5 µg/kg d.w. - initial dry substances 95%
- **Location B** samples: αHCH-1989 µg/kg d.w., βHCH-30823 µg/kg d.w., γHCH-618 µg/kg d.w., δHCH-591 µg/kg d.w., ΣHCH = 34022 µg/kg d.w., DDE-131000 µg/kg d.w., DDD-62000 µg/kg d.w., DDT-611230 µg/kg d.w., ΣDDX = 804230 µg/kg d.w. - initial dry substances 86%

Results and Conclusions

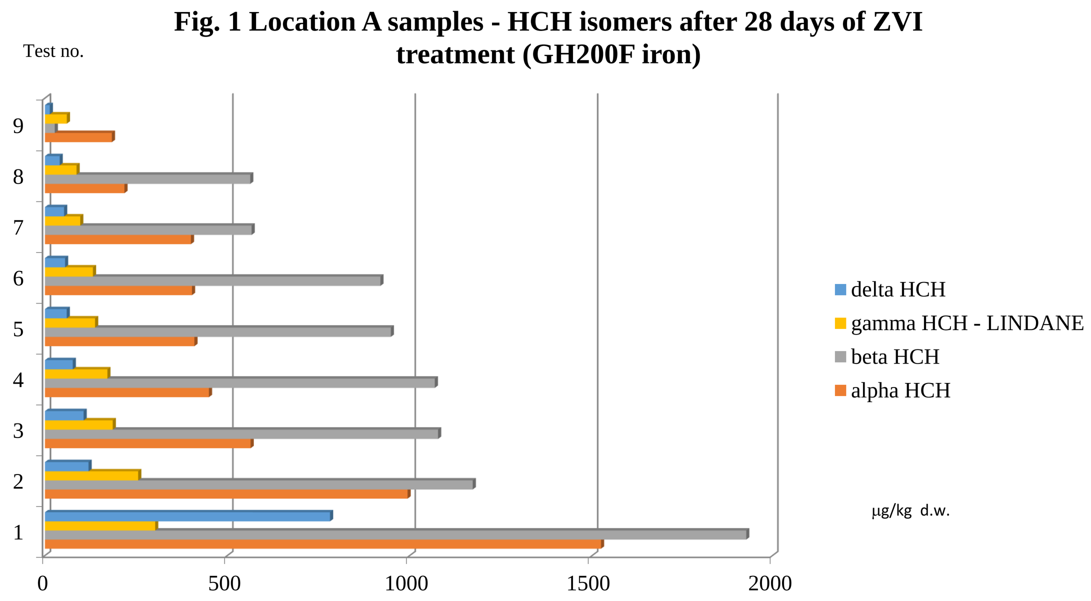

Fig. 1 Location A samples - HCH isomers after 28 days of ZVI treatment (GH200F iron)

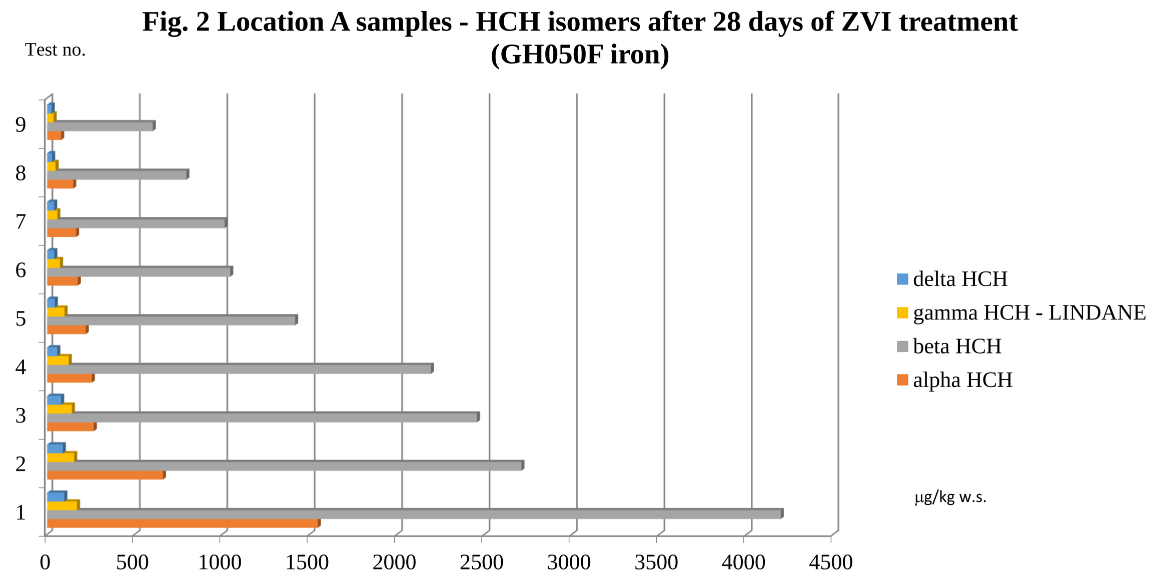

Fig. 2 Location A samples - HCH isomers after 28 days of ZVI treatment (GH050F iron)

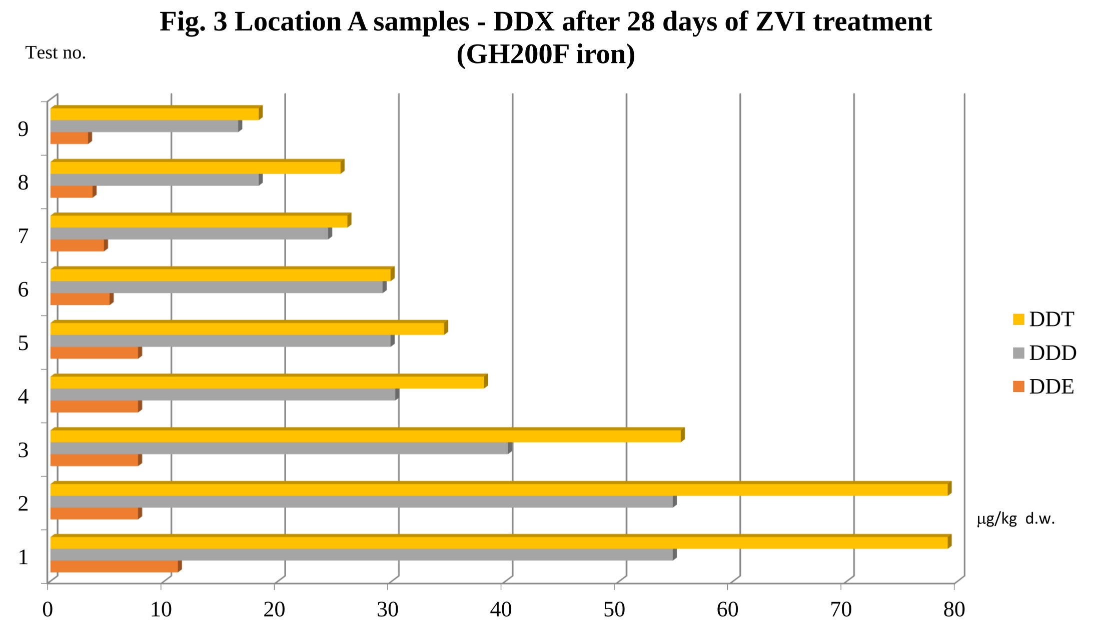

Fig. 3 Location A samples - DDX after 28 days of ZVI treatment (GH200F iron)

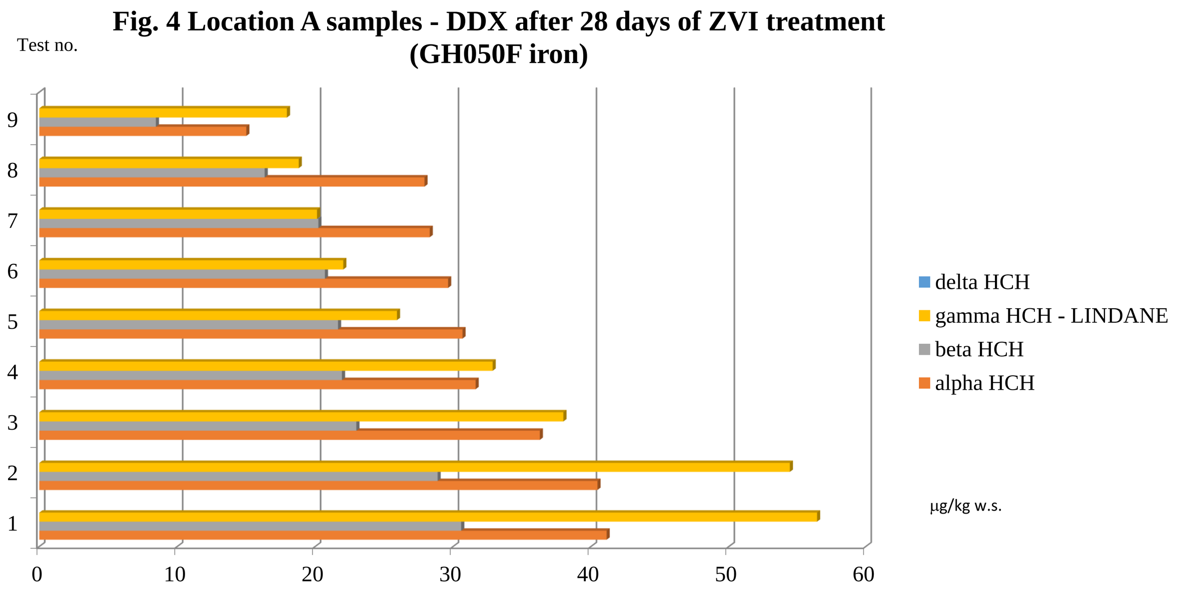

Fig. 4 Location A samples - DDX after 28 days of ZVI treatment (GH050F iron)

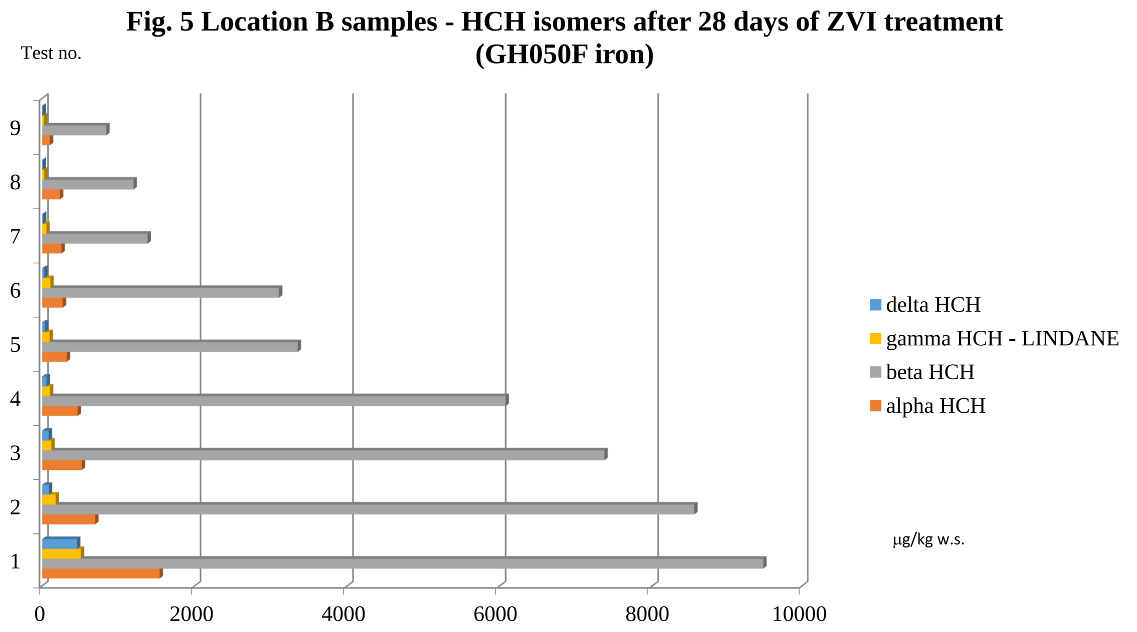

Fig. 5 Location B samples - HCH isomers after 28 days of ZVI treatment (GH050F iron)

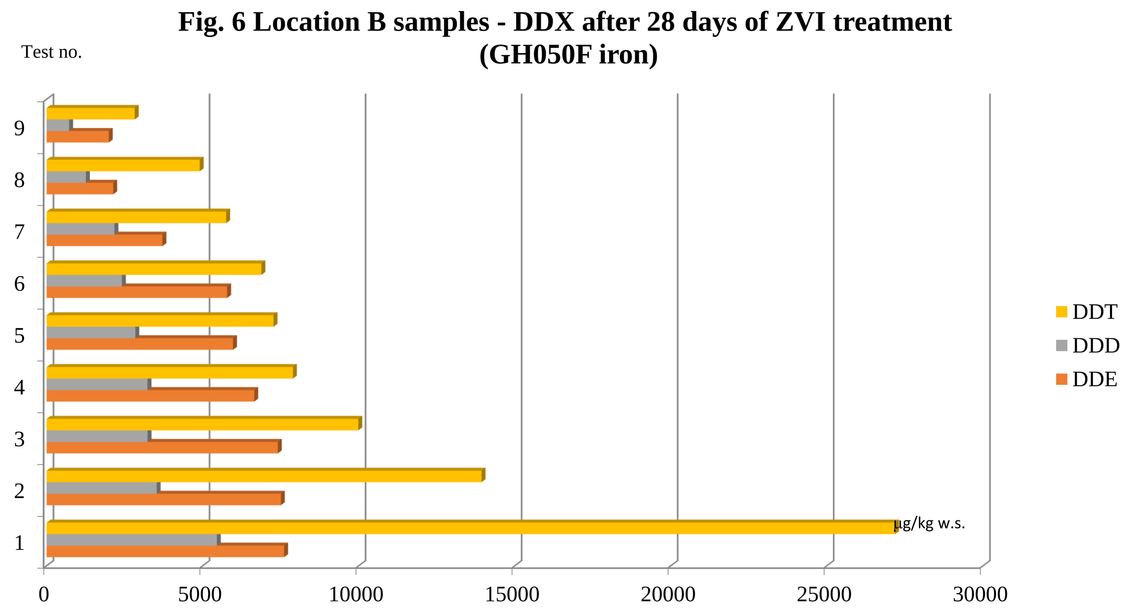

Fig. 6 Location B samples - DDX after 28 days of ZVI treatment (GH050F iron)

Taking into account the experimental results the main conclusions are as following:

- non linear variation of HCH isomers and DDX concentrations in time for the treated soil samples
- decreasing of ΣHCH and ΣDDX contents in treated soil, from both locations, with the increasing of iron and acetic acid doses, for the same contact time
- **the average reduction yields** of POPs concentrations (ΣHCH, ΣDDX) are rather high for all experiments (especially in case of test 9):
  - **test 9 location A** (5% iron and 1 ml acetic acid/100 g soil sample): 99% ΣHCH and 91% ΣDDX for large iron particles and 95% ΣHCH and 82% ΣDDX for small iron particles
  - **test 9 location B**: 93% ΣHCH and 97% ΣDDX for large iron particles and 93% ΣHCH and 97% ΣDDX for small iron particles

Acknowledgments: *The work for this paper was supported by the MCID through the Programme EUROSTARS, project: RESEARCH AND DEVELOPMENT OF METHODS FOR PERSISTENT ORGANIC POLUTANTS (POPs) ELIMINATION – POPELIM; PN2/Contract - 297E*