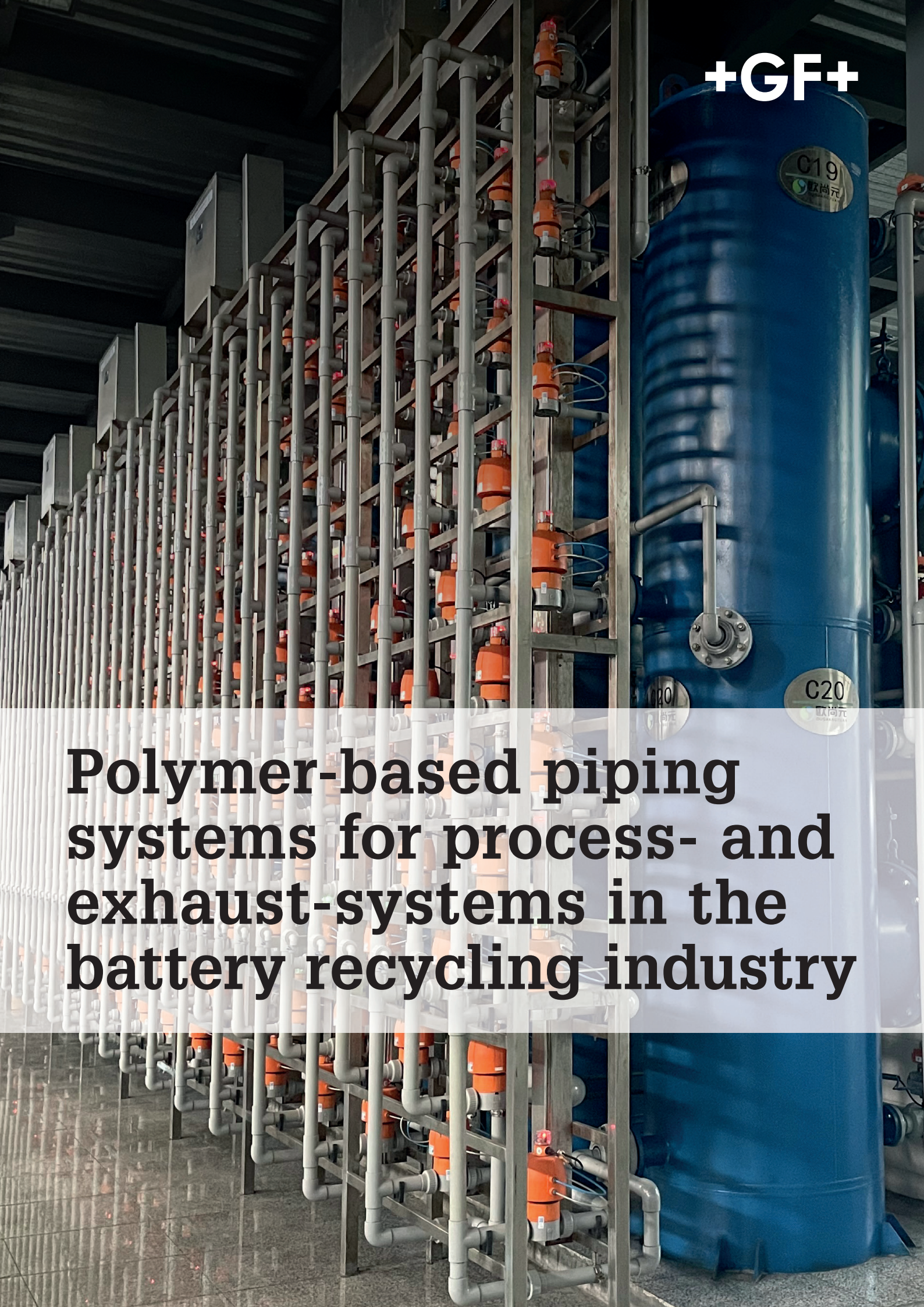


The image shows a large industrial facility, likely a battery recycling plant. In the foreground and middle ground, there are rows of tall, vertical grey pipes supported by metal frames. These pipes are connected to various orange-colored valves and components. To the right, there are large blue cylindrical storage tanks. One tank is labeled 'C19' and another 'C20'. The background shows more industrial structures and a dark ceiling.

+GF+

**Polymer-based piping
systems for process- and
exhaust-systems in the
battery recycling industry**

Polymer solutions for battery recycling

Use of polymer piping systems and components in wet-chemical / hydrometallurgical battery recycling processes

Mission

Georg Fischer is your partner when it comes to maximizing the proven advantages of polymer piping systems and the application of thermoplastics in plant engineering. Our extensive experience in chemical plant construction and the chemical processing industry enables us to support you in selecting the most appropriate polymer piping system for black mass processing as well as for the hydrometallurgical separation steps used in battery metal recycling.

Segment related information / technical background

- Battery recycling is a key element in implementing energy transition and is a prerequisite for long-term, cost-effective and sustainable electromobility.
- The efficient extraction and clean separation of valuable metals begin with the chemical digestion of black mass followed by hydrometallurgical process steps.
- The industry is currently experiencing new trends to establish and scale-up the process and operating conditions for these individual technical requirements.
- Most processes involve the use of strong acids, caustics, and oxidizing agents and are based on the principles of inorganic separation processes.
- Although many processes can be unique, technology owners may rely on operating conditions and experience gained from other sectors in the chemical industry. This experience can be transferred on the material selection, particularly in the scale up phase.

Added Value

- For almost 70 years, GF DEKA has supplied the global market with high-quality polymer piping solutions specializing in thermoplastics with a strong focus on chemical and industrial engineering. Our experience qualifies us as the partner of choice for pipe manufacturing and refinement as well as consulting on material selection and chemical resistance.
- As part of GF Industry & Infrastructure Flow Solutions, we belong to a worldwide team of experts in international polymer piping technology. Partnering with GF DEKA provides access to Georg Fischer global presence, expertise, and extensive network.

- A key strength of GF DEKA is its in-house development and compounding of PVC formulations. This capability allows us to tailor materials to meet individual customer requirements, while offering a comprehensive portfolio of highly chemical-resistant U-PVC and C-PVC piping systems for demanding industrial applications.
- GF DEKA offers extensive options for customizing your piping solution, including non-standard dimensional variants, mechanical machining, module fabrication, and adaptation of material formulations to individual requirements.
- Not all questions regarding chemical resistance can be answered in advance; this applies particularly to new and customized processes. GF DEKA can help in selecting and evaluating potential materials for piping systems, vessels, and equipment, and can support laboratory testing and field studies.
- GF DEKA has many years of experience in manufacturing industrial pressure pipes and thermoplastic liners based on clearly defined formulations of PP, U-PVC and C-PVC. As a global provider, we offer harmonized liner system components comprising of pipes, sheets and welding rods. This helps to ensure that all components of thermoplastic linings used in dual laminated piping systems, vessels and equipment provide the most consistent performance chemical resistance. This is of utmost importance for long-term operation of such components. Dual laminated components are an important alternative or supplement when elevated temperatures, enhanced operator safety requirements or legal compliance must be considered.
- Our products are manufactured in accordance with the standards relevant to the respective materials. Dimensions are usually based on metric systems; however,

manufacturing in inch-based dimensions is also possible on request.

- Backed by several decades of industry experience, we have an extensive reference base spanning a diverse range of

chemical processing applications. This knowledge provides a strong base for material selection, particularly in the development of new applications.

Our Material Solutions

Polypropylene (PP)

- PP has been established as an economical standard material in chemical plant engineering for decades.
- The extensive chemical resistance profile of PP serves as a valuable complement to PVC materials, extending the range of applications where thermoplastic solutions can be utilized.
- Based on defined high-performance formulations, GF offers the following solutions:
 - a) Complete pressure piping systems under the PROGEF brand are available for two different PP grades in various pressure ratings and across extensive dimensional ranges:
 - PP homopolymer (PP-H) with special beta nucleation and high-temperature stabilization for maximum permeation barrier performance, improved thermo-mechanical behaviour, and long service life.
 - PP random copolymer (PP-R) in pigment-free natural formulation for enhanced visual inspection of media flow. On request, GF also manufactures pressure and liner pipe dimensions from grey-pigmented PP-R (type RA 130 E grey).
 - These pressure pipe options are also available using the CONTAIN-IT portfolio, a double-containment system for increased operational safety requirements.
 - b) DEKAPROP liner pipes based on a clearly defined formulation:
 - PP block copolymer (PP-B) based on the established Hostalen PP H2222 resin with special high temperature stabilization – the proven classic for transporting caustics at elevated temperatures.
 - PP random copolymer (PP-R) in grey formulation based on RA 130 E grey; an economical option with increased safety against stress cracking.
 - c) Industrial ventilation pipes under the DEKAPROP-s brand based on flame-retardant Polypropylene (PPs).
 - Flame-retardant according to DIN 4102 B1, matching common fire-safety requirements.
 - System availability across the full dimensional range, including sheets, welding rods, and fittings.

U-PVC

- U-PVC has been one of the most widely used piping materials in industrial and chemical plant engineering for almost 100 years.
- U-PVC offers a unique and broad chemical resistance

profile combined with an economical cost to performance ratio. This material provides great resistance to oxidizing agents, strong mineral acids, and caustics in the temperature range from 0 to 60 °C. Details should always be clarified by consultation, especially for applications involving concentrated sulfuric acid.

- U-PVC offers a wide range of jointing technologies, from solvent cementing to infrared butt fusion welding.
- Based on defined high-performance formulations, GF offers the following solutions:
 - a) Complete pressure piping systems with the option of using different PVC pipe formulations in various pressure ratings and across an extensive dimensional range:
 - DEKADUR standard pressure pipes in grey, with very good basic stabilization, and covers many standard processes in chemical industry piping applications. For particularly demanding applications, GF DEKA additionally offers a more chemically resistant DEKADUR pressure pipes with increased wall thicknesses (SDR 9).
 - In addition to standard grey DEKADUR pressure pipes, transparent U-PVC DEKADUR G pressure pipes are available with a unique competitive advantage for pressure design and chemical resistance. Please contact us for further information.
 - For increased operational safety, these pressure pipes are also available in a double-containment by choosing GF's CONTAIN-IT® system portfolio.
 - b) DEKADUR liner pipes based on a clearly defined formulation:
 - DEKADUR troisdorf red: A high-quality and improved chemical-resistant U-PVC formulation. Together with Trovidur EN Liner Red sheets and welding rods from Röchling Industrial SE, it forms a harmonized system that has been the global standard for U-PVC-based dual laminated systems in chemical process industry for decades.
 - DEKADUR Plus: A highly chemical-resistant U-PVC formulation with an extended application range aimed toward higher temperatures, forming a harmonized system with liner pipes, liner sheets, and welding rods.
 - c) DEKADUR industrial ventilation pipes
 - Flame-retardant according to DIN 4102 B1 and EN ISO 13501 B-s1,d0, matching common fire-safety requirements.
 - System availability across the full dimensional range, including sheets, welding rods, and fittings.

C-PVC

- C-PVC is an important extension in chemical plant engineering with an attractive cost-performance ratio.
- The broad chemical resistance profile of C-PVC is similar to that of U-PVC for certain media classes, which can be used for media operated in a higher temperature range. The material shows strengths when in contact with Hydrochloric acid, Nitric acid, most media used in Chlorine chemistry and many oxidizing agents. Details should be clarified with us via an individual consultation. The use of C-PVC in contact with caustic media is not recommended.
- C-PVC offers a wide range of jointing technologies, from solvent cementing to hot-gas and butt welding.
- Based on clearly defined high-performance formulations, GF offers:
 - a) A complete pressure piping system in various pressure ratings and across an extensive dimensional range
 - The DEKADUR C formulation used for the pipes is characterized by particularly high chemical resistance and is optimized for contact with chemicals.
 - These pressure pipe options are also available as CONTAIN-IT double-containment concepts where increased operational safety is required.
 - b) DEKADUR C liner pipes are available based on clearly defined formulations.
 - DEKADUR C is a very high-quality and highly chemical-resistant C-PVC formulation that forms a harmonized system with DEKADUR C liner sheets and welding rods.
 - For decades, it has been the global piping construction standard for C-PVC-based dual laminated systems, particularly in large-scale industrial Chlorine production. DEKADUR C-based dual laminated piping systems are also established products in Nitric acid and Hydrochloric acid industries.

PVDF

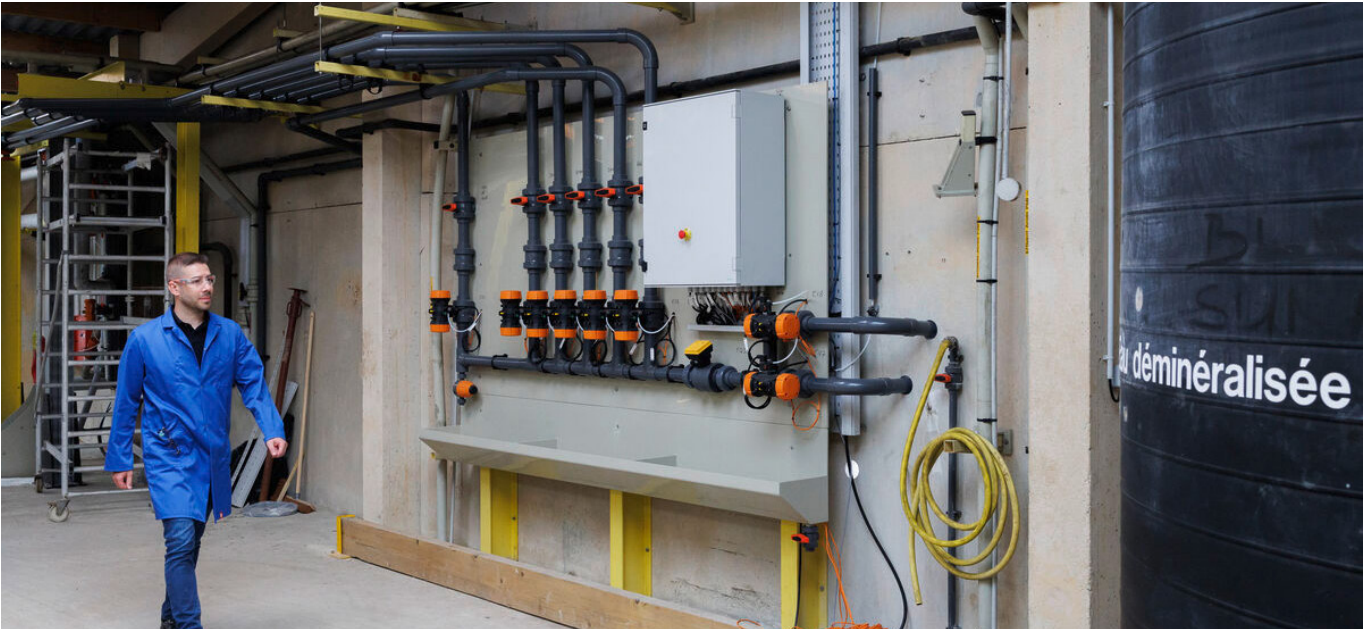
- PVDF belongs to the group of partially fluorinated polymers and is an important material in chemical plant engineering, particularly for applications at elevated temperatures.
- PVDF is resistant to mineral acids and strong oxidizing agents across wide application ranges. Details should be clarified with GF in an individual consultation. The use of PVDF in contact with caustic media is not recommended.
- In addition to the properties mentioned above, PVDF convinces with a very low leach-out level, which has qualified the material in the microelectronics and pharmaceutical industry since decades.
- Based on clearly defined material formulations, GF offers a complete pressure piping system in various pressure ratings and across an extensive dimensional range for different welding technologies.
-

Additional Materials

- In the field of high-performance thermoplastics, tubular semi-finished products or special constructions made from other thermoplastic materials can also become necessary. Please contact us regarding your requirements for special solutions. GF DEKA has extensive experience in processing high-performance thermoplastics such as PPS, PAI, PEI, PPSU, as well as engineering plastics.
- At this point, we would also like to refer once again to our extensive capabilities for customerspecific machining and the manufacturing of hollow rods (up to OD 600).
- Please contact us regarding the availability of ECTFE-based pipes and semi-finished products.

Disclaimer

The information and recommended values contained in this brochure reflect the current state of our knowledge and were compiled with the help of all available documentation. They can therefore be regarded as incorporating a high degree of reliability in practice, although they are not necessarily binding for all applications.



Excellence in Flow

Visit our webpage to get in touch with your local specialist:

www.gfps.com/our-locations



Georg Fischer DEKA GmbH

Kreuzstraße 22

35232 Dautphetal

Telefon +49 6468 9150

deka.ps@georgfischer.com

www.gfps.com/deka

The information and technical data (altogether "Data") herein are not binding, unless explicitly confirmed in writing.
The Data neither constitutes any expressed, implied or warranted characteristics, nor guaranteed properties or a guaranteed durability. All Data is subject to modification. The General Terms and Conditions of Sale of Georg Fischer Piping Systems apply.

