Biotrickling Technology for Air Pollution Control

The 4th Conference on New Environmental Technology

Cheonan, Korea

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Lecturer

- Name
- Profession
- Experience

- References

- Partner in Korea

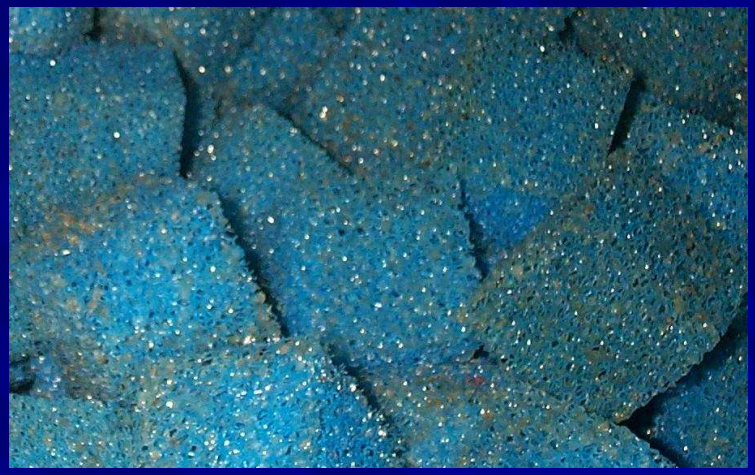
- Jürgen Loy
- Chemical Engineer
- 12 years in the field of Environmental technology and especially in Biological Waste Gas Cleaning

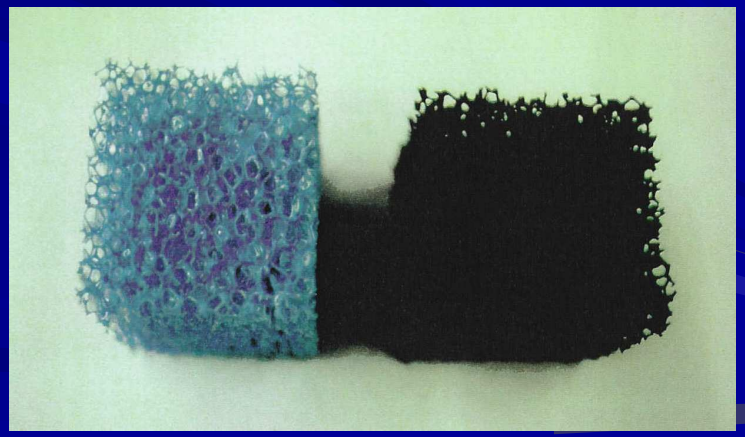
- Responsible for the installation of more then 20 Biotrickling Plants in Europe
  - Presentations in USA and Europe
  - Member of Air and Waste Management Association – Pittsburgh (USA)

- DAEGA Powder Systems (since 2000)

Biotrickling Technology

- Developed since 1991 to combine the advantages of biofilter and bioscrubber
  - Using an inert carrier
  - Low energy consumption
  - Less maintenance costs
  - Control of biomass and biological layer
  - Special nutrients for odour and VOC elimination
  - Control of mass transfer



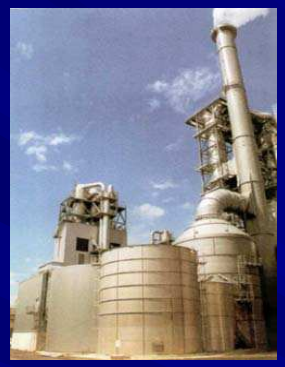


Purpose of the Biotrickling Technology Development

- Develop a controllable biological process
- Use the advantages of a biofilter and bioscrubber by avoiding the disadvantages
- Improve the biological process for the removal of nonsoluble pollutants
- Reduce the operating costs
- Possibility for a flexible installation should be given

Competitive Technologies

- Biofilter
- Bioscrubber
- Chemical Scrubber
- Thermal/Katalytic Incineration

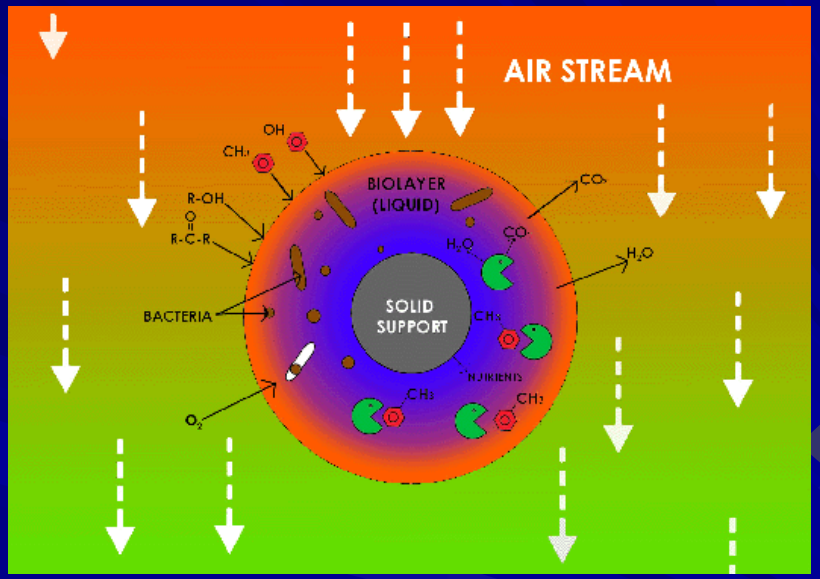


Applications of Biotrickling Technology

- Odour Removal
  - Tobacco industry
  - Slaughterhouse
  - Waste water treatment
  - Composting plant
  - Chocolate production
- VOC Removal
  - Printing industry
  - Cosmetic industry
  - Coating industry
  - Chemical industry
  - Semiconducting industry

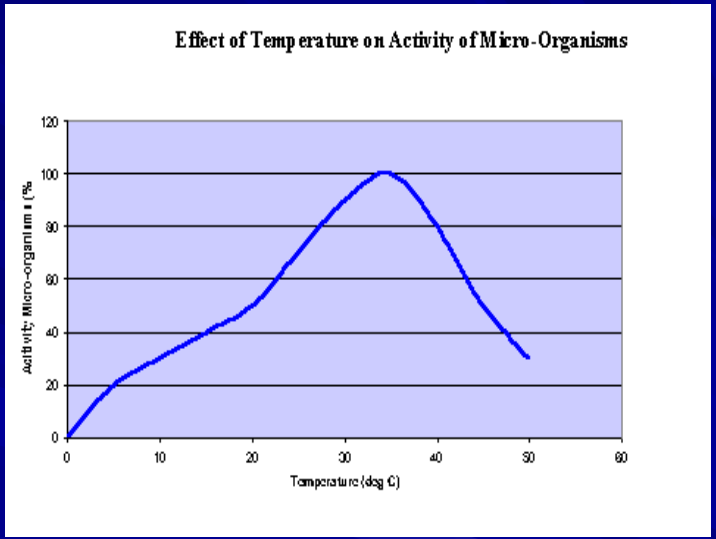
Scientific Fundamentals

- Influences on kinetics and efficiency
  - Mass transfer
  - Residence time
  - Solubility in water
  - Temperature
  - Biological degradation
  - Type of microorganism



Temperature Influence

- Temperature has an important influence on the elimination rate
  - best efficiency between 28 ˚C and 35 ˚C
  - Mesophilic bacterias
  - Slow reaction/low influence on temperature changes over a short time

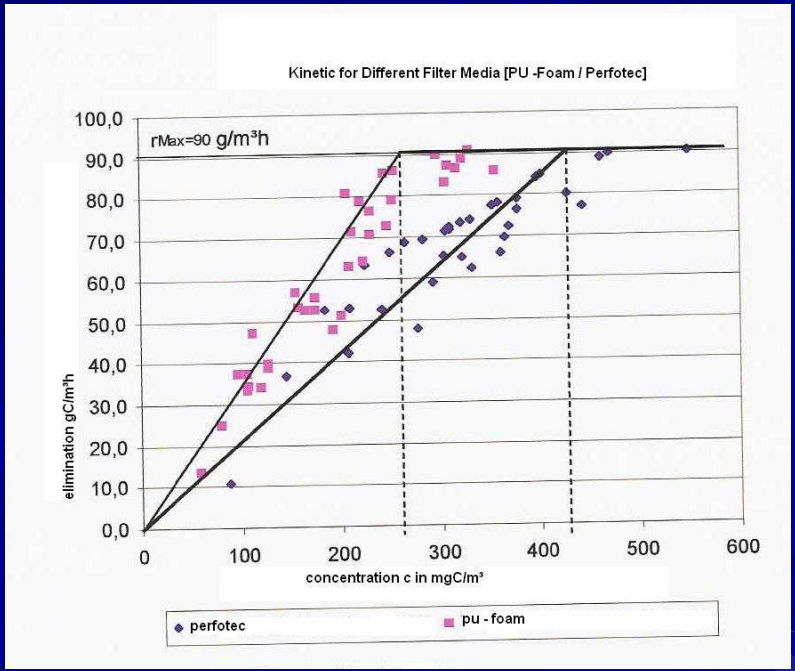


Influence of Nutrients

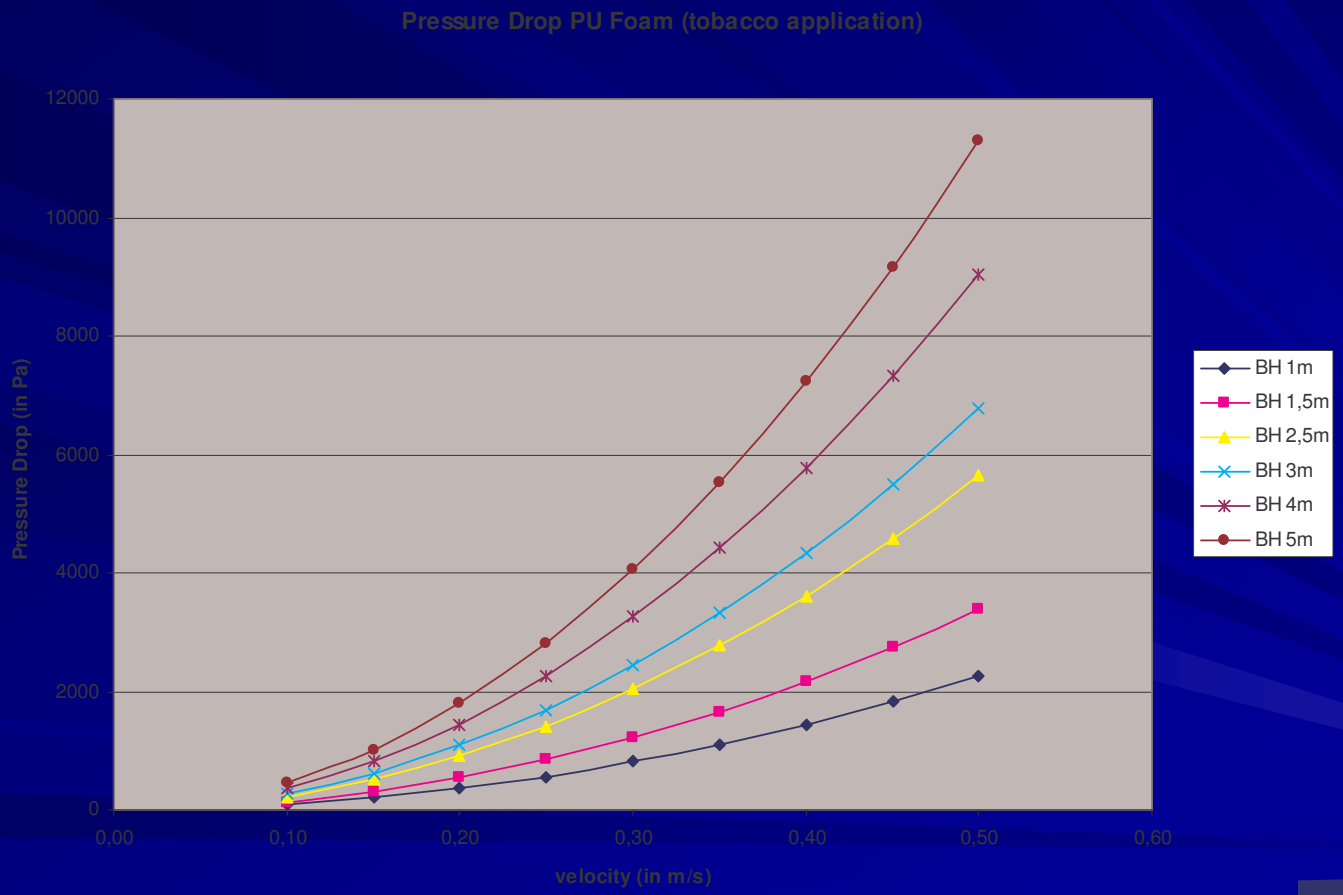
- Special Nutrients for different applications
- C:N:P:S ratio important
- Influence of ammonia elimination and growth of biomass
- Control mechanism to avoid clogging

Influence of Media I

- Important characters of Biotrickling media
  - Surface area
  - Water storage capacity
  - Pore size
  - Pressure drop
  - Stability/physical data
  - Endless lifetime
  - Chemical and biological resistance

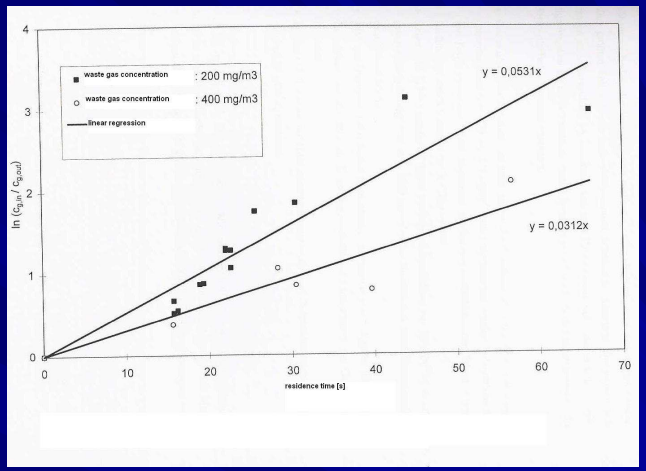


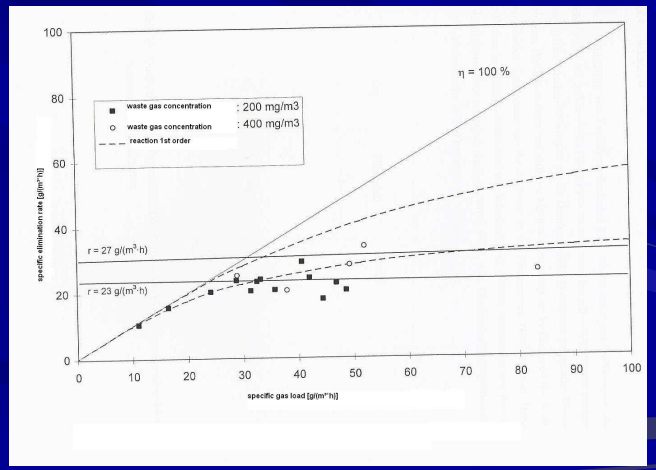
Pressure Drop in Dependence of Reactor Velocity



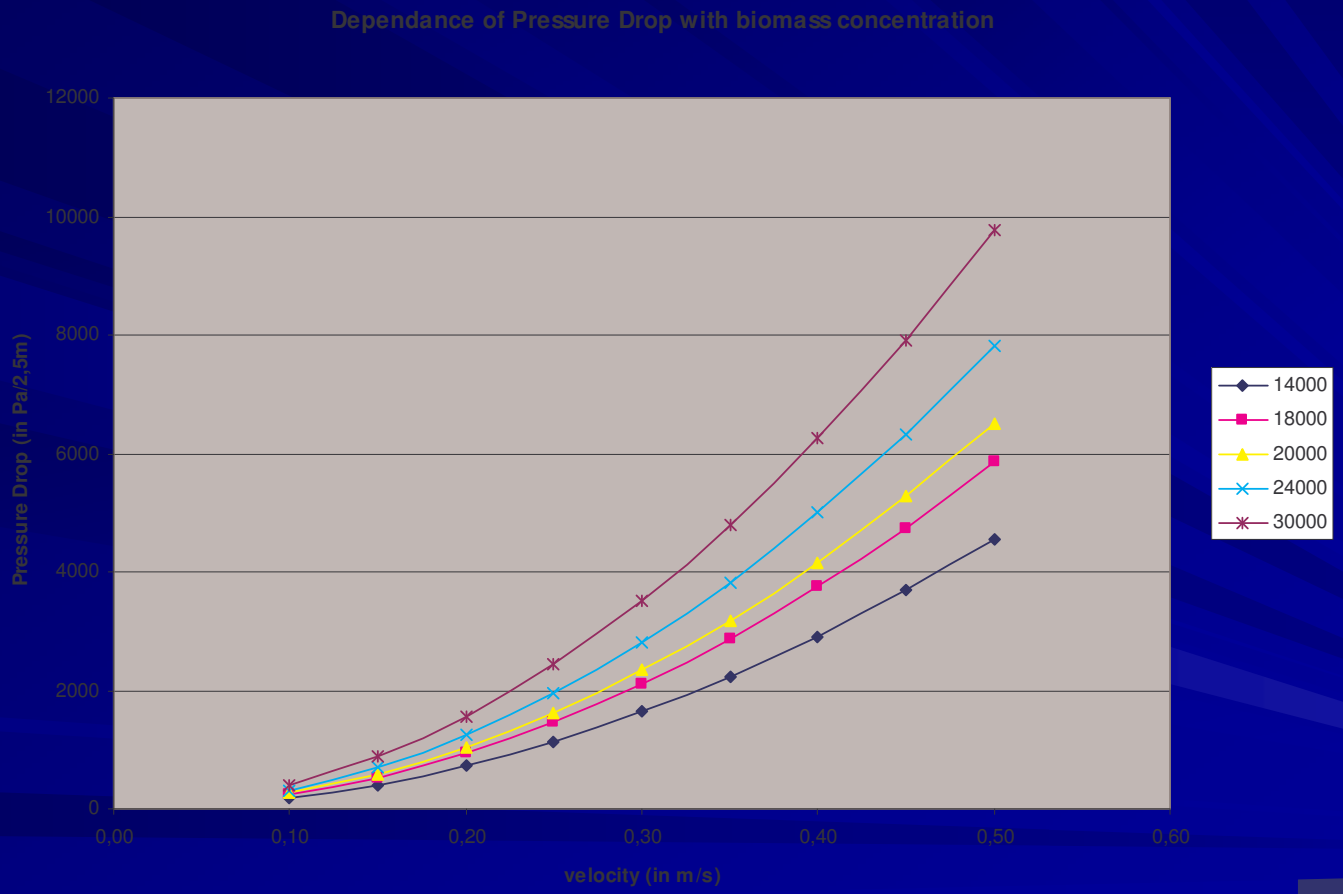
Influence of Variations in Concentration

- Concentration influences the kinetics of the reaction
- Limitation in elimination possible
- Most applications are working with a kinetics of 0 or 1 order



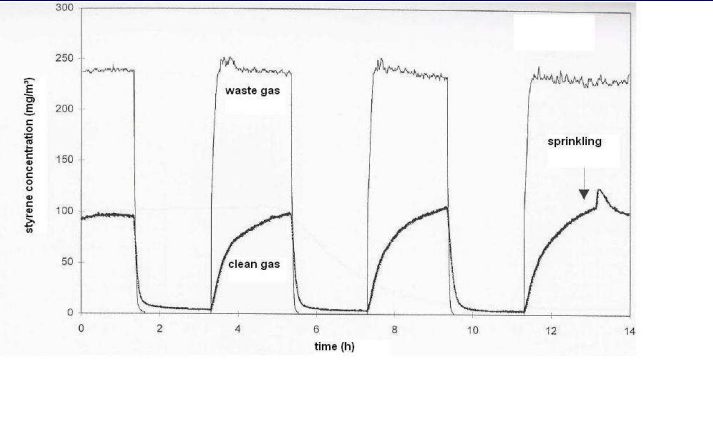


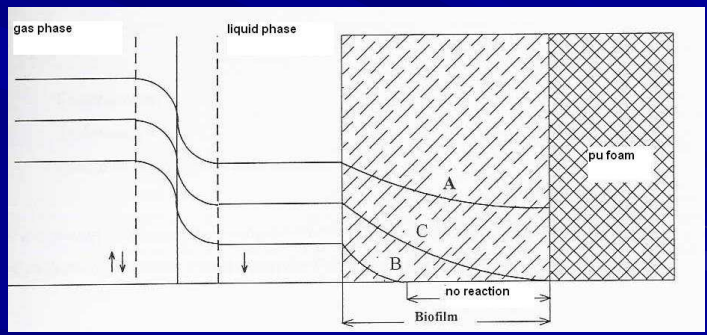
Pressure Drop in Dependence of Biomass Concentration



Influence of Humidity

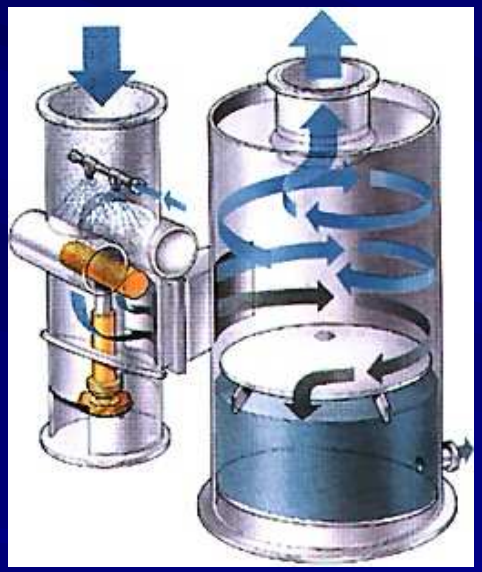
- Humidity has an important influence on the efficiency
  - Clogging can appear by uncontrolled humidity
  - Kinetics can be influenced by humidity



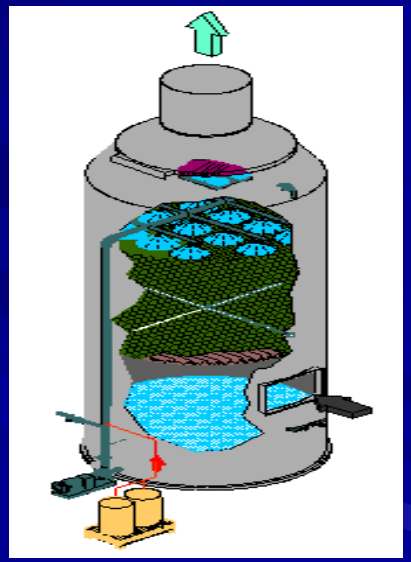


Flow direction

- Downflow principle



- Countercurrent flow



Types of Reactors

- Column type
  - Single level
  - Two levels

- Container module
  - Stackable
  - 20- ft size
  - 40- ft size
  - Individual construction

Basic Evaluation for Biotrickling Filter Application

- Determination of parameters
  - Flow rate
  - Temperature
  - Humidity
  - Operating hours
  - Space Availability
  - Process water analyses
  - Dust concentration
  - Solubility of pollutants
  - Regulation of required efficiency
- Odour Removal
  - Olfactometric Measurement
    - Gas chromatographic analyses (if necessary)
- VOC Removal
  - FID analyses
  - Gas chromatography

Determination of Process Parameters

- **Laboratory tests**
  - residence times
  - Sprinkling quantity
  - Solubility
  - Type of microorganism
  - COD/BOD
  - Nutrient recipe
  - Pressure drop
  - Filter media

- **Pilot tests on Site**
  - residence times
  - Sprinkling quantity
  - Pressure drop
  - Adaption of microorganism
  - Adaption on exhaust parameters
  - Nutrient consumption
  - Scale up parameters

Pilot Tests in Tobacco Industry

- Reemtsma (Germany)
  - Primary
  - Flow rate 300 – 1000m³/h
  - Temperature 35 – 65 ºC
  - Humidity > 70 %
  - Dust < 5mg/m³
  - Test period 3 month
- Result
  - Efficiency: 85% - 96%
  - Pressure Drop: < 550 Pa

- KT&G (Korea)
  - Primary and Secondary
  - Flow rate: 500 – 800 m³/h
  - Temperature: 38 – 60 ºC
  - Humidity > 85 %
  - pH: 3,5 -7,4
  - Test period 6 month
- Results
  - Efficiency: >90%
  - Pressure Drop: < 450 Pa

Comparison with Competitive Technologies

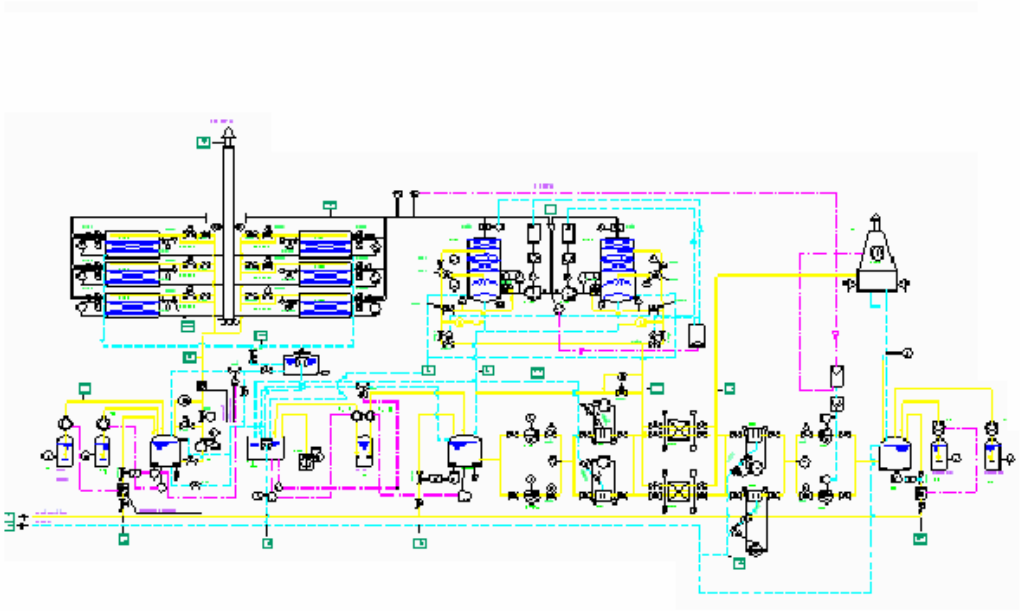
- **Comparison in operating costs of Biotricklingfilter with Bioscrubber**
  - Examination of operation and maintenance costs of both technologies by Reemtsma – Berlin during the evaluation phase [reference Mr. Radola - Plant manager]

Basic Data:	flow rate	3000 m^3/min
	available space	200 m^2
	odours/ m^3	max 1000 m^3
	temperature	55 - 65Celsius
	dust	< 5 mg/m^3
	substances in pollutants	> 50
	Required efficiency	>90%

Comparison in operating costs of Biotricklingfilter/Bioscrubber

- Results of Reemtsma-BiotricklingFilter (calculation)
  - Operation costs
    - **< 92000 €/year**
  - Maintenance costs
    - **< 12000 €/year**
  - Results of existing plant
    - 2001 < 82000 €/year
    - 2000 < 78000 €/year
    - 1999 < 85000 €/year
    - 1998 < 83000 €/year
- Results of Reemtsma – Bioscrubber (calculation)
  - Operation costs
    - **> 245000 €/year**
  - Maintenance costs
    - **> 21000 €/year**

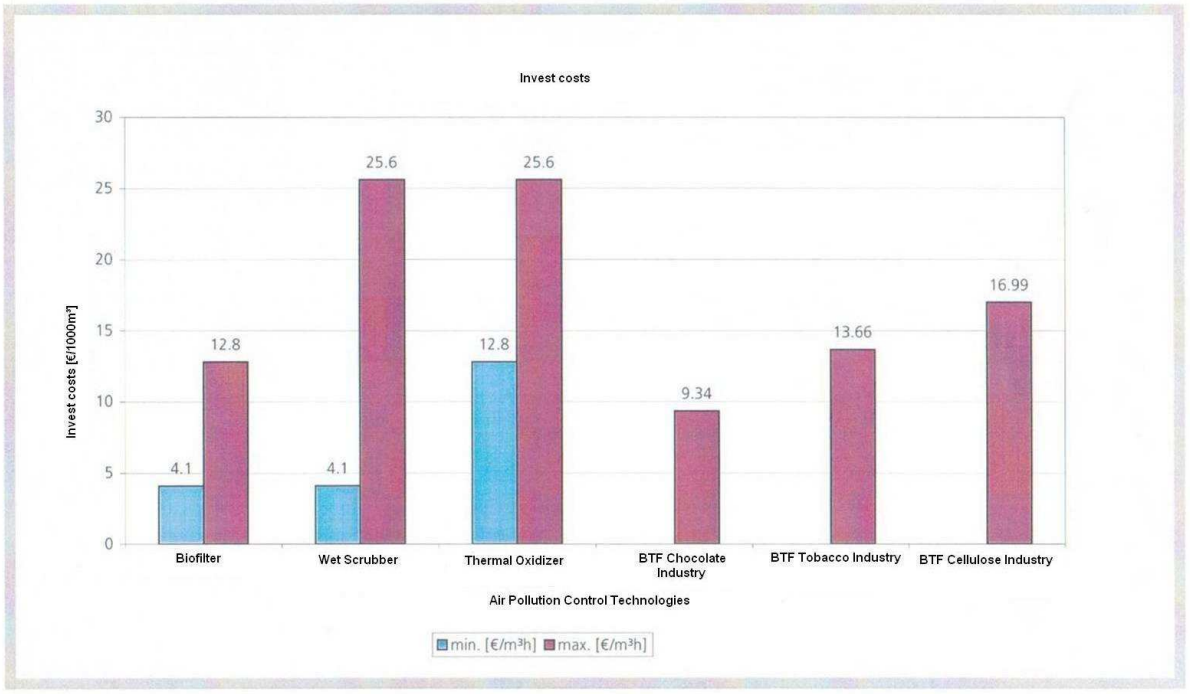
Design of Biotrickling Plant



DAEGA Biotrickling Installation at KT&G

Invest Cost of Biotrickling Technology

(European Prices)



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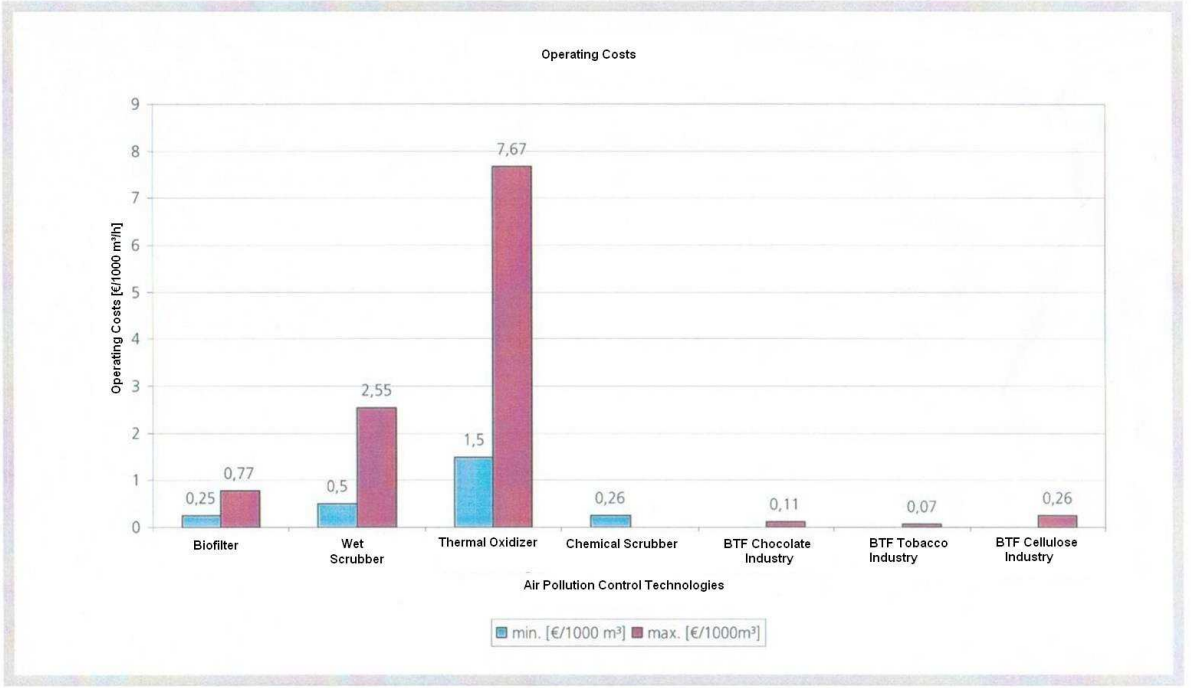

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