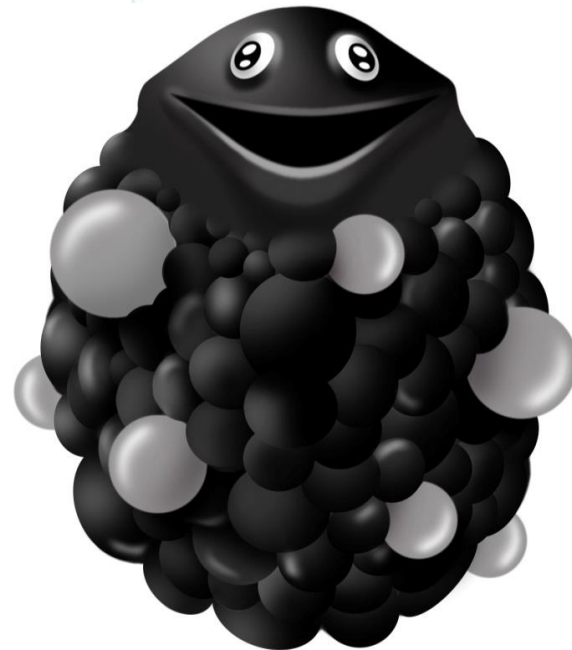


# Major reactor development for anaerobic treatment in the pulp and paper industry

**Norrköping 7 November 2018**

**Leo Habets**

[l.habets@paques.nl](mailto:l.habets@paques.nl)  
+31653827804



**1 History of sludge bed reactor development**

**2 Introduction of a new type reactor**

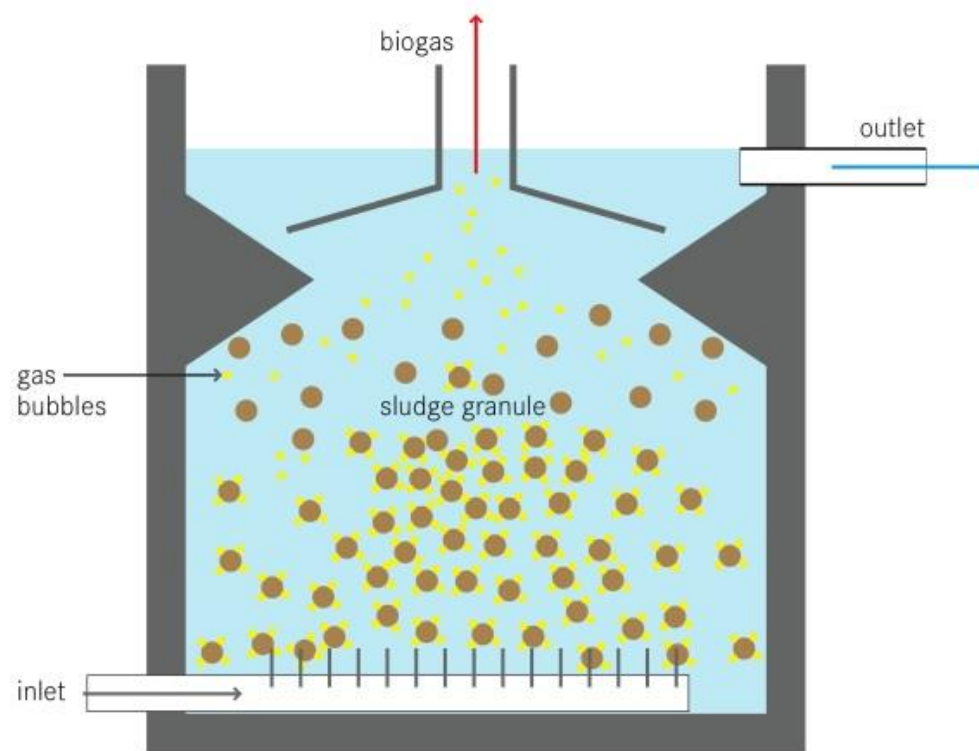
**3 Number of sludge bed reactors in P&P**

**4 conclusions**

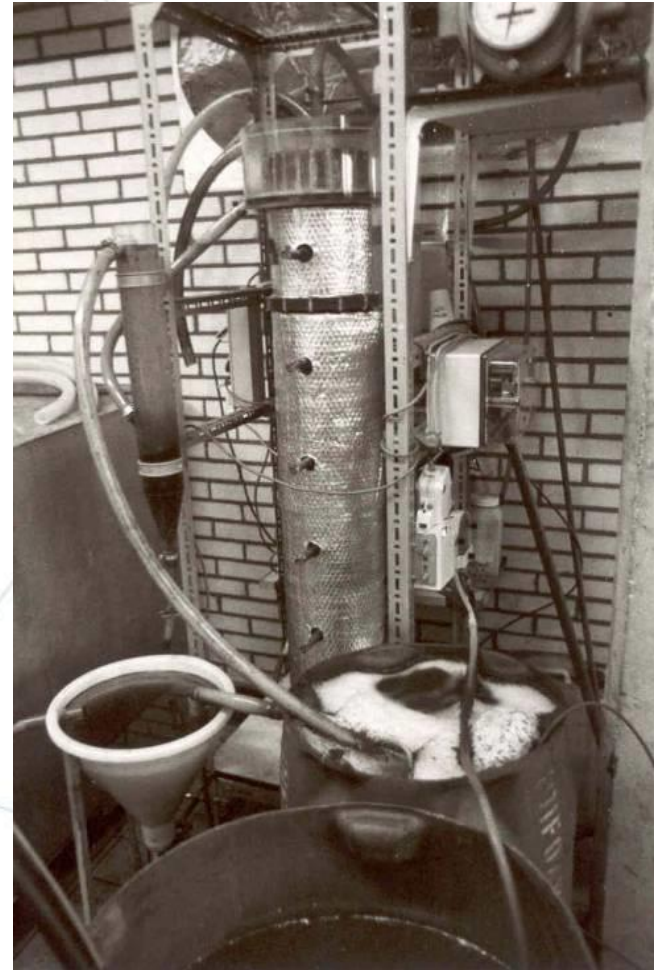
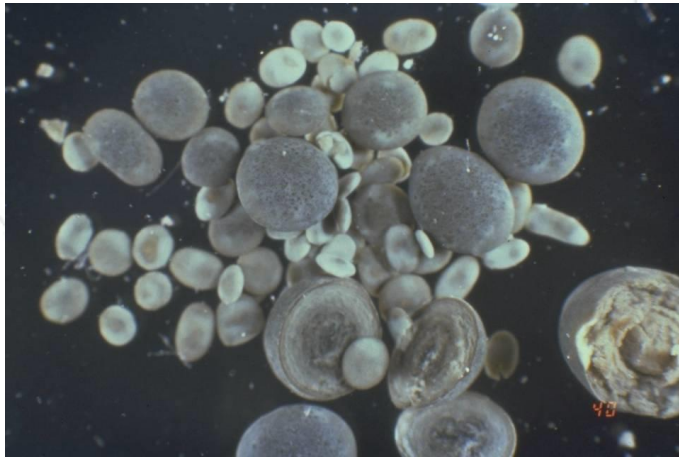
Invented in the 70-ties in Wageningen (group Gatzke Lettinga)

## Upflow Anaerobic Sludge Blanket

UASB



## **Trials started in 1981 at Roermond Papier (NL) confirmed granulation**





## Initial square UASB settler design at Smurfit Kappa Roermond Papier in 1983



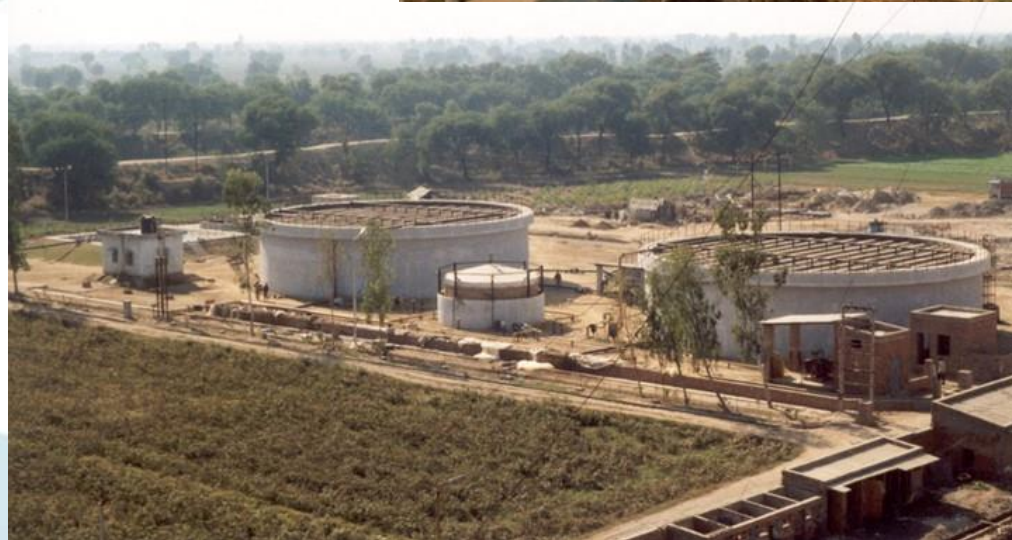
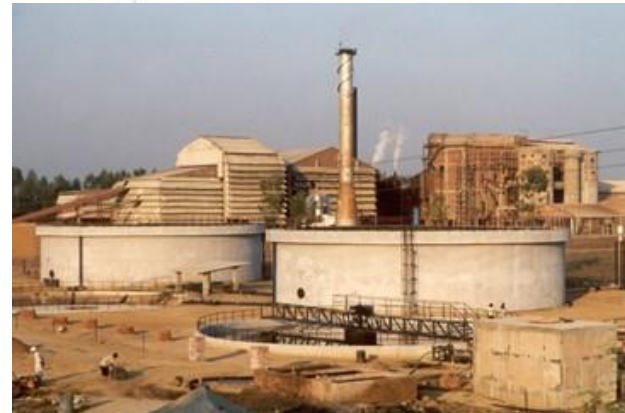
revitalizing resources

# Circular UASB settler design in 1994 and later

## Industriewater Eerbeek 1985



## Satia Paper India 1994





# Move to modular settler design as of 1987

For retrofit



and new



## Standard settler modules



**All piping inside**



## Modular UASB plant design at Paper Mill in Aschaffenburg (1990)



and at SK Zülrich papier  
closed circuit (1995)



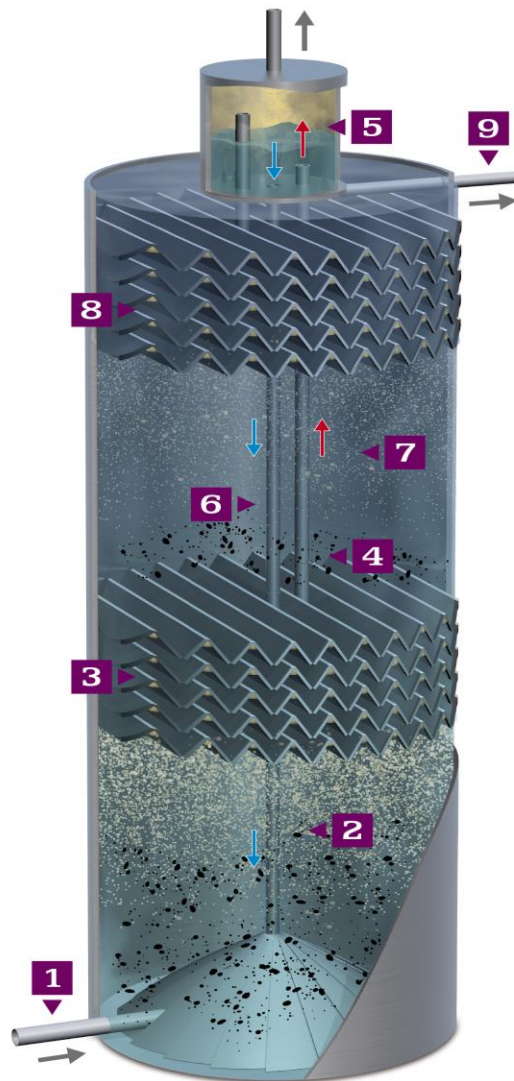
revitalizing resources

Invented at Paques in  
the 80-ties  
(by Sjoerd vellinga of Paques BV)

## Internal Circulation

**IC** reactor

Applied since 1996





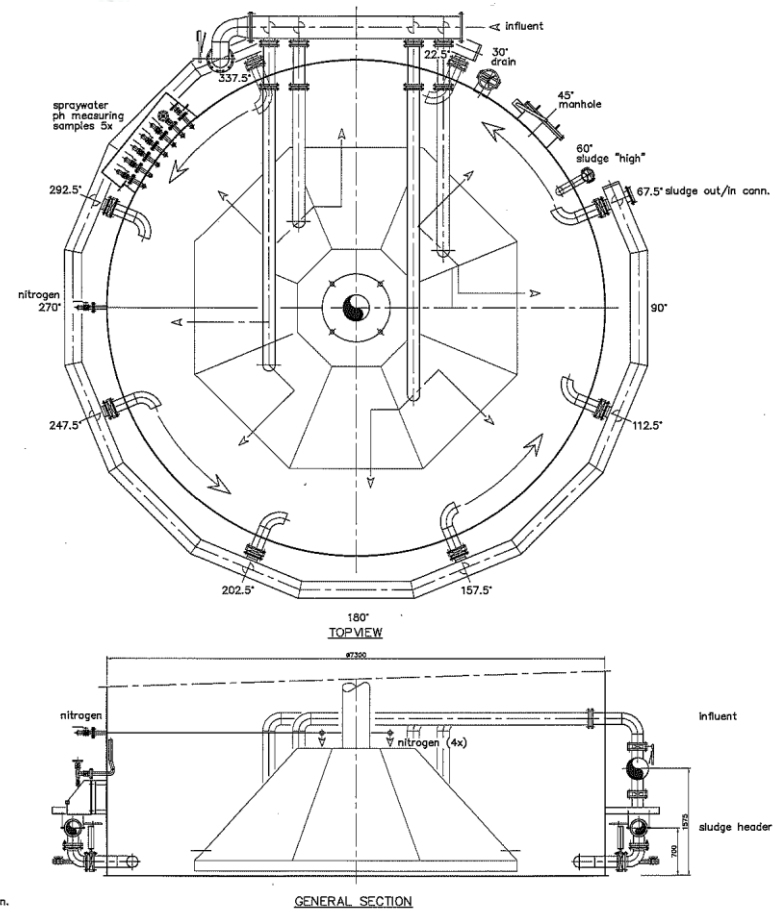
## Need for robust design and good process control



revitalizing resources



# Inlet distribution by “mixing chamber” and sludge extraction by ring line



## Inlet header and sludge extraction ring line



**1 History of sludge bed reactor development**

**2 Introduction of a new type reactor**

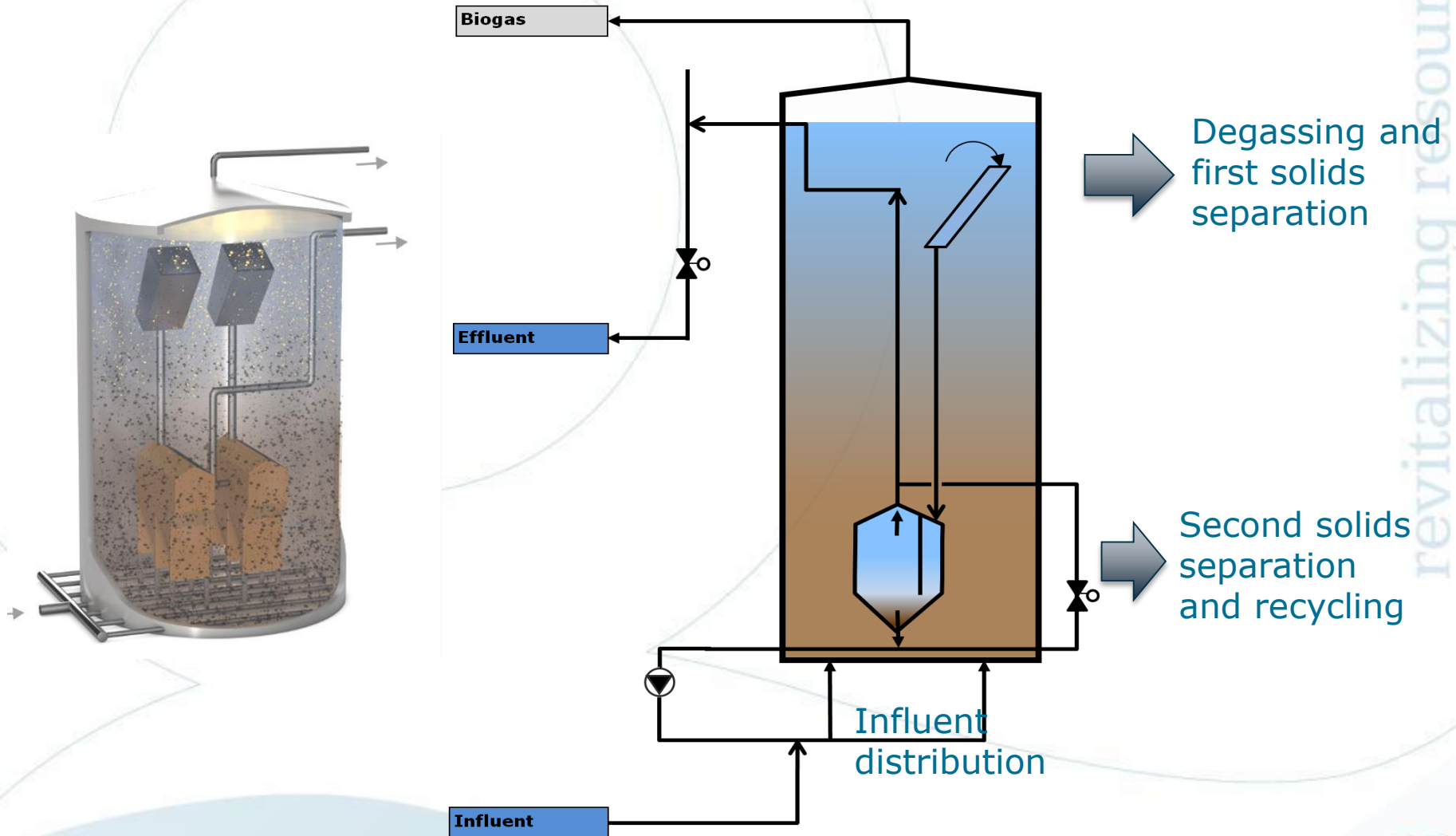
**3 Number of sludge bed reactors in P&P**

**4 conclusions**

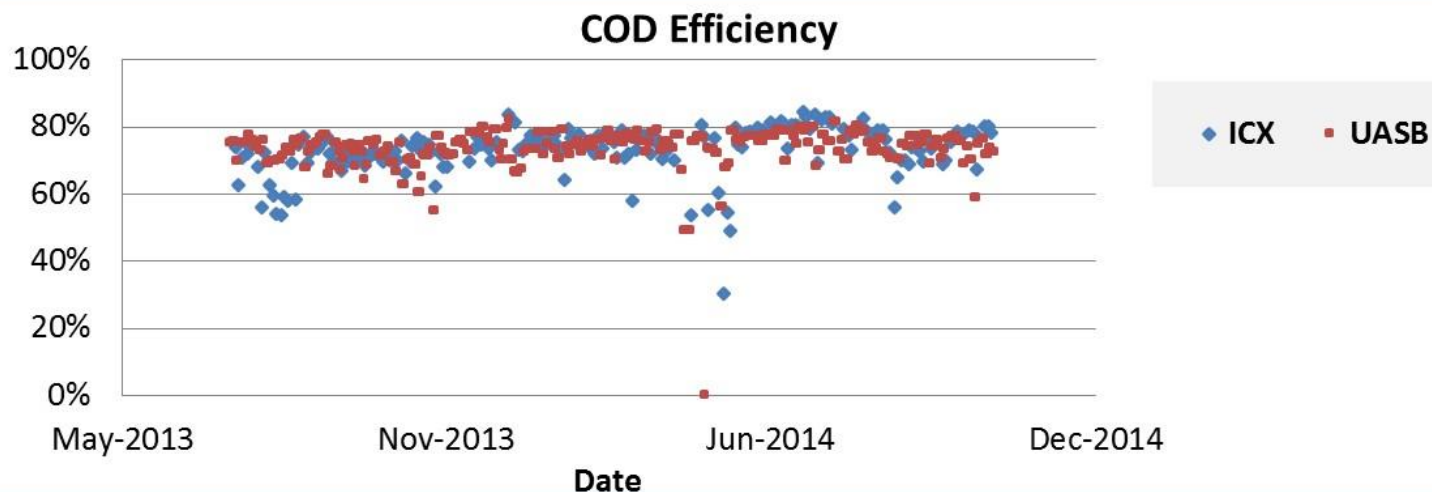
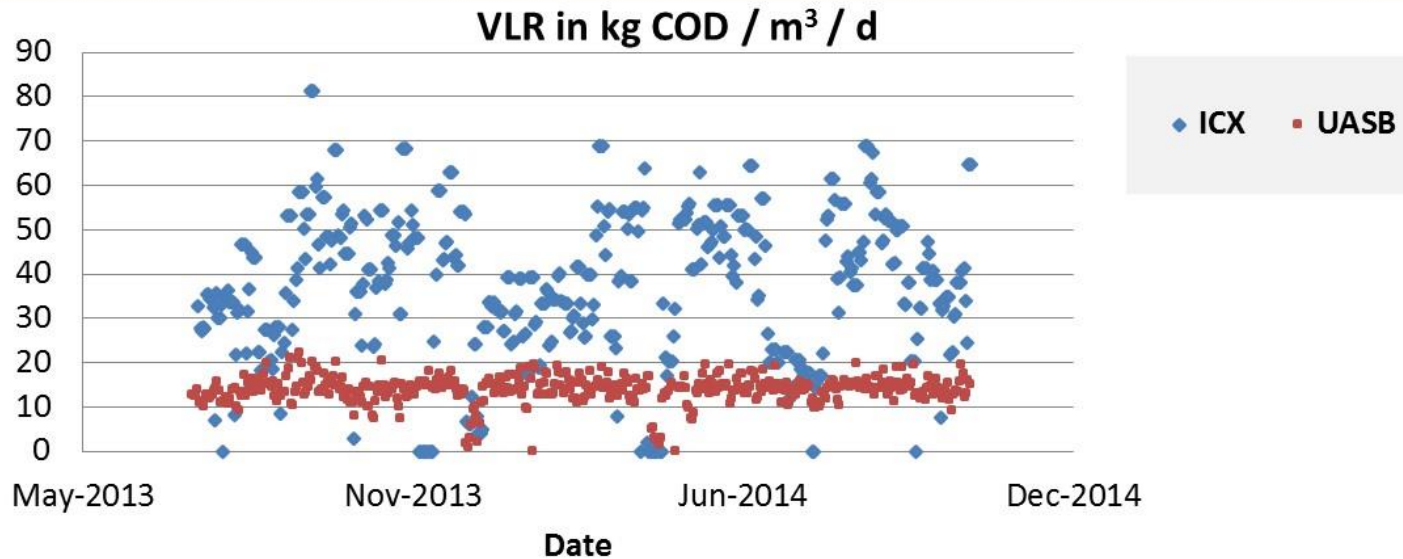


# BIOPAQ ICX reactor schematically

invented by Rienk Prins of Paques BV



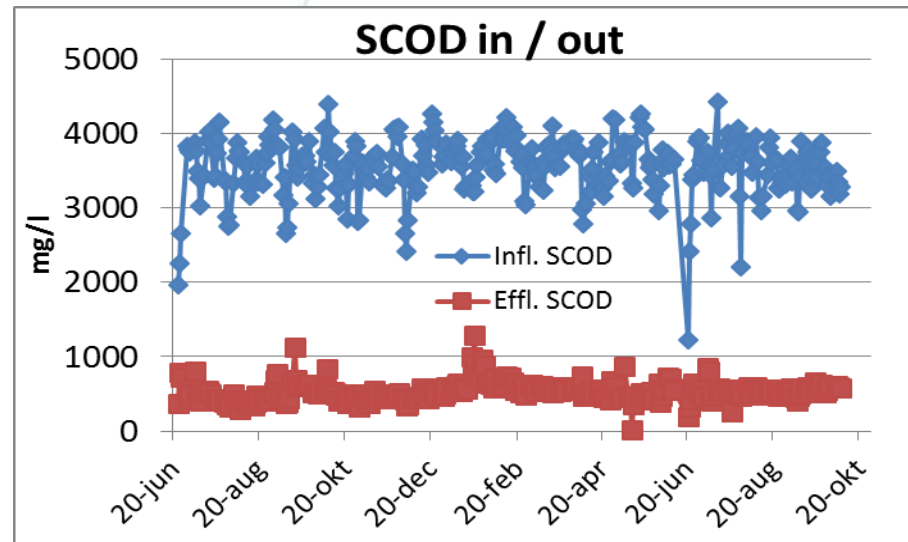
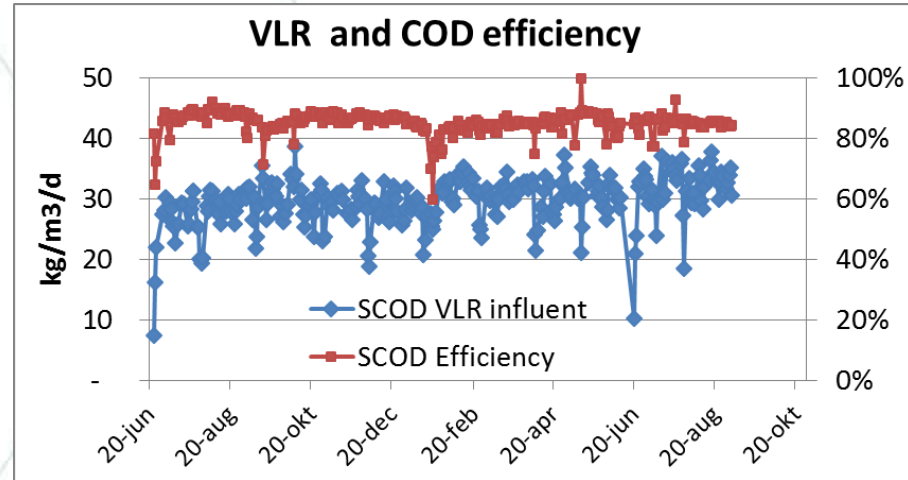
# Results of the 1.5 year 100 m<sup>3</sup> demo ICX in parallel to UASB on paper mill effluent



# First full scale ICX replaces fluidized bed at Allard Emballage in France



Ø4m x 16m (200m<sup>3</sup>)  
6 t COD/d





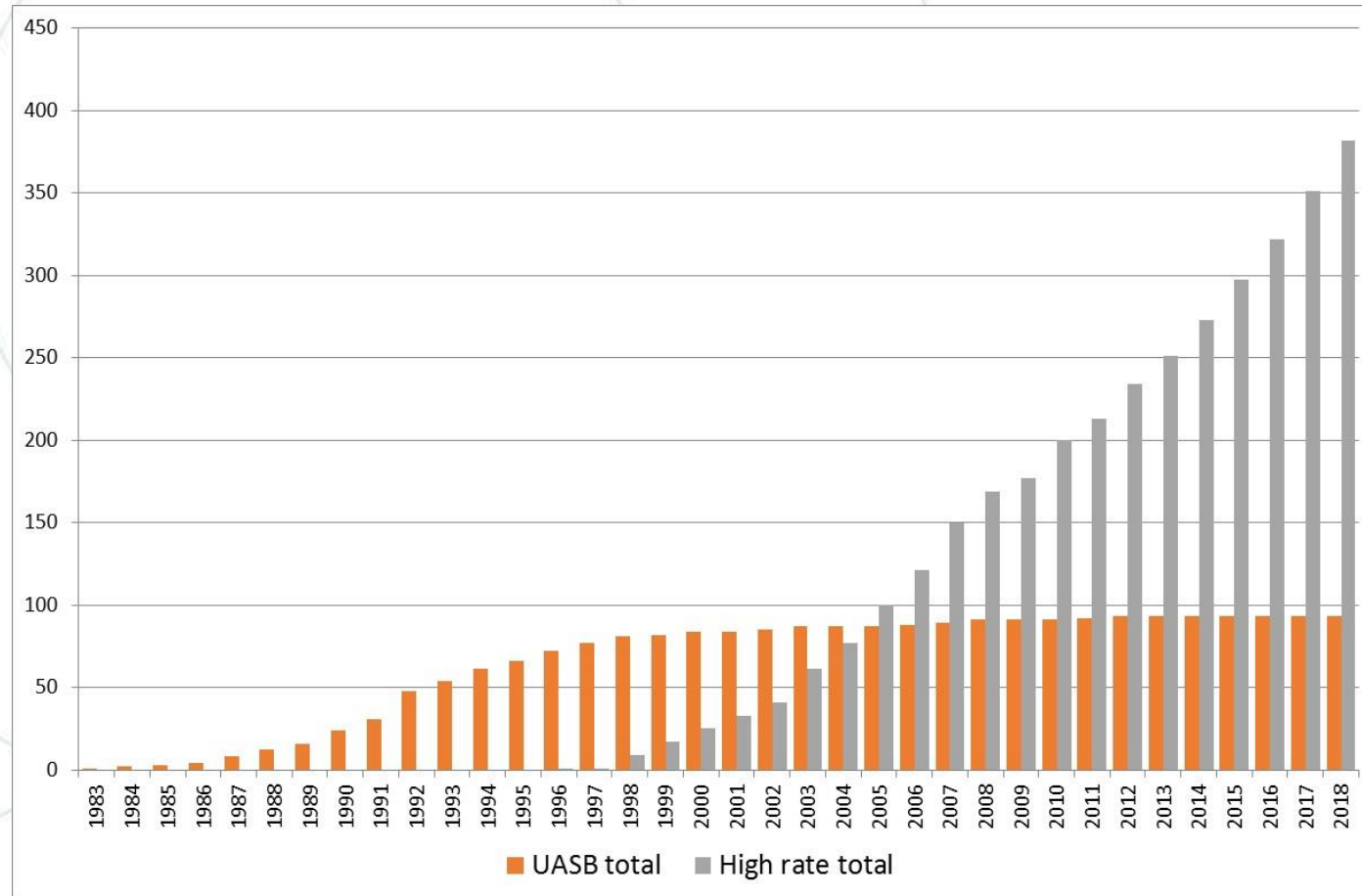
**1 History of sludge bed reactor development**

**2 Introduction of a new type reactor**

**3 Number of sludge bed reactors in P&P**

**4 conclusions**

# Cumulative number of UASB and high rate (EGSB + IC + 'IC' + ICX) reactors in P&P



# Overview of Biopaq anaerobic plants in P&P (2016)

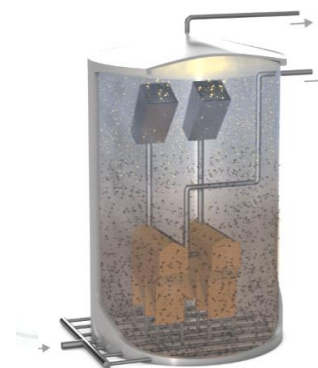
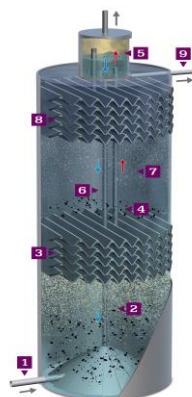
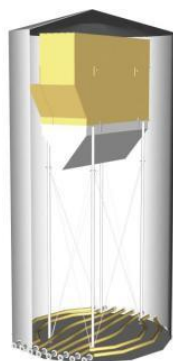
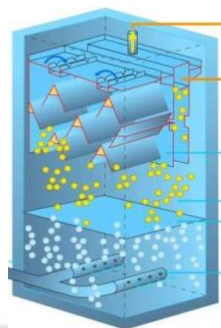


revitalizing resources



# Reactor design parameter comparison

	UASB	EGSB	IC	ICX
Height (m)	5 - 6	14 - 19	20 - 28	14 - 17
Upflow (m/h)	0.8 - 1.0	3 - 6	8 - 12	4 - 8
Typical VLR kgCOD/m <sup>3</sup> .d	10	15	20 - 25	20 - 30



**1 History of sludge bed reactor development**

**2 Introduction of a new type reactor**

**3 Number of sludge bed reactors in P&P**

**4 conclusions**

# Conclusions

- **Continuous move towards smaller footprint and lower cost reactors**
- **More efficient use of volume and flexibility in tank sizing**
- **Robust design and corrosion free internals**
- **Closed reactors to prevent odor; for safety and no effluent overflow weirs to be cleaned**
- **Trend to more modular design**



Thanks all



revitalizing resources