RADIOACTIVIDAD NATURAL EN AGUAS DE CONSUMO HUMANO

NATURAL RADIOACTIVITY IN WATER FOR HUMAN CONSUMPTION

Life ALCHEMIA

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SEMINARIO ONLINE 17 JUNIO 2021

ON-LINE SEMINAR 17 JUNE 2021

RESULTS OF THE LIFE ALCHEMIA PROJECT

Radionuclide removal in the HMO pilot plant in Viimsi, Estonia

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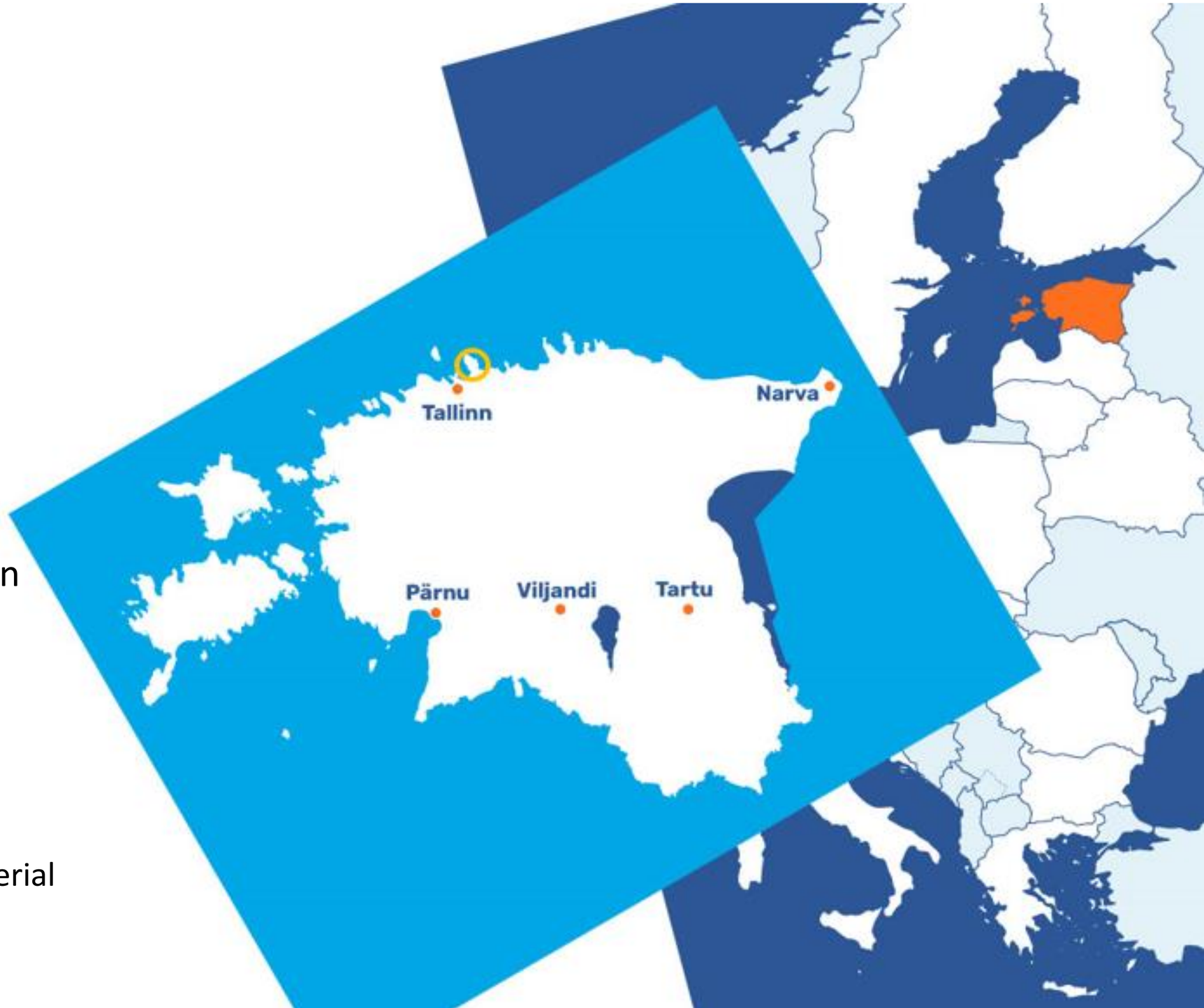
OUTLINE

- How does HMO work for radionuclide removal?
- What does it mean for a water treatment plant operator?
- Regulatory requirements in Estonia
- Results:
  - Radium removal efficiency
  - Radionuclides in filter backwash water
  - Radionuclides in filter material



RADIONUCLIDE REMOVAL WITH THE HMO-TECHNOLOGY. HOW DOES IT WORK?

HMO =

hydrous manganese oxide

Radium removal*:

- Sorption on MnO_2
- Sorption on hydrous oxides
  - $Fe(OH)_3$
  - $Mn(OH)_4$

*Also works for other bivalent metal cations.

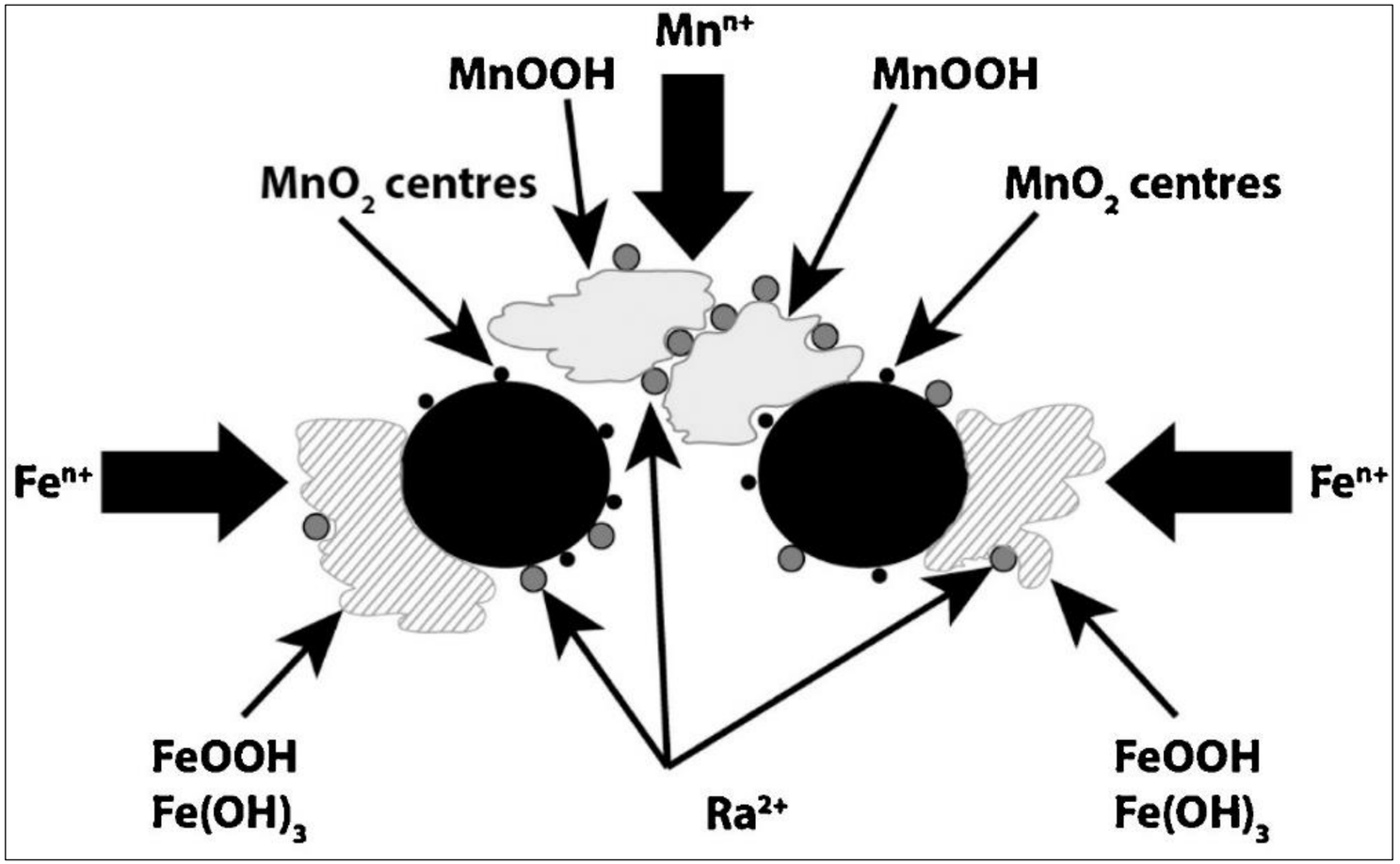


Fig.: Goi et al., *2019. Journal of Water Process Engineering 30 (2019) 100464*

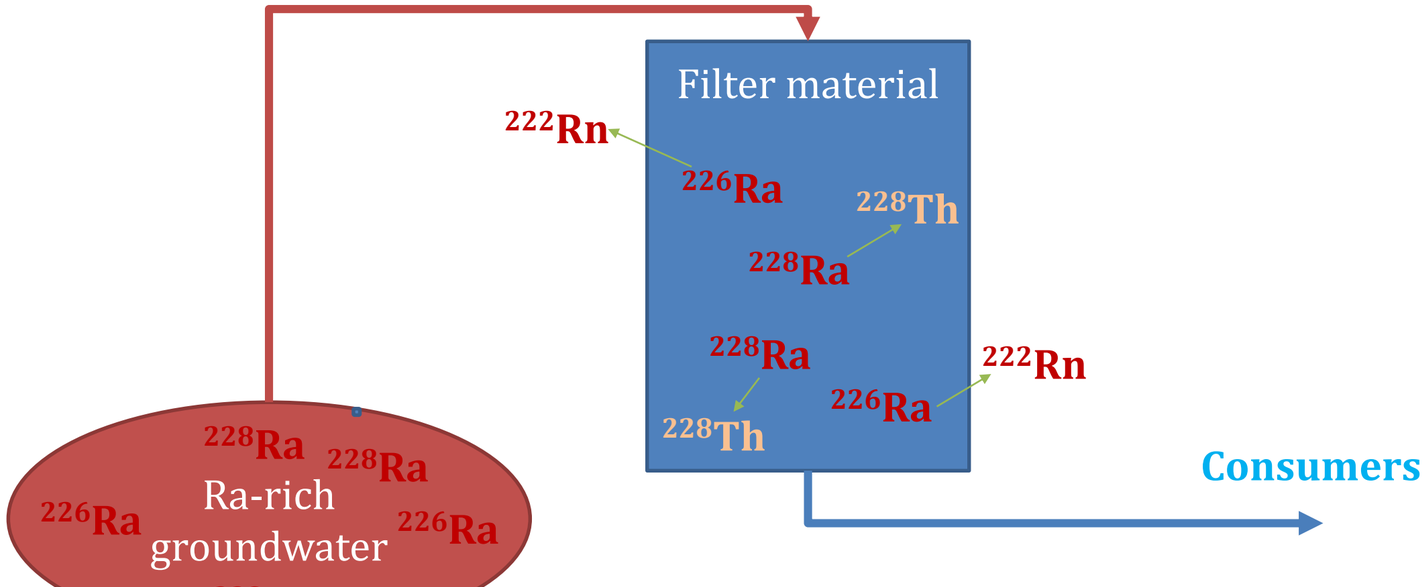
RADIONUCLIDE REMOVAL WITH THE HMO-TECHNOLOGY. WHAT DOES IT MEAN?

Clean drinking water for the consumers

- Compliant with drinking water quality standards

Accumulation of radium in the filter material

- NORM waste management (Naturally Occurring Radioactive Material)
- Potential increase of indoor ^{222}Rn.
- Ingrowth of ^{228}Th in the filter.



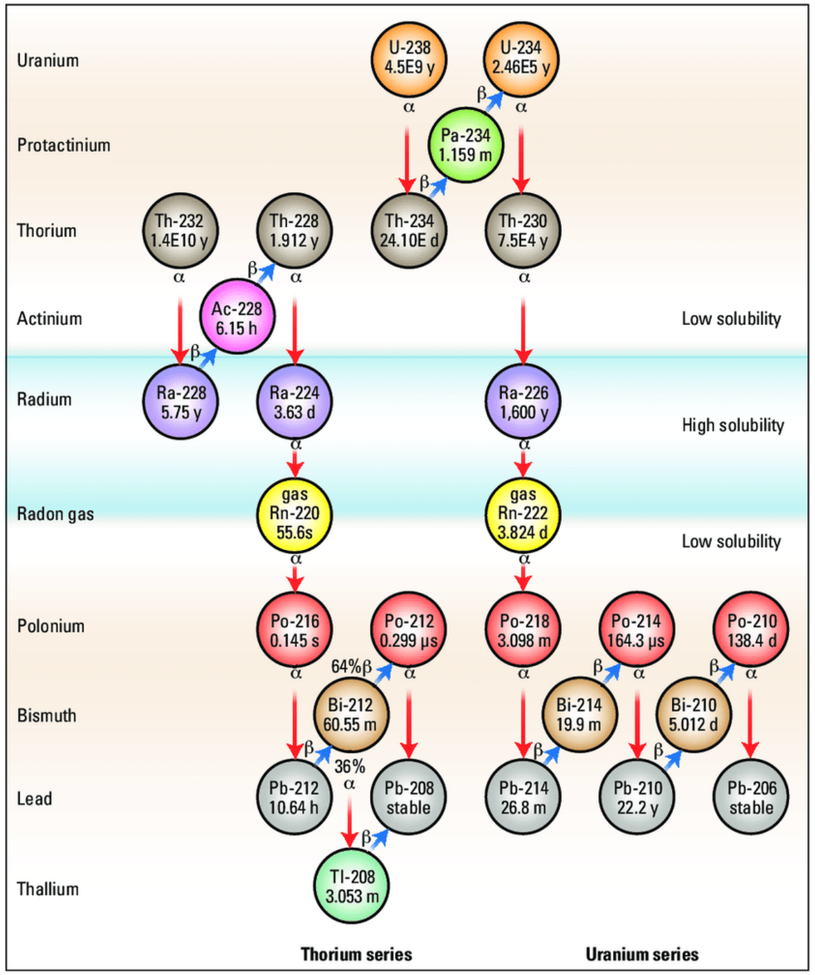


Fig.: Nelson et al*, 2015. Environmental Health Perspectives, 123(7).*

REGULATORY REQUIREMENTS FOR RADIOLOGICAL PARAMETERS

Drinking water

Parametric values given by EU Directive 2013/51/Euratom.

- **Indicative dose (ID)** **≤ 0.10 mSv/year**
- Tritium (^{3}H) activity concentration ≤ 100 Bq/L
- Radon (^{222}Rn) activity concentration ≤ 100 Bq/L

$$ID = \sum A_i \cdot f_i \cdot V$$

Committed effective dose from all the radionuclides* in water.

*Excluding tritium, potassium-40, radon and short-lived radon decay products.

- A_i – Activity concentration of radionuclide in water (Bq/L)
- f_i – Effective dose coefficient of the radionuclide (Sv/Bq)
- V – Yearly water consumption (2 L per day = 730 L per year)

Filter material

Limit values given by EU Directive 2013/59/Euratom.

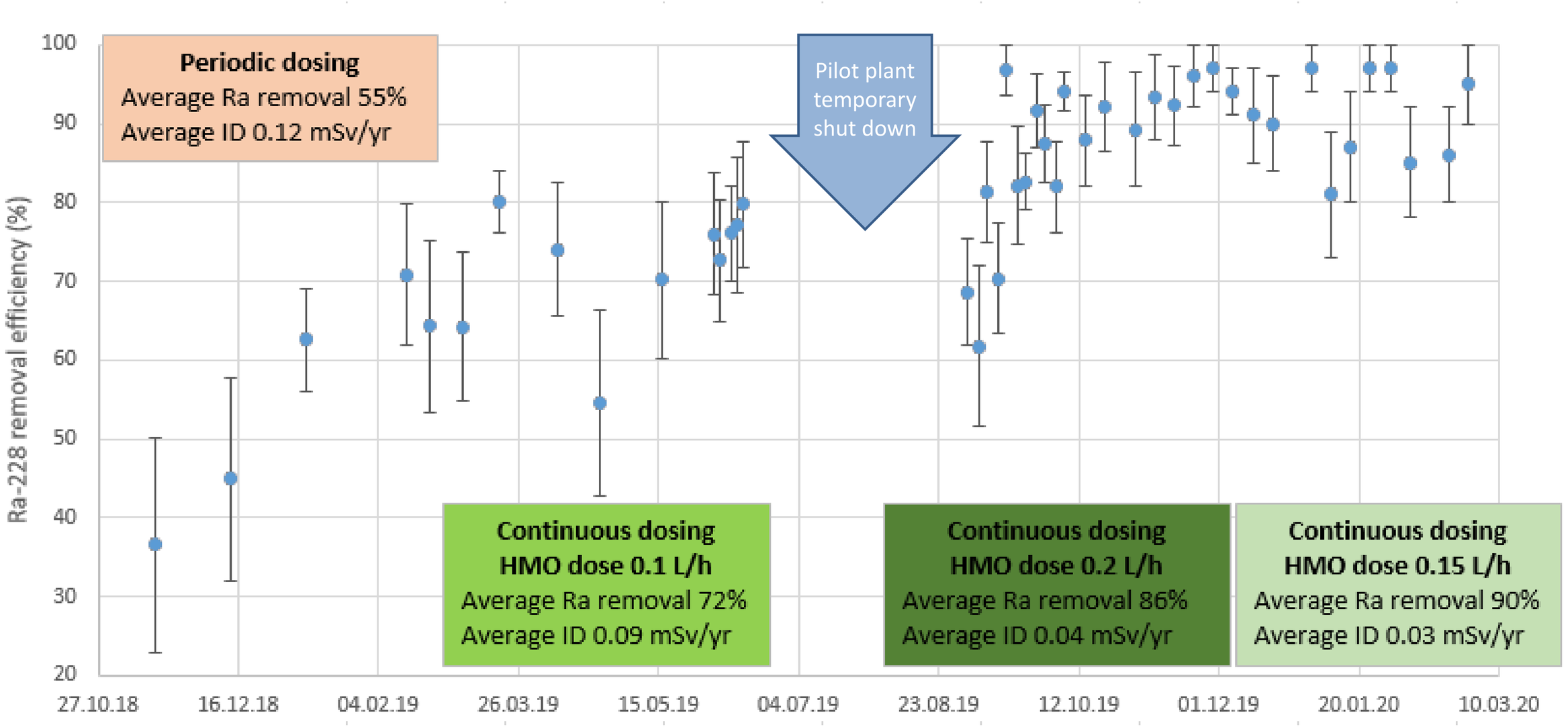
- **Exemption levels**
  - ^{226}Ra: ^{238}U decay series **1000 Bq/kg**
  - ^{228}Ra, ^{228}Th: ^{232}Th decay series **1000 Bq/kg**
- Dose criteria for NORM 1 mSv/year

Our aim with the HMO pilot plant:

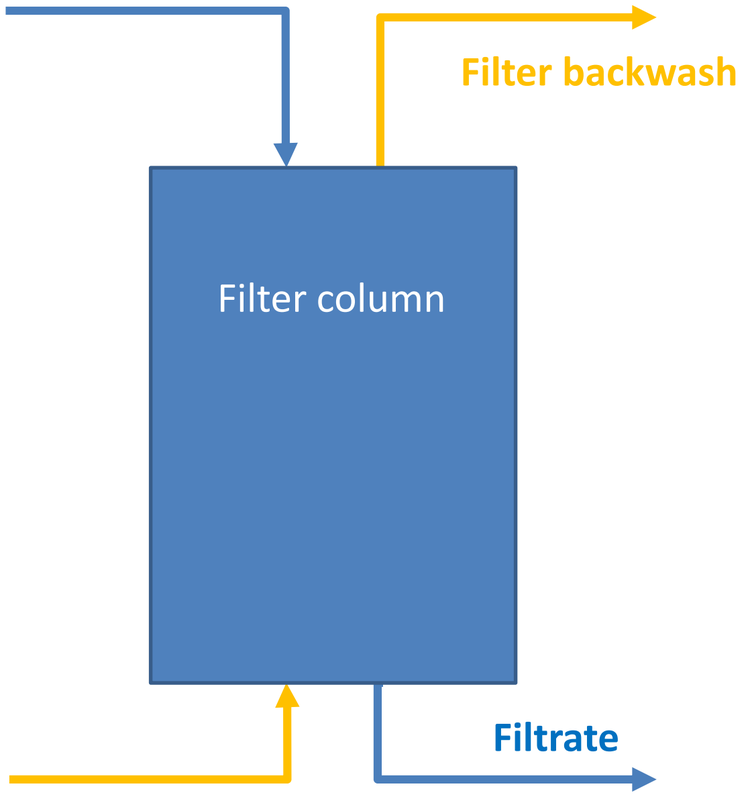
OPTIMIZED TREATMENT

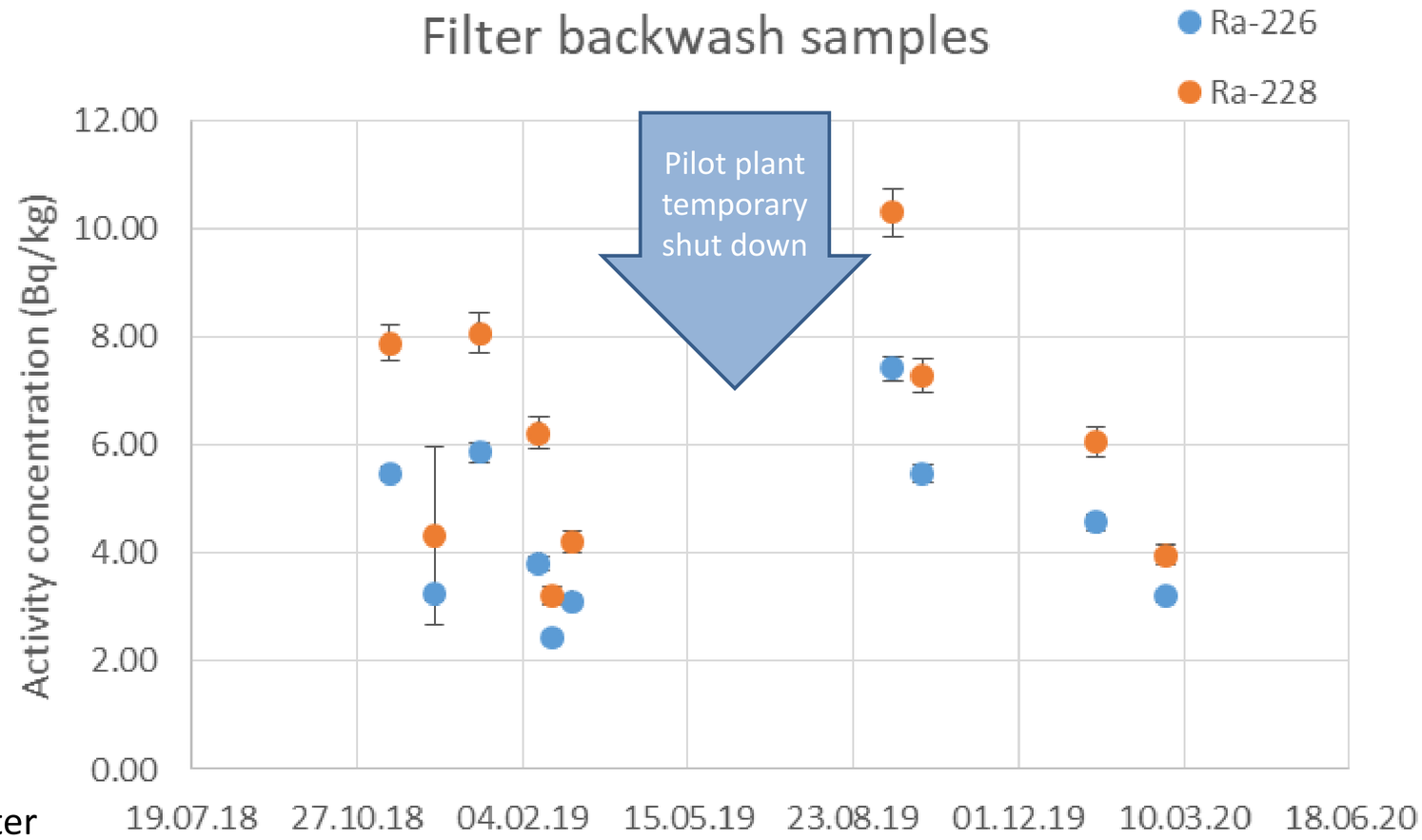
- Remove as much radium as needed to guarantee ID < 0.10 mSv/year.
  Not as much radium as possible!
- Reduce NORM accumulation.

RESULTS: RADIUM REMOVAL EFFICIENCY FROM WATER



RESULTS: RADIONUCLIDES IN FILTER BACKWASH WATER

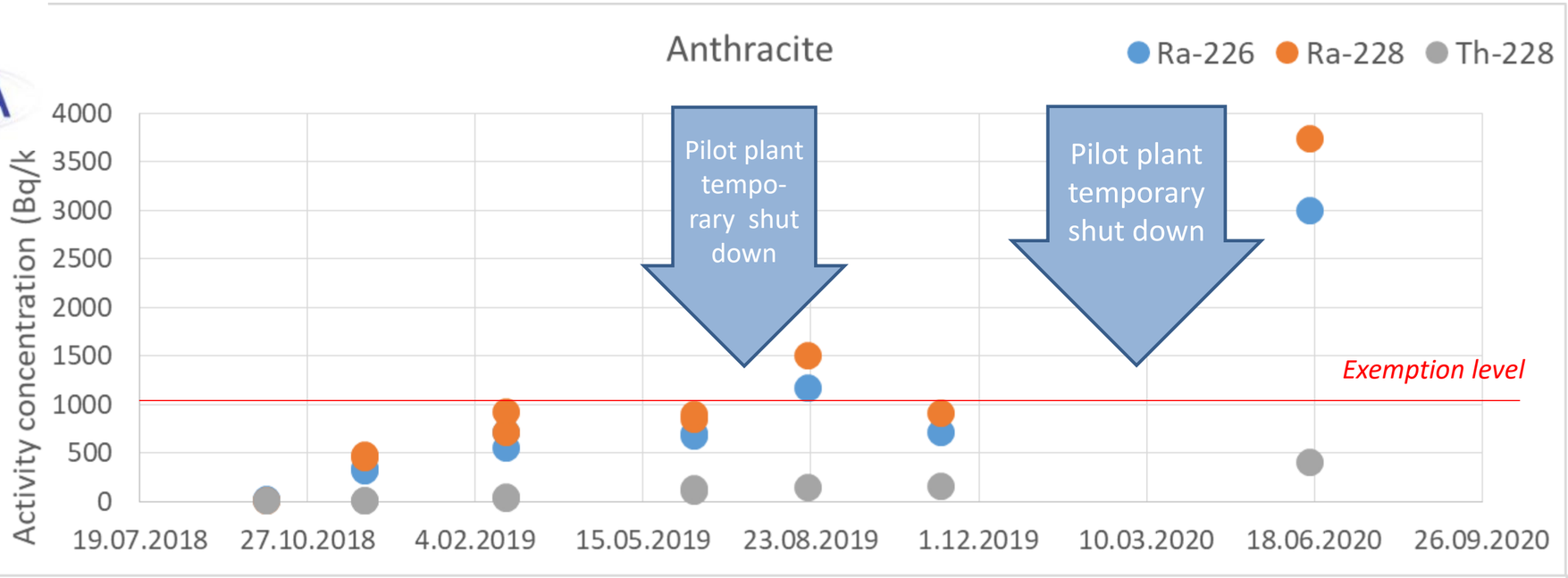


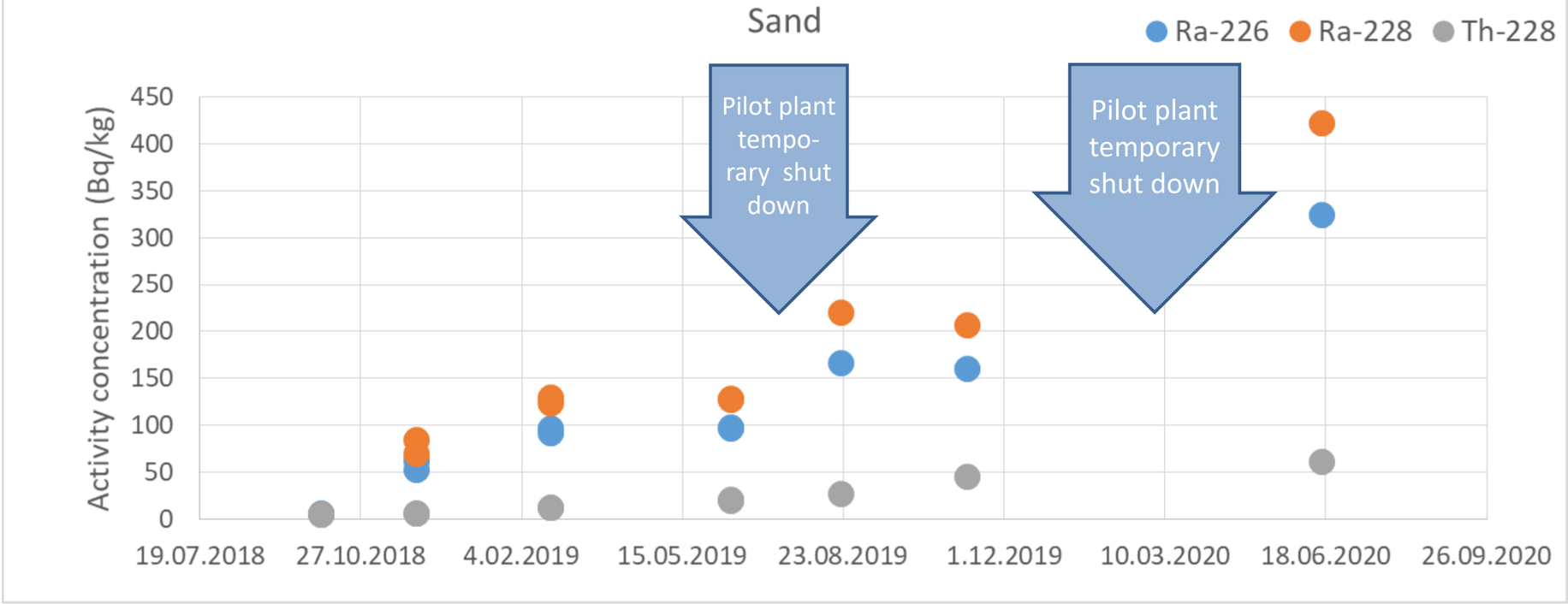


- Most of the radium is not removed from the filter material.
- Backwash water is discharged directly to the sewerage.

RESULTS: RADIONUCLIDES IN FILTER MATERIALS

- Radionuclides accumulate more on the upper part of the filter.
- Exemption levels exceeded in **anthracite** → NORM waste.
- Exemption levels are not exceeded in **sand** → regular waste.





CONCLUSIONS

HMO technology for drinking water treatment:

- Continuous dosing (HMO dose rate 0.15 L/h) ensures radium removal efficiency 80-90%.
- Significantly lower NORM waste generation rate than the current technology in Viimsi.
- Stable performance when the technology is operated continuously.

THANK YOU FOR YOUR ATTENTION!
Any questions?

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