Stabilization of PFAS contaminated soil with waste-based biochar sorbents

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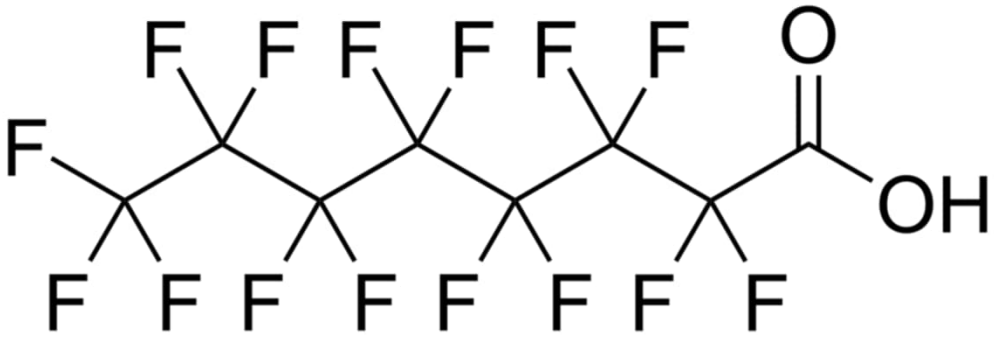
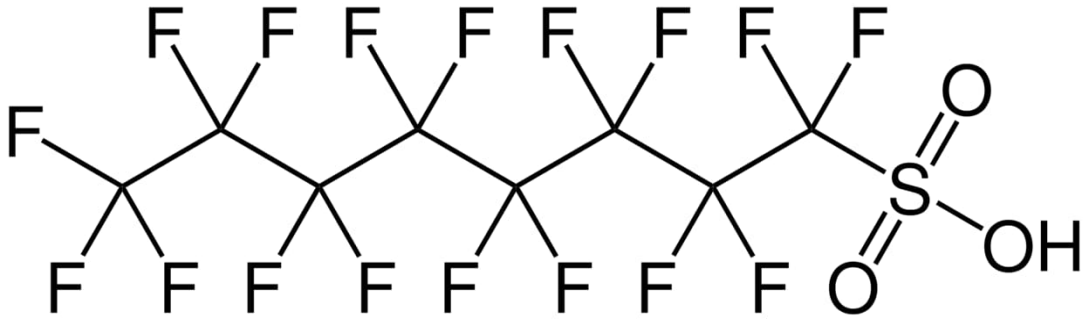
What are PFAS?

- Per- and polyfluoroalkyl substances
- More than 12,000 substances
- Used in many every-day products
- “Forever chemicals”



Perfluorooctanoic acid (PFOA)

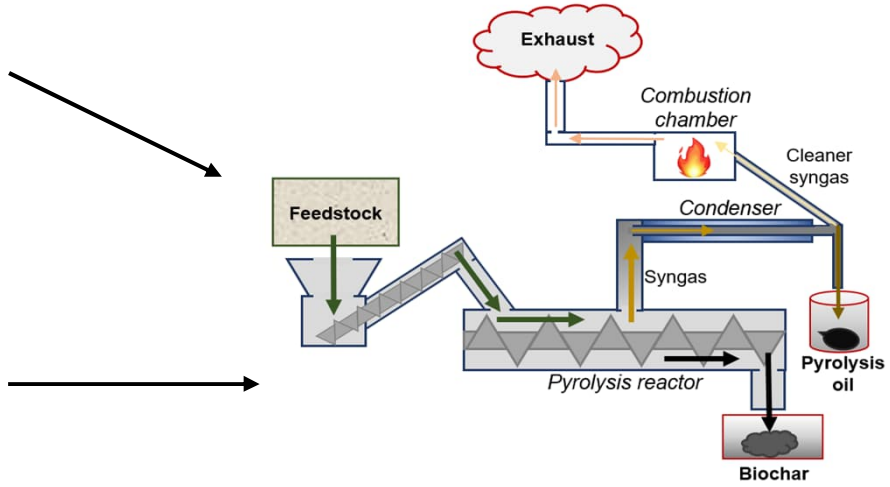


Perfluorooctane sulfonic acid (PFOS)

PFAS remediation with biochar

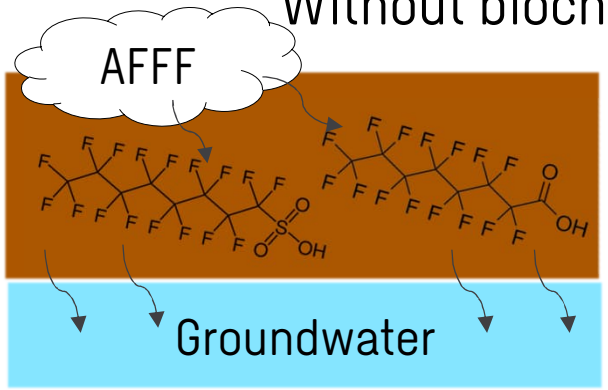
Sewage sludge

Waste timber

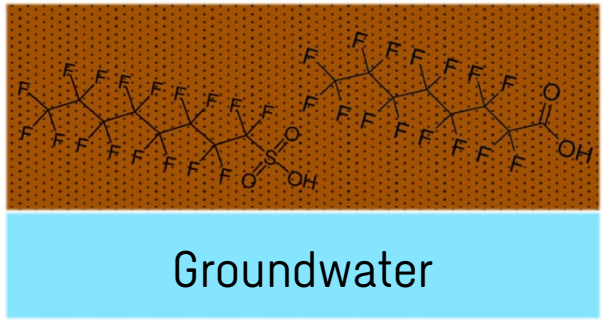


Biochar

Without biochar



With biochar



SWECO

Aim of thesis

Study effects of different waste-based biochars on sorption and transport of PFAS through leaching tests in columns.

Column setup

Columns with PFAS contaminated soil and 1 % w/w biochar

- **Control** (Only soil)
- **Clean wood chips**
- **Waste timber**
- **Waste timber, activated 100% with CO_2**
- **Digested sewage sludge 1**
- **Digested sewage sludge 2**
- **Dewatered raw sewage sludge**

Collection of leachate samples at 6 liquid-solid ratios (L/S)

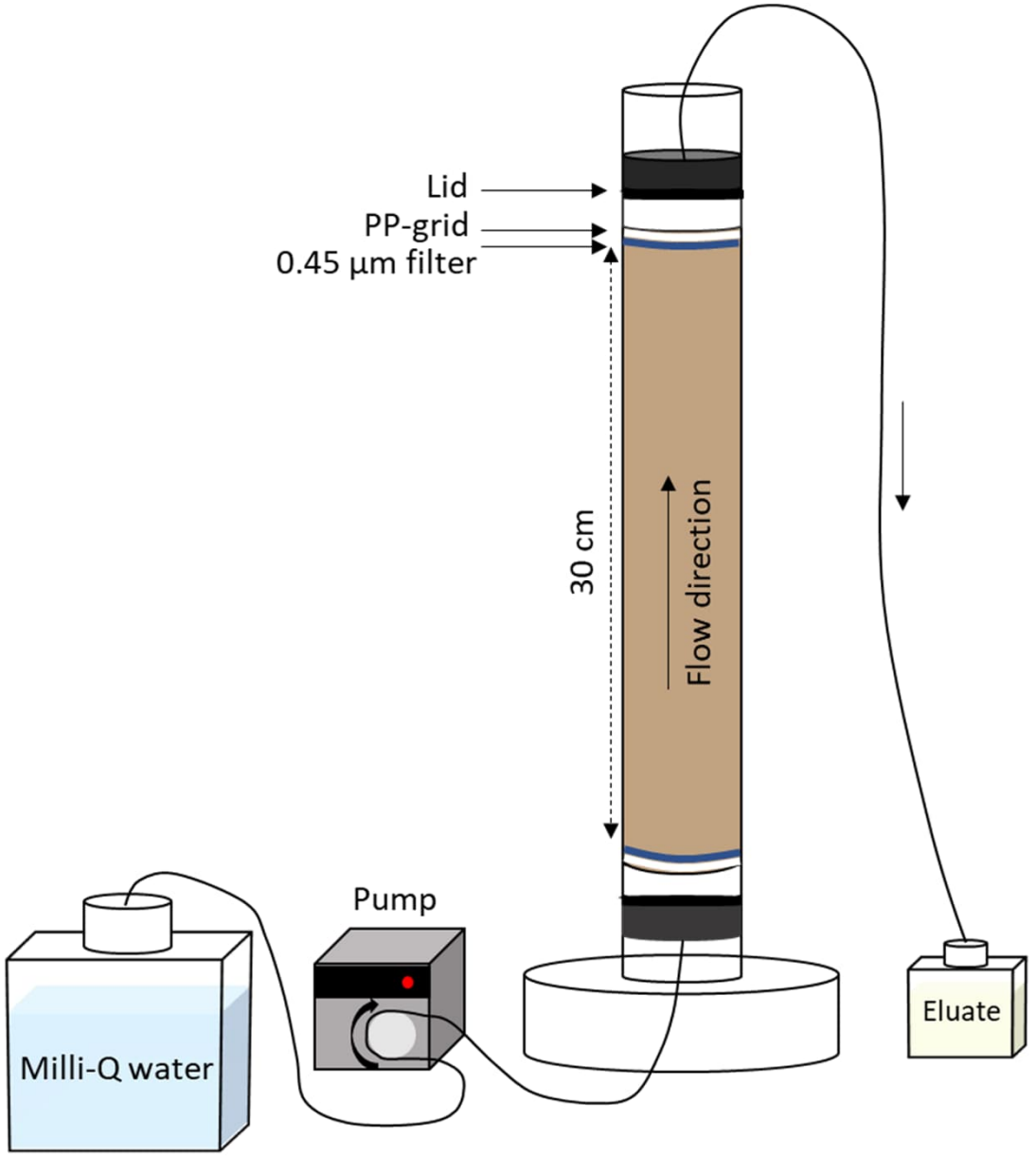
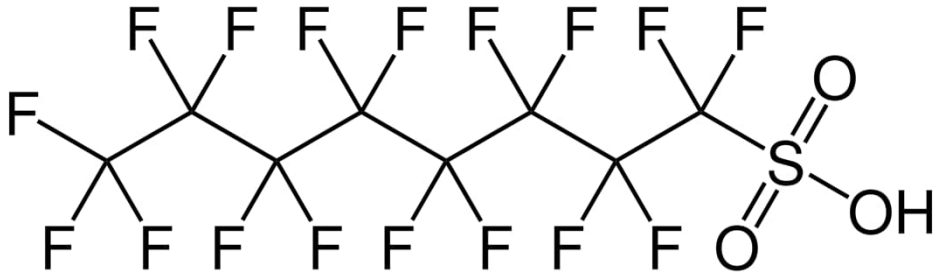


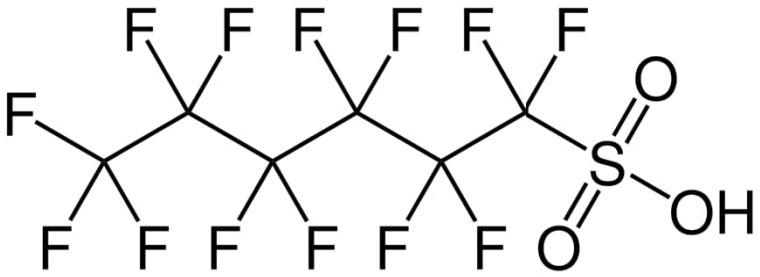
Figure 1: Schematic of column setup

SWECO

PFAS immobilization by biochar



Perfluorooctane sulfonic acid (PFOS)
> 90%



Perfluorohexane sulfonic acid (PFHxS)

PFAS immobilization by biochar

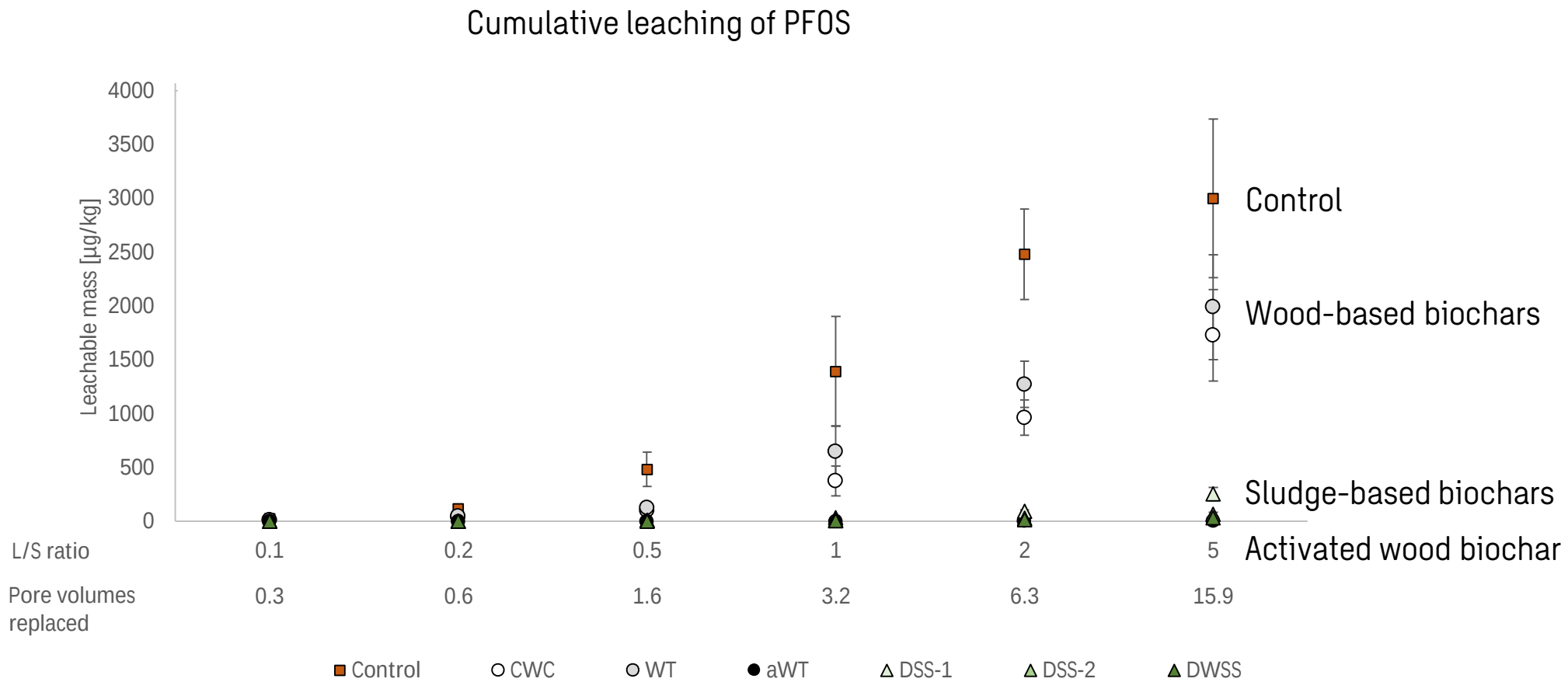
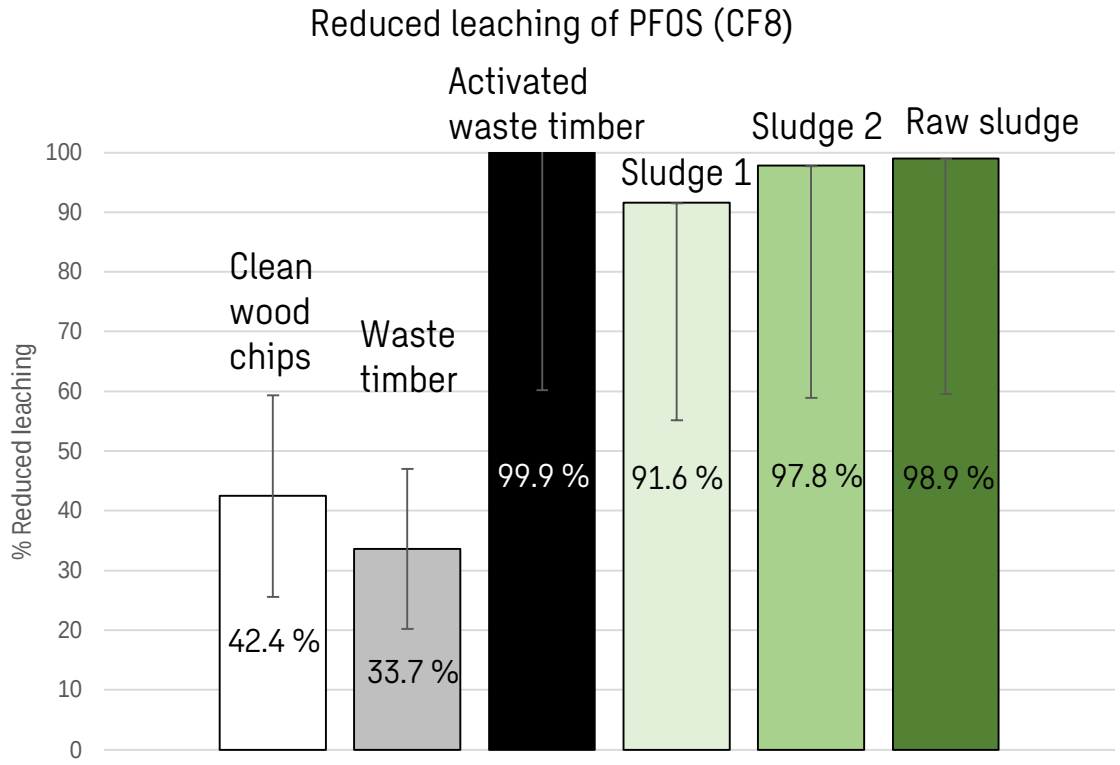


Figure 2: Cumulative leachable mass of PFOS per kg of soil in the over the L/S ratios 0.1 to 5

PFAS immobilization by biochar



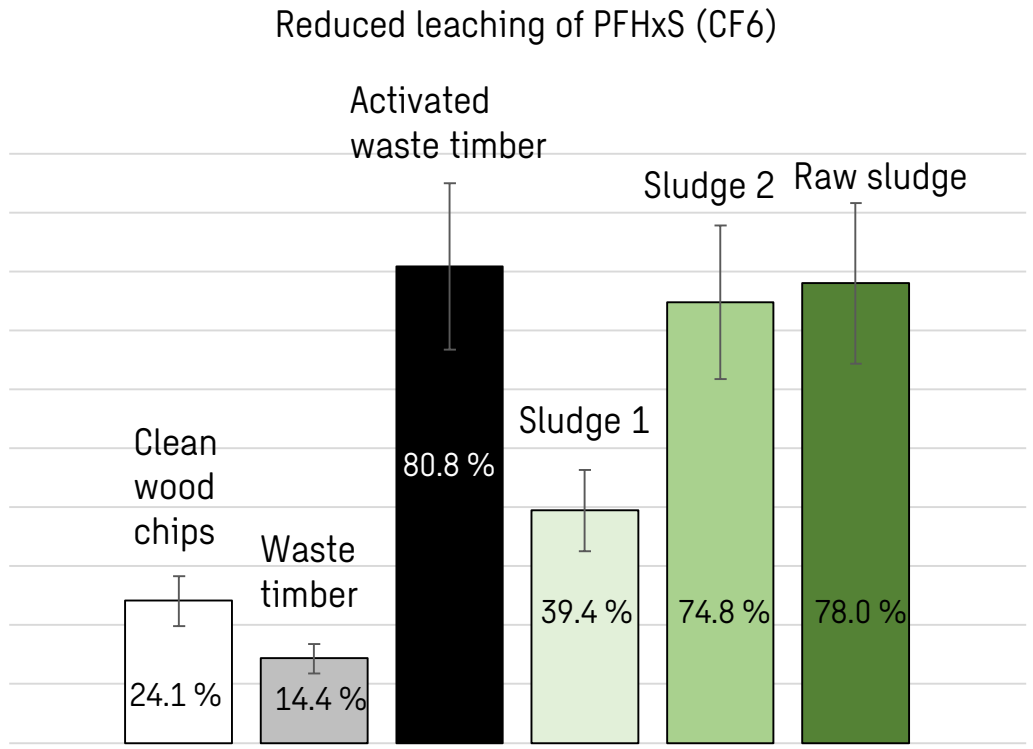


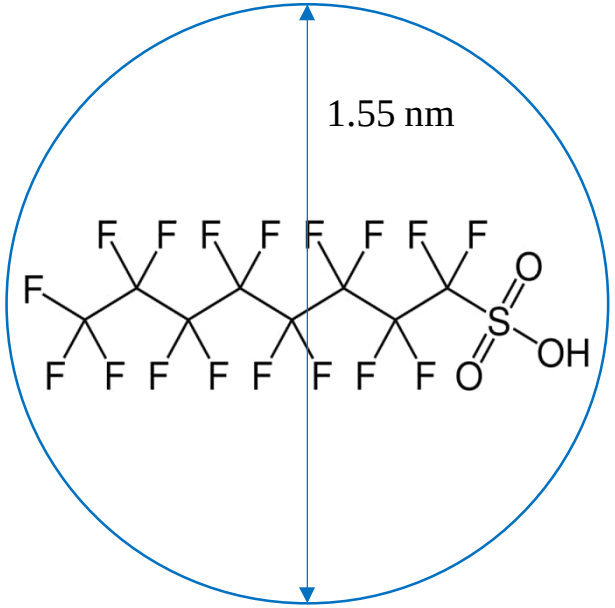
Figure 3 + 4: Reduction [%] in leaching of PFOS and PFHxS relative to the control

What determines a good PFAS sorbent?

Mean pore size:

- Sludge 1: 3.73 nm
- Raw sludge: 3.07 nm
- Sludge 2: 2.86 nm
- Clean wood chips: 1.46 nm
- Waste timber: 1.42 nm

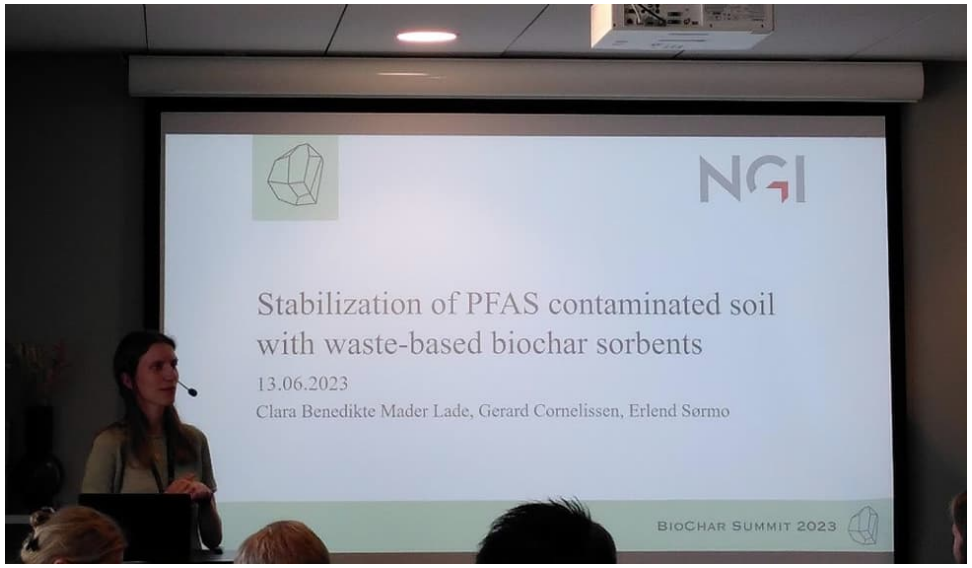
PFAS max diameter: 1.02-2.20 nm



Conclusions

- Sludge-based biochars are better PFAS sorbents than wood-based biochar
- Activation leads to considerably increased sorption strength
- Pore diameter is important for sorption strength
- Biochar has less effect on short-chain PFAS
- Waste can successfully be utilized for remediation of PFAS
- Biochar amendment can limit spread of PFAS

Biochar Summit in Helsingborg and article in STOTEN



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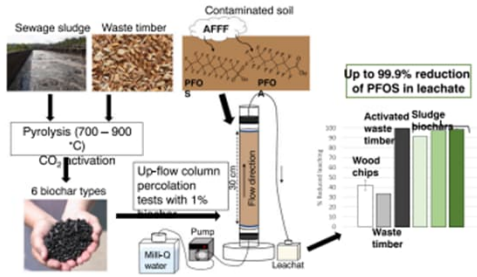
HIGHLIGHTS

- Waste-based biochars were applied to field-PFAS-contaminated soil in column tests.
- 1 % biochar doses were sufficient to reduce PFOS leaching rates by >90 %.
- Activated wood- and sewage sludge biochars were the most effective at reducing leaching.
- Sorption was weakened by the presence of diverse PFAS.

GRAPHICAL ABSTRACT



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- Miljøringen

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