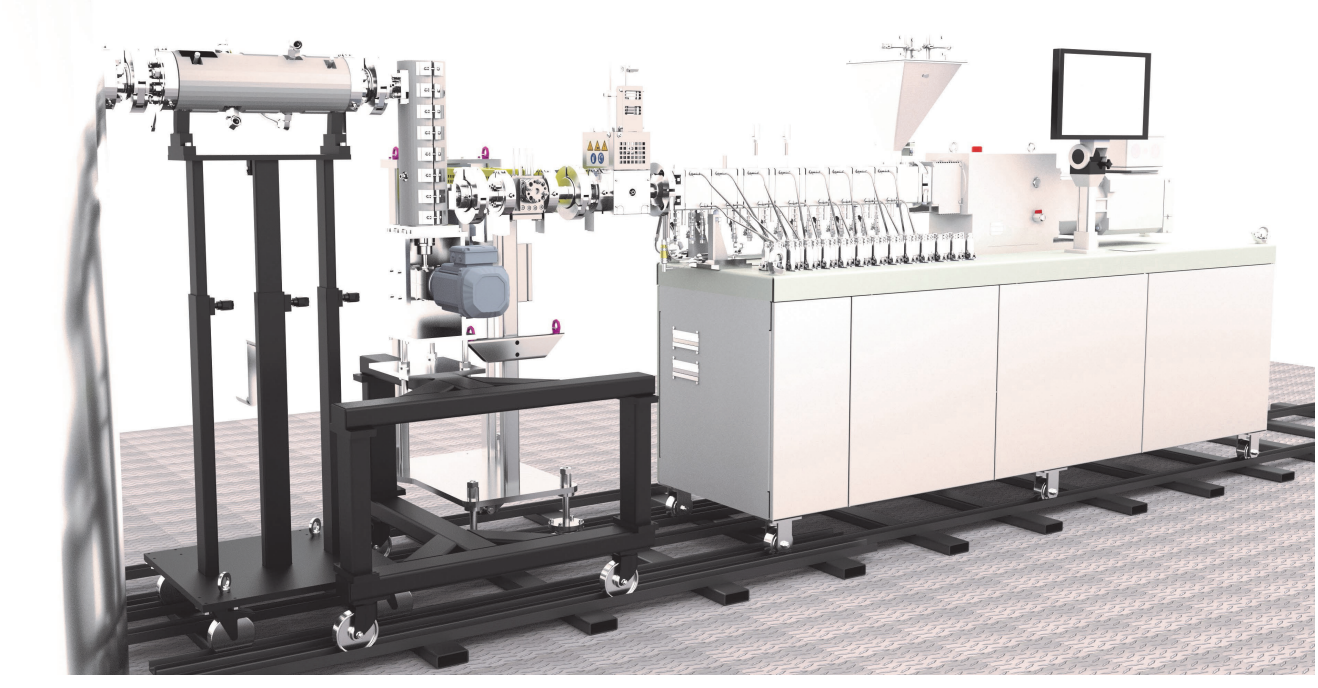
Perfectly Round

Research Project to Manufacture Powder for Selective Laser Sintering of Plastics

To extend the range of polymer powders for selective laser sintering, Paderborn University in collaboration with the Maag Group has developed an extrusion line that can produce round particles with good flowability. In this line, a polymer–gas mixture is sprayed under high pressure. The challenges lay in the control system, sensor technology, and gas tightness of the line.



The extrusion line to manufacture powder for selective laser sintering of plastics is in the Paderborn University laboratory © Maag/KTP

The design and implementation of individual plants for plastics manufacture and processing are the everyday business of the experts at the Maag Group. So they were the right partners for a research project at Paderborn University, Germany. The Plastics Engineering Department needed support to build an extrusion line for the manufacture of laser sintering powder. The project was a win-win for both partners. The Maag Group contributed the extrusion line components and was responsible for the control system of the flexible line – the scientists contributed innovative ideas and comprehensive process knowledge.

Plastics are becoming increasingly important in modern machinery manufacture and are replacing traditional materials such as wood, metal or glass. Against this background, the Mechanical Engineering Faculty at Paderborn University has been carrying out research in the areas of plastics technology and plastics processing for almost 30 years. The nearly 50 scientific and technical staff who work in the Paderborn Plastics Engineering Department (KTP) undertake practical and theoretical work in areas such as extrusion, injection molding, and welding or bonding of plastics. Besides extensive teaching activity at the University, the KTP supports industry with a variety of services.

A current project, sponsored by the European Regional Development fund and arousing great interest among industrial companies, is concerned with the manufacture of novel powders for selective laser sintering (SLS). In charge of the project for KTP is PhD student Jan Hendrik Martens. The project is being carried out in collaboration with another Department, the Paderborn Particle Technology Group (PVT). The aim of the research is to solve a problem which is still encountered in selective laser sintering, i.e. the range of available polymer powders is largely restricted to PA12 (over 90%). Special materials or even standard materials cannot be produced economically with the required properties. "Often the necessary flowability for even powder application is simply not achieved," explains Martens. The aim of the project, therefore, is to produce the roundest possible particles with good

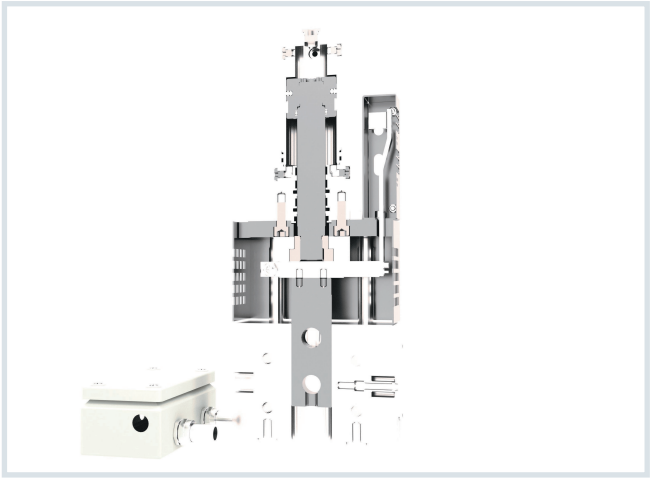


Fig. 1. The PoDV 20 start-up valve ensures stable, optimized volume flow right from the start © Maag

Fig. 2. The extrex[6] gear pump is equipped to process very low viscosities © Maag

flowability from other materials. There are potential applications, for example, in prototyping and small-lot production for the automotive and aircraft industries. Wider availability of usable powders would also open up applications in new industry sectors.

Trials to produce the powder are being carried out on an extrusion line in which a polymer – in this case polypropylene – and gas are mixed. In this way, such a low viscosity is achieved that the polymer-gas mixture can be sprayed under high pressure. Other effects during gas release and a subsequent curing phase then produce the required powder.

From Theory to Practice: Extrusion Line with Special Requirements

Jan Hendrik Martens was responsible for building the extrusion line in the specially designed laboratory space. When ordering the components for the line, he came into contact with the experts in the Maag Group while searching for an efficient gear pump. A real stroke of luck, Martens enthuses: "They supported us with their know-how right from the start."

Wolfgang Martin, team leader Sales Pump & Filtration Systems at the Maag Group, explains: "KTP had precisely defined requirements for the line and clear ideas as to how it would be used. We quickly realized that the control system would have to play a key role." Martin brought Carsten Richter on board, a control system expert at the Maag Group. The line itself comprises a feed unit, co-rotating twin-screw extruder, start-up valve, extrusion gear pump, mixer, and melt cooler. Individual components such as the extruder had already been ordered before Maag became involved in the project. These were incorporated in the design of the line and the control system to provide the scientists with a high-performance, user-friendly line.

The Maag Group contributed an extrex[6] extrusion gear pump and a PoDV 20 start-up valve for the line. The gear pump was matched to the extruder performance so as to achieve optimum throughputs. A special feature of the pump is its stuffing box seal. With this modification, two customer requirements are fulfilled at the same time. Firstly, the line is equipped for the very low viscosities occurring in the trials and secondly, a special seal is required to ensure the gas tightness of the line and prevent escape of the gases used. To ensure a high degree of safety in the trial line, it is also equipped with mercury-free pressure sensors for high-temperature applications in conformity with Machinery Directive 2006/42/EC. The self-monitoring sensors utilize the piezoelectric effect and ensure safe shutdown in the event of limit-value violations.

Besides safety, flexibility of the extrusion line is a top priority for Jan Hendrik Martens and his colleagues. The line should be capable of operation in various configurations. Wolfgang Martin therefore recommended the use of C clamps instead of the conventional screw adapters. "This tip was worth its weight in gold," says Martens. Now he can re-configure the components quickly and easily without compromising the gas tightness of the line. For the start-up valve, too, Maag found a solution that satisfied the need for an extrusion line with maximum flexibility. Thanks to a modification, it can be used as a bypass through which, if necessary, material can be discharged during the course of the trial. »

The Authors

Dipl. Ing. (FH) Wolfgang Martin is team leader Sales Pump & Filtration Systems at Maag Germany GmbH; wolfgang.martin@maag.com
Carsten Richter is a control systems expert at Maag.
Prof. Dr.-Ing. Volker Schöppner heads up the Plastics Engineering Department at Paderborn University, Germany.
Jan Hendrik Martens, M.Sc., works in the Paderborn Plastic Engineering Department (KTP) at Paderborn University.
Moritz Rüther, M.Sc., is a research assistant in the Particle Technology Group (PVT) at Paderborn University.

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Everything under Control, thanks to a Customized Control System

Martens ascribes the high user friendliness of the whole extrusion line to the involvement of the Maag Group. "Maag assembled an overall package that was customized for our purposes and in which the Maag Group had thought of everything," he explains. The extrusion line control system permits a wide range of settings, leaving plenty of scope for the trials being carried out.

For Carsten Richter, the greatest challenge was to design the control system so that all components could be incorporated – i.e. also components that had already been ordered such as the temperature control unit and the extruder. This problem was solved with the aid of the maax 600S automation system, which is suitable for installing on turnkey and complex extrusion lines. It can be adapted individually to customer requirements – a particular plus point for the research work of the Paderborn scientists. If components are removed or added to their line, the control system can map this. "At KTP, we have developed a very complex and flexible control system especially for research purposes. This was necessary because laboratory plants make considerably more control demands than production plants," explains Carsten Richter. All in all, eight variable-speed components such as the pump, mixer, and feed unit as well as up to 16 heating zones are controlled.

Ideal Combination

The extrusion line has been in operation since mid-2020. Thanks to the installation-ready components delivered by the Maag Group and the adapter flange they also supplied, it took Jan Henrik Martens only a matter of minutes to assemble the extrusion line. "The cooperation was really special and the ideal combination of science and practice." All those involved agreed on this. Wolfgang Martin explains: "Despite my long-standing experience, I have learnt a lot more about the manufacturing process, which can be used in day-to-day practice." Jan Hendrik Martens feels confident that this extrusion line will be able to produce new laser sintering powders in the very near future. And he already has a specific idea for future research. He plans to develop a laser sintering powder from glass fiber-reinforced polyamide 12 for additive manufacturing. ■

Company Profil

The Maag Group is a globally active manufacturer of gear pumps, pelletizing and filtration systems, and powder mills for the plastics industry. Its portfolio also includes digital automation solutions for challenging applications.

The Maag Group combines long-standing experience with the product brands Automatik, Ettlinger, Maag, Gala, Reduction, Scheer, and Xantec. Today, it employs over 1100 people worldwide and functions as a business unit of Pumps & Process Solutions, a segment of the Dover Corporation.

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Feddem

Twin-Screw Extruder for Upcycling

Feddem will be presenting a twin-screw extruder of the type FED 43 MTS 32 L/D at Fakuma. With a screw diameter of 43 mm and up to 142 kW drive power, this extruder size is ideal for pilot and production applications of small to medium batch sizes. The model range offers all properties that are of great benefit in compounding and masterbatch applications: efficient melting and mixing of product components, kneading-block-free screw, modular, thermally insulated protective covers of the processing section as protection against contact and for a more favourable energy balance of the process. The process length can be individually adapted by extension unit. The FSK strand head is compact and equipped with swivel hinge. On request, it is also available with patented arched nozzle for special applications.

LFT pultrusion line technology for the production of high-performance materials will also be the focus of the trade show. "The technology of LFT pultrusion lines for the production of LFT-G long pellets has been around for several years. Feddem has taken a fresh look at the details of the line components to improve performance, quality and handling. The result is not only unprecedentedly tight tolerances from the fibre content in the pellets, but also the repeatability of the achievable material properties of the LFT compound on different lines and line sizes with haul-off speeds of up to 60 m/min," says Klaus Hojer, Business Development Manager at Feddem GmbH & Co. KG..

In order to keep as much plastic as possible in production in the course of global efforts, compact plants for the processing of production waste are becoming increasingly interesting. In upcycling applications, twin-screw extruders are proving their worth in terms of high mixing performance in a gentle process that delivers high-quality recyclate.

Additives can be incorporated into the process that, for example, adjust the viscosity and color of the recyclate for optimal reuse. At the same time, the space requirement can usually be reduced to a minimum, which can be a great advantage when setting up in the production environment

↘ **Hall A6. booth 6217**

FED 26 MTS extruder with three gravimetrically metered material streams and metal separator in the main stream © Feddem