



Kan man lage gode PFAS-sorbenter fra lett forurenset organisk avfall?

Miljøringen, 23. mars 2021

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NGI, NMBU, Lindum AS, Scanship

Can biochar save the world????

“Engineered” charcoal:

- Combustion of biomass without air (pyrolysis)
- High carbon (80-90%)
- Stable for 1000s of years: climate change mitigation!



Biochar:
Carbon as a
Resource

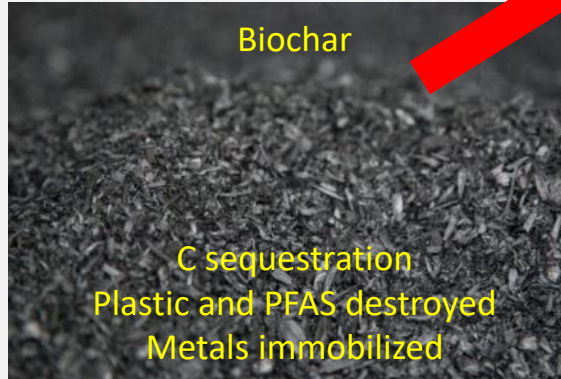
Can we turn contaminated waste streams into clean sorbents?



Contaminants:
Plastic, Organic,
PFAS, Metals



Pyrolysis



Biochar

C sequestration
Plastic and PFAS destroyed
Metals immobilized



Strong binding of contaminants

 **SCANSHIP**
for cleaner oceans

 Lindum

 NGI

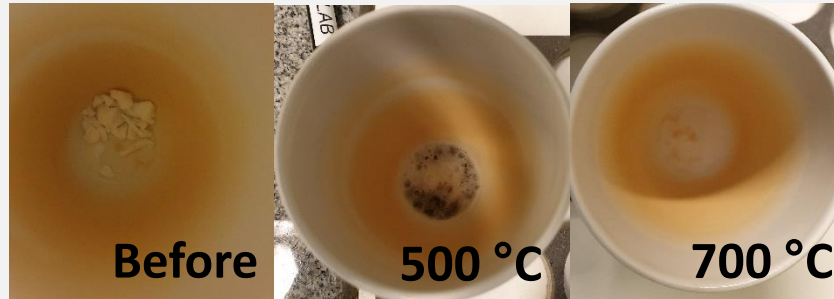
Hva skal vi lage biokull av?

- **Hageavfall**
Greiner, stammer, stubber
- **Returtrevirke**
Hus, pall, flis
- **Biorest**
Fra biogassanlegg
- **Slam**
Avløpsslam, fiskeslam – fokus på PFAS
- **Rejekt**
Forbehandling av matavfall før biogass



What happens to PFAS in the waste?

- ↗ **What happens to PFAS compounds during pyrolysis?**
- ↗ Teflon decomposed at 600 and 700 °C, but not at 500 °C
- ↗ Emissions of fluorinated gases?





Pyrolyse ved Lindum

Kapasitet: 550 tonn biokull/år
Oppvarming ved hjelp av mikrobølger
Dampkjele for energi
Tatt i drift juni 2020

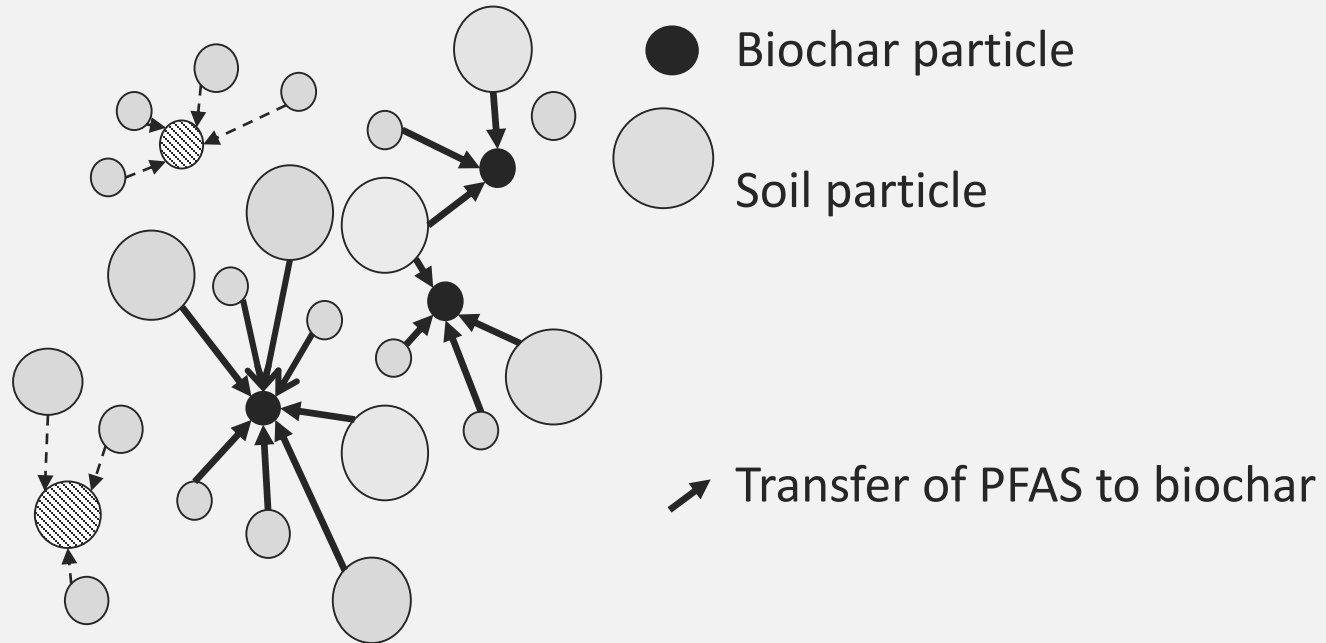


What is a sorbent?

➤ Sorbents bind contaminants strongly

➤ Uses:

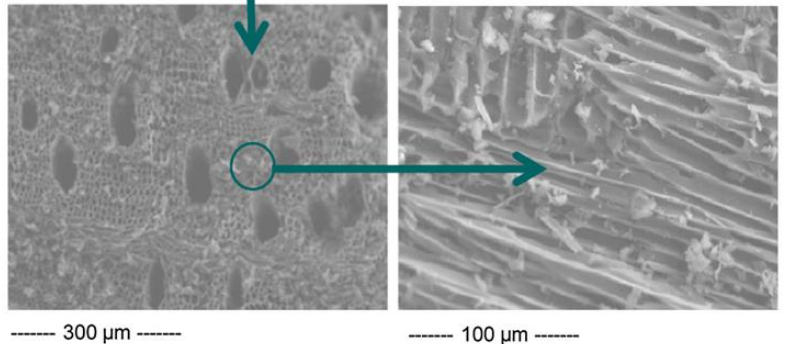
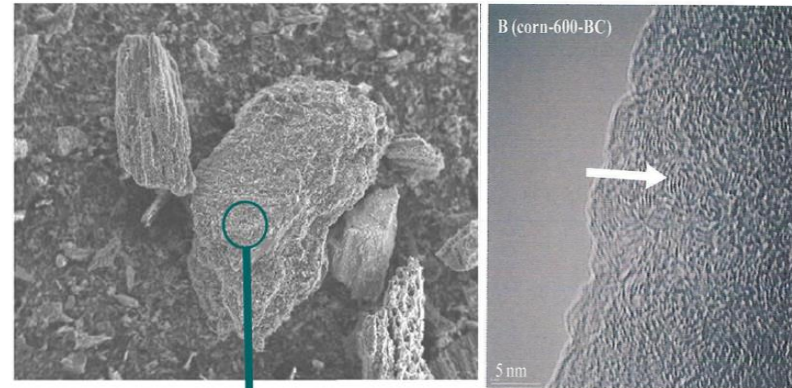
- Waste water
- Landfill leachate
- Drinking water
- Air filters



(Activated) Biochar as a PFAS sorbent



- **Hydrophobic interactions** between nanopore walls and CF chain
- High **capacity**: lot of binding sites
- High **affinity**: strong interactions
- **Activation**: High surface area and aromatic surfaces
- Add **H₂O at 900 C** for activation



Waste timber activated biochar

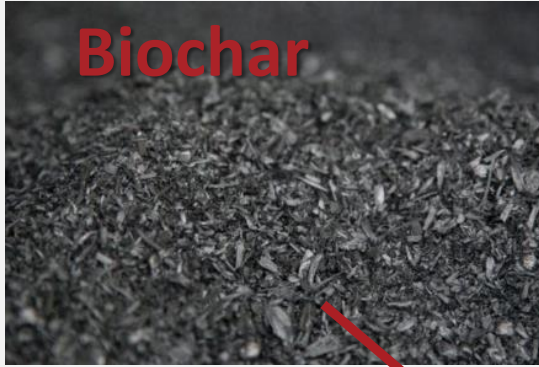
- ↗ 660 000 t/y in Norway
- ↗ Lightly contaminated
 - Paint
 - Binders
 - Metals



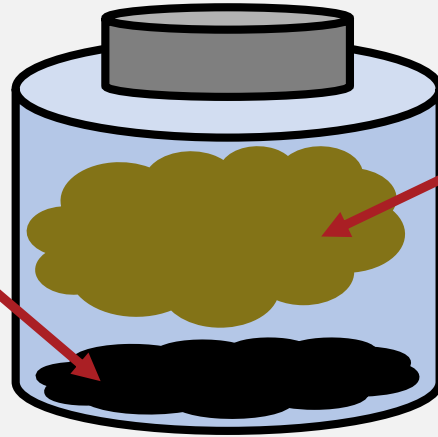
Properties of Activated Waste Timber Biochar

Sorbent	Biochar Mass Yield (%)	Pores >0.3 nm	
		Surface area (m ² /g)	Pore volume (cc/g)
BC900	19.0	411	28 %
BC900,50% activated	12.2	550	45 %
BC900,75% activated	12.1	605	52 %
BC900,100% activated	8.9	713	83 %
BC900,125% activated	8.0	623	51 %

Can (activated) biochar reduce PFAS leaching from soil?



Batch shaking test
(L/S 10)



Analysis of leachate

Biochar reduces PFAS leaching to almost zero!

Soils from fire fighting area, Rygge airport				
Sorbent name	Low-TOC soil		High-TOC soil	
	Reduced leaching of PFOS (%)		Reduced leaching of PFOS (%)	
	0.1 % biochar	1 % biochar	1 % biochar	5 % biochar
Only soil	-	-	-	-
0% activated	8.3 %	92.5 %	59 %	78 %
50% activated	41.7 %	99.95 %	21 %	48 %
75% activated	58.4 %	99.74 %	21 %	70 %
100% activated	76.3 %	99.96 %	14 %	89 %
125% activated	92.5 %	99.98 %	41 %	99 %

Similar effect for other PFAS

Conclusions

- ↗ We can make fantastic PFAS-sorbents from lightly contaminated organic waste
 - Environmental sustainability: better than fossil AC
 - Economic sustainability: cheaper than conventional AC
 - Circular economy
- ↗ Challenges:
 - Will the biochar be clean enough? (metals , PAHs)
 - Sorbent effect vs. carbon sequestration
 - Does this work in the field?



Takk for oppmerksomheten!

VOW

Valorization of Organic Waste into Biochar for
Clean-up of Contaminated Water, Soil & Air
NFR project #299070, BIA Bærekraft program

