Master Study Program
Utilities & Waste

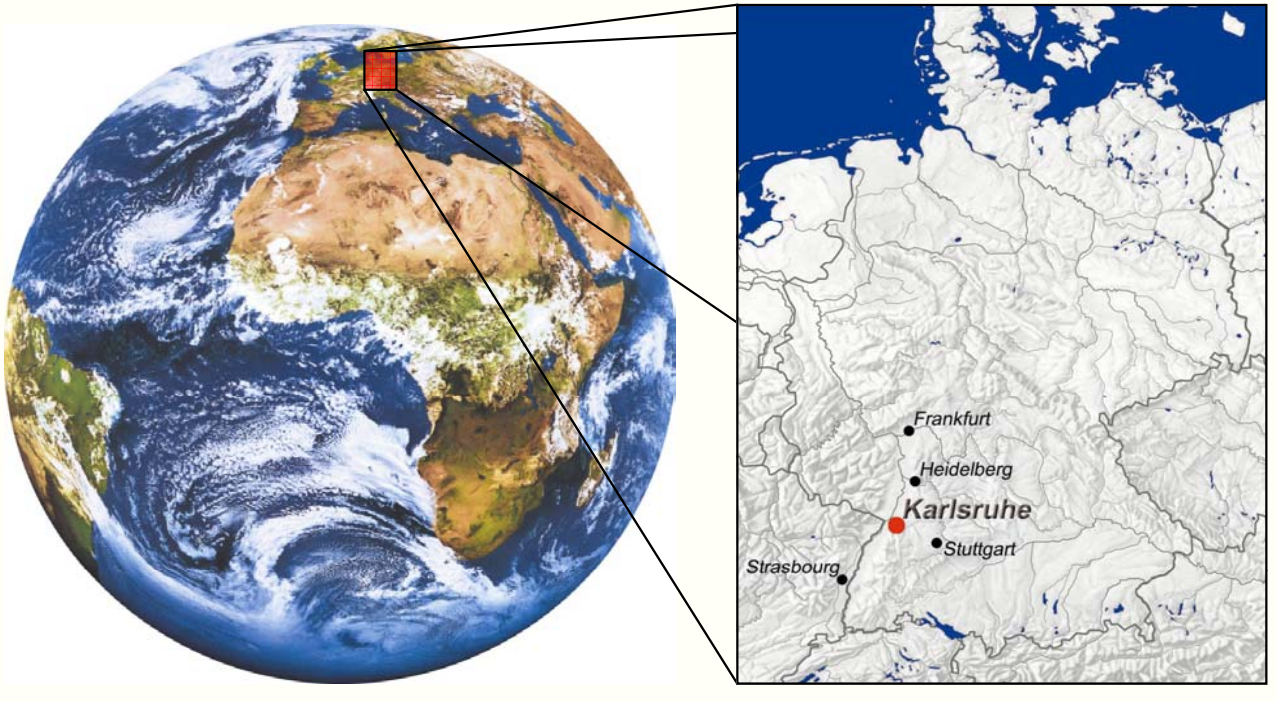
„Utilities and Waste– Sustainable Processing“
a new master study program
at the Universität Karlsruhe (University of Karlsruhe)

Contents

University of Karlsruhe

- was founded in 1825
- 117 institutes, 17,000 students

The ***Engler-Bunte-Institute*** is one of the largest institutes and represents a considerable part of the chemical engineering department



Aim and Concept of the Study Program

The study program will enable the students to **operate public utilities** for gas and water and waste treatment and disposal, respectively.

It is a **multidisciplinary approach** to the planning, process engineering, and management aspects of such utilities.

The study program is compact and has a **strong focus on this topic**.

The whole program is **offered in English**.

A mandatory intensive **course for the German language** enables the students to take courses from the entire faculty program.

Master Study Program
Utilities & Waste

Entry Requirements

Bachelor's Degree

Motivation Letter

Professional Experience

→ **above-average**

→ **in related subject**

→ **from an accredited university**

Master Study Program
Utilities & Waste

Structure of the Study Program

Master of Science in ”Utilities and Waste– Sustainable Processing“

4	**Master‘s Thesis**
3	**Post-graduate Study Program** 2 Major Subjects (12 SWS) + 2 Minor Subjects (4 SWS) + 1 Design Project (6 SWS) + 5 Mandatory Courses (17 SWS)
2	
1 Semester	

Laboratory Work (20 SWS)

Accompanying Study Program

Mandatory:
German Language (12 SWS)

Selected (2 SWS):
Economy, Culture, History and Media in German and Europe

Optional:
Excursions
Night Caps
Weekend Seminars

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Courses and Credit Points

	1. Semester		2. Semester		3. Semester		4. Semester	
	SWS	CP	SWS	CP	SWS	CP	SWS	CP
Mandatory Syllabus								
German-Language	4	2	4	2	4	2		
Basic experimental work	4	4						
Phenomena of storage, transport and conversion I	4	6						
Phenomena of storage, transport and conversion II			3	4				
Introduction to utilities and waste	2	4						
Utility facilities I (Design and operation)	4	8	2	4				
Utility facilities II (Management and economics)	2	4						
Laboratory work								
Fuels	2	2	1	1				
Combustion			1	1	2	2		
Waste					3	3		
Water					3	3		
Design project			3	3	3	3		
Optional Courses								
1. Optional Course (Major Subject)			3	6	3	6		
2. Optional Course (Major Subject)			3	6	3	6		
Optional Course (Minor Subject; freely selected)			2	4	2	4		
Master's Thesis - Research Project (6 Months)							20	30
Sum	22	30	22	31	23	29	20	30

Master Study Program
Utilities & Waste

Major Subjects

1. Combustion Technology
2. Fossil and Renewable Fuels
3. Waste Technology
4. Water Chemistry and Water Technology

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Utilities & Waste

Major Subject " Combustion Technology "

Combustion Technology consists of 3 courses:

- Combustion Technology (CT)
- Combustion related Environmental Protection (CREP)
- Energy Conversion Processes (ECP)

Responsible Institute for Combustion Technology:

Combustion Division of Engler-Bunte-Institut (EBI-VBT)

Master Study Program
Utilities & Waste

Major Subject " Combustion Technology "

Combustion Technology (CT)

Aim:
Enable the Students to Design Burners for Gaseous, Liquid and Solid Fuels

Contents:

- Balances for Mass and Energy in Order to Calculate the Mass Fluxes of the Reactants and the Flame Temperature
- The Origin of Premixed and Diffusion Laminar and Turbulent Flames
- Flame Stabilisation Methods for Gaseous and Liquid Flames

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Major Subject " Combustion Technology "

Combustion Related Environmental Protection (CREP)

Aim:

- Understanding of the most Important Formation Routes of Pollutant Formation
- Development of Primary and Secondary Means for the Reduction of Pollutants Emissions
- Methodology of Lifecycle Analysis

Contents:

- Global Cycles of Carbon, Nitrogen and Sulphur
- Further Contributions to Environmental Pollution from Combustion
- Effects of Combustion Pollutants
- Primary and Secondary Means for Reduction of Pollutants from Combustion
- Ecological Assessment of Means for Pollutant Reduction

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Major Subject " Combustion Technology "

Energy Conversion Processes (ECP)

Aim:

Understanding of the Basics for Thermodynamic Description and Optimization of the Main Thermal Conversion Processes of Energy

Contents:

- Energy Resources and Consumption of Fossil Fuels
- Characterisation of the Energy Forms and their Use
- Thermodynamic Basics and Discussion of Important Conversion Processes
- Economic and Environmental Aspects of Combustion Processes Based on Fossil Fuels

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Engler-Bunte-Institut, Division of Combustion Technology (EBI-VBT)

Research Fields

Periodic Combustion-Driven Instabilities
- Excitation Mechanisms
- Design Criteria for Prevention

Ignition and Transient Combustion
- Analyses of Ignition Process
- Deflagration of Gaseous Fuel/Air-Mixtures
- Minimization of Explosive Hazards

Ignition Stability and Emission Characteristics
- Ignition Stability / Burner Load Control
- Formation of Pollutants (NO_x, CO, ...)
- Soot Formation and Oxidation

Mathematical Combustion Modelling
- Turbulence Modelling
- Reaction Mechanisms
- Periodic Combustion-Driven Instabilities
- Combustion Stability

Airblast Nozzle for Gas Turbine Combustor

Engler-Bunte-Institut, Division of Combustion Technology (EBI-VBT)

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Experimental Capabilities

Velocity Measurement Methods

- Multiple Hot Wire Anemometry
- 3D (3 colour) LDV (Laser Doppler Velocimetry)
- PIV (Particle Imaging Velocimetry)

Two-Phase Flow

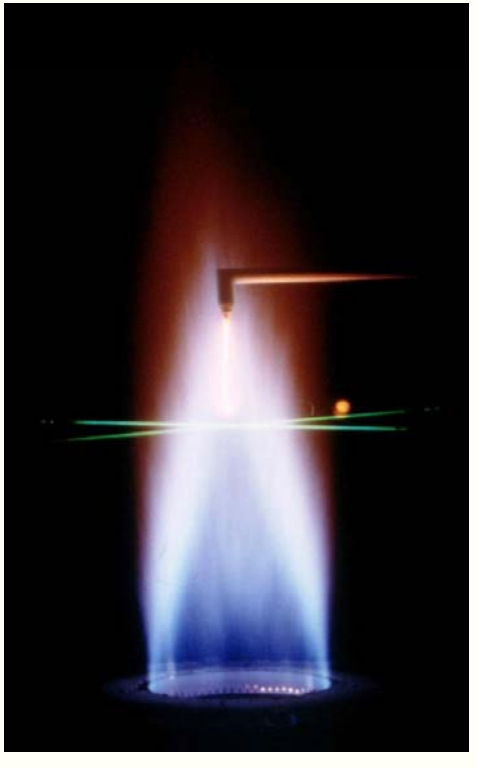
- Phase Doppler Anemometry

Investigation of Scalars in Turbulent Reactive Flows

- Exhaust probe measurement
- Advanced Thermocouple Technique
- LIF (Laser Induced Fluorescence)

Flow-Visualisation

- High speed cameras
- Laser sheet
- Schlieren optic



Velocity Measurement (LDV)

and Exhaust Gas Analysis

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Major Subject "Fossil and Renewable Fuels"

"Fossil and Renewable Fuels" consists of 3 courses:

- Fuels I (Liquid Fuels, LFU)
- Fuels II (Gaseous Fuels, GFU)
- Fuels III (Solid Fuels, SFU)

Responsible Institute for "Fossil and Renewable Fuels":

Fuel Chemistry and Technology Division
of Engler-Bunte-Institut (EBI-GEK)

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Utilities & Waste

Major Subject "Fossil and Renewable Fuels"

Fuels I (Liquid Fuels, LFU)

Aim:

- Understanding of Characteristic Properties of Liquid Fuels
- Understanding of Characteristics of Fuel Conversion Processes Producing Liquid Fuels

Contents:

A. Petroleum and Petroleum Processing

Petroleum and Petroleum Products, Testing Methods, Physical Separation Processes, Chemical Conversion Processes, Refinery Structures, Environmental and Economic Aspects

B. Non-Conventional Liquid Fuels

Liquid Fuel Products from Gaseous or Solid Feedstocks, Liquid Fuels from Biomass Feedstocks

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Major Subject "Fossil and Renewable Fuels"

Fuels II (Gaseous Fuels, GFU)

Aim:

- Understanding of Characteristic Properties and of the Thermodynamics of Gaseous Fuels
- Understanding of Fuel Gas Treatment and Manufacturing Processes

Contents:

A. Natural Gas Properties and Processing

Genesis and Composition of Natural Gas, Analytical Methods, Thermodynamics and Equations of State, Purification Processes and Gas Conditioning, Distribution and Transportation

B. Manufactured Gases

Reforming and Gasification of Various Raw Materials, Purification and Conditioning of Raw Manufactured Gases

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Utilities & Waste

Major Subject "Fossil and Renewable Fuels"

Fuels III (Solid Fuels, SFU)

Aim:

- Understanding of Characteristic Properties and of Thermal Behaviour of Solid Fuels
- Understanding of Conversion Processes of Solid Feedstocks

Contents:

A. Solid Fuels – Coal, Biomass and Waste

Utilisation Pattern, Characteristic Properties and Qualities, Production and Beneficiation

B. Application of Solid Fuels

Combustion, Pyrolysis, Gasification, Coke and Smokeless Fuel Production, Liquefaction and Upgrading Processes

Engler-Bunte-Institut, Division of Fuel Chemistry and Technology (EBI-GEK)

Research Fields

Fossil and Renewable Fuels
- Synthesis-/ H_2-Gas Production from Hydrocarbons
- Biomass Gasification
- Raw Gas Conditioning
- Behaviour of light Hydrocarbons under the Conditions of Vacuum Carburisation of Steel

Synthetic Fuels
- H_2 for Fuel Cell Applications (Reforming, Desulphurisation, Purification)
- Synthetic Hydrocarbons (Fischer-Tropsch- Synthesis, Synthetic Natural Gas)
- Transportation Fuels from Biomass**Pollution**

Control Related to Fuels
- Combined Dry Gas Cleaning (Catalytic Filters)

Fundamentals and Methods
- Multi-Phase Reactors
- Magnetic Resonance Imaging

Catalytic Sponge Reactor for Gas Purification Processes

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Engler-Bunte-Institut, Division of Fuel Chemistry and Technology (EBI-GEK)

Experimental and Modelling Capabilities

Characterisation Methods for Gaseous, Liquid and Solid Fuels

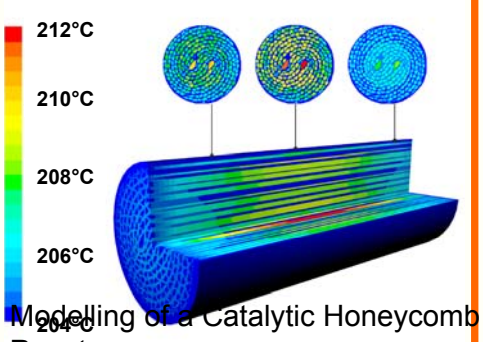
- Thermogravimetric Balances
- Combustion and Calorific Measurement Devices
- GC Analysis Methods

Lab-Scale Reactors

- Biomass Gasifiers for Entrained Flow and Moving Bed Reactors
- Catalytic Reaction Test Rigs for Fischer-Tropsch-Synthesis, Steam Reforming, Hydrocarbon Reactions, Gas Cleaning and Conditioning
- Vacuum Carburisation Reactors

Mathematical Modelling

- Chemical Reaction Kinetics Modelling
- Process and Reactor Modelling Tools
- Fuel Cell Modelling



Modelling of a Catalytic Honeycomb Reactor

Major Subject " Waste Technology "

Waste Technology consists of 4 courses:

- Technical Systems of Thermal Waste Treatment (TWS)
- Basic Design of a Waste Incineration Plant (WIP)
- Non-Thermal Waste Treatment Processes and Waste Management (NON-TWS-WM)
- High Temperature Process Engineering (HTPE)

Responsible Institutes for Waste Technology:

- ***Institute for Technical Chemistry – Thermal Waste Treatment Division Forschungszentrum Karlsruhe (ITC-TAB)***
- ***Combustion Division of Engler-Bunte-Institut (EBI-VBT)***
- ***Institute of Biology for Engineers and Wastewater Biotechnology***

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Major Subject " Waste Technology "

Technical Systems of Thermal Waste Treatment (TWS)

Aim:

Students understand principle design of thermal waste treatment plants and gain a competence to evaluate thermal processes for the treatment of different fractions of waste.

Contents:

- High Temperature Processes
- Grate Furnace
- Rotary Kiln
- Fluidized Bed
- Pyrolysis / Gasification Technology
- Co-Combustion Technology

Major Subject " Waste Technology "

Basic Design of a Waste Incineration Plant (WIP)

Aim:

Enable the students to do a principle design study and to evaluate the basic design parameters of a plant for waste incineration

Contents:

- Basic Design Parameters
- Mass / Energy Balance
- Turbulent Mixing
- Fuels: Solid / Liquid
- Combustion and Thermo-chemistry
- Pollutants
- Materials / Refractory

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Major Subject " Waste Technology "

Non-Thermal Waste Treatment and Waste Management (NON-TWS-WM)

Aim:

Students gain a competence to evaluate mechanical and biological processes for the treatment of different waste fractions, basic knowledge about waste management including legal aspects

Contents:

- Waste Treatment
  - Waste Specification
  - Analytics
  - Technical Aspects of collection and Transport
  - Mechanical Waste Treatment
  - Biological Waste Treatment
  - Disposal
- Waste Management
  - Waste Specification
  - Legal Aspects; Germany; EU, others
  - Waste Management: Collection, Transport, Treatment, Disposal, Analytics
  - Documentation

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Major Subject " Waste Technology "

High Temperature Process Engineering

Aim:
Provides the Students a Profound Knowledge of the Thermochemical Construction of High Temperatured Process Plants

Contents:

- High Temperature (HT) Processes and Plants
- Principles and Technologies for HT Generation
- Calculation of Heat Transfer in Plants by Flames and Hot Gas Streams
- Heat Transfer Models for Combustion Chambers and Furnaces
- High Temperature Metallic and Ceramic Materials
- Examples of HT Plants

Technical Chemistry – Thermal Waste Treatment Division ITC-TAB

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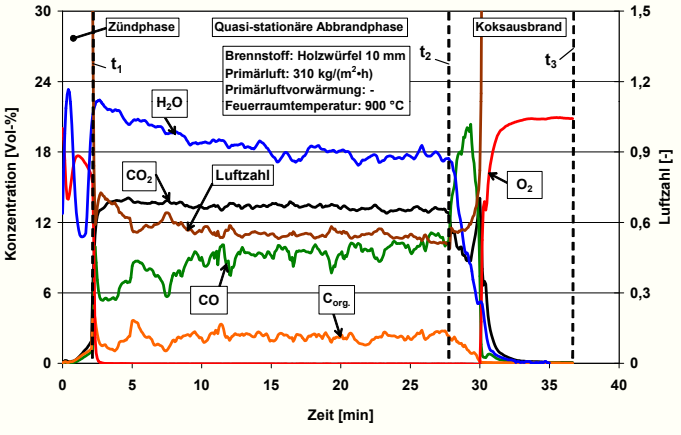
Research Fields

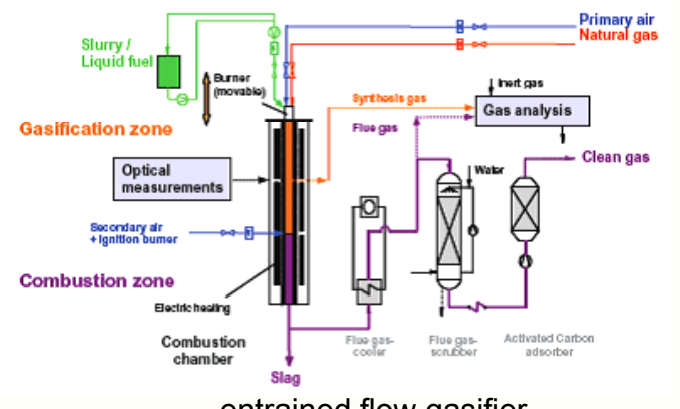
high temperature processes
- combustion
- gasification
- pyrolysis

solid fuel
- waste, RDF, waste
- characterization of combustion behavior
- slagging, corrosion potential

emissions / reduction
- NO_x-reduction
- trace species (PCDD/F, Hg,..)
- particulate matter
- gas cleaning



solid fuel combustion



entrained flow gasifier

Technical Chemistry – Thermal Waste Treatment Division ITC-TAB

Experimental Capabilities

Pilot plant TAMARA
- Municipal Solid Waste Incineration
- grate furnace
- waste heat boiler
- flue gas cleaning

Batch reactor KLEAA
- characterization of combustion behavior
- solid fuels

Pilot plant THERESA
- Hazardous Waste Incineration
- rotary kiln with SCC
- dust burner for RDF

Experimental gasifier REGA
- entrained flow gasification
- biomass based slurry
- syngas from biomass

batch reactor KLEAA

waste incineration

Master Study Program

Utilities & Waste

Major Subject " Water Chemistry and Water Technology "

Water Chemistry and Water Technology consists of 4 courses:

- Introduction to Water Chemistry and Technology
- Water Quality Assessment
- Waste Water Treatment
- Advanced Water Technology

Responsible Institute for Water Chemistry and Water Technology:

Water Chemistry and Water Technology Division
of Engler-Bunte-Institut (EBI-WCH)

Prof. Dr. Fritz H. Frimmel, fritz.frimmel@ebi-wasser.uni-karlsruhe.de
Dr. Gudrun Abbt-Braun, gudrun.abbt-braun@ebi-wasser.uni-karlsruhe.de

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Major Subject " Water Chemistry and Water Technology "

Introduction to Water Chemistry and Technology

Aim:

To learn the physical and chemical fundamentals of
reactivity, and the basic techniques of water treatm

Contents:

- Hydrological Cycle, Water Demand
- Resources (types)
- Physical, Chemical, Biological Properties
- Water Treatment: Separation, Oxidation, Biodegradation, Disinfection
- Water Distribution

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Utilities & Waste

Major Subject " Water Chemistry and Water Technology "

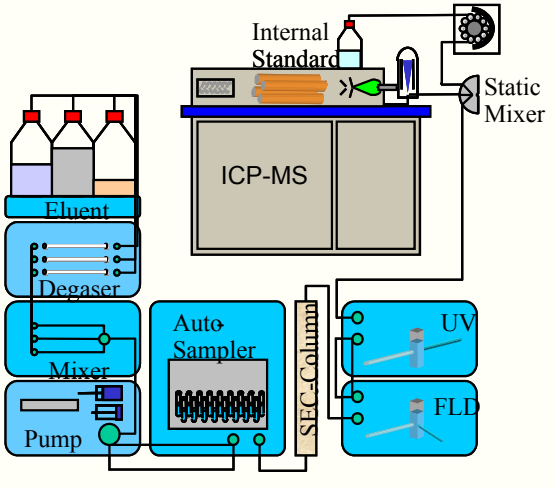
Water Quality Assessment

Aim:

To obtain knowledge about the modern analysis of water, and the assessment of water-quality

Contents:

- Quality Guidelines
- Parameters
- Microbiology, Gases
- Major and minor Constituents,
  Trace Elements and Micropolluntants
- Assessment Strategies
- Sum Parameters, Indicator Parameters
- QSAR, Biorespons



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Major Subject " Water Chemistry and Water Technology "

Waste Water Treatment

Aim:

To obtain knowledge in the processes of wastewater treatment, and to enable the students to assess the different wastewater treatment strategies

Contents:

- Water Demand and Water Consumption
- Types of Wastewater and Wastewater Components
- Conventional Wastewater Treatment
- Advanced Waste Water Treatment
- Treatment and Disposal of Sewage Sludge
- Legislation concerning Wastewater and Sewage Sludge

Major Subject " Water Chemistry and Water Technology "

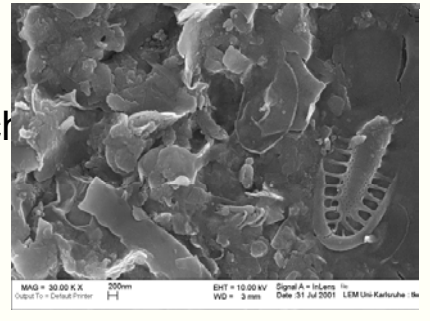
Master Study Program *Utilities & Waste*

Advanced Water Technology

Aim:

To deepen the basic-knowledge of water treatment,

see module "Introduction to Water Chemistry and Tech



Contents:

- Physical Methods
- Chemical Methods
- Microbiological Methods
- Case Studies

Engler-Bunte-Institut Division of Water Chemistry and Water Technology (EBI-WCH)

Research Fields

In research and development the scientific work is closely connected with actual problems in water management and supply

- Analysis of chemical and biological water constituents
- Oxidation and disinfection techniques
- Physical water treatment
- Membrane technology
- Biochemical processes
- Remediation

Engler-Bunte-Institut Division of Water Chemistry and Water Technology (EBI-WCH)

Experimental Capabilities

Advanced analytical equipment for water analysis

HPLC/DAD,HPLC/MS-MS, GC/MS,

HPLC-ICP/MS, LC/DOC, field flow fractionation (FFF),

NMR, FT-IR, UV/vis, fluorescence,AAS, OES, ICP/MS

FISH

Analysis of basic water parameters

DOC, TOC, AOX, turbidity, toxicity-tests, BOD,

bacterial counts, fluorescence microscopy

Small-scale experimental plants

Chlorination, flocculation, adsorption by activated carbon, filtration by membrane,

ozonation, photochemical reactors (batch, continuous flow), bioreactors

immersed membrane modules

Social and Financial Aspects

When people go abroad for their university studies,
they have to cope with a variety of cultural, social - and financial - challenges!

Due to its high proportion of international students (ca. 20 %),
the Universität Karlsruhe (TH) is very experienced in helping people from foreign countries to cope with those challenges.

Within the Master Study Program “Utilities and Waste”, an intensive contact between the faculty and staff members and the students, respectively, guarantees that the students can successfully finish their program.

Such contact is achieved by limiting the number of students to 25, and by involving 12 teaching persons (professors, assistant professors, industrial representatives), and additional tutors in the study program.

Furthermore, the students will have access to excellent facilities and they will have the opportunity to get hands-on experience in all fields of U&W.

The course fees of 7,372 € per year will be used to ensure the high quality of teaching levels, facilities, and other services.

Scholarships

For excellent students the possibility of two kinds of scholarships is given.

1. DAAD-scholarship for living cost in Germany.

In this case the study program will be free of charge.

Additional requirements for DAAD-scholarship:

- Age limit: 36
- Two years of professional experience

2. Industrial scholarship

In this case the study program will be free of charge. So, the student has only to care about the cost of living.

Additional requirements for Industrial-scholarship:

- Age limit: 36

Master Study Program
Utilities & Waste

Summary

Target group:	chemical, process, civil and mechanical engineers
Focus areas:	fuels, combustion, waste, water (major subjects)
Course language:	English
Entry requirement:	bachelor's degree, one year of professional experience, English certificate (TOEFL)
Course begins:	October 2008
Course duration:	24 months

Application deadline:

- 12th October 2007 for DAAD scholarship
- 30th June 2008 for industrial scholarship or self-pay students

Degree/Certificate:	M.Sc.
Course fees:	7372 €/year

Universität Karlsruhe (TH)
Research University · founded 1825

Karlsruhe Institute of Technology

Master Program
Utilities and Waste – Sustainable Processing

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