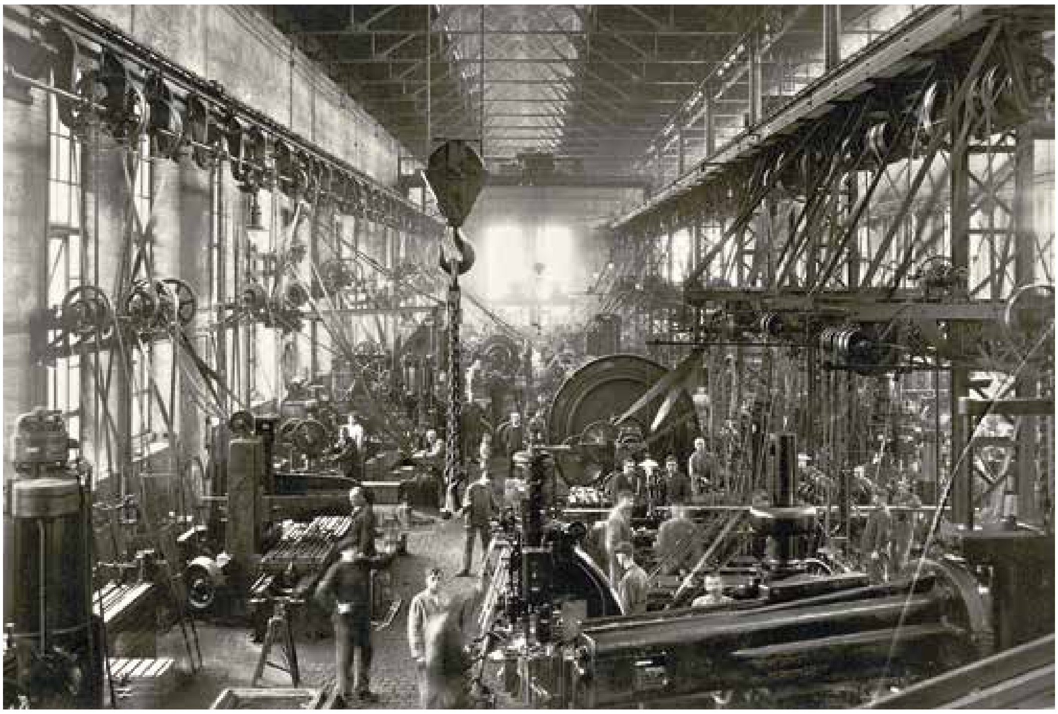
Cradle of Thermoplastics

BASF's Pilot Plant Facility for Thermoplastics Celebrates Anniversary

From the very beginnings of plastics processing to the digital age, many plastics innovations originated in the laboratories and workshops of the Ludwigshafen chemical company. This year, BASF's pilot plant facility for thermoplastics can look back on a history stretching over 80 years.



Circa 1921: view of the fitter's shop and main turning shop in what was then the Badische Anilin- und Sodafabrik AG. In 1948, the Plastics Raw Material Department, which had been established ten years earlier, moved into this building as the forerunner to the present pilot plant facility (© BASF)

Under the name "Plastics Raw Material Department" (Kunststoffrohstoffabteilung or "Kuro" for short), the thermoplastics technical development department of what is now BASF SE, Ludwigshafen, Germany, was established on February 1st, 1938 in the company then known as I.G. Farbenindustrie Aktiengesellschaft. In 1948, the Plastics Raw Material Department moved into a new home in building F 204 at the BASF headquarters in Ludwigshafen. The building had previously served as a fitter's shop and main turning shop (**Title figure**). In 1953, the department was renamed the "Thermoplastics Technical Development Department" (Anwendungstechnische Abteilung Thermoplaste or Aweta Thermoplaste for short). At this point, BASF was already collaborating with machinery manufacturers in the development of screw injection molding machines. At the end of the 1950s, these superseded the previously used plunger injection molding machines and made a very significant contribution to the efficient production of plastic components. Other important milestones in which the technical development specialists played a major role in the following years included applications implemented using complex processing technology such as the production of blow molded fuel tanks, lost-core molded intake manifolds, and engine mountings made from plastic instead of metal.

Focus on New Products and Users

Today, the thermoplastics processing development facility, now known as "Pilot Plant & Processing Technologies", is still in the same building. The **Title figure** and **Figure 1** show the building over the course of around 100 years. While it was once a mechanical workshop with metal-cutting machines centrally driven by a leather belt, it is now a technical development center for plastics processing fitted with highly automated machines. This pilot plant facility contains 20 injection molding machines with clamping forces ranging from 50 to 15,000 kN, equipped for various specialized processes such as gas-assist and water-assist injection molding, as well as more than ten extruders, a monofilament stretching unit, and two thermoforming machines.

This year the facility can now celebrate its 80th anniversary. Looking at the preamble (**Fig. 2**), it is clear that the tasks described at that time are still relevant today. Of course, globalization must now be taken into account and the phrase "Ludwigshafen and Oppau sites" would have to be replaced by a term such as "worldwide production facilities", while anglicisms such as "Sales" and "Technical Services" might perhaps be substituted for the Germany terms "Kunststoffverkauf" and "Technischer Kundendienst". But it was important then and still is today to be open to new ideas and adapt to the continually increasing demands of the ever-changing market.

The pilot plant facility continues to have two important functions: firstly to assist product development by evaluating the processability and properties of new materials and secondly to undertake joint developments with plastics processors and OEMs. Assistance with design and production is not just an ancillary service for products but an essential part of customer projects. The aim is, in collaboration with users, to develop new materials and components as well as economic processes for their production. Both pilot runs and small-lot production can be carried out directly in the pilot plant facility.

Fig. 1. Time leap: For 70 years, the pilot plant facility established in 1938 has been located in building F 204 on the site of the BASF headquarters. Over 20 semi-automated injection molding machines with clamping forces between 50 kN and 15,000 kN are available there for trials (© BASF)

Fig. 2. The preamble for the Plastics Raw Material Department when it was established in 1938 is somewhat dated linguistically but still fundamentally relevant today: be open-minded to new ideas and go with the market (© BASF)

Digital Records since the Turn of the Millennium

2011 saw the start of a general modernization of the pilot plant facility with the investment project "Technology Update" – many machines had become rather old, even if they no longer dated right back to the time of the facility's foundation.

So in 2011 and 2012, two new manufacturing cells for efficient, highly automated production of test parts for product development went into operation. They are equipped with the latest generation of robots but have the same functionalities as the older generation of manufacturing cells that were developed by BASF from 1992. Since the turn of the millennium already, a job management system has been passing the setting parameters to the machine control system. At the end of the trial, the actual values are read and stored in digital records – a functionality often summarized today by the term Industry 4.0.

An example of the far-reaching customer focus of the pilot plant facility can be seen in a near-real-world manufacturing cell that since March 2013 has been able to produce multifunctional composite test parts in one step (**Fig. 3**). The Ultracom manufacturing cell is part of the lightweight design activities of BASF. The aim was to develop a fully automated process that could be completed within a typical injection molding cycle time. Through systematic parallelization of the individual process steps, rapid laminate heating, and short, reproducible transport times within the cell, cycle times of less than a minute can be achieved.

Besides construction of the manufacturing cells, the extrusion section has also been technologically upgraded, partly by replacing outdated machine control systems with the latest electronics and partly by installing completely new machinery, such as a monofilament stretching unit and a coextruded blown and cast film line. The latter can produce films with up to seven layers (**Fig. 4**).

Many Processing Options

The aim of the replacements or new investments is to provide the right processing options for current research and development projects. Today, the pilot plant facility has injection molding machines covering a component spectrum ranging from microtensile test bars with shot weights of 0.1 g to fan impellers with shot weights of 6.5 kg.

It is important for a pilot plant facility to provide a wide variety of machines that can be used flexibly. Every day, different components must be produced in different molds. Besides the right clamping force and platen area, suitable »

Fig. 3. The Ultracom manufacturing cell enables a fully automated process for producing thermoplastic composites within a typical injection molding cycle time to be achieved (© BASF)

plasticizing units must also be selected to ensure a high-quality plastic component. All machines in the pilot plant facility have special plasticizing units that can also process high-temperature materials with melt temperatures of over 400 °C.

Besides two conventional multi-component injection molding machines, four other machines offer the possibility of both horizontal and vertical operation of the plasticizing units. The two machines that were installed in the pilot plant facility at the end of 2017 have a special rotary kinematic system for cylinder mounting that allows very safe changing of the plasticizing units.

Unlike in most production plants, the need for flexible machines and frequent changeover is paramount in a pilot plant facility. In the production of standardized test part geometries, the changeover process can be automated and mold changing carried out by a robot. With the other machines, it is important to equip them as efficiently as possible with the right plasticizing unit, screw geometry and size, and also with a suitable mold. Safety aspects and safety measures should be given the utmost priority here.

With the introduction of a manufacturing execution system (MES) specially tailored to the pilot plant facility, huge progress is possible through the use of digitization. Along the entire process chain, the MES makes the necessary information available in digital form and stores the conditions and parameters. This starts with trial planning, machine utilization, and the provision and drying of materials. It continues with setting up the injection molding machine, pre-defining material-specific safety requirements, processing parameters, and standard operating procedures, and, then, comprehensively logging the trial results. Because of our long-standing experience with fully automated manufacturing cells, the introduction of a comprehensive MES is not a radical change but an evolutionary step towards the systematic use of digital methods. ■

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Fig. 4. Besides injection molding, extrusion is also covered in the pilot plant facility. The coextruded blown and cast film line can produce films with up to seven layers (© BASF)