

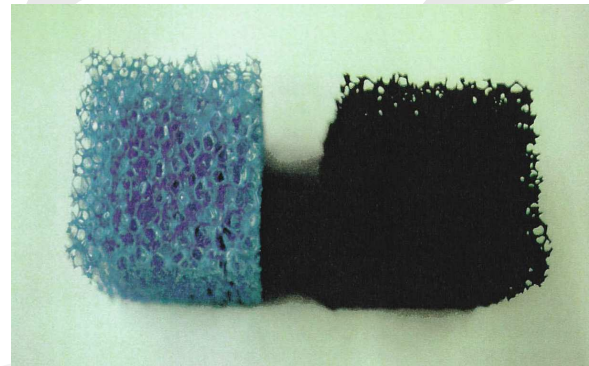
# Biotrickling Technology

Presentation by Jürgen Loy

Elimination of Odour and VOC in  
Exhaust Gas with Biotrickling  
Technology

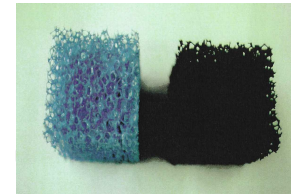
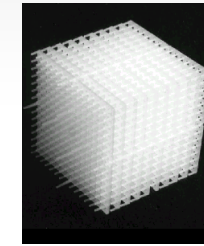
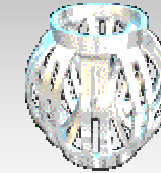
# Biotrickling Technology

- 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 vov elimination
  - Control of mass transfer



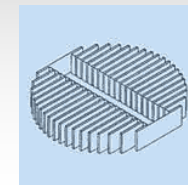
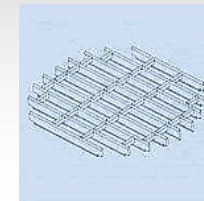
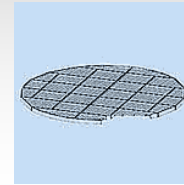
# Types of Biotrickling Technologies

- Trickle reactor
  - Different inert medias
    - Plastic packing, porous stones, carbon coated media
- Different types of nutrient supply
- Different quantities in Spraying
- Continuous or intermitted spraying



# Technical Equipment for the Biotrickling Reactor

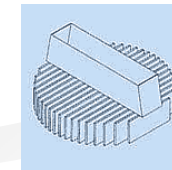
- Grid



- Water Distributor



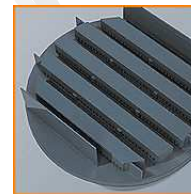
- Collector



- Drop separator



- Air Distributor



# Types of Reactors

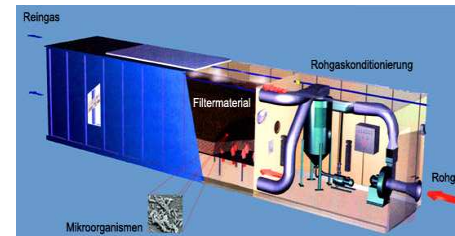
- Column type

- Single level
- Two levels



- Container module

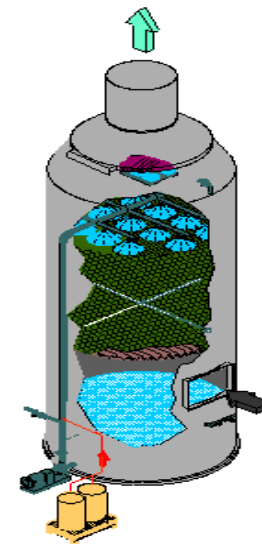
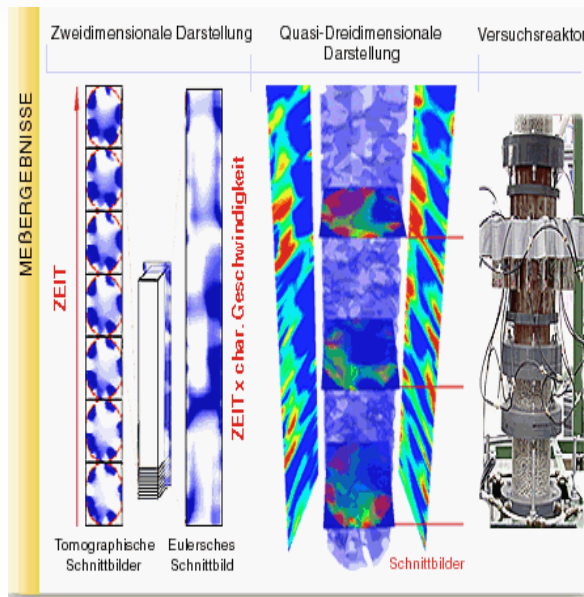
- Stackable
- 20-ft size
- 40- ft size
- Individual construction



# Flow direction

- Downflow principle

- Countercurrent flow



# Key Persons in the Science of Biotrickling Technology

- Prof. Marc Deshusses
- Joe Devlinny
- Huub Cox
- Paul Tonga
- Prof. Burkhardt Egerer
- Jürgen Loy

# Applications of Biotrickling Technology

## ■ Odour Removal

- Tobacco industry
- Slaughterhouse
- Waste water treatment
- Composting plant
- Chocolate production

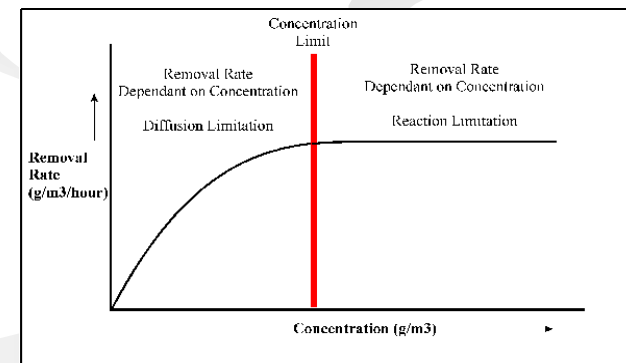
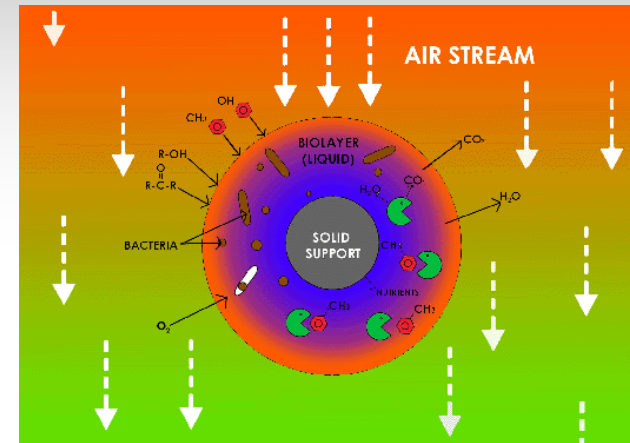
## ■ VOC Removal

- Printing industry
- Cosmetic industry
- Coating industry
- Chemical industry
- Semiconducting industry

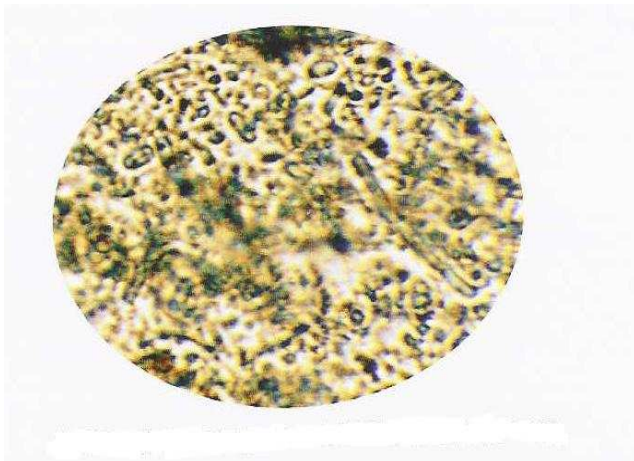
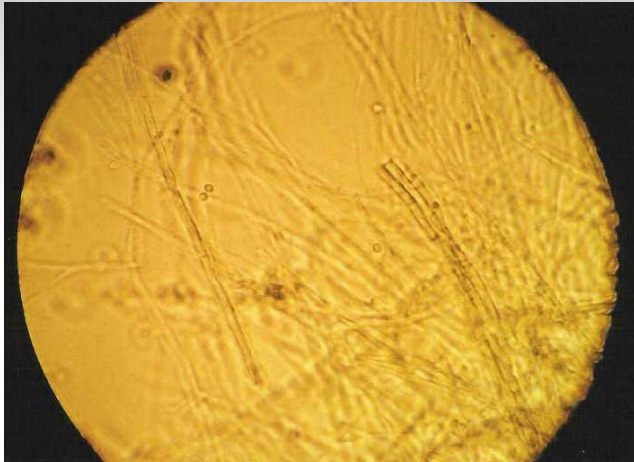


# Processes and Kinetics

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

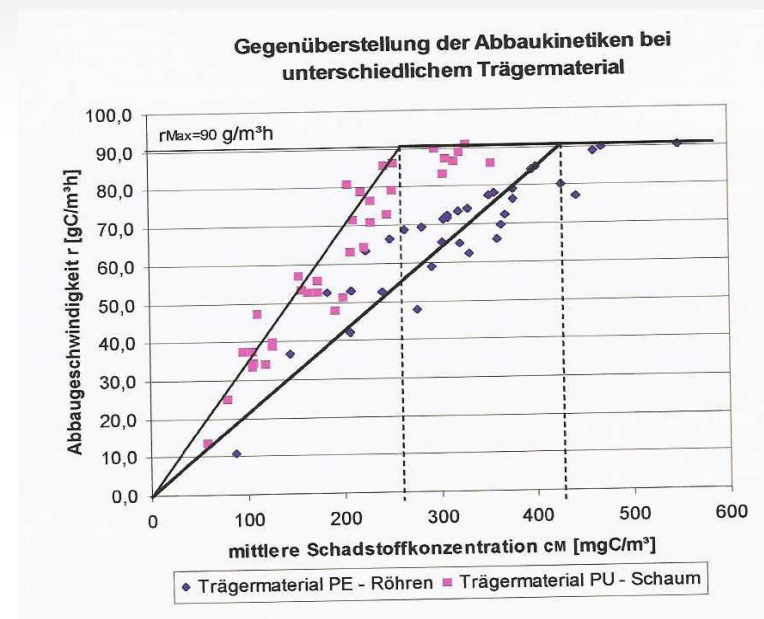


# Pictures of microorganisms



# Influence of Media

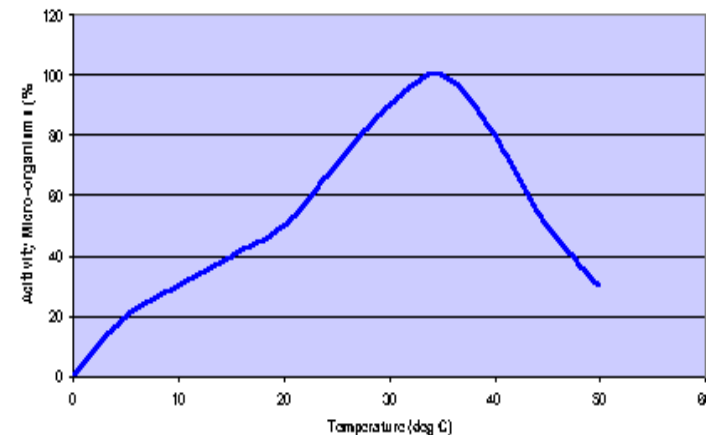
- Important characters of Biotrickling media
  - Surface area
  - Water storage capacity
  - Pore size
  - Pressure drop
  - Stability/physical data
  - Endless lifetime
  - Chemical and biological resistance



# Temperature Influence

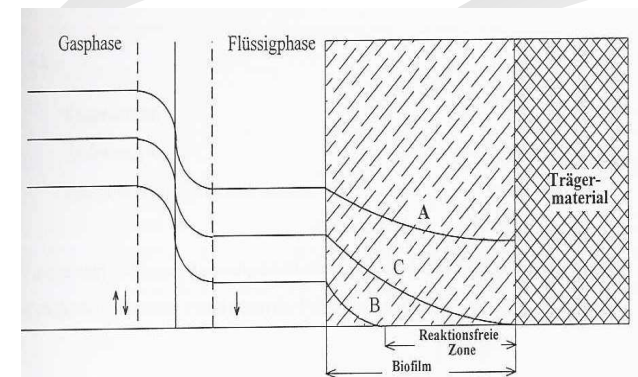
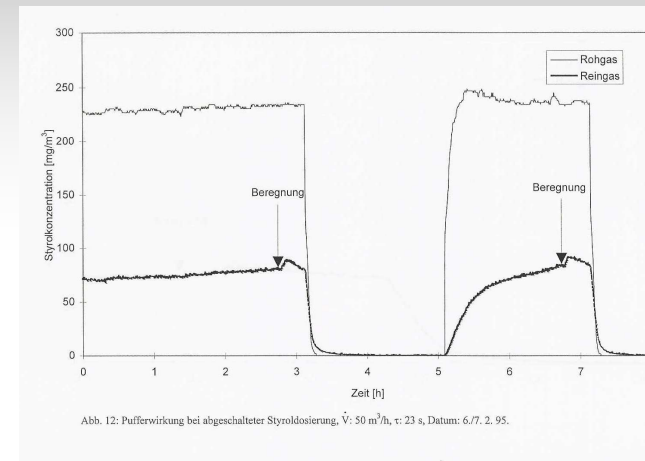
- Temperature has an important influence on the elimination rate
  - best efficiency between 28 °C and 35 °C
  - Mesophilic bacteria
  - Slow reaction/low influence on temperature changes over a short time

Figure 4 Effect of Temperature on Activity of Micro-Organisms



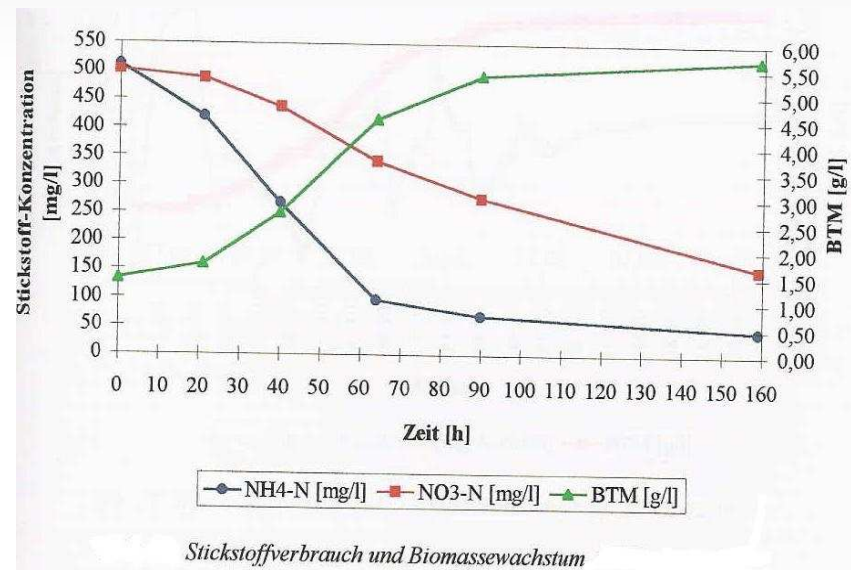
# Influence of Humidity

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



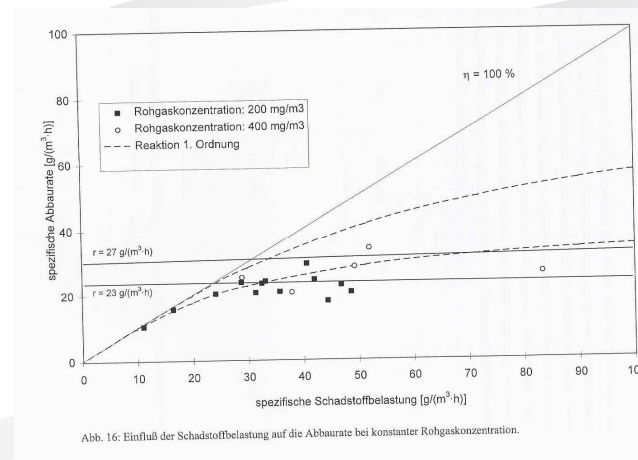
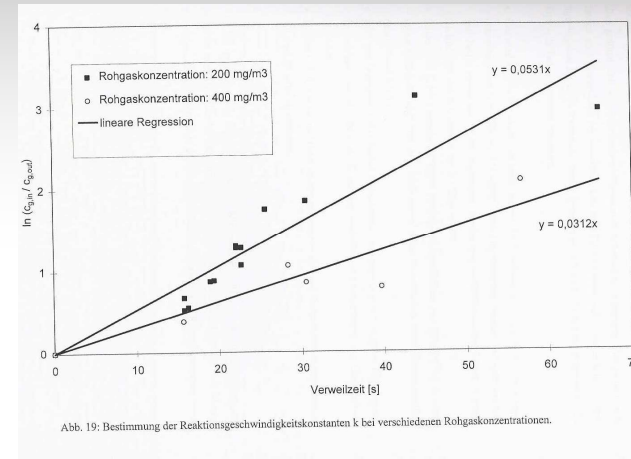
# Influence of Nutrients

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

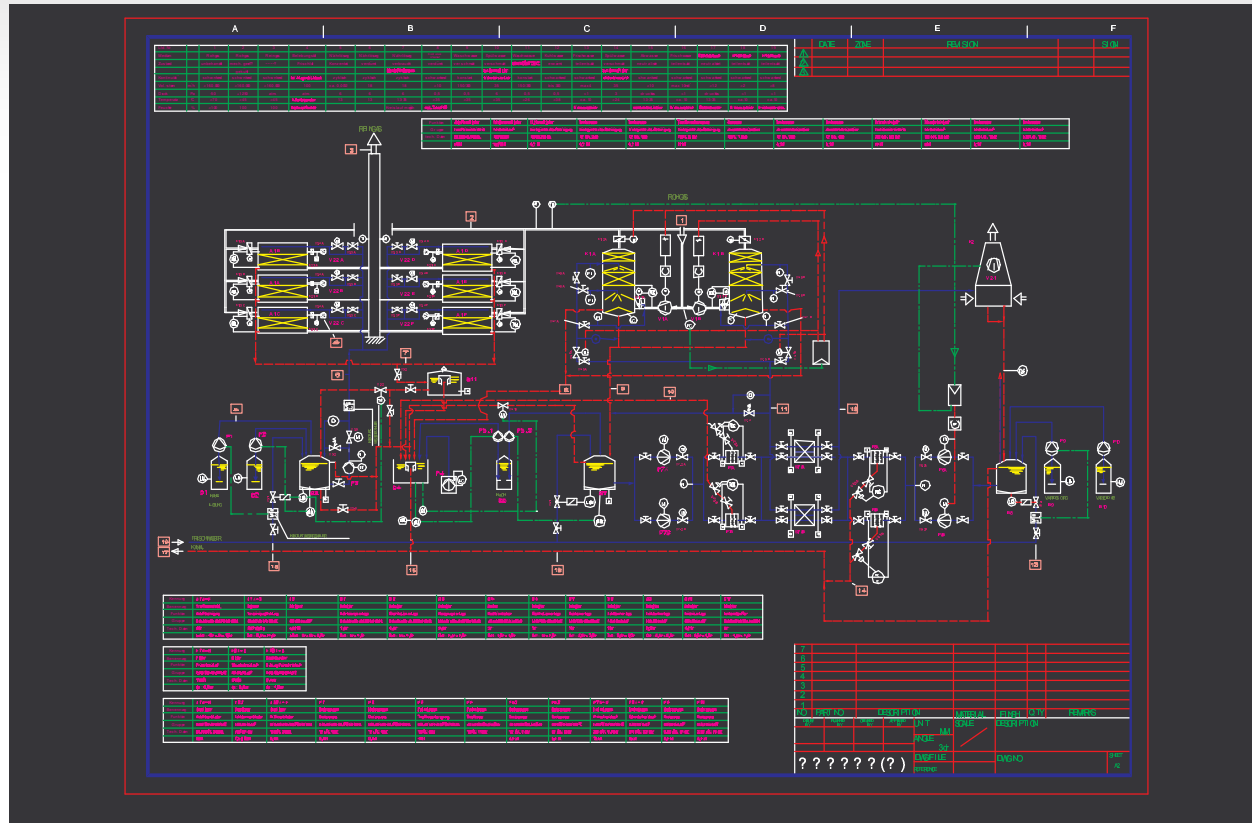


# Influence of Variations in Concentration

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



# Flow Sheet of an Industrial Application



# Comparison in operating costs of Biotricklingfilter/Bioscrubber I

- 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 <sup>3</sup> /min
	available space	200 m <sup>2</sup>
	odours/	max 1000 m <sup>3</sup>
	temperature	55- 65Celsius
	dust	< 5 mg/m <sup>3</sup>
	substances in pollutants	> 50

# Comparison in operating costs of Biotricklingfilter/Bioscrubber II

- Results of Reemtsma- Zander BiotricklingFilter (calculation)

- Operation costs
  - < 92000 €/year
- Maintenance costs
  - < 12000 €/year
- Results of realised 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

# Main Equipment

- Scrubber
  - High efficiency in dust separation
- Inert Media
  - Polyurethane foam with high surface area and physical, and chemical stability
- Biotrickling reactor
  - Anti corrosive material
- Measuring and control system
  - Automatically controlled
- Cooling equipment
  - Guarantee a temperature lower 45 °C
- Nutrient Station
  - pH controlled

# Materials

## ■ Reactor

- Stainless steel
- Coated steel
- Plastic fibre grid

## ■ Inert Carrier

- Polyurethane Foam

## ■ Scrubber

- Plastic fibre
- Polyethylene

## ■ Dosage tanks

- Polypropylene
- Polyethylene

## ■ Ductwork

- Stainless steel
- Polyethylene
- Polypropylene
- PVC
- PTFE hoses

# Dust Separation

- Due to the character of the filter media it is important to avoid dust on the surface of the polyurethane foam
- Character of the scrubber
  - High efficiency
  - Tangential feed construction
  - Controllable quantity of water
  - Capable of temperature reduction
  - High water separation

# Waste Water

- Low COD/BOD
  - In Germany acceptable for our Government
- pH- controlled in a range of 5,5 to 7,5
- Less particles and slurry
  - In Germany also acceptable
- Low discharge quantity
- Advantage of biological cycle of nutrient

# Installation Phases of a Biotrickling Plant – Deinstallation of Biofilter



„Alte“ Abluftreinigung mit dem  
vorhandenen Biobeet

Zwischenlösung während des Baues der neuen Anlage



VDI, Gerüche in der Aussenluft, Juni 2002

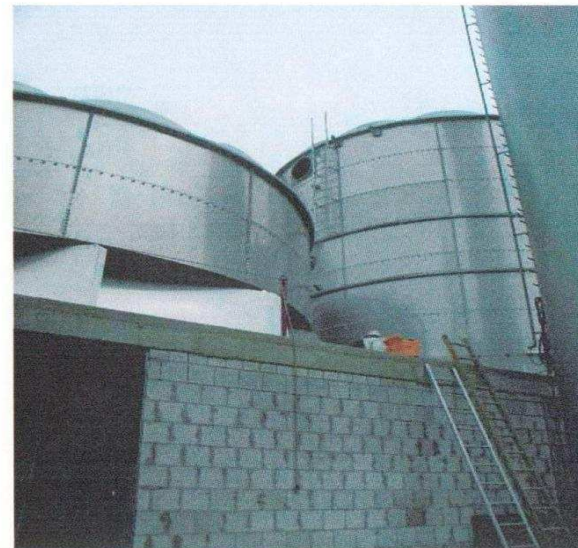
# Installation Phases of a Biotrickling Plant – Installation of Reactors

## Montage der Edelstahlbehälter



Erster Ring des Edelstahlbehälters

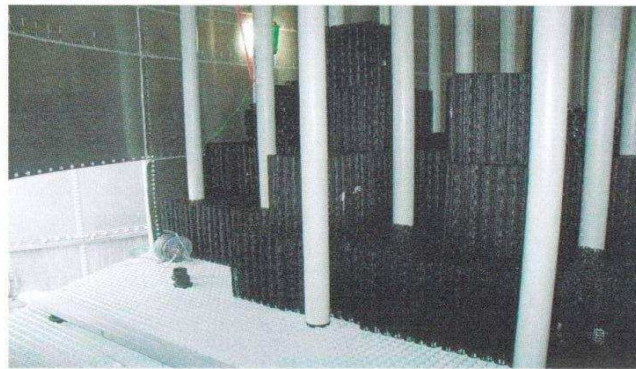
Montage des zweiten Behälters  
und des zweiten Ringes



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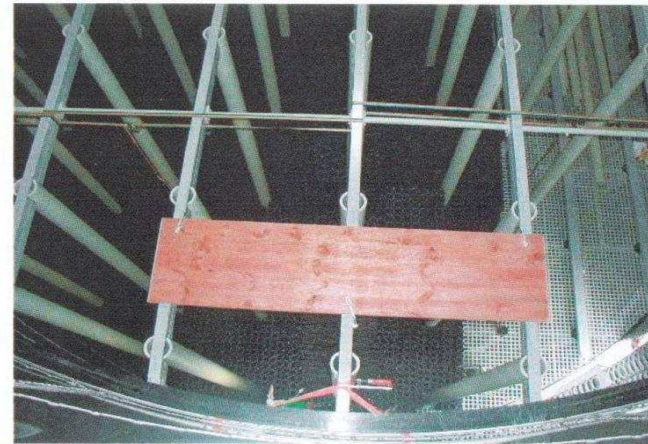
# Installation Phases of a Biotrickling Plant – Filling with Media –Layer 1

## Einbringung des Trägermaterials



Schichten der unteren Lage aus PT-Material

Draufsicht auf die Ständerkonstruktion  
und das Trägermaterial

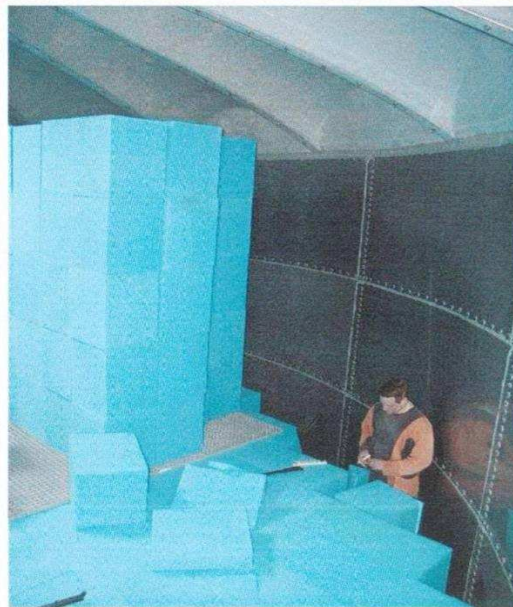


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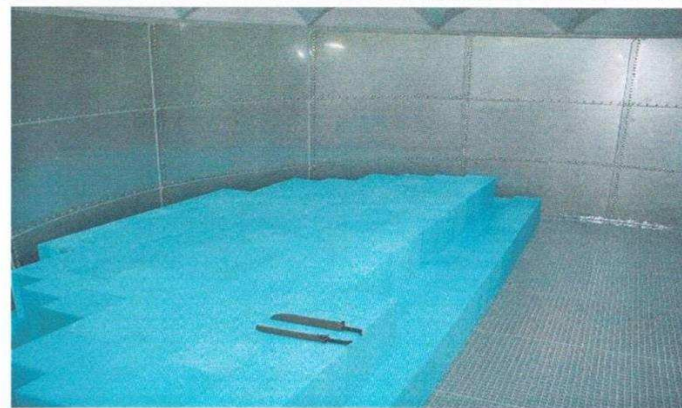
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# Installation Phases of a Biotrickling Plant – Filling with Media layer 2

## Einbringen der zweiten Stufe



Genaueres Zuschneiden des PU-Schaumes



Lagenweises Einbringen der zweiten Stufe

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# Installation Phases of a Biotrickling Plant – Installation of sprinkling system/ Airinlet

## Beregnungsdüsen / Luftverteilung



Beregnungsdüsen zum Verteilen  
der Nährlösung in der PU-Stufe

Einströmöffnungen zur optimalen  
Luftverteilung im Eintrittsbereich



VDI, Geräte in der Aussenluft, Juni 2002

# Installation Phases of a Biotrickling Plant – Separation of special particles/Cooling unit

## Fettabtrennung aus der Abluft der Kakaoröster



Wäscher zur Kühlung und Fettabscheidung

VDI, Gerüche in der Aussenluft, Juni 2002



Fettabtrenner zur Entfernung und Entsorgung  
des ausgewaschenen Kakaofettes

# Installation Phases of a Biotrickling Plant – Water and nutrient station

## Wassertechnikraum



Wäscher und Rohgaseintritt  
in den Biotropfkörper



Wassertechnik mit Beregnungsvorlagen,  
Pumpen etc.

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# Installation Phases of a Biotrickling Plant – Connecting Ductwork

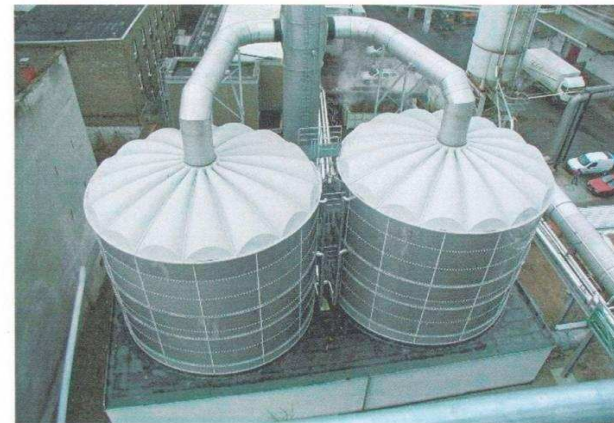
## Anbindung der Biotropfkörper



Aufstellen des 30m hohen Edelstahlkamines

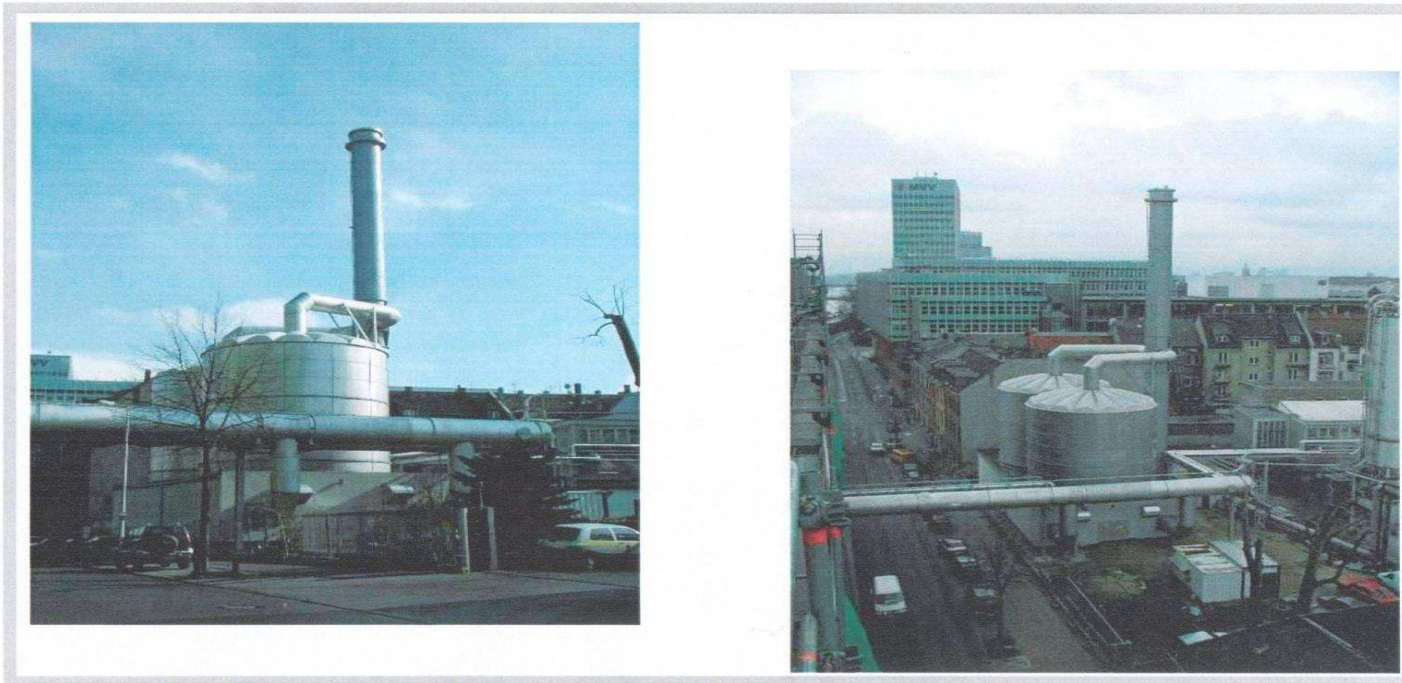
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Reingasseitige Anbindung der  
Biotropfkörper an den Kamin



# Installation Phases of a Biotrickling Plant – Final Situation

Ansicht der Biotropfkörperanlage im Endzustand



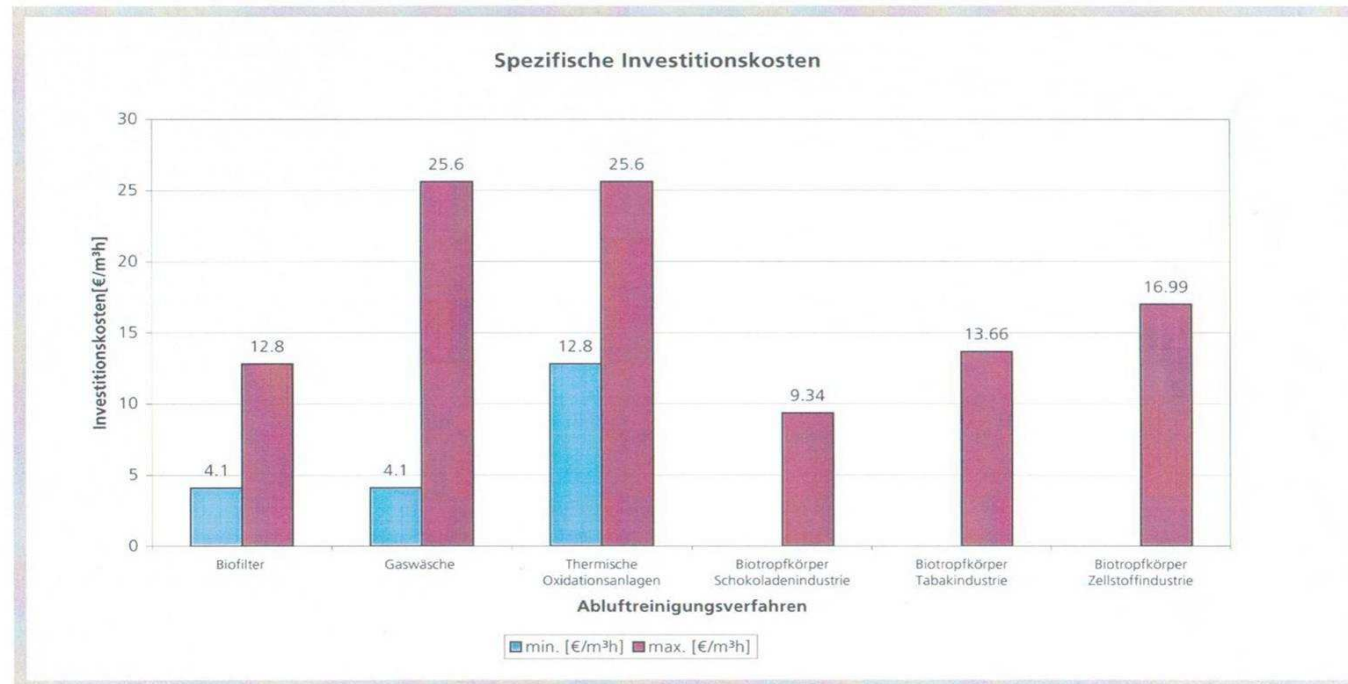
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# Investment Costs

## Comparison of different Technologies

based on German Prices 2002

### Investkostenvergleich

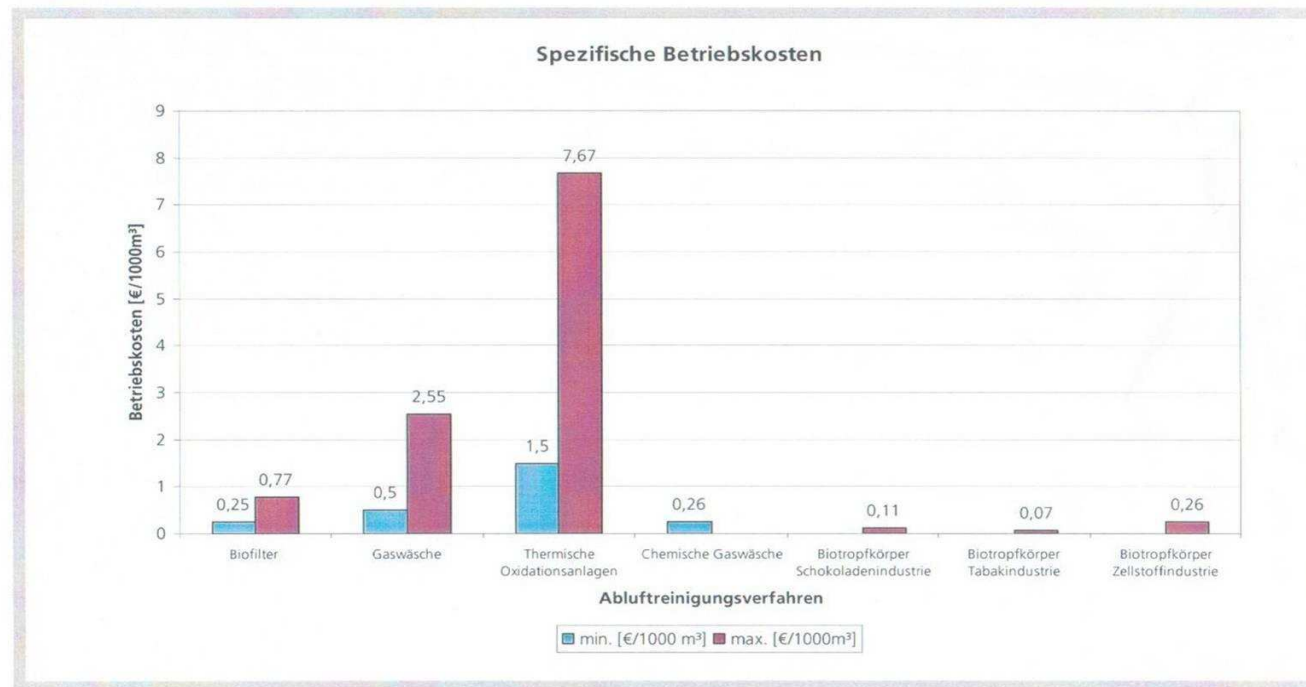


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# Operating Cost

## Comparison of different technologies

### Betriebskostenvergleich



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# Acknowledgement

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- Prof. Burkhardt Egerer – University of Nürnberg
- Mrs. Clarissa Kellner – M+W Zander (Nürnberg)
- Mr. Christoph Radola – Reemtsma (Berlin)
- Mr. Paul Tonga – Envirogen N.Y.
- Mr. Eiermann – Schokinag (Mannheim)