Interreg North-West Europe WOW!

EUROPEAN UNION

European Regional Development Fund

CELLULOSE PILOT

FROM CELLULOSE (TOILET PAPER) TO ACTIVATED CARBON

PRODUCTION, EXTRACTION AND PROCESSING

CELLULOSE

Sewage contains valuable substances that can be used as raw materials for biobased products. One of the options is the production of activated carbon. For this, the influent sievings (mainly toilet paper) of a sewage treatment plant is used. During the process noty only biochar but also bio-oil and acid are being produced.
Cellulose from toilet paper can be turned into activated biochar by five consecutive steps:

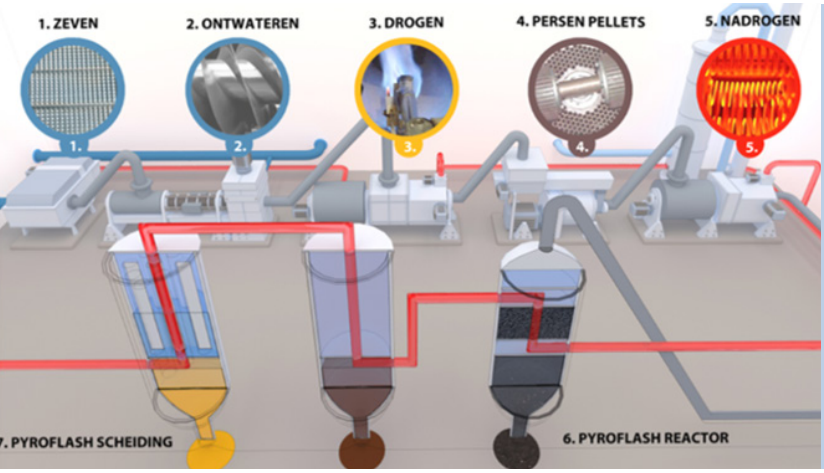
- Sieving of raw wastewater to recover toiletpaper.
- Dewatering of the sieved material.
- Drying and pelletization
- Pyrolization (carbonisation) to biochar, bio-oil and pyroligneous acid.
- Activation of the biochar to activated carbon.

The activated carbon can be used for the removal of pharmaceuticals from wastewater.

WHAT IS THE ISSUE ON PHARMACEUTICALS?

We all take a lot of medicines and most end up in the urine and in the sewage. Sewage treatment plants remove some medicines completely like paracetamol, but others are not removed well and end up in the receiving surface waters. In the Netherlands about 160 tons of pharmaceuticals end up in the surface water every year. Pharmaceuticals affect aquatic ecosystems, fish and other aquatic organisms may for instance feminize or become disoriented.

PRODUCTION PROCESS



1. Sieving
2. Dewatering
3. Drying
4. Pelletizing
5. Drying
6. Pyroflash reactor
7. Separation in
8. Biochar
9. Bio-oil
10. Pyroligneous acid

CELLULOSE PILOT; RECOVERY OF TOILET PAPER

Each year, in the Nertherlands more than 150.000 tons of toilet paper end up in the sewage. The toilet paper can be filtered easily from the 'raw' sewage using rotating belt fine sieves (filtermesh 350 µ).
The sievings then are dewatered to approximately 50 % dry solids and then are ready to be processed further to products which can be used in the sewage treatment plant itself of by other companies which are capable to valorise this valuable resource

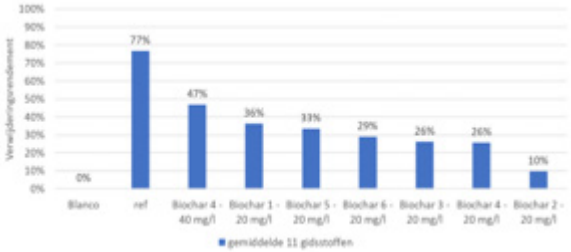
PYROLIZATION AND ITS PRODUCTS

The pyrolysis flash reactor generated enough syngas to operate the installation. However, the temperature became too high (up to 800 oC) which resulted in a lower yield and high ash content of the biochar (considerable loss of organics). The bio-oil production was relatively high but the product will need further valuation steps to be able to use it as an energy source.
The pyroligneous acid can be used in the STP to enhance biological denitrification and phosphorous removal (as requirements are not high for this purpose). The amounts however are relatively small to the overall loading of the STP.

ACTIVATION AND REMOVAL OF PHARMACEUTICALS

The biochars were physically activated (with CO2, Air or Steam) or chemically (with H3PO4 or NaOH). Compared to commercially available activated carbons (removal efficiency 93 %; the physically activated chars showed lower removals of 10-26 % probably caused by the high ash content of about 80 %. The chemical activations did not increase the removals compared to the not activated biochar which already had removal efficiency of about 36 %.

It therefore can be stated that the quality and quantity of the activated chars produced are not sufficient to apply it on full scale. It would require the addition of commercial powder activated carbon to reach over 80 % removal.



CONCLUSIONS

WOW! has shown that it is possible to recover toilet paper from raw sewage on full scale. The toilet paper cellulose pulp was dewatered, dried and pelletized. In a flash pyrolization reactor this was turned into biochar, bio-oil and pyroligneous acid. However, during pyrolization a (too) large part of the organics were converted into syngas and by products. The biochar when activated also resulted in a loss of organics which resulted in not sufficient pharmaceutical removal efficiencies. Also, the quantity and quality of the bio-oil and acid was less than expected.

Future research should focus on the production of 1 product i.e. biochar.

MORE INFORMATION

Download the complete report
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