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The Institute of Plastics Processing (IKV) in Industry and the Skilled Crafts at RWTH Aachen University is Europe’s largest research and training institute in the field of plastics technology. The Institute has more than 300 employees working on questions connected with the processing, materials technology and part design of plastics and rubber.

IKV’s excellent contacts with industry, together with its outstanding facilities, ensure that students benefit from a comprehensive, practically oriented course of study. Plastics engineering graduates from IKV are sought-after experts in industry.

IKV as a research partner

This close contact between IKV and industry has come about through a large number of practically oriented joint research projects. We make well-trained engineers and specialists as well as state-of-the-art machinery in four pilot plants and laboratories available to our research partners. We would be pleased to have an opportunity to share our know-how with you and support you in your R&D projects. Please do not hesitate to contact us.

For large, complex research projects, IKV operates close communication networks with other industrial partners, research institutions and sponsors.

Research for practical use – the IKV Sponsors’ Association

IKV is supported by an Association Sponsors, founded in 1950. The majority of the companies in this Sponsors’ Association are small and medium-sized enterprises. They benefit directly from the research work done at IKV and thus secure their competitive edge in the increasingly global competition.

The motto “Research for practical use” and the numerous innovations created at IKV are impressive proof of this. The around 250 members of the Association of Sponsors are a representative cross-section of the global plastics industry. Members include raw material and machine manufacturers, plastics processors and converters, associations and research institutes as well as car manufacturers and other users of plastic parts.
Extrusion and Rubber Technology

From the raw material to the finished product

In terms of the volume of raw materials processed, extrusion is one of the most important processing technologies in the plastics industry for the continuous production of semi-finished and finished products.

Typical extruded products that we encounter in our day-to-day lives are packaging materials in the food and consumer goods industries, technical profiles for furniture and window manufacture, and hollow blow-moulded articles for beverages and cleaning agents. From the compounding and granulation of the material to the manufacture of the finished product, the raw materials pass through a complex process chain. Every single step of the process must be adjusted optimally to the overall process. This results in tailor-made, high-quality products, manufactured by reliable, resource-conserving and energy-efficient processes.

The entire process at a glance

The Extrusion and Rubber Technology department at the Institute of Plastics Processing (IKV) has been carrying out research for many years along the entire process chain – from the construction of the die and screw to the further processing.

Our aim is to ensure an integrative examination of all the process stages and make a decisive contribution to the practical relevance and the quality of our Institute’s work.

Compounding

Specific compounding enables the properties of plastics to be adjusted specifically to the application requirements. IKV therefore carries out research on the incorporation of various nano- and micro-scale particles into the polymer material and studies their effects on the subsequent properties of the finished part.

Current research activities also cover the reactive extrusion of different polymers in twin-screw extruders and the processing of rubber.
Process simulation and die design

The quality of extruded plastics depends to a large extent on the properties of the process and the dies. Our work is therefore focused on the simulative examination of the extruder from the feed zone to the entry to the die, as well as the numerical design of manifolds and dies for film and profile extrusion.

Processing

Optimisation of the production processes offers major potential for the more efficient manufacture of plastic products.

Apart from the two classic processes for film production – cast film and blown film extrusion – IKV is also involved with the further development of foam extrusion, rubber extrusion and extrusion blow moulding. The scientists also study the further processing of semi-finished plastic products by thermoforming and stretch blow moulding.

During the processing stage, the IKV specialists assess the quality of the semi-finished and finished parts using optical inspection systems. Furthermore, the outstandingly equipped laboratories allow detailed quality analysis of the individual processing steps. This enables IKV to analyse complete process chains and identify ways of process optimisation.

Rubber technology

In this department, IKV endeavours to solve research problems in the field of rubber technology. The Institute’s experts carry out research along the entire value chain – from the raw material, through the various processing methods to the finished product. Among the processes currently being studied are rubber extrusion and the injection moulding of various elastomeric moulding compounds.
Exploiting the full potential of FRP

The material-oriented design and cost-efficient processing of composites such as fibre-reinforced plastics (FRP) are vital factors in the pursuit of effective, resource-saving lightweight construction. Accurate knowledge of the complex interactions between anisotropic behaviour, part design and production processes is essential if full advantage is to be derived from the potential of FRP.

Research carried out by the IKV Composites and Polyurethane Technology department is focused on the entire product development process – from design and production to final testing.

Structural engineering/Material modelling

In highly stressed structural parts, fibre-reinforced plastics are generally used in the form of unidirectional laminates, which have to be designed so that they satisfy the stress specifications for the particular application. The basis for this design process is a layer-by-layer stress and strength analysis. As part of the research activities carried out at IKV, the calculation principles are therefore constantly subjected to further development. The IKV experts investigate, for example,

- the extension of modern calculation theories and the verification of these theories by experimental tests
- the implementation of actual research results in user-friendly software tools and
- the design and analysis of FRP parts.

Processing technologies

The department’s second main area of research alongside calculation processes involves the development of efficient processing and production techniques. Here, the IKV staff tackle research issues relating in particular to:

- compression moulding processes for thermosetting and thermoplastic moulding compounds
- automated processes for the production of high-performance thermoplastic parts (Diaphragm Forming, 3D Fibre Spraying)
liquid composite moulding processes (Resin Transfer Moulding, Resin Infusion, Gap impregnation) for thermosetting plastics and in-situ polymerising thermoplastics

processing of rovings (pultrusion and filament winding)

The process development is supported and accompanied by the use of innovative process simulation tools and quality assurance systems.

Key area of research: High volume production

A major challenge for the widespread application of FRP is the industrialisation of the production process chains. For this, short cycle times for the individual processes are of major importance. Through the research work carried out at IKV in recent years, significant progress has been made in this respect. Following the development of new process chains for high-performance fibre-reinforced parts with a thermoset matrix, cycle times of less than 5 minutes can now be reached.

Using the 3D Fibre Spraying and Diaphragm Forming processes, thermoplastic parts can now be produced in one-minute intervals.

The department is also involved in ongoing projects which deal with the transfer of the basic principles to industrial practice, and the further development of the relevant processes.

Polyurethane technology

Polyurethane technology is an important addition to the expertise of the Composites department. Apart from contributing innovative methods for the production of rigid and flexible foams, IKV benefits from the vast experience in this field to use these materials in structural composite parts. With their wide range of properties, polyurethanes can make an important contribution towards the production of parts in very short cycle times.
Successful development of plastic parts

The performance of engineering polymers has increased at a tremendous rate in the last few years. In the same way the product requirements for plastic parts have risen strongly. These demands can only be met if the maximum potential of the material and manufacturing process is known and utilised completely.

For developers of plastic parts, this represents a highly complex set of tasks. To solve them, they make use of the very latest development tools in combination with their expertise and experience in the field of plastics.

From the original idea to the finished part

The Part Design and Materials Technology department of IKV has been involved for many decades with the key aspects surrounding the development of plastic parts. That is why we have the necessary know-how to accompany research and development processes from the original product idea to the finished part.

The department’s expertise extends from the drawing up of requirement lists, project specifications and functional specifications to the production of the finished article. It also includes selection of the optimum materials for a particular application.

IKV makes use of a broad portfolio of CAE methods to assist with the material- and production-oriented design of moulded parts and tools. This makes it possible to predict many properties of the finished part at an early stage of development, including crash behaviour and service life. The research teams are even able to obtain information on potential weak points in the production process.

For economic or technical reasons, the use of joining techniques is often necessary. Furthermore, specific demands are increasingly made on the surface functionality of the finished part. Our specialist working groups also have the necessary knowledge base to deal with these issues.
Design of plastic parts

IKV is constantly working to refine and improve the various FEM simulation tools, taking account of the many different influences exerted on the behaviour of plastics in specific applications. The IKV experts study unreinforced, short-fibre and long fibre-reinforced thermoplastics as well as elastomeric materials. Such simulation tools nowadays make it possible not only to obtain a description of the short-term material characteristics, but also to predict the crash properties, structure-borne sound behaviour and service life of the part. Integrative simulation approaches also make use of data from process simulation so that e.g. influences of fibre orientations can also be taken into account in injection-moulded parts.

In order to design and dimension load-resistant parts of continuous fibre-reinforced plastics, special calculation theories and processes are needed. IKV researchers are constantly refining these methods and validating them.

IKV is in an excellent position to perform all the necessary material data measurements and validation tests in its well-equipped laboratories. The methods used by the research teams lead quickly to the design of optimised parts, so that unnecessary development iterations can be avoided.

Joining technology

Many parts can only be produced through the use of joining technologies. For this reason, the department is also very much involved with the further development and application of modern joining techniques. IKV’s research activities are focused on ultrasonic welding and laser transmission welding.

Plasma/surface technology

In many cases, particular requirements made on the surface functionality of a part can be met using our plasma processes. Plastic substrates can be given barrier, hydrophilic or hydrophobic properties, and surfaces can be suitably pretreated before undergoing adhesion and coating processes.
The Injection Moulding department

The field of injection moulding is becoming increasingly complex and can be divided into many different sub-sections. The research groups within IKV’s Injection Moulding department carry out research into all the major injection moulding processes as well as the related technologies and production resources. The department’s activities cover the entire process chain from the original idea to the finished product. In addition to thermoplastics and thermoplastic elastomers, the research teams also study thermosets. Our expertise is focused on:

- Mould and machine technology
- (Special) process development
- Process combinations
- Process analysis and monitoring
- Design and simulation
- Industrial engineering

Putting technology into practice

Practice-oriented research is at the heart of the everyday work carried out by the highly qualified young engineers at IKV. For more than six decades, IKV has encouraged the transfer of technology between research and industry in the shape of public research projects as well as industrial joint research projects.

One of the main areas of work in the Injection Moulding department involves intensive process analysis and development. For many years, analytical and practical studies of special injection moulding processes such as fluid-assisted injection moulding (FIT) and foam injection moulding have been providing users with valuable guidance on the application and evaluation of such processes.

These intensive research activities have repeatedly led to the development of new special injection moulding processes and the further development of existing techniques. These include, for example, foam injection moulding of thermoplastics and elastomers with physical blowing agents. One important milestone in terms of special processes is the water injection technique (WIT), which was successfully implemented at IKV for the first time in 1998. The Institute’s research activities on the gas assisted injection moulding (GIT) provided the basis for
this success. Now, the projectile injection technique (PIT) is moving into the focus of IKV research as a logical further development of these processes.

**Key future technologies**

Apart from developments connected with special processes, the department also performs research into key future technologies such as optics, hybrid technology, nano- and micro technology as well as medical engineering.

Intensive networking with the other IKV departments and the many interdisciplinary cooperation agreements with partners in research and industry offer outstanding potential for technology developments outside the box of traditional plastics injection moulding. Results of such cooperations include innovations like the hybrid multi-component technique.

**Tailor-made solutions for a variety of challenges**

Any research project begins with a structured, target-oriented concept. The extensive know-how of IKV’s scientists in conjunction with state-of-the-art machines and laboratories in excellently equipped pilot plants provide outstanding conditions for finding holistic, made-to-measure solutions to a wide variety of challenges. The equipment in the injection moulding pilot plant at IKV includes:

- Injection moulding machines with clamping forces between 60 and 200 t plus one micro injection moulding machine,
- Machines for the injection moulding of elastomers,
- Tools with simple geometries for analytical testing, for the production of standard test specimens and for moulding complex practical geometries, and
- Modern CAD/CAM/CAE tools for mould design design and mould process simulation,
- Extensive plant technology for variothermal mould temperature control, foaming of plastics and the multi-component technique.
KAP – the Centre for Analysis and Testing of Plastics looks at specific problems in business and science and seeks optimal solutions. For this purpose, we can fall back on extensive, state-of-the-art analysis and testing capabilities.

Using faults to advantage

Defects, faults and damage actually provide a useful opportunity to make key improvements to a product. A damage analysis gets straight to the heart of the matter. It reveals the general state of a product and its quality. This helps to obtain valuable findings for ongoing production and for future developments – and thereby minimises risks. The Centre for Analysis and Testing of Plastics offers a wide-ranging support in this.

Solutions from a single source

The aim of damage analysis is to establish the causes of faults or damage and, by identifying specific characteristics of a defective product, to draw conclusions on the causes of the fault. These causes may be rooted in any of the lifecycle phases of the part. A fault analysis looks at the following parameters:

- incomplete or wrong definition of requirements
- faulty design
- unsuitable choice of material and inhomogeneities in the material
- inappropriate processing conditions
- overstressing of the material

To draw up a successful and systematic solution strategy, we get together with you to isolate potential negative influences and identify the likely reasons for the damage, which can then be specifically targeted. This makes damage analysis efficient and profitable.

Using analytical procedures to your advantage
Only when the damage history has been tracked and the cause of the damage clarified is it worth moving on to instruments for analytical testing. The testing and analysis equipment available in the KAP offers a solid basis for answering all questions that may arise concerning the process, the material or the stresses to which plastics are subjected in practical application.

The advantages are obvious. In addition to its wide range of machines and equipment, the KAP also offers sound expert know-how, scientific methods, many years of experience in analysis and testing, and a wealth of technical knowledge relating to the plastics industry. This enables us to find suitable solutions to your problems.

Product testing

For particularly challenging applications simulation is not a sufficient way to predict the product properties. In such cases, tests must be performed on the finished product under conditions that accurately reproduce the stresses to which it will be later subjected. For this purpose IKV has a range of testing equipment at its disposal, e.g. for carrying out media tests under alternating mechanical loads.

Cooperation with customers

After making initial contact by phone or e-mail, we study your problem and examine possible solutions. We can usually tell you straight away how to solve the matter quickly, uncomplicatedly and successfully.

Analysis and testing facilities in the KAP

- Microscopy
- Spectroscopy
- Thermal analysis
- Rheometry
- Mechanical testing
- Other chemical/physical methods
Correct processing and application of plastics

Nowadays, plastics are processed and used on a large scale both by industry and by skilled craftsmen. Plastics frequently serve as substitutes for traditional materials such as metal, wood, natural stone, etc., but the properties and methods used to process plastics differ from those of other materials. Thus the challenge is to process them correctly and make optimum use of their individual properties.

Technology transfer from the outset

This situation was recognised more than 60 years ago by companies from the then young plastics industry, who founded IKV. This was the first time know-how relating to technical processing methods had been pooled with knowledge of the chemical characteristics of plastics. Furthermore, the Institute’s founders recognised the opportunities offered by plastics in the skilled crafts, and subsequently created the Training and Further Education department. This is one of the aspects that sets IKV apart from other plastics institutes. Ever since this time, the training and further education of plastics users in industry and the skilled crafts have benefitted from the fundamental as well as practical research carried out at IKV: Technology transfer from the outset.

Plastics know-how as a key success factor

With the advancing substitution of traditional materials by plastics, the Training and Further Education department of the Institute of Plastics Processing plays a very important role in today’s world. Keeping up with the latest developments in plastics is a key success factor, especially for small and medium-sized enterprises involved in the skilled crafts. This is equally important for their suppliers – the manufacturers of plastics products and semi-finished materials. With its qualification courses, IKV creates the basis for high innovative strength and optimum economic performance for companies in industry and the skilled crafts.
Centre for plastics training

As the centre for plastics processing for the skilled crafts in Germany, IKV has developed a wide range of modern training and further education courses that are constantly enriched with the results of the institute’s research activities. The courses are offered throughout Germany at more than 30 training centres, and are accompanied by close technical and educational support of the plastics training supervisors.

This ensures on the one hand that the training activities are always oriented to practice and, on the other, that the supervisors receive competent, qualified advice on all matters connected with education and training in the field of plastics. Well over 20,000 (!) people on the courses every year benefit from IKV’s know-how and experience in the field of plastics. IKV’s qualification courses also enjoy an excellent reputation in the international plastics industry.

They all benefit from IKV’s know-how

IKV’s Training and Further Education department develops seminars and courses e.g. for the following sectors: plant and apparatus engineering, tank and pipeline construction, geothermal energy, construction and development, processing of fibre-reinforced plastics, boatbuilding and vehicle technology, drinking water and plumbing, sewer construction and renovation, trade fair construction, etc.

Courses are also developed in line with the rules and guidelines of the following institutions:

- German Welding Society (DVS)
- German Association for Gas and Water (DVGW)

Further information on the individual courses and contacts can be found on the Institute website at www.ikv-aachen.de/en/training-and-further-education.

The team at the Training and Further Education department of IKV would be pleased to advise you personally on any questions you may have.