Department of Food and Nutritional Sciences

University of Reading

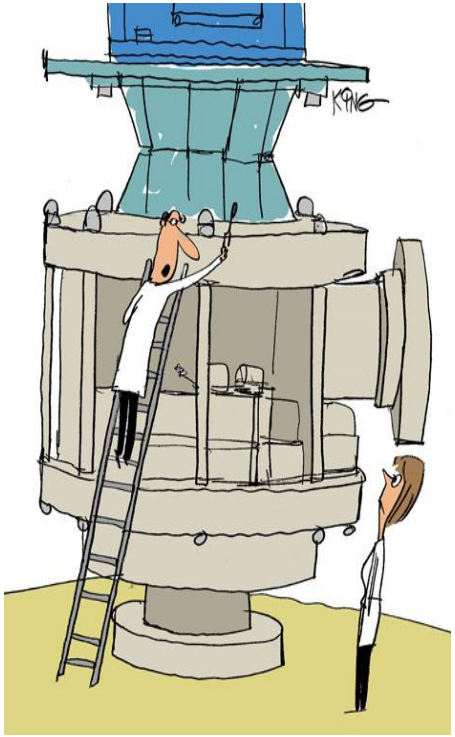
# THERMAL PRE-TREATMENT OF LIGNOCELLULOSIC BIOMASS AS A SUBSTRATE FOR ANAEROBIC DIGESTION

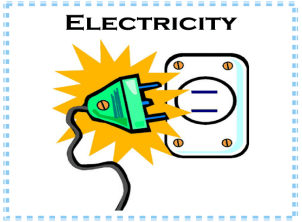
F. Kaldis, D. Cysneiros, A. Chatzifragkou, K.A. Karatzas

# ANAEROBIC DIGESTION

Anaerobic bacteria (inoculum)

Intricate structure
Lignin content





Renewable fuels


(Digestate)

# PRETREATMENT CHOICE

1. Physical (maceration of the substrate)
2. Chemical (alkali or acid pretreatment)
3. Biological (the use of fungi)
4. Hydrothermal (steam explosion)

- Biomass structure opens up due to thermal expansion, (reduction of the particle size and an increase in the pore volume)
- The polysaccharides are hydrolysed to simpler sugars
- Higher degradation rates from the microorganisms of AD

# AIMS

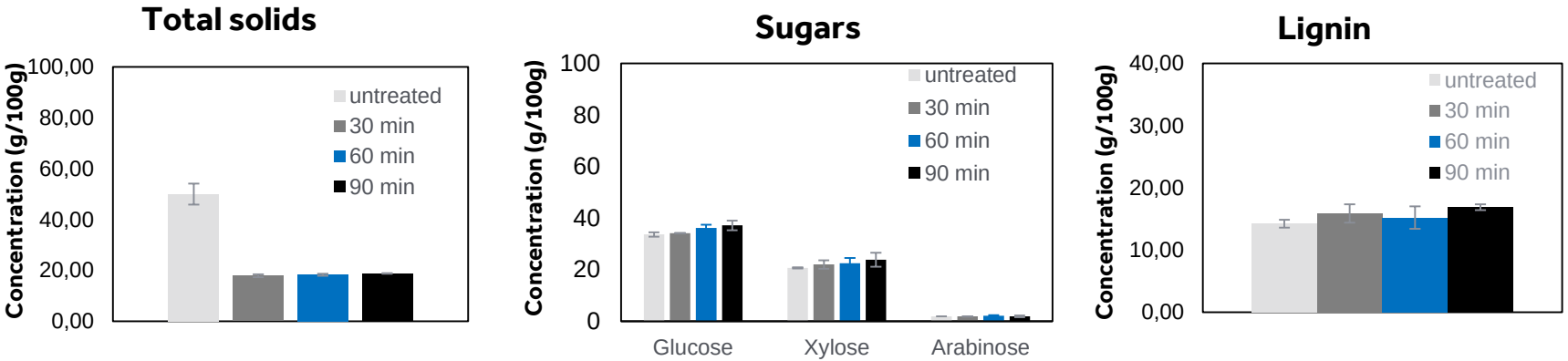
- Effect of different retention times in a thermal pre-treatment and the correlation between this and the organic load rate of mesophilic anaerobic bioreactors
- Introducing the liquid part of the thermal pretreatment in AD systems and assessing its effects
- Modeling the biomethane production data of the experiment using an one phase exponential model

# MATERIALS AND METHODS

- Batch mode (mesophilic conditions)
- Inoculum :The effluent of a full scale biogas plant (digesting crops )
- Substrate: Wheat straw (WS)
- Pretreatment: high temperature (140 °C) and pressure (2.75 bars))
- Retention times (0, 30, 60 and 90 minutes)
- OLR (2, 4, 8 and 12 Kg VS/$m^3$ )

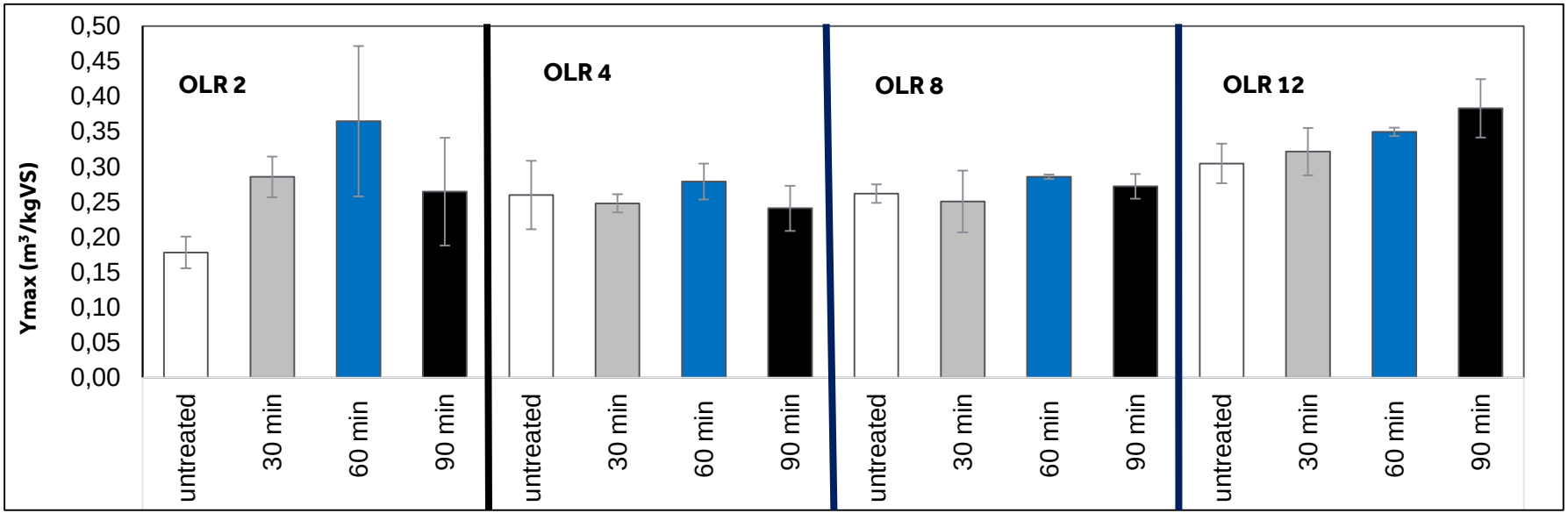
# EFFECT OF THE PRE-TREATMENT ON THE WS

University of Reading



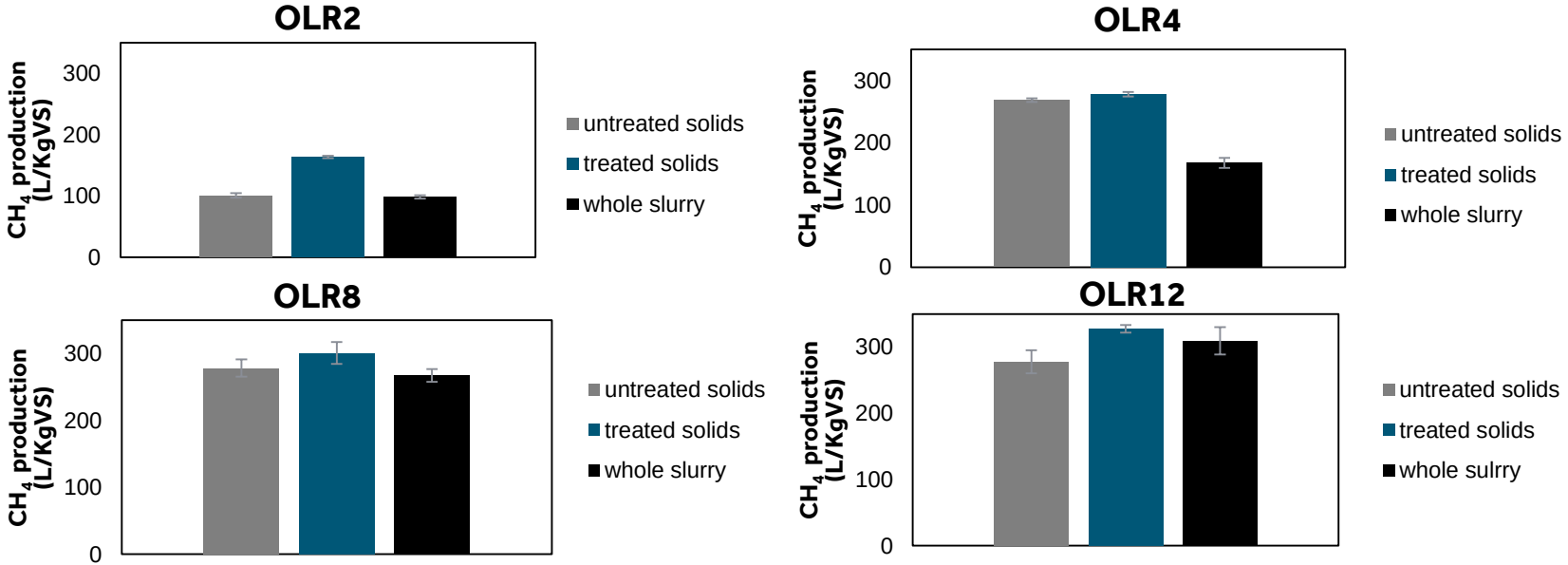

- The pores of the substrate were opened and the water absorption from the WS increased
- Part of the sugars were released from the lignocellulosic structure and passed into the liquid phase (no washing step was carried out)
- The increase trend in lignin concentration can be attributed to the formation of cross-linked aromatic compounds due to the pre-treatment

# $CH_4$ PRODUCTION (L/KG VS)




- $Y = Ymax\ (1 - e^{-k(t-t_{lag})})$
- OLR of 2 kg/ m³, a retention time of 60 min was more efficient
- OLR of 12 kg/ m³, a pre-treatment of 60 or 90 min led to increased biomethane production

# EFFECT OF THE LIQUID ADDITION




- AD systems with lower organic loads seemed to be more affected by the addition of the liquid fraction of the pre-treatment
- It is believed that the amount of active microorganisms is playing vital role for the digestion of the thermal treated samples

# CONCLUSIONS

- Thermal pre-treatment was successfully applied on WS prior to anaerobic digestion.
- This specific pre-treatment seems to have different effect on the process under different OLR.

1. OLR of 2 kg/ $m^3$ favoured 60 min treatment
2. OLR of 12 kg/ $m^3$ favoured 60 or 90 min treatment

- Anaerobic bioreactors are more likely to handle higher OLR when fed with thermally pre-treated lignocellulosic biomass. In that way, higher volumetric methane yields can be achieved, maintaining the biogas output of existing Plants.

University of Reading

# GREAT THANKS

futurebiogas

EPSRC
Engineering and Physical Sciences Research Council

**Supervisors team:** Dr. Kimon-Andreas Karatzas*, Dr. Aphrodite Chatzifragkou, Dr. Denise Cysneiros
**Dr. Karatzas group:**
Marcia, Carolina, Ruth, Oluwabunmi and Ranju

Contact: k.karatzas@reading.ac.uk
f.Kaldis@pgr.reading.ac.uk