Introduction to Anaerobic Digestion Engineering Part 1a
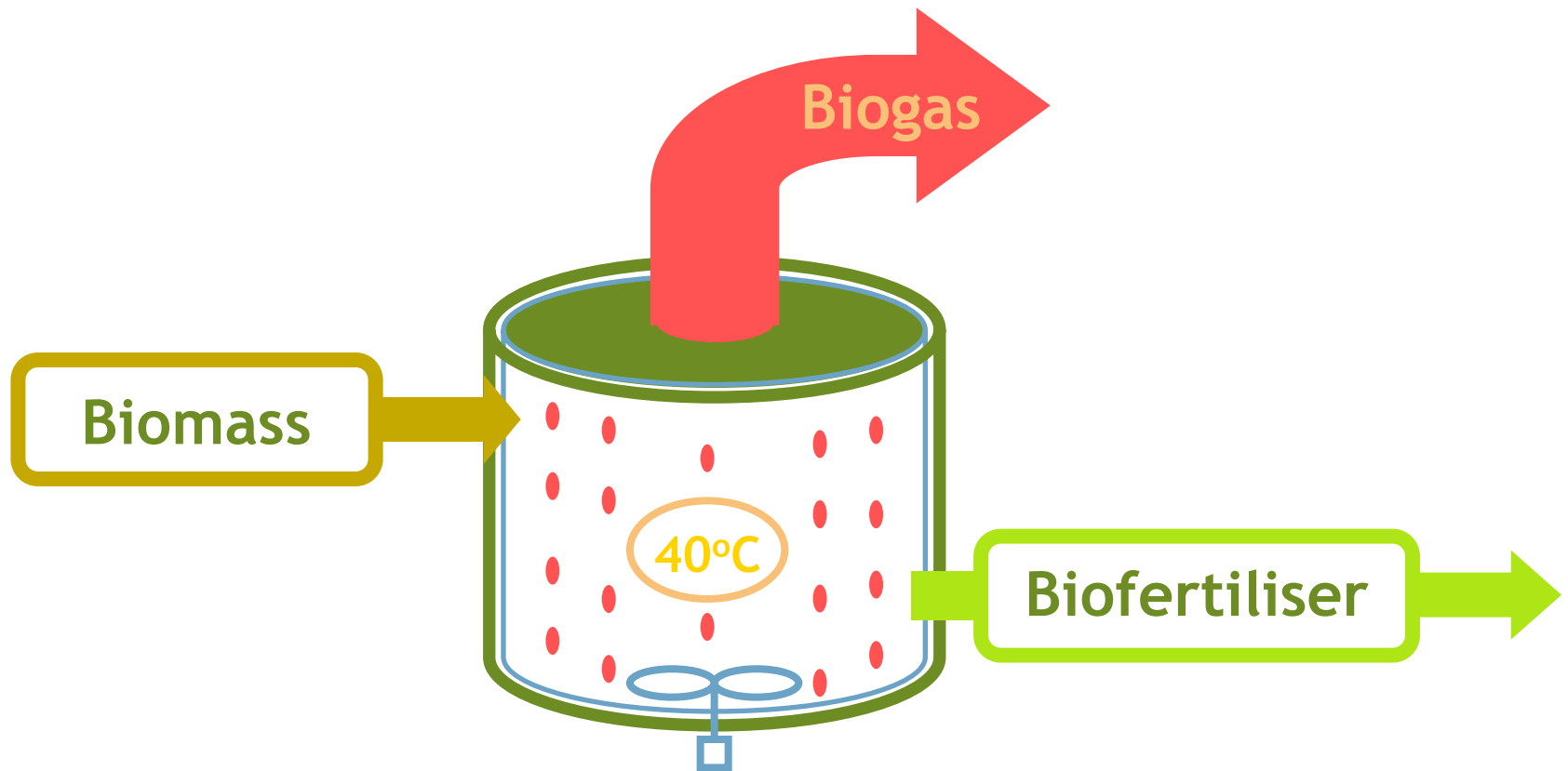
Michael Chesshire

University of Southampton
&
Evergreen Gas Ltd

UNIVERSITY OF Southampton

Jyväskylä Summer School 2013

EvergreenGas

Anaerobic digestion - a natural biological process

Biogas

Biomass

40°C

Biofertiliser

UNIVERSITY OF Southampton

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AD Engineering

- Part 1a
- Reactor types and sizing.
- Part 1b
- Plant components – mixing, heating, feeding, etc..
- Part 2
- Gas storage & energy conversion
- Mass balance
- Energy balance

Energy

Digestate

Design

Feedstock

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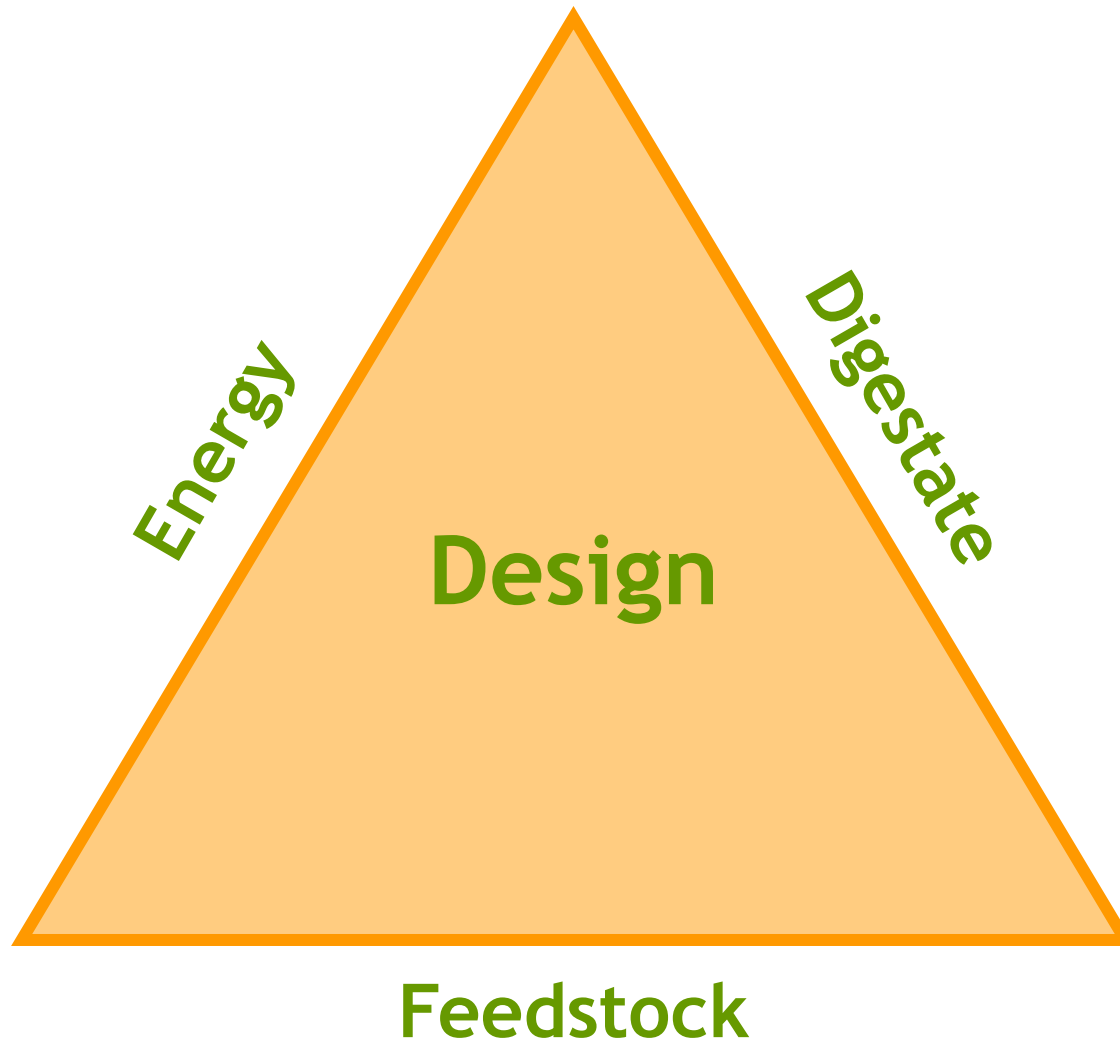
Reactor Type - CSTR or Plug Flow

- CSTR is "Continuous Stirred Tank Reactor", where the digester contents are fully mixed & homogenous, and is the most common form of digester design.

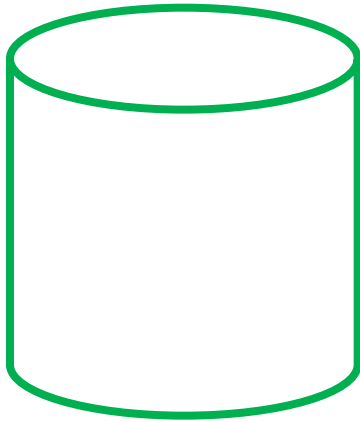- "Plug Flow" is where the feedstock enters the digester at one end and flows to the opposite end.

CSTR

Plug
Flow

Reactor Shapes

Tank Construction

- Reinforced concrete
- Brick
- Steel – welded or enamelled
- Plastic – e.g. glass reinforced polyester
- Other – e.g. wood
- Tank insulation

Concrete

Brick

Steel

GRP

Insulation

Reactor sizing

Key feedstock parameters:-

- Volume ($m^3.d^{-1}$) or mass (tonne.d^{-1})
- % dry matter (%DM)
- % organic dry matter (%ODM)
- Biological methane potential (BMP)

Rate limiting parameter no.1 (HRT)

- **Hydraulic retention time:- HRT (d)**

  HRT = reactor volume (m^3) ÷ feed rate ($m^3.d^{-1}$)

- **Tends to be rate limiting parameter for low solids feedstocks (e.g. <12%DM)**

  Reactor volume (m^3) = feedstock ($m^3.d^{-1}$) x HRT

- **Typical HRT = 20 to 40 days**

Rate limiting parameter no.2 (OLR)

- <u>Organic loading rate:</u>- OLR ($kg.m^{-3}.d^{-1}$)
  OLR = ODM ($kg.d^{-1}$) ÷ reactor volume (m^3)

- Becomes rate limiting parameter for high solids feedstocks (e.g. >12%DM)
  Reactor volume (m^3) = $kg_{ODM}.d^{-1}$ ÷ OLR

- Typical OLR = 2.5 to 5.0 $kg.m^{-3}.d^{-1}$

Now Reinhold Waltenberger ….