INTERACTIONS OF MICROPOLLUTANTS WITH WATER DISTRIBUTION SYSTEMS MATERIALS – PARAQUAT AS A CASE STUDY

Mónica S. F. Santos, L. M. Madeira, A. Alves*

LEPAE, Chemical Engineering Department, Faculty of Engineering, University of Porto

Rua Dr. Roberto Frias, 4200-465 Porto, Portugal

*Corresponding author: Tel. +351 22 508 1687. E-mail: aalves@fe.up.pt

INTRODUCTION

The intensive use of paraquat for agriculture purposes has generated a great concern about possible groundwater, and consequently drinking water contamination. According to the EU Council Directive, the maximum individual pesticide concentration in drinking water is 0.1 μg/L. In water distribution systems, paraquat can be adsorbed by pipe materials and by inorganic deposits presented in the internal pipe surface. If this interaction is high, paraquat can be accumulated during a long period and, later on, released at high concentrations into drinking water, exceeding the maximum individual pesticide concentration allowed.

Attending to this problematic, this work intends to evaluate the interaction of paraquat analytical standard and paraquat commercial product (gramoxone) with pipe materials and inorganic deposits.

EXPERIMENTAL

Batch Assays

Parquat Dichloride (PQ) Analytical Standard

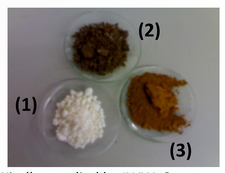
24 h; 20 ºC; dark; V_0 = 50 mL; C_0 = 5 mg/L

Most common materials

PVC (polyvinyl chloride) — **Copper** Cu — **Stainless steel** alloy (Cr, Ni; Mo; C) — **Perspex** (polymethacrylate)

24 h; 20 ºC and 4 ºC; dark; V_0 = 50 mL; C_0 = 20 mg/L; $m_{deposite}$ = 15 g

Real pipe deposits



Kindly supplied by IWW, Germany

48 h; 20 ºC ; dark; C_0 = 20 mg/L

Cast iron pipes with deposits

Kindly supplied by Veolia UK

Continuous Assay

Gramoxone with 32.5 % PQ (W/W)

48 h; 20 ºC ; dark; C_0 = 20 mg/L

Cast iron pipes

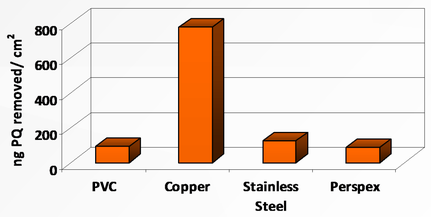
Kindly supplied by Veolia UK

HPLC Analysis

- Hitachi Elite LaChrom system
- Chromolith® Performance RP-18e 100-3 (4.6 mm) column
- Injection volume: 99 µL
- Mobile phase: 85% HFBA 10 mM + 15% acetonitrile
- Flow rate: 1 mL min^{-1}
- Scanning wavelength: 220-400 nm
- Monitoring wavelength: 259 nm

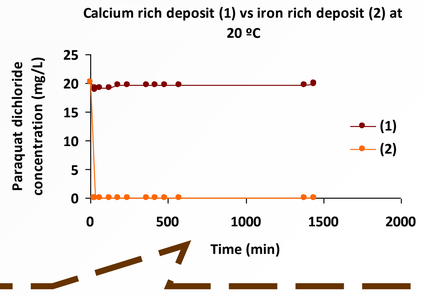
RESULTS

1) Preliminary adsorption studies of paraquat dichloride on PVC, Cu, Stainless steel and Perspex



- Copper presents the highest paraquat dichloride adsorption.

2) Adsorption studies of paraquat dichloride on real pipe deposites

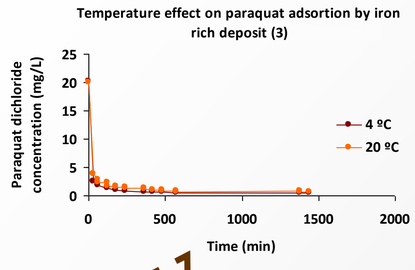


- The presence of high iron quantities in the deposit improves paraquat adsorption.
- Paraquat adsorption does not occur in the presence of calcium.

Table 1 – Inorganic deposit samples composition in mg/kg and water content in % (ICP-OES).

Element	deposit sample		
	(1)	(2)	(3)
Al	22.0	1610.0	371.0
Ca	**423000.0**	**3860.0**	**4830.0**
Cd	< 0.2	46.0	< 0.3
Co	< 1.1	27.7	114.0
Cr	< 1.1	15.7	132.0
Cu	6.0	1130.0	461.0
Fe	**55.7**	**471000.0**	**552000.0**
K	< 574.0	< 790.0	< 800
Mg	2590.0	< 790.0	< 800
Mn	4.4	126.0	2170.0
Na	< 574.0	< 790.0	< 800
Ni	< 2.3	42.3	215.0
Pb	4.2	33.4	< 400
P	159.0	315.0	2590.0
Si	< 574.0	2600.0	2040.0
Zn	608.0	92.2	68.7
water content %	n.n	29.2	----------

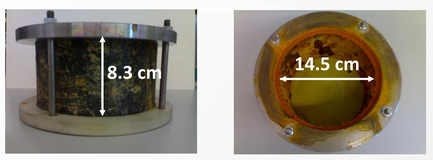
Deposits characterisation kindly supplied by IWW, Germany



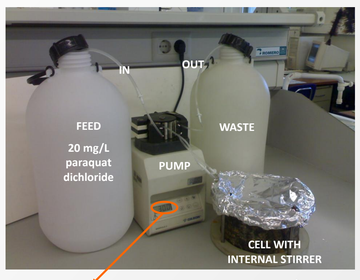
- Slightly higher removal was attained for the case of experiments at 4ºC than at 20ºC.

3) Paraquat adsorption on cast iron pipes

Continuous Assay



Negligible iron deposit



30 r.p.m. = 9.5 mL/min

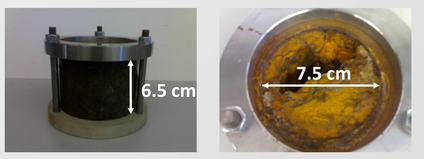
- No paraquat adsorption was observed, but residence time is relatively low (about 2 h). Higher contact times were considered in subsequent batch experiments.

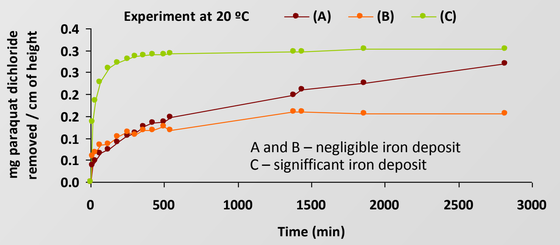
Batch Assays

(A)

(B)

(C)





- The presence of high iron deposit quantities, strongly improves paraquat adsorption.

ACKNOWLEDGEMENTS

The authors wish to thank:

- SECUREAU European project Nº217976 for the financial support
- FCT for the financial support (SFRH/BD/61302/2009)
- Gabriela Schaule (IWW) and Teddy Belrain (Veolia UK) for sending deposits and pipes, respectively
- Syngenta for supplying Gramoxone

CONCLUSIONS

- Paraquat is strongly adsorbed by deposits with high iron content (96% after 360 min contact at 4ºC, initial paraquat dichloride concentration of 20 mg/L) and is not adsorbed by deposits whose dominant element is Calcium.
- Continuous experiment with pipe with negligible iron content indicates that there is no paraquat adsorption for 2 h of residence time.
- For batch assays on cast iron pipes, the paraquat adsorption depends on the deposit quantity.