# SEWAGE SLUDGE: A SUCCESSFUL APPROACH BASED ON THERMO-CATALYTIC REFORMING

Andreas Hornung, Nina Schmitt, Andreas Apfelbacher, Robert Daschner

Fraunhofer Institute for Environmental, Safety, and Energy Technology UMSICHT Sulzbach-Rosenberg




**Suncor Academic Forum on Transformational Technology for Energy Systems**

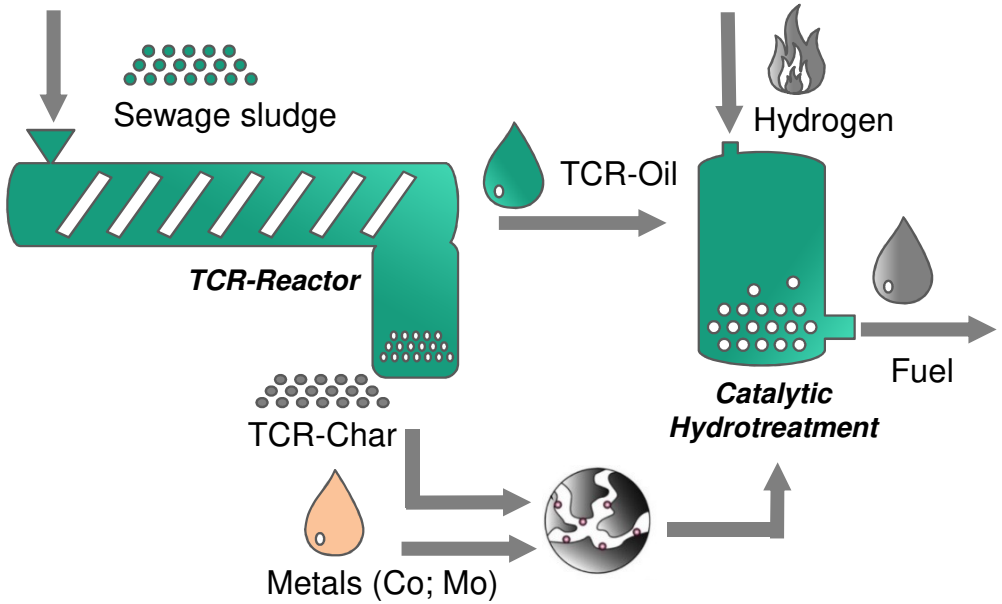
**October 10th to 12th, 2018**
**Vancouver, Canada**


© Fraunhofer UMSICHT

Fraunhofer
UMSICHT

# SEWAGE SLUDGE: A SUCCESSFUL APPROACH BASED ON THERMO-CATALYTIC REFORMING

## Integrated TCR concept




- Wet impregnation of TCR and active char (AC):
  - Solve precursor salts
  - Drying
  - Calcination (773K; $N_2$)
  - Activation (Sulfurization)


© Fraunhofer UMSICHT

Fraunhofer UMSICHT

# SEWAGE SLUDGE: A SUCCESSFUL APPROACH BASED ON THERMO-CATALYTIC REFORMING

## Hydrogen production and requirement at different temperatures

| **Gas** | **773 K** | **973 K** |
|---|---|---|
| Yield (wt.%) | 15.5 | 34.5 |
| Composition | | |
| $H_2$ (vol.%) | 33.5 | 43.9 |
| CO (vol.%) | 6.0 | 19.4 |
| $CO_2$ (vol.%) | 37.1 | 16.4 |
| $CH_4$ (vol.%) | 1.5 | 6.0 |
| n.d. (vol.%) | 21.9 | 14.3 |
| **$H_2$ (g)** | **18.8** | **76.2** |

| **Oil** | **773 K** | **973 K** |
|---|---|---|
| Yield (wt.%) | 11.6 | 5.6 |
| Composition | | |
| C (wt.%) | 70.1 | 71.7 |
| H (wt.%) | 9.7 | 8.2 |
| N (wt.%) | 8.6 | 10.1 |
| S (wt.%) | 1.1 | 1.5 |
| $O_{diff}$ (wt.%) | 10.5 | 8.5 |
| **$H_2$ required (g)** | **27.7** | **18.1** |

- 4.5 kg feedstock (sewage sludge)
- 773 K $T_{reforming}$ required 8.9 g $H_2$
- 973 K $T_{reforming}$ leads to 58,1 g $H_2$ surplus

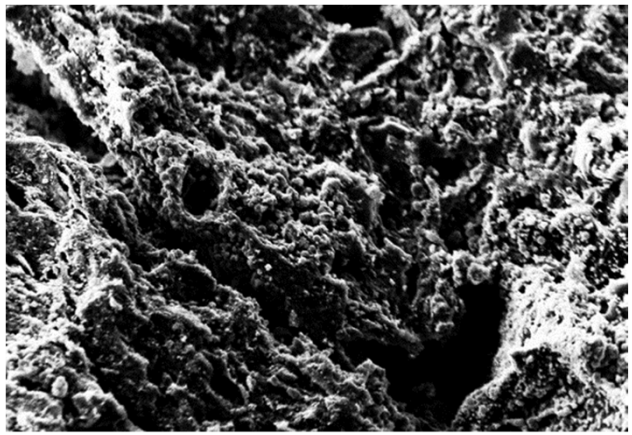

© Fraunhofer UMSICHT

Fraunhofer UMSICHT

# SEWAGE SLUDGE: A SUCCESSFUL APPROACH BASED ON THERMO-CATALYTIC REFORMING

## Catalyst characterization

- XRD:
- Preferred species:
  - CoO
  - $MoO_3$
- Detected species:
  - CoO, $CoMoO_3$/$CoMoO_4$
  - MoC
  - $Ca(MoO_4)$, $Fe_{0,88}Co_{0,19}(Fe_{1,02}Co_{0,94})O_4$, $Li_{0,33}Ca_{0,33}Bi_{0,33}MoO_4$



- specific Surface (BET):

| ***Support material*** | **pure [m²/g]** | ***with CoMo*** **[m²/g]** |
|---|---|---|
| *Active char* | 716.2 | 420.9 |
| *TCR (773K)-char* | 12.7 | 36.3 |
| *TCR (973K)-char* | 71.6 | 75.3 |

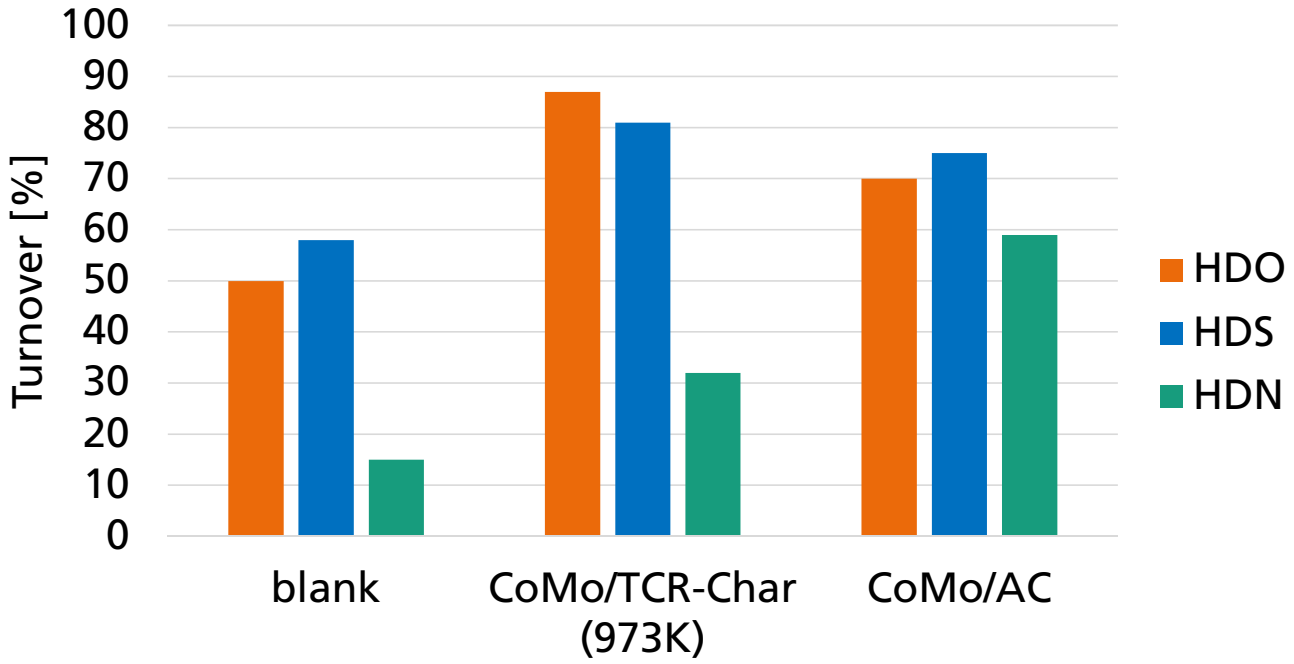

© Fraunhofer UMSICHT

Fraunhofer UMSICHT

# SEWAGE SLUDGE: A SUCCESSFUL APPROACH BASED ON THERMO-CATALYTIC REFORMING

## Hydrotreatment

- Process parameter:
- Up to 170 bar (hydrogen)
- T (t) = 613K (1h); 653K (4h)
- Stirrer speed 400rpm
- 10 wt% of catalyst





© Fraunhofer UMSICHT

Fraunhofer UMSICHT

# SEWAGE SLUDGE: A SUCCESSFUL APPROACH BASED ON THERMO-CATALYTIC REFORMING

## Conclusion

- $H_2$ requirement can be met for TCR experiments at 973 K

- TCR®-char as catalyst
  - feasible
  - Better results by activated carbon (due to surface &compounds)




© Fraunhofer UMSICHT

Fraunhofer UMSICHT

# SEWAGE SLUDGE: A SUCCESSFUL APPROACH BASED ON THERMO-CATALYTIC REFORMING

Fraunhofer UMSICHT

## Thank you!

**Fraunhofer UMSICHT**
**Institute Branch Sulzbach-Rosenberg**

**Andreas Hornung**
An der Maxhütte 1
92237 Sulzbach-Rosenberg
Phone: +49 (0) 9661 908-400
E-Mail: info-suro@umsicht.fraunhofer.de
Internet: http://www.umsicht-suro.fraunhofer.de
http://www.centrum-energiespeicherung.de



*Fraunhofer UMSICHT*


© Fraunhofer UMSICHT

Fraunhofer UMSICHT