Innovative and complex ideas in the field of polymer injectable drug delivery systems need a capable partner to succeed in realisation. For customised products such as new and innovative Injectable Drug Delivery Systems it needs a wide range of polymer technologies including injection moulding, extrusion and assembly. Starting with a first idea through prototyping, design studies, risk analysis, research and development up to mass serial production under clean room conditions, packaging and sterilisation the complete supply chain is more than just complex.

In this article, Thomas Jakob, PhD, Director, Business Unit Moulding, Pharma Solutions, RAUMEDIC AG, describes innovative injectable drug delivery systems together with a broad range of know-how and experience of polymer technologies. The most common starting point of all innovative injectable drug delivery systems is a customer idea.

Innovative Injectable Drug Delivery Systems

With a share of approximately 25%, injectables were the number two in the global pharmaceuticals market in 2010, preceded only by oral medication. Double-digit growth rates, for example, in the areas of biotech products and injectable generics show the importance of this market segment. Besides standard prefilled syringes, vials and containers, more customised and innovative injectable drug delivery devices, such as safety syringes, customised...
pen systems, needle-free or intradermal injectors are required by the market. Currently in the injectable drug market an estimated 2.7 billion prefilled syringes are used annually (Greystone Associates, 2009). In particular, polymer systems are estimated to undergo double digit growth rates in the coming years, especially those custom-developed for new drugs.

TECHNOLOGIES FOR INNOVATIVE DRUG DELIVERY SYSTEMS

A common stage in the manufacture of most injection devices (with the obvious exception of needle-free systems) is that a needle, which comes in a range of differing dimensions, is embedded in an injection-moulded polymer component. Three principal technologies are used for the connection: gluing, over-moulding and welding and the most appropriate process is dependent on the one hand on the needle size and surface, and on the other hand on the polymer type, size and geometry of the injection moulding part. Furthermore factors such as the required needle-holding forces, its final intended use in practice, and of course economic considerations, are relevant.

Figure 1 shows an example of a fully automatic needle-gluing process. The glue is cured with UV LED lamps followed by 100% vision control of the result, and an additional 100% needle force control according to standard norms (Figure 2). A UV-fluorescent glue system is used in order to enhance the visual inspection. The glue is visualised under a UV light as shown in Figure 3.

In addition to absolute precision in the fully automated needle handling process, there are also very narrow tolerances for the manufacture of injection-moulded parts. High-precision injection-moulded polycarbonate components are shown in figure 4. The specialities in this case are on the one hand the small size of the injection moulding part and on the other hand the tooling concept. The size of these parts is in the range of one pellet of polycarbonate before injection moulding. The second highlight in the development is the injection tool concept, where a 64-cavity tool was built with a highly innovative melt-disc hot runner system. One of the benefits for the customer is that precision injection moulding results in accurate holding forces for the embedded and glued needle.

For the handling system, different production systems are possible, starting from manual needle handling to fully automatic handling with linear or six-axis robot systems, where needles can be directly over-moulded with a polymer injection moulding part.

Another available manufacturing technology is multi-component injection moulding, which allows hard and soft thermoplastic polymers to be combined in one product without post-assembly. Especially for applications such as sealing and connecting combinations of different thermoplastics this technology can perfectly be applied. The soft component reacts chemically with the hard component and can only be separated through destructive force. This makes the product perfectly safe - an important factor in the pharmaceutical industry. Furthermore, the reduction of individual parts contributes to reduce costs.

A multi-component technology can even be enhanced by combining it with metal insert tech-
Figure 6 shows a metal needle directly moulded with a two-component injection moulding technology, first with a soft polymer and subsequently with a hard polymer. In the two-component luer cannula, the soft component has an additional sealing function. The adhesion between the metal insert and the polymer is comparable with gluing processes. Applications can be found in all kinds of injection systems.

In the pharmaceutical/drug delivery devices market there is a growing demand for new devices with directly over-moulded needles. Especially with regard to extractables and leachables, the advantage of an over-moulded needle is that the drug is only in direct contact with the polymer and the needle but not with any glue. Over-moulding technology in combination with fully automatic needle-handling in particular is growing in popularity and one reason for this is that the sophistication of injection device design, using new polymer materials, is increasing.

One area where the industry is able to take advantage of the availability of more sophisticated injection moulded polymer components, for the benefit of their customers, patients and healthcare workers alike, is in the development of needle-safety technologies.

In May 2013, the new EU Directive 2010/32/EU for the prevention of needle stick injuries came into force in all Member States of the EU. It dictates that employers in the medical field should provide systems with an integrated safety mechanism.

For this reason RAUMEDIC has developed a new safety device for injection systems. RauSafe™ (see Figure 6) can be adapted to a variety of existing injection systems on the market and provides reliable protection whilst being simple and intuitive to use.

The RauSafe™ needle safety device is activated after an injection by simply pushing it forward. As soon as the needle is completely enclosed, you can hear and feel the system click into the end position.

“ONE AREA WHERE THE INDUSTRY IS ABLE TO TAKE ADVANTAGE OF THE AVAILABILITY OF MORE SOPHISTICATED INJECTION MOULDED POLYMER COMPONENTS, FOR THE BENEFIT OF THEIR CUSTOMERS, PATIENTS AND HEALTHCARE WORKERS ALIKE, IS IN THE DEVELOPMENT OF NEEDLE-SAFETY TECHNOLOGIES”

Worldwide, there are an estimated 3.5 million needle-stick injuries annually in doctors’ clinics, hospitals and in the home-care setting. Associated with this is a risk of infection with dangerous viral diseases such as HBV, HCV or HIV. The resulting health and financial consequences after an infection are risk factors that have to be taken seriously.

Innovative customised innovative injectable drug delivery systems are one example of the development and manufacturing expertise of RAUMEDIC and its customer-oriented conversion into high-quality medical and pharmaceutical products. RAUMEDIC meets all the requirements for generating tailor-made solutions in the areas of rapid prototyping, material development, precision and multi-component injection moulding, injection of moulded parts onto tubes, extrusion, micro-extrusion, multi-layer extrusion, part assembly as well as end packaging, sterilisation and certification. With its in-house laboratory RAUMEDIC can provide for all customers a broad range of different chemical, physical and individual test methods. RAUMEDIC creates complex concepts and developments for its customers and is consistently putting these into practice.

RAUMEDIC, a family owned company, is a spin-off of REHAU AG + Co, providing customer-specific polymer products and complete assembled systems on fully automated manufacturing machines, all manufactured from biologically suitable and approved materials under clean room conditions according to ISO 14644 class 7.

RAUMEDIC provides customer service worldwide through local subsidiaries and the development and processing competence centre in Münchberg, Germany. RAUMEDIC has established a comprehensive quality management system encompassing all processes within the company. The quality management system is process-oriented and certified in compliance with ISO 13485.