

Specialty Polymers Technology

An adaptable, customized batch or continuous process

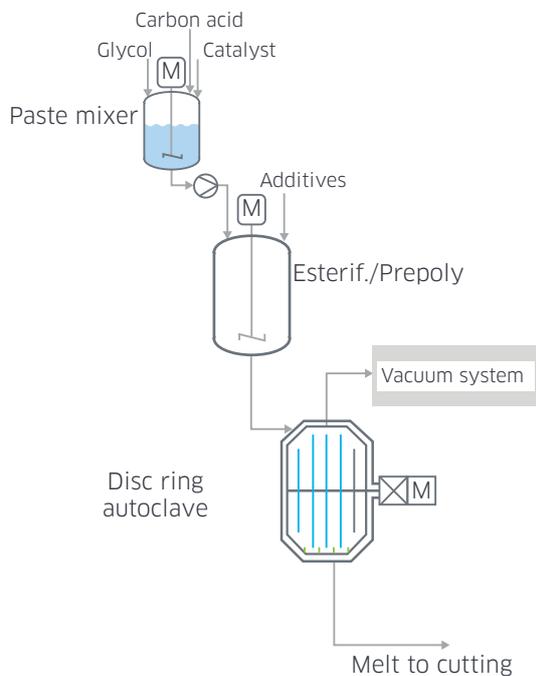
Typical specialty polymers produced with Zimmer's batch process include:

- ▶ PET containing various additives and co-monomers
- ▶ PCT (Polycyclohexylene dimethylene terephthalate)
- ▶ PEN (Polyethylene naphthalate)
- ▶ PTT (Polytrimethylene terephthalate)
- ▶ PBT (Polybutylene terephthalate)
- ▶ Biopolymers (PBAT, PBS)

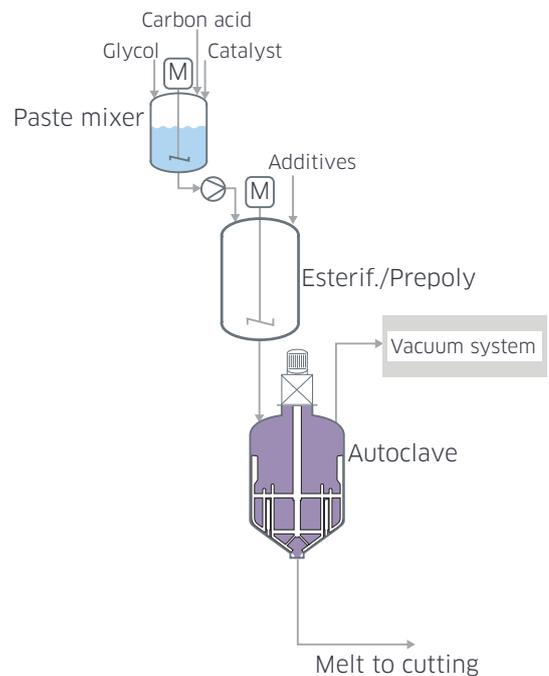
Cast polyester resin based on carboxylic acids and glycols

The process can be adapted to polymer specific requirements and is tailor made up to a capacity of 12.5 metric tons per batch. In batch production, a repeatable and reproducible operation must be ensured. Batch cycle times vary less than minutes to achieve a consistent product.

Please note these polymers can also be produced using a continuous process for larger capacities.



TechnipFMC Zimmer Specialty Polymer Batch Plant with Disc Ring Autoclave



TechnipFMC Zimmer Specialty Polymer Batch Plant with Standard Autoclave

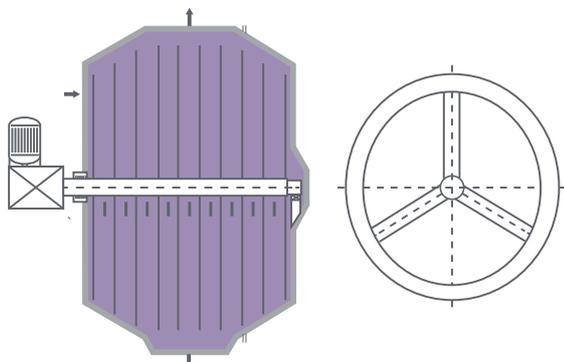
Steps of the batch process

The carboxylic acid and glycol are mixed while adding catalyst/additives in the paste preparation vessel. From there the paste is fed into the Esterification/Prepolymerization reactor. This step is controlled using a special temperature/pressure regime and additives can be fed as required per recipe. The split-off vapors are released from the esterification stages and fed into the process column for rectification. The intermediate polymer product is then transferred to the Disc Ring Autoclave for final polymerization.

Zimmer's Disc Ring Autoclave - the high performance reactor

Advantages of the Disc Ring Autoclave compared to a conventional autoclave design:

- ▶ Higher evaporation surface
- ▶ Lower process temperature
- ▶ Shorter polycondensation time
- ▶ Lower thermal stress
- ▶ High surface renewal



TechnipFMC Zimmer's Disc Ring Autoclave



Manufacturing of Disc Ring Autoclave

TechnipFMC Zimmer Polymers Technology

We provide technology, engineering, project management and procurement services for polyesters (PET, PBT, PTT, PBS) and polyamide (PA6, PA6.6) production plants. We are focused on our customers' needs. Over the last 60 years, our engineers have worked to enhance our portfolio of well-proven technologies using in-house research and development facilities. This dedication to quality has helped us to build an outstanding track record of placing our technologies in more than 800 plants.

As part of a global network of centers which manages the company's expanding portfolio of onshore process technologies in petrochemicals, refining, hydrogen and syngas, polymers, gas monetization and renewables, we have access to TechnipFMC's leading global engineering, procurement, project management and construction network. TechnipFMC operates in 48 countries around the world with more than 37,000 employees.



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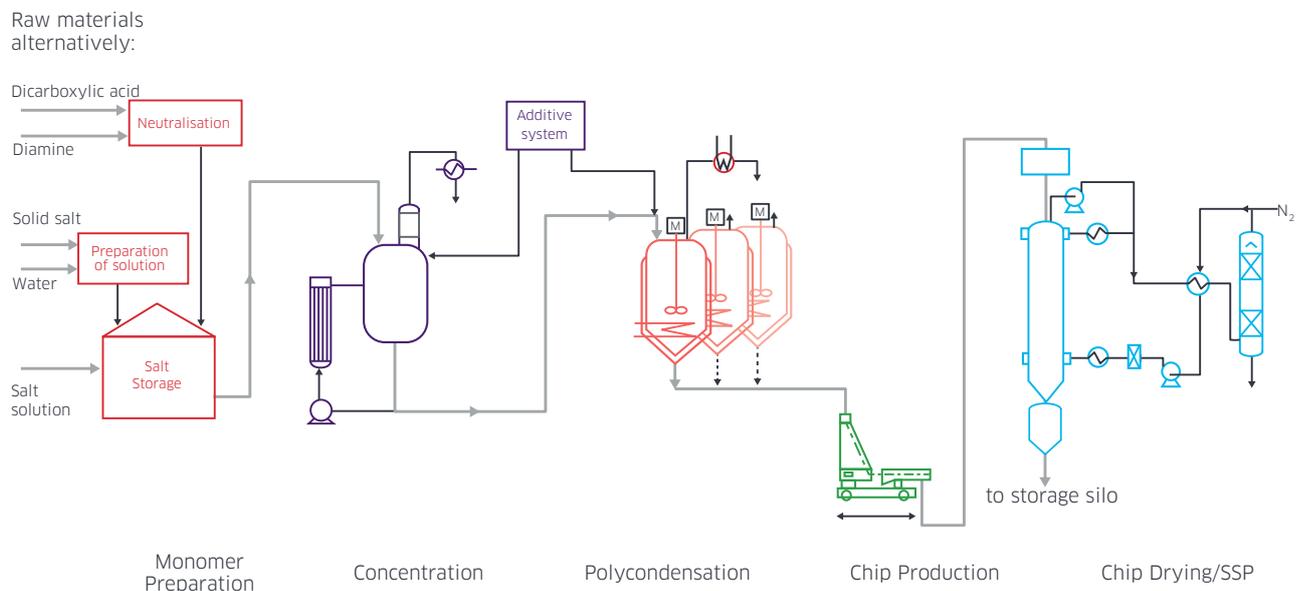
PA6.6 and speciality polyamides

Zimmer® multi-autoclave process for PA6.6 and other speciality polyamides.

To produce the nylon polyamide PA6.6 an AH-Salt solution is either created from the monomers adipic acid and hexamethylenediamine (HMD) or by dissolving solid AH-Salt with water. This nylon salt solution is added to the concentration unit where water is evaporated to increase the salt concentration. It is then transferred to the autoclave where the polycondensation reaction takes place. Additives can be blended to the concentration unit and polycondensation unit. Multiple autoclaves in parallel ensure a continuous solid state polycondensation (SSP) after chip production.

Efficient reactor design

Our reactor design with a sophisticated agitator ensures high shear rates, good homogenization, self-cleaning and homogenous heat input. Its versatility allows for production of a wide range of speciality polyamides (PAx.y polyamides).



Typical set-up of batch plant showing the PA6.6 process

Other speciality polyamides

Other PAx.y produced with our batch process are:

- ▶ PA5.6 – based on the feedstocks of PMD and adipic acid
- ▶ PA6.10 – based on the feedstocks HMD and sebacic acid
- ▶ PA6.12 – based on the feedstocks HMD and dodecanedioic acid (DDDA)



Polymer strands from die head

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