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Plastic pipes in industry

Over the last 60 years plastic pipes have been introduced in a wide variety of applications and have even become market leaders in numerous segments. One major reason for this success has been their high potential for innovation. Application-specific solutions have become possible through new and advanced plastics and through improvements in production and process engineering. The German Plastic Pipe Association KRV in Bonn (www.krv.de) believes that new markets will continue to open for plastic piping systems, e.g. through ongoing developments in renewable energies and in information and telecommunication networks.

Although the industrial sector only plays a minor role for plastic pipes, the requirements on industrial piping systems nevertheless tend to be highly sophisticated and complex. This is an area where modern plastics, pipe layouts and connection technologies permit demand-focused and ever widening areas of application. Plastic piping systems have been used successfully in industry and in plant engineering and are increasingly replacing conventional materials. What makes plastics so suitable for use is above all their corrosion resistance, handling qualities, energy savings, cost effectiveness and safety.

Plastic pipes, containers and connectors are used in a wide range of industries. Plastics are particularly important in the chemical industry. Requirements on such media are especially high in the transportation of chemicals and to ensure special water qualities. The most important quality that should be mentioned here is chemical resistance. Substantial demands are also made on safety, service life and cost efficiency. Moreover, maintenance repairs and fitting procedures must be as simple as possible. These requirements have led to a large variety of different polymer materials in the construction of plastic piping systems.

Materials for a wide range of applications

In chemical engineering the most widely used materials are, above all, polyolefins, fluoroplastics, PVC-C, GFRP and often also compounds such as combinations of thermoplast and duroplast materials. ABS (acrylonitrile butadiene styrene), for example, is suitable because of its mechanical properties, its good chemical resistance and its high impact resistance, even in the lower temperature range, and can be used for a large number of applications, particularly in refrigeration and air conditioning.

GFRP (glass-fibre reinforced plastic) is a high-strength composite and especially suitable for high-stress mechanical, thermal and chemical piping systems. By combining different raw materials, it is possible to produce GFRP pipes that meet the specific requirements of each application. GFRP displays a high level of stiffness and strength even under high temperatures and under chemical impact. As well as being low in weight, the material – according to KRV – offers benefits for large pipe diameters, in particular.

Over the last few years the ongoing development of PE-moulding compounds has led to marked improvements in the efficiency of PE pipes and connectors. Being UV-resistant, PE (polyethylene) has excellent processing qualities and combines a high level of chemical resistance with viscosity and stiffness. Moreover, PE can be used within a wide temperature range, both above and below zero. PE is now no longer classified according to thickness, but is divided into the strength categories specified in ISO 9080 (PE 63, PE 80, PE 100). Compared with other thermoplasts, PE – says Frank GmbH (www.frank-gmbh.de) – has excellent diffusion resistance and has therefore been used in the transportation of gas for many years now. Other key benefits of the material are its UV stability and flexibility.

Improved mechanical properties

PE 100 is a further development. Thanks to a modified polymerisation process, it is thicker and has better mechanical properties as well as being stiffer and harder. Moreover, there have been marked improvements to its creep resistance. The material is suitable, among other things, for the production of pressure pipes with large dimensions.

PE pipes can generally also be used in high-energy radiation, for instance when draining off radioactive wastewater from hot laboratories or transporting cooling water in nuclear power plants. According to the relevant companies, PE pipes do not turn radioactive even after many years of use. Thanks to their physiological safety, PE pipes and connectors have also been tested and approved for use with drinking water.

One of the special qualities of PE is its chemical resistance. PE is uncommonly resistant to a large range of acids and alkalis. These include aqueous solutions of salts as well as non-oxidising acids and alkalis. However, PE only has limited resistance to powerful oxidising agents such as nitric acid, ozone, oleum, hydrogen peroxides and halogens.

We should also mention PE-EL (electrically conductive polyethylene), which is often used for transporting highly flammable media such as fuels as well as dusts at temperatures up to 60°C. Compared with standard PE, PE-EL has a lower impact strength, creep resistance and slightly modified level of chemical resistance.

PP (polypropylene) offers high mechanical strength, good chemical resistance and physiological safety. Other qualities are its high chemical resistance and good long-term properties with numerous media, even at high temperatures. As its heat resistance is higher than PE, PP is regarded as a more suitable standard material for use in high temperatures. It is therefore given preference for above-ground piping systems.

PP comes in a variety of polymer types. As a homopolymer, PP-H consists exclusively of propylene molecules, whereas the two copolymers PP-B (polypropylene block copolymer) and PP-R (polypropylene random copolymer) include ethylene monomers. Both types have a high level of heat resistance and are well-suited for piping systems under high pressure. As the temperature rises, their impact strength increases, and a drop in temperature leads to a decrease. According to Frank GmbH, PP-R has better impact strength than PP-H.

PP is known to be resistant to many acids and alkalis, such as alkali lyes, phosphoric acid and hydrochloric acid. However, PP only has limited resistance to free chlorine, ozone and hydrocarbons, and thus also to petrol. Because of its high temperature resistance, PP is valued for its use in picking lines, in the chemical industry and with highly aggressive wastewater. Moreover, it must be noted that its chemical resistance is dependent on the operating temperature, operating pressure and any external impact strain.

Safety through flame-retardant plastics

To dissipate static charges which may occur with liquids and dusts when operating thermoplastic piping systems in explosion-proof areas, it is important for a material to be electrically conductive. The addition of conductive carbon black, however, also reduces the impact strength and creep resistance of electrically conductive PE-EL and PPs-EL materials, whereas chemical resistance largely remains the same. The flame-resistant polypropylene type PPs contains flame retardants, so that its classification as a building material is B1 (according to DIN 5102), and it is often used for ventilation and exhaust gas lines within buildings. According to Frank, PPs-el (which is flame-retardant and electrically conductive) combines the positive qualities of both the flame-retardant and electrically conductive PP types. For safety reasons, this material is therefore used mainly in the transportation of highly flammable media.

Other flame-retarding materials are the two types of polyvinyl chloride PVC-U and PVC-C. PVC-U contains no plasticiser and is a universal material with a good level of cost effectiveness, allowing convenient thermo-mechanical processing. Post-chlorination of PVC leads to PVC-C, which is more temperature-resistant than PVC-U and, in some cases, even has better chemical resistance.

The last product that should be mentioned here is PVDF (polyvinylidene fluoride), a highly crystalline high-performance thermoplastic material with a high level of stiffness even in the upper temperature range. It is extremely resistant to many organic and inorganic media. As PVDF is a homopolymer without additives such as stabilisers or colouring, it is regarded as physiologically safe and can be used with high-purity media. As well as displaying good mechanical strength, PVDF has excellent chemical resistance and is easier and more convenient to process than other fluoroplastics. Moreover, because of its chemical structure, PVDF has a good level of resistance to UV and gamma radiation, while also being resistant to ageing.

New pipe generation with increased abrasion resistance

Thanks to the wide range of materials described above, the plastic pipe industry is in a position to develop optimum solutions for a large number of applications. One example is the transportation of media containing solids where the liquid/solid mixture has a substantial impact on the inside of the pipe due to a high level of mechanical friction. Both PE 80 and PE 100 pipes are generally suitable for such applications, as they have good mechanical/hydraulic qualities and are highly resistant to corrosion and incrustation. To improve these good qualities even further and to increase the economic lives of such piping systems in those applications, Simona AG (www.simona.de) has now developed a new generation of pipes. It involves a coextrusion process, fusing together different PE materials.

In this instance a basic PE 100 pipe is combined with PE material lining that has a high molecular weight. The coextruded, wear-resistant lining forms an integral part of the standard pipe wall geometry. This means that the dimensions of the pipes meet the requirements of DIN 8074 and can be combined and processed with well-known, commercially available connectors. Trials such as internal pressure creep tests have shown, according to the manufacturers, that the product has the required strength, as specified in DIN 8075. This combination of materials is expected to lead to a 30-50% longer service life of the piping system, depending on the medium that is conveyed.

Saving energy with plastic pipes

Georg Fischer Piping Systems (www.piping.georgfischer.com) has developed an eco-friendly algae-based bioreactor based on special pipes. The speciality of this company is a translucent plastic piping system which, according to the manufacturer, successfully balances translucency and a long service life. It consists of transparent PVC pipes which allow sufficient light to get through at the correct wavelength, so that microalgae can grow there. This turns the piping system into a bioreactor for growing algae and thus for the production of biomass and biofuel. At the same time the organisms process carbon dioxide (CO_2) which is required for growth. CO_2 can be obtained, for instance, from a combustion power plant, thus reducing CO_2 emissions.

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