

**I.A.R. – The Chair of Processing and Recycling, RWTH Aachen University** is one of Europe's leading research departments, specialized in the development of sustainable waste management, processing technologies and recycling systems. The Chair of Processing and Recycling of Solid Waste offers not only top level teaching courses, as well as research and development (R&D) for new treatment processes, but also a variety of external services for industry clients and waste disposal companies, such as technical assistance and "trouble shooting" in existing processing plants. These services include pilot scale testing of a wide variety of different treatment techniques with miscellaneous input materials in the technical centre of the I.A.R. department. Since most of the available equipment is mobile, the investigation can also be carried out on-site at the respective waste treatment plant, for instance in order to characterize specific material streams or to elaborate material flow mass balances of a complete process plant. In addition, the department offers a range of advisory services in order to optimize the operation of waste treatment processes. Highly sophisticated analytical tests make it possible to characterize complex material mixtures, to determine product quality and the efficiency of the treatment process performed.

## **Research & Development**

Amongst others the following topics are subject of current R&D activities of the department:

- **Waste Characterization / Sampling of Waste**

Accurate sampling of heterogeneous waste is very important for process design and essential to fulfil ambitious quality standards for recycling products. In order to obtain a good and reliable basis for the characterisation of waste streams, the "Aachen Sampling Model" was developed, applied and tested in several operating full-scale waste treatment plants with respect to its efficiency. Based on the resulting model the sampling and analysis of different solid wastes can be carried out, thus providing a complete material balance of the respective processing plant. For this purpose skilled employees and mobile aggregates for sampling (e.g. a drum screen) are available.

- **Simulation and Modelling of Processes**

Within the framework of a research project on dynamic process simulation, a basic model for the dynamic simulation of waste treatment processes was developed by the department and a fundamental model library using the software *Umberto* created. The library includes models for various types of processing units, ranging from comminution, classification to a variety of automated and highly sophisticated sorting technologies. The results created within the simulation of plant models have been verified through a comparison with other measured data from industrial scale processes. During the development of this new software, the user interface and friendliness have been a high priority.

- **Mechanical Waste Processing prior to Biological Treatment**

The objective of the investigation is to determine the influence of different mechanical pre-treatment methods with respect to the biodegradability of the organic fraction of household waste. In addition to a range of industrial scale treatment units for mechanical processing (some of which reach capacities of several tons per hour), there are special reactors for the aerobic

and anaerobic treatment with a volume of 45, 100 and 210 litres available. These reactors often are used by our industrial partners for pilot scale tests of biological treatability.

- **Recycling of plastics**

The IAR department has developed a new technology for completely mechanical treatment, sorting and size reduction of light packaging waste, which was initially tested and operated for three years on a pilot scale. The industrial realisation occurred in the form of the SORTEC 3.1 plant and set into operation on the occasion of the EXPO 2000 in Hanover. Numerous components of the pilot plant like the Sorting Centrifuge are still available in the laboratories of the department, which uses this technical equipment mainly in order to solve questions concerning separation and characterisation of waste rich in plastic materials.

- **Recovery of Refuse derived Fuel (RDF) from Municipal Solid Waste**

Another focus of research topics is the selective enrichment of highly calorific constituents from waste mixtures to be utilised as RDF. The chair deals with the optimisation of suitable processing technologies as well as the characterisation of the recovered products with respect to the strict quality requirements of power plants. Advanced skills in relation to quality and composition of RDF were obtained during a long term sampling period in a mechanical biological waste treatment plant.

- **Recycling of Metals**

Originating from the collaborative research centre 525 sponsored by the DFG (German Research Foundation), there are two main fields of activity concerning metal recycling:

- **Recycling of End of Life Vehicles (ELVs):** In addition to the evaluation of the available state-of-the-art techniques in the treatment of ELVs, the Chair is active in the development of innovative “cutting-edge” processing technologies. In doing so it focuses not only on the recovery of metals, but also on compliance of the European ELVs Directive with respect to the recycling of plastics and elastomers from Automobile Shredder Residues. In the framework of a research project named “SILAS” a novel separation method has been developed, which provides a sorting of light metals into different alloys using Laser Breakdown Spectroscopy.
- **Electric and Electronic Scrap:** In this field new processing methods for different groups of WEEE (Waste Electrical and Electronic Equipment) are developed. Amongst others an innovative treatment system for the separation of metal and plastic fractions from scrapped telephone sets has been investigated and optimised. Especially the recovery of pure plastic products like ABS (Acrylonitrile Styrene Butadiene Plastics) is highly important in order to meet legislative requirements.

- **Waste Processing on a Pilot Plant Scale**

As a service for industrial partners the I.A.R. offers a series of practical processing tests; such as: conveying, size reduction, screening and sorting. For this purpose, the substantial amount of equipment in the technical labs of the chair is available in order to conduct tests with capacities

up to approximately 500 kg/h. Thus, complete systems can be simulated in order to process different kinds of waste mixtures.

- **Development and Testing of Sensor Based Sorting Machines**

The I.A.R. is making great efforts to develop new techniques in the field of Sensor Based Sorting of solid waste materials. New applications of state-of-the-art sensors (e.g. CCD cameras) for the recognition of a variety of material properties, as well as the use of innovative separating systems are developed and tested. Moreover, a multi-sensor test machine named "MIDAS" allows benchmarking with a great variety of input materials. The results are periodically presented on the Conference "Sensor Based Sorting" which is organized by the I.A.R. every two years in Aachen.

### ***Teaching and Training***

In the field of teaching the Chair of Recycling and Processing (I.A.R.) supervises the Waste Management Engineering and the Raw Materials Engineering program (Branches of study: Mineral Processing, Mining, Fuel Technologies and Refinement), as well as the course of study for Technical Editorial Staff at the RWTH Aachen University.

Contents of teaching include the following topics:

- Recycling techniques for solid waste materials and further recycling technologies
- Rehabilitation of contaminated sites
- Introduction to recycling management
- Conception of waste processing plants
- Disposal logistics
- Introduction to disposal techniques
- Environmental protection in metal recycling processes.

In order to remain on the cutting-edge of recycling technology, the **I.A.R.** is constantly updating course material and lecture notes for students. Its purpose is to prepare young engineers for their working-life after their degree and to impart modern working methods to them. Therefore some of the courses are designed for small groups of less than twelve persons. Other courses are open and not limited.

**Professor Pretz** is responsible for the co-ordination and the courses. He is the head of the Chair of Processing and Recycling since 1997. Next to that he is an associate and Managing Director of pbo, Engineering Company for planning, consulting and organisation in waste treatment and management. Prof. Pretz' main fields of activity are:

- Organisation of municipal and industrial waste management, separate collection, waste transport and logistics
- Minimisation of waste production and optimisation of recycling
- Design and evaluation of sampling systems for waste and resource materials
- Design of waste treatment plants, such as composting plants for biowaste, mechanical-biological waste processing, recovery of refuse derived fuel plants (RDF) from household, industrial and bulky waste
- Static and dynamic simulation of waste treatment and recycling processes

- Evaluation of recycling processes with RDF production and production of secondary raw materials from waste

**Service to Industry/ Industry Partners I.A.R. is a service partner for industry** in the waste management field. In the following its main fields of activities are shown and some industrial partners are mentioned:

## 1. Development of recycling processes and recycling concepts

### Industrial Partners:

Babcock Borsig Power, Wetterauer Entsorgungsanlagen Gesellschaft (WEAG), REMA Anlagenbau GmbH, Deutsche Bundesstiftung Umwelt (DBU), Polysius AG, HTTP GmbH, Bundesamt für Bauwesen und Raumordnung, Betriebsforschungs-institut VDEh GmbH

## 2. Development of technical documents for organizations

### Organizations:

ERFO - European Recovered Fuel Organisation, Bundesministeriums für Wirtschaft und Technologie (BMWi), Ford Forschungszentrum GmbH, Deutsche Forschungsgesellschaft (DFG), EdDE e.V. Köln - (Entsorgungsgemeinschaft der Deutschen Entsorgungswirtschaft e.V.), Ministerium für Wirtschaft und Arbeit des Landes NRW, USB Bochum, DECOMA Europe, BDSV

## 3. Planning of recycling plants for RDF, compost, plastics, waste from building sites and incineration ashes

### Companies:

Wetterauer Entsorgungsanlagen Gesellschaft (WEAG), HTTP GmbH, pbo Ingenieurgesellschaft mbH

## 4. Additional Industrial Partners:

Bergischer Abfallwirtschaftsverband (BAV), Umweltservice Bochum GmbH (USB), RWTH Aachen University, Babcock Borsig Power, WEAG – Wetterauer, Entsorgungsanlagen Gesellschaft, Hese Umwelt GmbH, BMBF, DKR, GTZ GmbH (Deutsche Gesellschaft für Technische Zusammenarbeit), TU Dresden, UMICORE Belgium, Universität Essen (Institut für Siedlungswasser- und Abfallwirtschaft, Wetterauer Entsorgungsanlagen Gesellschaft (WEAG), DAW - Deutsche Abfallwirtschafts GmbH, Polysius AG, F&E Wärme- und Umwelttechnik, avea, Krones AG, IFUA - Projekt – GmbH, HTTP GmbH, DECOMA Europe, pbo Ingenieurgesellschaft mbH, Bundesanstalt für Geowissenschaften und Rohstoffe, Interseroh ERC, BVSE, Ministerium für Wirtschaft, Mittelstand und Energie des Landes Nordrhein-Westfalen, Kreis Euskirchen - Kompostwerk Mechernich, GVG Köln, AISAufbereitung industrieller Sekundärstoffe GmbH, DAAD Bonn, Volkswagen-Stiftung Hannover, Duales System Deutschland, GRS Batterien Stiftung Gemeinsames Rücknahmesystem Batterien, Herhof Umwelttechnik GmbH, Hüttenwerke Krupp Mannesmann GmbH

## ***Equipment/Lab Scale Processing Devices***

**Key equipment in the I.A.R. laboratories includes the following:**

- Agitator Ball Mill
- Air Table
- Analytical Test Screens
- Bahco-Sifter
- Box Screen
- Bumping and Shaking tables
- Circular Vibrating Screen
- Corona Roll Separators
- Cross Belt Magnetic Separator
- Cross Flow Air Classifier
- Drum Screen
- Eddy Current Separator (rare earth magnets)
- Flip-Flow Screen
- Flotation Cells.
- Free Fall Electrostatic Separator
- Granulators
- Gyratory Screen
- Hammer Mills
- High Gradient Magnetic Belt Separator (rare earth magnets)
- High-Intensity Induced Roll Magnetic
- Hydro Cyclones (10 to 200 mm diameter)
- Impact Crushers
- Impact Jaw Crusher
- Jaw Crusher
- Jig
- Laboratory Sorting Centrifuge "Baby-CENSOR"
- Laboratory Test Screens
- Laser Diffraction Analyser
- Linear Motion Screen
- Low Intensity Magnetic Drum Separator
- Medium Intensity Magnetic Drum Separator (rare earth magnets)
- Planetary Ball Mill
- Riffled Roller Mill
- Rotor Shear

- Sensor Based Sorter with NIR Identification
- Sensor Based Sorting Device “CombiSense®”
- Single Shaft Shredder
- Smooth Roller Mill
- Sorting Centrifuge “SENSOR®”
- Spiral Concentrators
- Suspended Magnetic Belt Separator
- Suspended Magnetic Belt Separator (rare earth magnets)
- Tumbling Mill
- Vibrating Disk Mill
- Vibrating Tube Mill

Most of the above equipment is mobile and can be mounted on-site at solid waste treatment plants in order to perform pilot scale tests.