Radioiodine's behaviour in wastewater treatment plants samples

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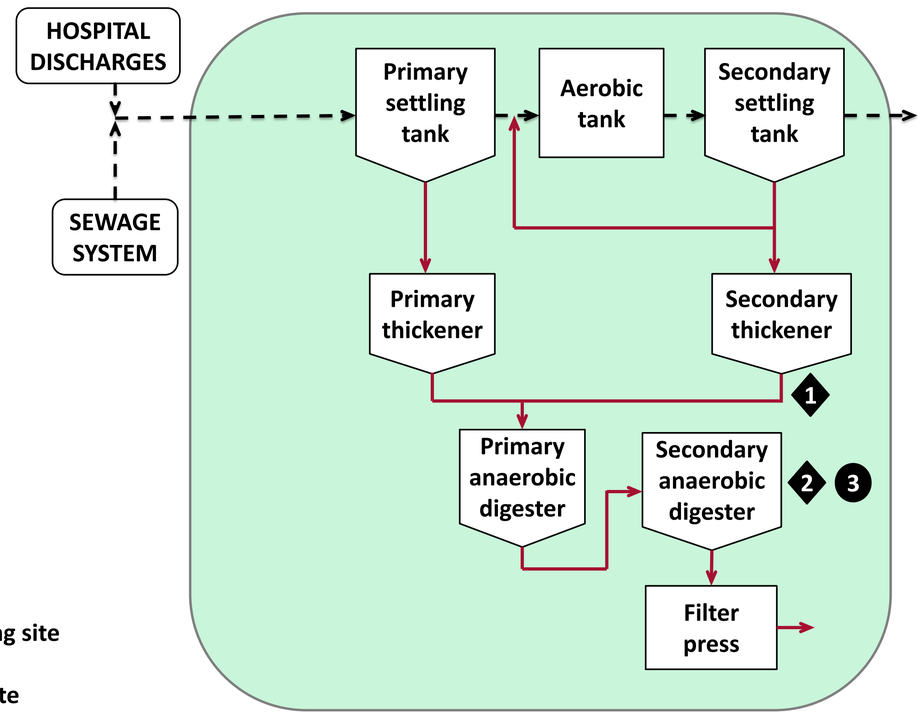
01 INTRODUCTION

Nuclear medicine involves the administration of ^{131}I to patients in order to treat or diagnose thyroid lesions. This radionuclide is mainly excreted via urine and in this way it can reach wastewater treatment plants (WWTP)[1]. As a result, ^{131}I can be present in the different stages involved in this kind of facilities. Thus, WWTP workers can be exposed to this radioisotope via external irradiation or via inhalation due to the possible resuspension of dewatered sludge particles in air[2]. Moreover, as some works suggest[3], ^{131}I can be potentially mobilized to air during the anaerobic digestion, which can also contribute to the occupational exposure.

Several studies can be found in the literature dealing with the determination of ^{131}I in WWTP samples[2,4]. For instance, in a previous research of our group ^{131}I was quantified in sludge samples from a WWTP which receives hospital effluents[2]. Besides the presence of ^{131}I in this kind of samples, in recent years, attention has also been paid to the speciation of this radioisotope although, there is still limited literature related to this topic[5].

In view of these facts, the present work aimed to evaluate the speciation of radioiodine in secondary and digested sludge samples from a WWTP, located in Reus (South Catalonia, Spain), which is influenced by a leading hospital in the field of the nuclear medicine. Understanding the chemical behaviour of this radionuclide in the sludge treatment process followed in this facility can be essential to determine the presence and fate of this one in the environment, for example in air. With this in mind, air sampling was also carried out of the same WWTP. The findings can be useful to assess the potential occupational exposure, as well as to increase the existing data in this field.

02 SAMPLING



Water line

Sludge line

X Sludge sampling site

X Air sampling site

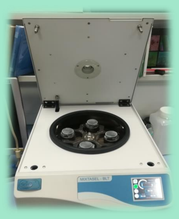
03 MATERIAL AND METHODS

^{131}I CHEMICAL EXTRACTION PROCESS

Sampling points 1 and 2

a) 500 mL of sample are γ measured to determine ^{131}I total activity.

b) 2.5 mL/kg KEMIRA PAX XL-10 flocculant are added to 500 mL of sample to precipitate the organic ^{131}I.



c) The previous mixture is centrifuged 15 min at 3,500 rpm.

γ measurement → PRECIPITATE 1

SUPERNATANT 1

d) Adjust to pH < 2 with HCl 37%.

e) The supernatant is treated in order to precipitate the inorganic ^{131}I by adding: 1.3 g/L KI, 0.05 g Na_2SO_3, 0.5 mL H_2SO_4.

f) Stir and add: 3.2 g/L $AgNO_3$, 0.3 g/L H_2O_2.

g) Stir and adjust pH to 9 with NH_3.

h) 0.5 mL/kg SUPERFLOC A-120 WG is added and the mixture is centrifuged 15 min at 3,500 rpm.

SUPERNATANT 2 → γ measurement

PRECIPITATE 2

PAX XL-10: aluminium polychlorosulfate

SUPERFLOC A-120 WG: polyacrilamide

AIR SAMPLING

Sampling point 3

DIGESTER GAS EFFLUENT

IN-LINE HOLDER

AIR SAMPLER
Sampling time: 16 h
Flow rate: 70 LPM

TEDA IMPREGNATED CHARCOAL CARTRIDGE

PETRI BOX

GLASS FIBER FILTER

γ measurement
Time: 72,000 s

LPM: litre per minute

04 RESULTS

SECONDARY SLUDGE (point 1)

After the steps a), b) and c)

PRECIPITATE 1
79 % of the initial ^{131}I

SUPERNATANT 1

After the steps d) to h)

PRECIPITATE 2
11 % of the initial ^{131}I

SUPERNATANT 2
3 % of the initial ^{131}I

DIGESTED SLUDGE (point 2)

After the steps a), b) and c)

PRECIPITATE 1
59 % of the initial ^{131}I

SUPERNATANT 1

After the steps d) to h)

PRECIPITATE 2
16 % of the initial ^{131}I

SUPERNATANT 2
25 % of the initial ^{131}I

^{131}I IN AIR SAMPLE FROM DIGESTER

Filter MDA < 0.7 Bq/m³
Charcoal MDA < 1 Bq/m³

There was no presence of ^{131}I in the air samples of the digester of the WWTP under study

The ^{131}I in...	...is associated with
PRECIPITATE 1	organic matter
PRECIPITATE 2	inorganic matter
SUPERNATANT 2	residual

MDA: minimum detectable activity

05 CONCLUSIONS

- ^{131}I is present in WWTP sludge.
- After the radioiodine chemical extraction process, our results demonstrated that this radionuclide is mainly associated with organic matter in both analysed types of sludge.
- During the anaerobic digestion process, a change in the distribution of the radioiodine over the sludge fractions could occur.
- There was no presence of radioiodine in the air of the digester at levels higher than the MDA and it could suggest that this radionuclide do not volatilise during the digestion process.

06 REFERENCES

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