Departamento de Energias Renováveis
Department of Renewable Energy

LNEG – Laboratório Nacional de Energia e Geologia
National Laboratory of Energy and Geology

Anaerobic digestion of Olive Mill Wastewater: Anaerobic Filter vs. Hybrid

Isabel Paula Marques
isabel.paula@ineti.pt

Marta Gonçalves and Paulo Freitas

Bioenergy – II: Fuels and Chemicals from Renewable Resources
8-13 March 2009, Rio de Janeiro. Brasil


FRANÇA
PORTO
ESPANHA
LISBOA
ALGARVE
PORTUGAL

Olive tree → **olives (fruit)** → **olive oil**

Olive oil industry

Great economic and social importance: Mediterranean area

[Olives are also cultivated: USA, Argentina, Australia and South Africa]

5 kg olives

5 L OMW

1 L olive oil

Anaerobic digestion of OMW: anaerobic filter vs. hybrid

OMW

[three-phase extraction system]

OMW

- generated in huge quantities
- during a short period of the year
- one of the most polluting agro-industrial effluents

OMW holds a great energetic potential (Biogas)

Anaerobic digestion - OMW

promising attempt to face the negative environmental impact

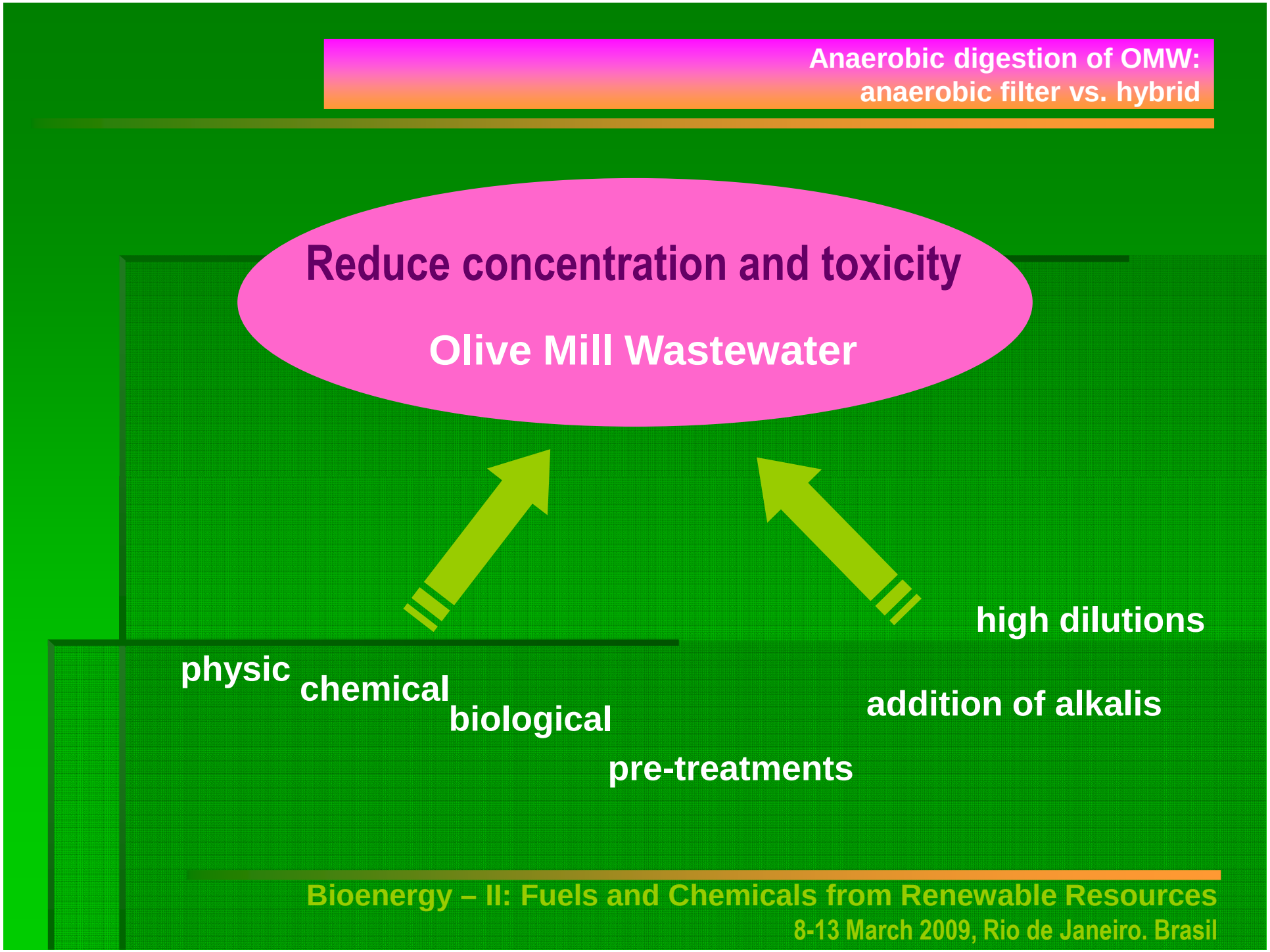
- high organic matter of these effluent (200 kg COD m-3)
- lower: sludge volumes, space requirement and capital cost - aerobic proc.,
- easily restarting after several mouths of shutdown,
- low energy requirement for operation,
- recovering the valuable end-product **--- methane**

Olive Mill Wastewater - OMW

- inhibiting substances (phenolic lipidic-LCFA)
- unfavourable C/N ratio
- acid pH

render

OMW inappropriate
direct biological treatment


Reduce concentration and toxicity
Olive Mill Wastewater
physic
chemical
biological
pre-treatments
high dilutions
addition of alkalis

OBJECTIVE: treat and recover the energetic potential of the raw OMW anaerobic digestion

Successful digesting stability is obtained

"complementary substrate" concept

Depart. of Renewable Energies - LNEG

- without any pre-treatment
- tap water dilution
- chemical correction of OMW

OMW: composition + seasonal effluent

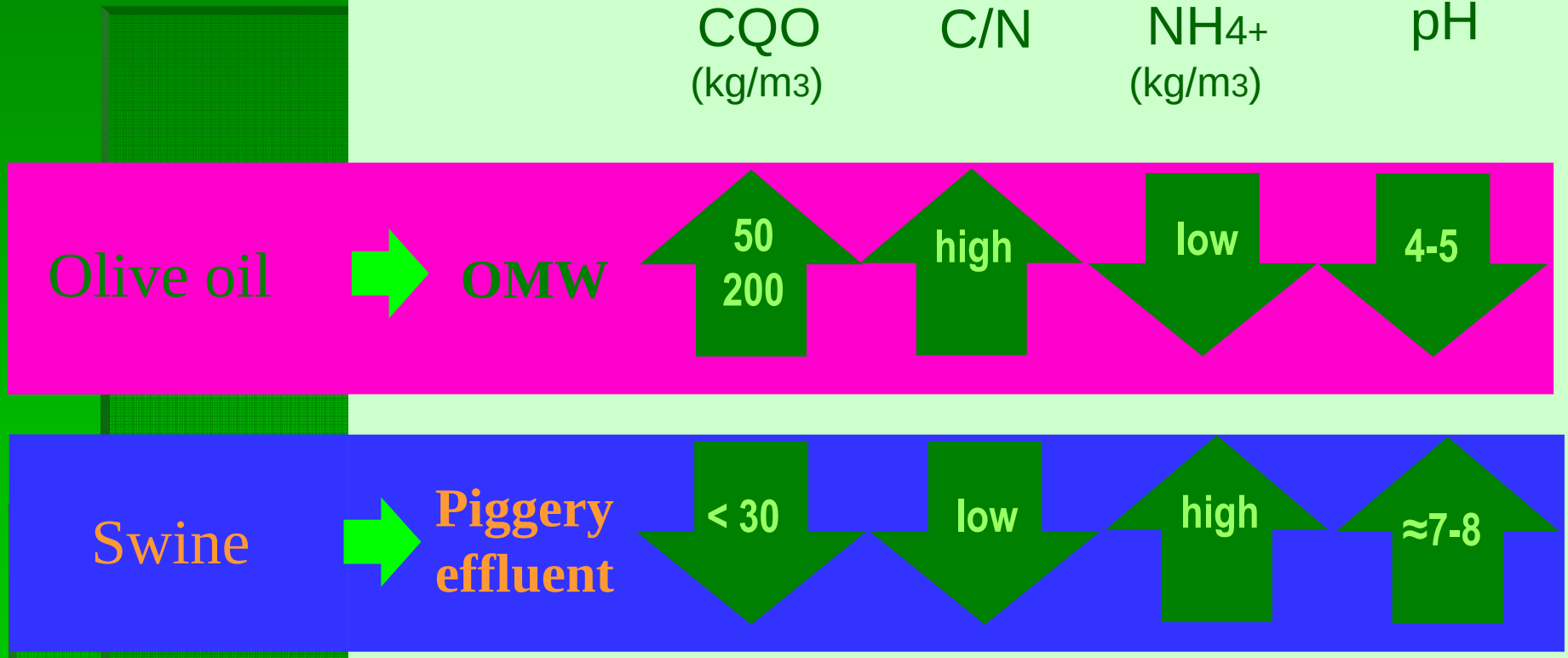
Another effluent: continuously produced - same region

+

able to complement OMW

Piggery effluent to secure a stable operation year-around

Anaerobic digestion of OMW: anaerobic filter vs. hybrid



Olive Mill Wastewater

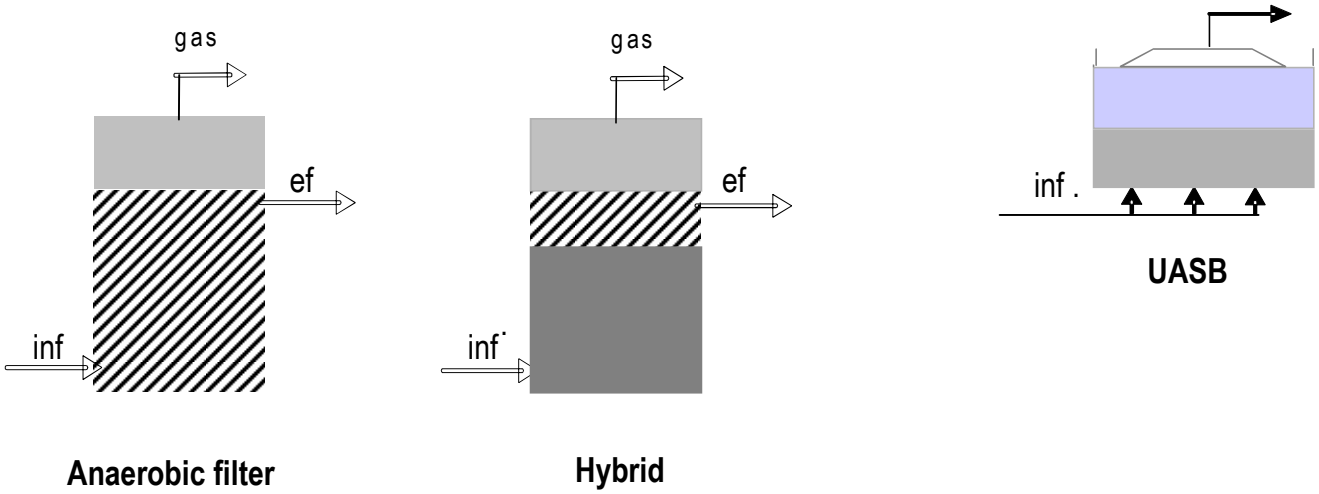
Piggery effluent

dilute and to supplement (N, P)

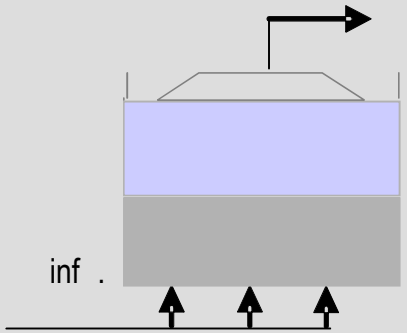
+

- decrease - inhibiting capacity
- more favourable C/N ratio
- pH values

OBJECTIVE: Anaerobic Filter vs. Hybrid

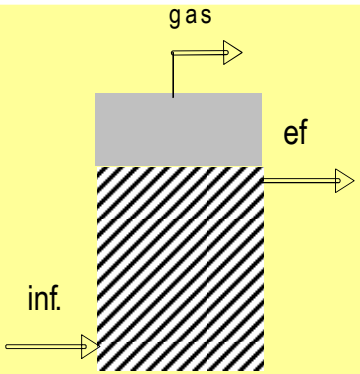


Operational difficulties



UASB

Washout – overload
concentrated effluents



Anaerobic filter

[concentrated effluents]
Channelling - Column clogging

Packing bed material – Lab.

AF classic problems

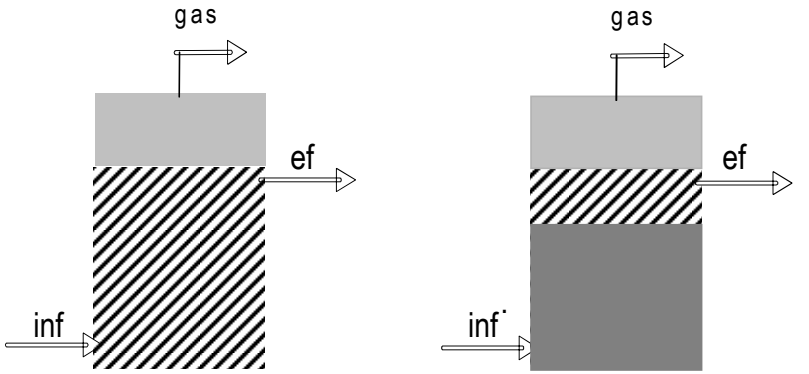
Packing bed material – Lab.

good progress

several long-term experiments

no troubles as a result of a clogging process

OBJECTIVE: Anaerobic Filter vs. Hybrid



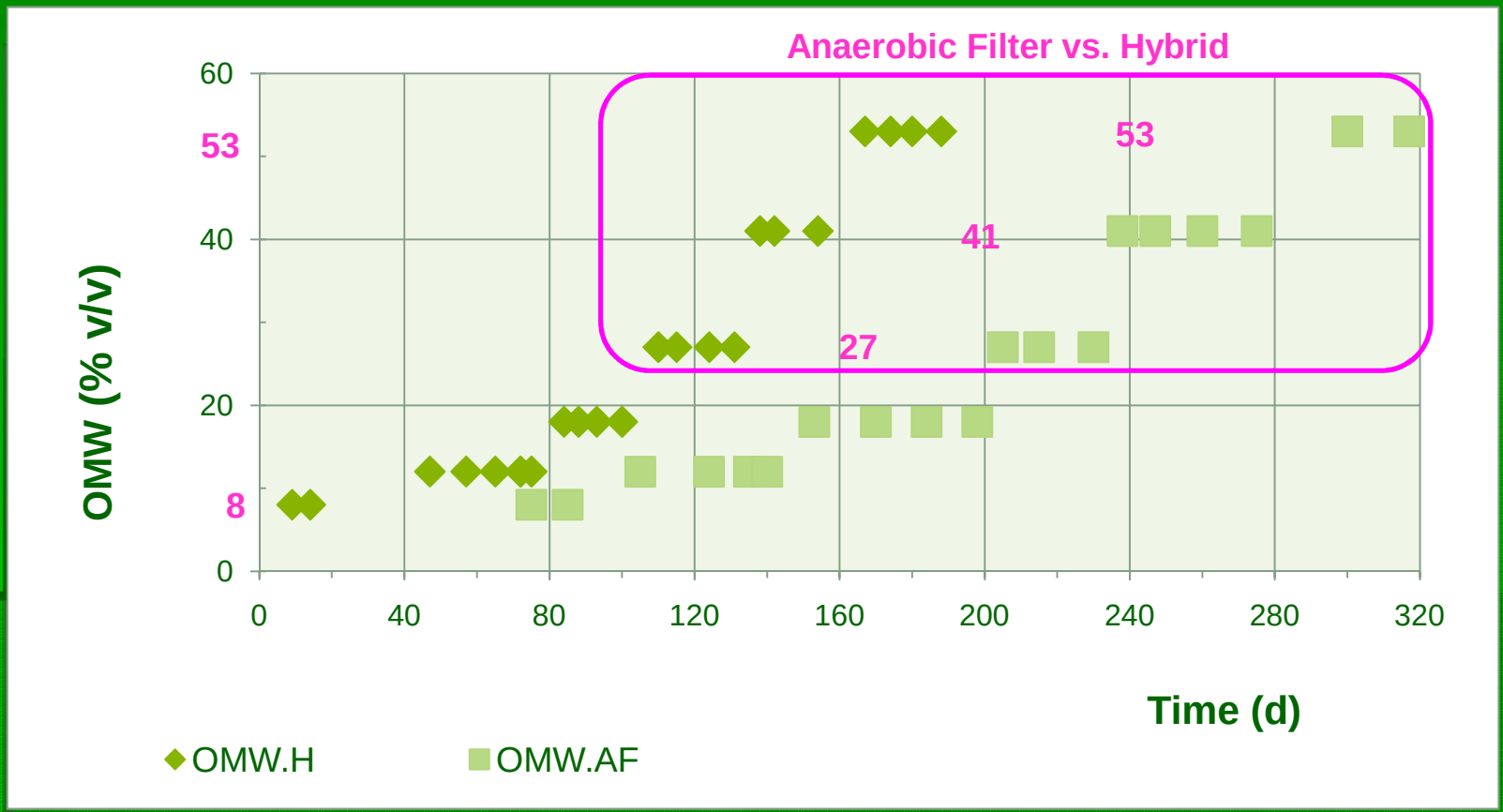
economic issue:

least of packing material required

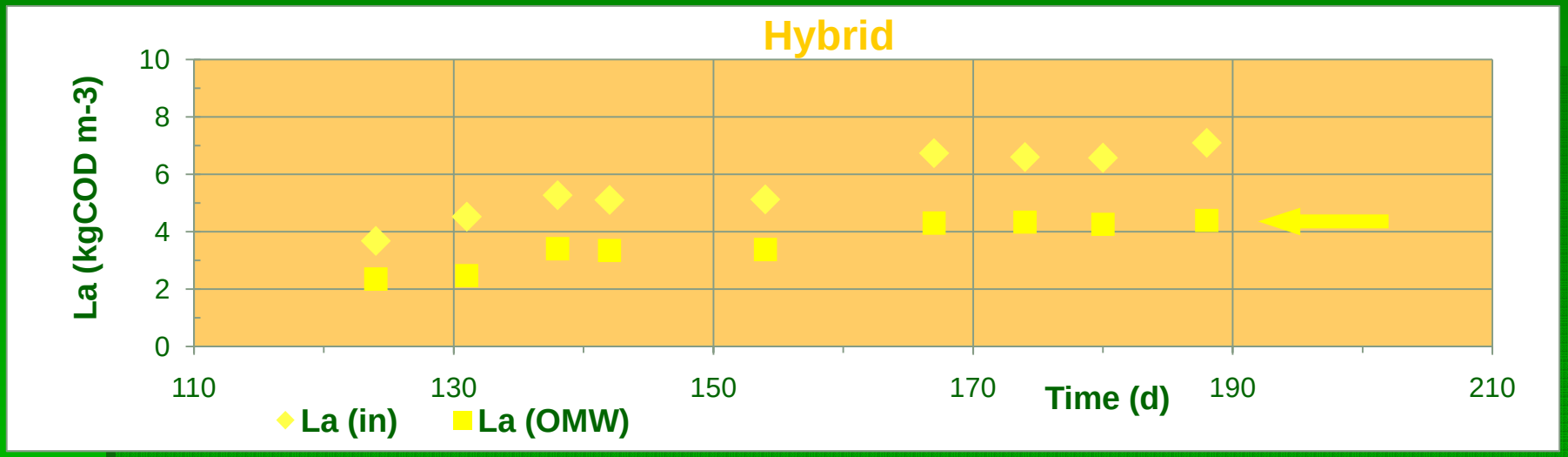
Anaerobic digestion of OMW: anaerobic filter vs. hybrid

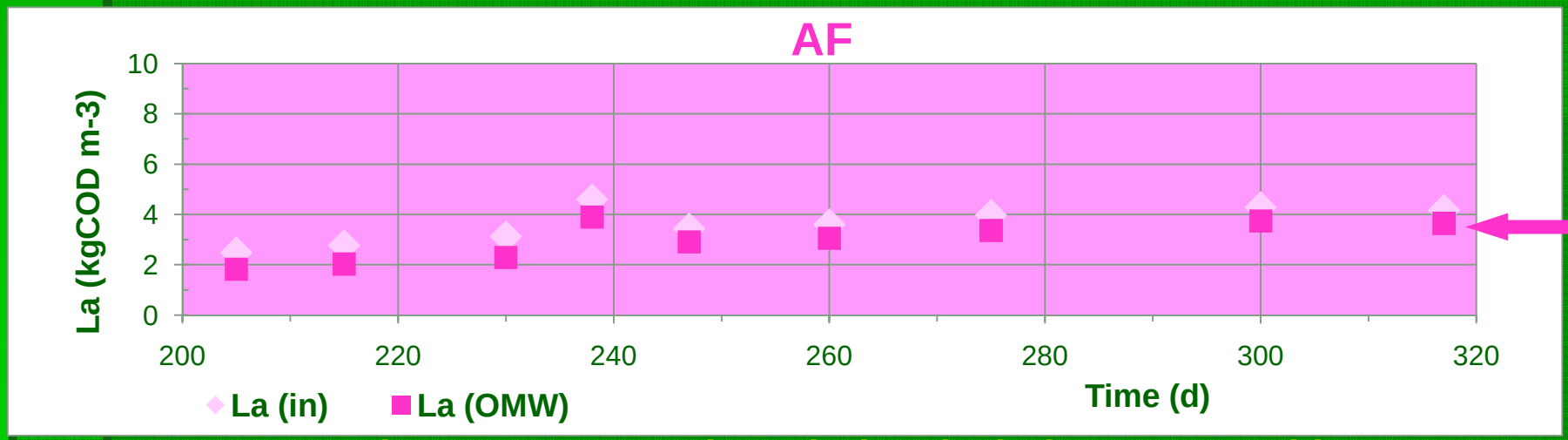
packing material = 30% reactor height

Operational conditions

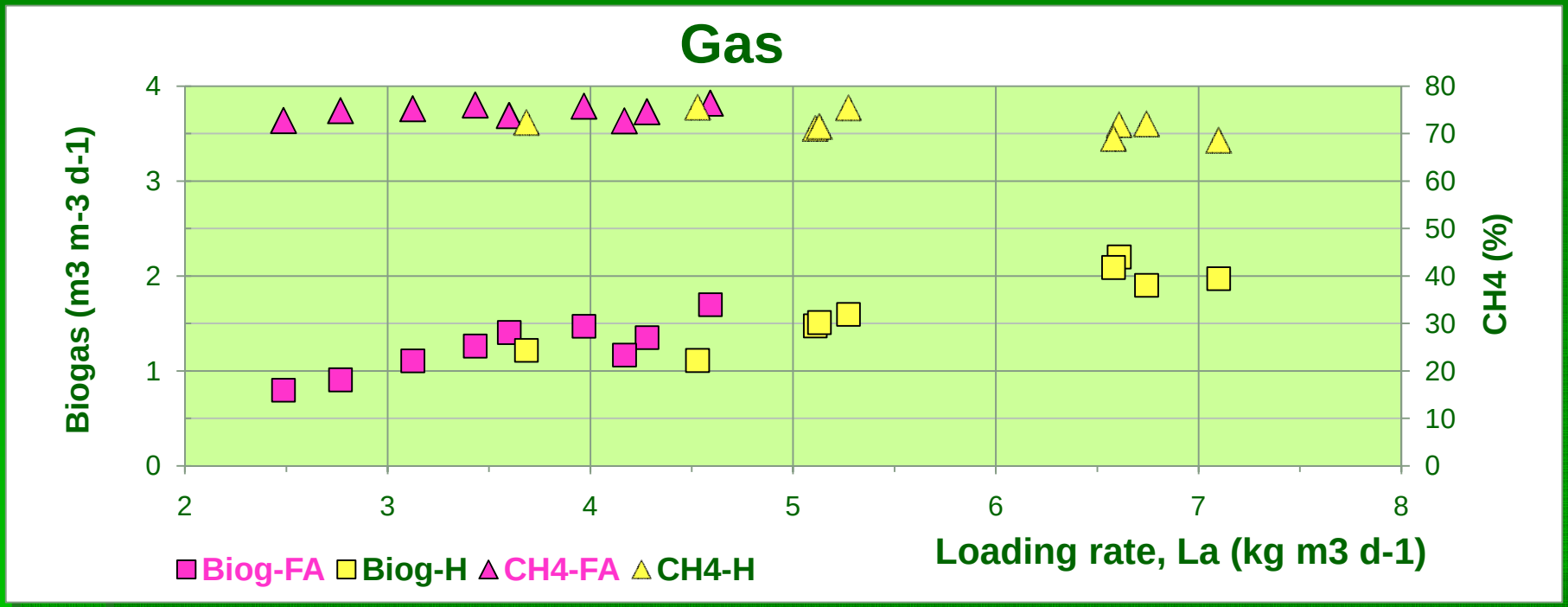


Operational conditions



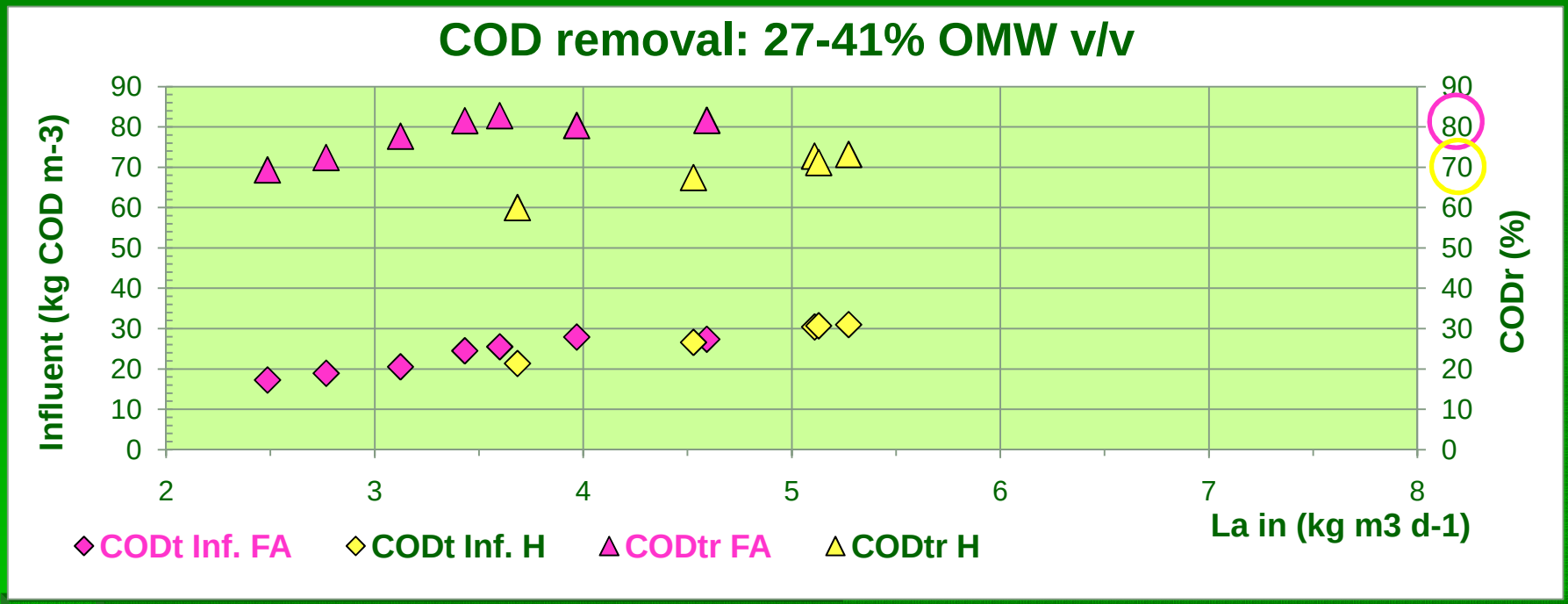


Results



Gradual increase of biogas production – increment LA
Good methane content

Results



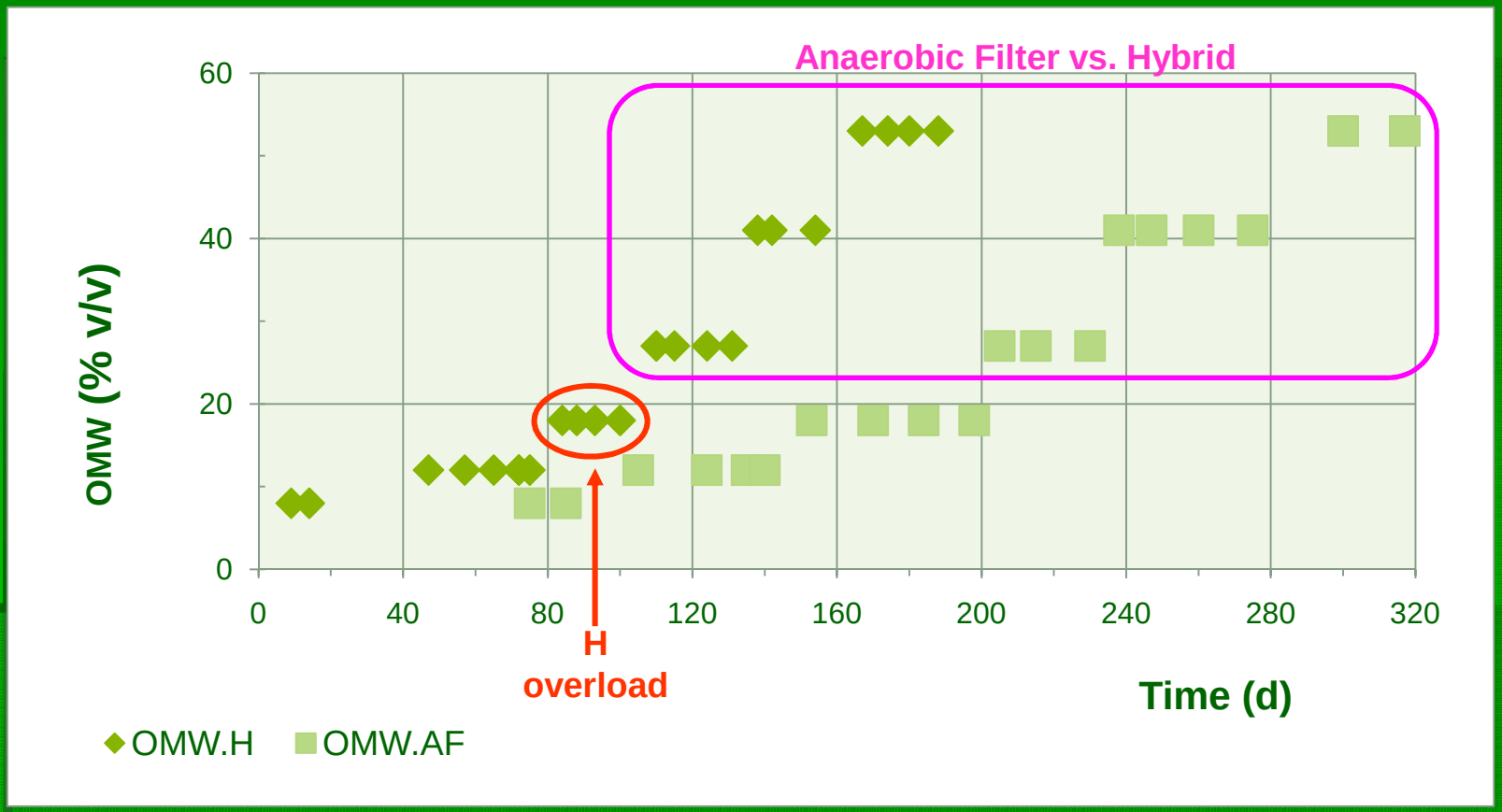
AF ≠ H = COD removal

Results. *Solids removal*: 27-41% OMW v/v

	AF	H
TS (%)	51-63	22-50
VS (%)	60-76	41-67
VSS (%)	66/80-96	5/55-69

Some comments are needed to better understand the finding

Operational conditions



Sharp change in sludge bed

The blanket of biologic solids went upwards
and penetrated the fixed bed section

Some biomass was lost - not cause the failure

[18% OMW]

La = 5.3-9.5 kg COD m^{-3} d^{-1} (31-55 kg COD m^{-3})

Gas - 1.3-2.1m^3 m^{-3} d^{-1}

COD removal - 57-65/69%

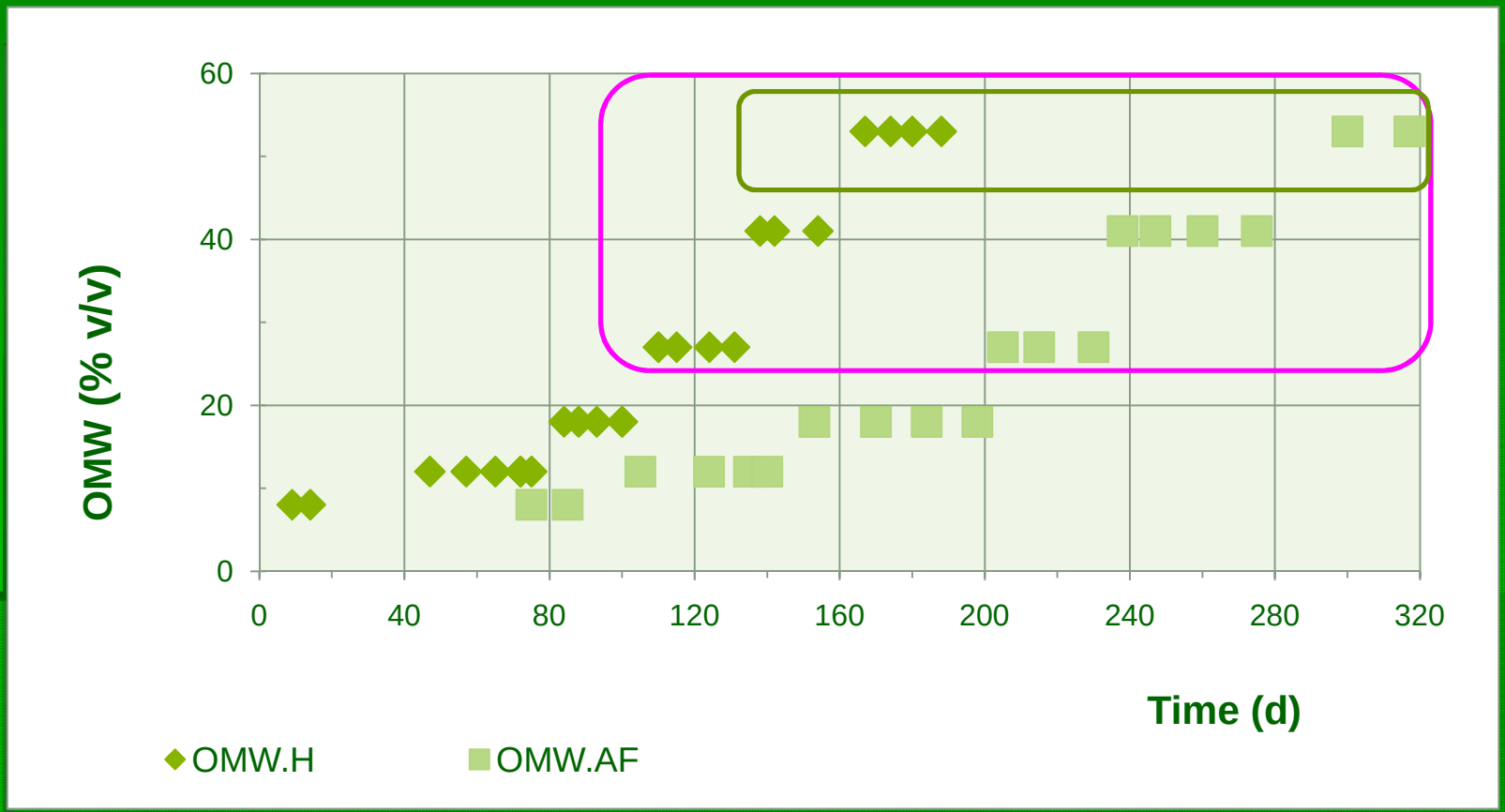
ability of resisting

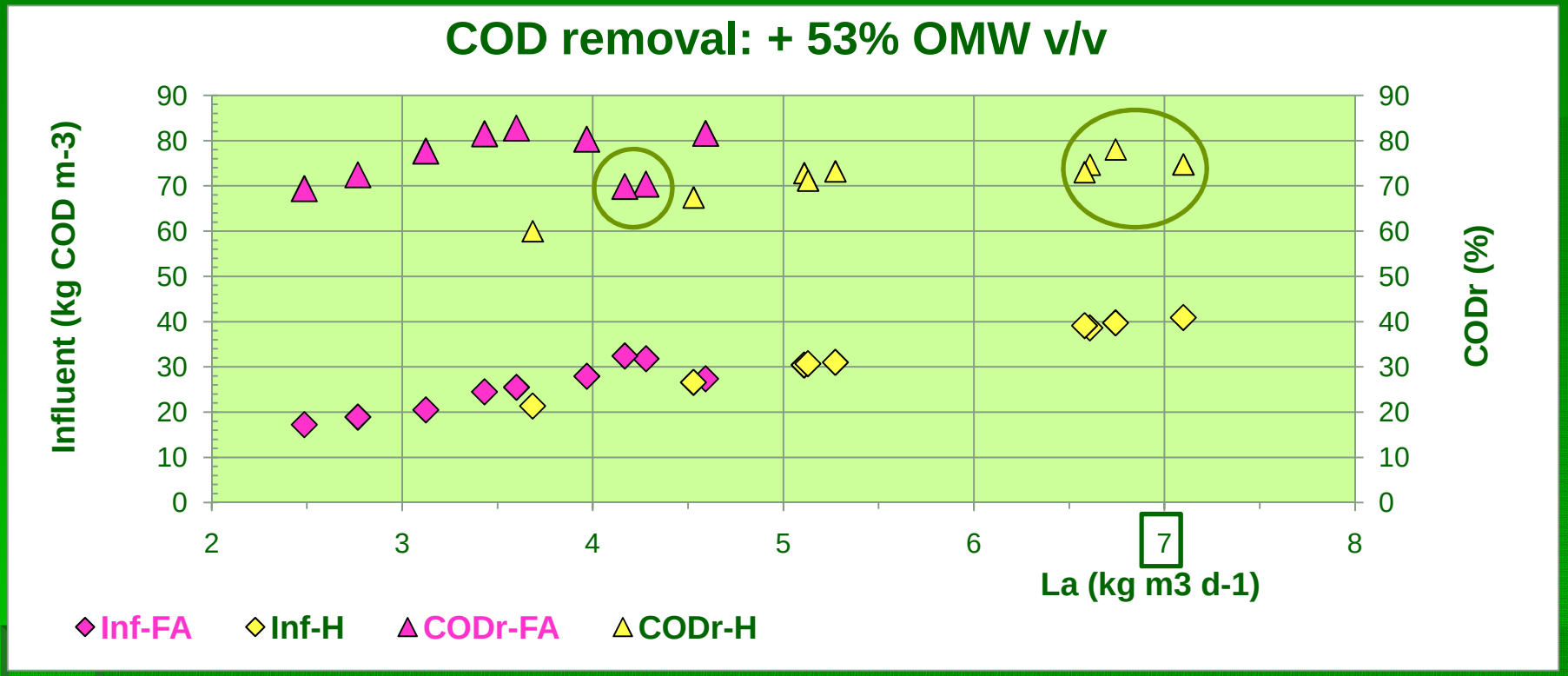
H - overloading

was tested - new influent

previous plan of work (27% OMW v/v)

Operational conditions





≠ digesters behaviour = AF ↓ . H↑

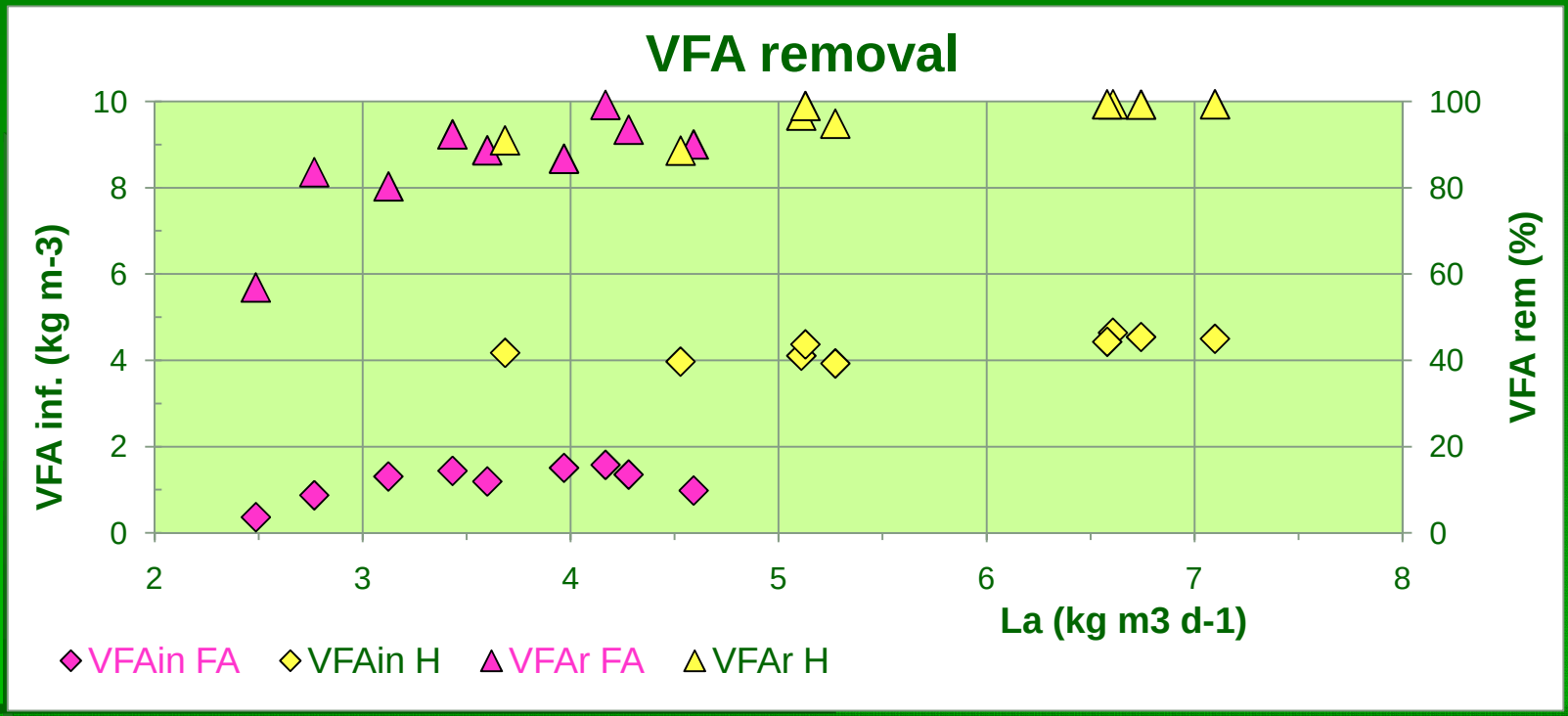
RESULTS

H digester: remaining packing material - 1/3 height

Effective
effects - accidental overload

The maintenance of a sufficient amount of biomass inside the unit allowed preventing the process failure

Anaerobic digestion of OMW: anaerobic filter vs. hybrid



Hybrid: VFA = ≈ 4 times more concentrated

Conclusions

Anaerobic filter and hybrid: can be used to treat the raw OMW
(without any pre-treatment or chemical correction)

AF ≠ H (27 and 41% OMW v/v) = COD and solids removal
AF=69-83% vs. H=60-73%
[overload (18% OMW v/v)]

H recovery process → packed bed material was effective
in preventing the excessive loss of biomass

Confirmation → better performance of H than AF (53% OMW v/v)
[COD removal: AF = 80 → 70%, H = 73-78%]

Conclusions

Anaerobic Filter vs. Hybrid

Important issue related to the applicability of the Hybrid

Anaerobic digestion of Olive Mill Wastewater

is the lower costs related to the amount of packing material

Acknowledgements

FCT Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR

financial support project PTDC/ENR/69755/2006
and the grant given to Marta Gonçalves SFRH/BD/40746/2007.

Departamento de Energias Renováveis
Department of Renewable Energy

LNEG – Laboratório Nacional de Energia e Geologia
National Laboratory of Energy and Geology

Anaerobic digestion of Olive Mill Wastewater: Anaerobic Filter vs. Hybrid

Isabel Paula Marques
isabel.paula@ineti.pt
Marta Gonçalves, Paulo Freitas

Thanks for your attention

Bioenergy – II: Fuels and Chemicals from Renewable Resources
8-13 March 2009, Rio de Janeiro. Brasil