New Zimmer two reactor process

Keeping sustainable margins in polyester business means increasing efficiency and reduction for utility cost in production plants. The new Zimmer two reactor polycondensation process shows a possibility.

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In the last decade the use of economies of scale and therefore large capacities have been the major requirements in the PET market. Due to the importance of the raw material cost and the increasing utility cost like energy on the margins, the reduction of conversion cost will be the challenge of the next years. This requirement was one of the starting points for Lurgi Zimmer's latest development in PET technology: a new two reactor process consisting of a vertical cascade reactor combined with the well-known disc ring reactor.

The development target was an improved melt process for economical PET production with a significant reduction of investment and production costs. The new process will have excellent plant reliability and process flexibility while giving outstanding product properties.

Lurgi Zimmer developed a combined esterification/pre-polycondensation reactor without any mechanical drive, which increases reliability and reduces maintenance efforts.

The reactor is followed by the well known disc ring reactor used to produce medium IV polymer (0.50 dl/g < IV < 0.66 dl/g) for standard or textile applications or a double drive disc ring reactor is used to produce the required high IV in the range of 0.66-0.85 dl/g for packaging applications or higher IV for industrial yarns and engineering plastics.

The vertical cascade reactor is divided into 3 pressure stages. The mixture of terephthalic acid (PTA) and glycol (EG) enters the top stage. By boiling of water and glycol a natural circulation is induced inside the stage well mixing the incoming paste. The integrated heating coils provide the heat required by the process and serves as additional mixing elements. The optimized design allows a good conversion at low temperatures and with low side reactions at reduced residence time.

The intermediate stage is built as a reaction cascade guiding liquid product and vapor together through several chambers with stepwise-reduced pressure. This results in faster reaction. By guiding the vapors through the liquid product the liquid is well mixed. Reducing the pressure shifts the vapor-liquid equilibrium and increases the evaporation of water. Moderate process temperatures reduce the formation of DEG and color bodies. The third stage serves as pre-polycondensation stage and is divided into two chambers. The vapors of the upper chamber are guided via a distributor ring below the liquid level of the lower chamber, inducing there a heavy boiling like agitation. The prepolymer leaves the reactor to be further processed in the disc ring reactor.

The two reactor process is combined with a vacuum system using the vapors from the first stage as motive vapor. The vapors from the finisher are partially condensed in a scraper system and extracted using a glycol vapor jet system. A second jet system directly driven by vapors from the esterification stage extracts the vapors from the pre-poly stage. The vapors are condensed and sent to the process column. This ensures the total recovery of EG and other valuable materials.

Fig. 1
Zimmer polyester polycondensation process overview

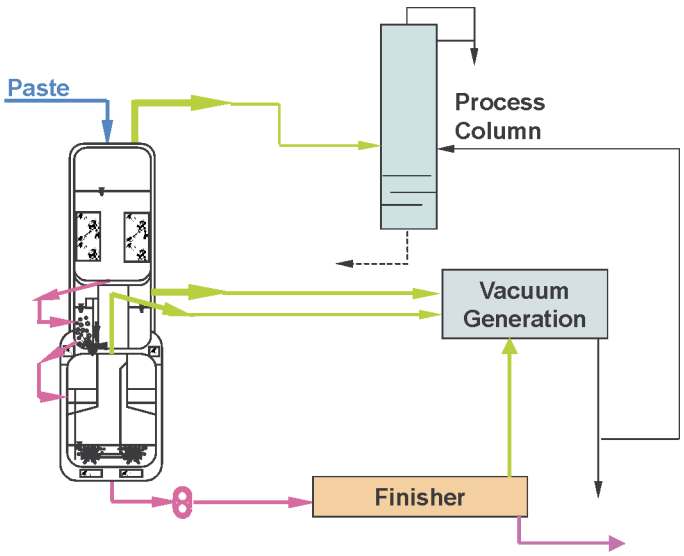
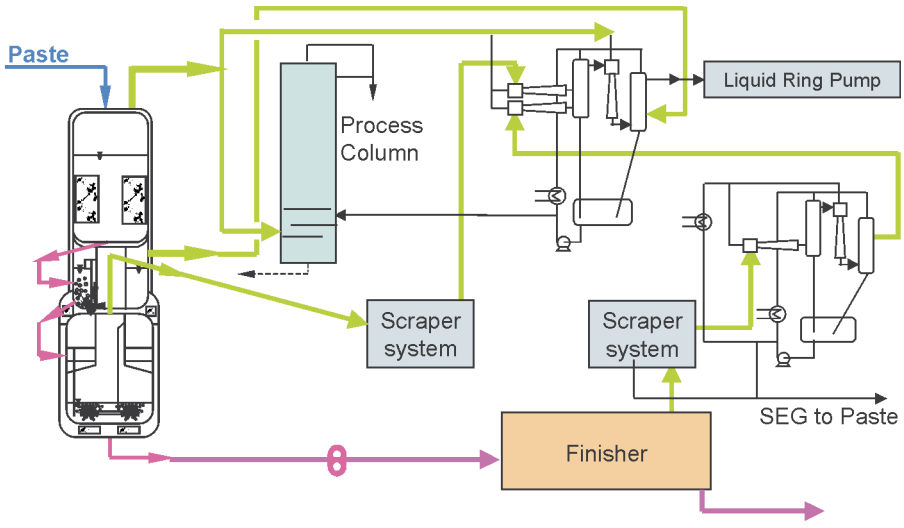


Fig. 2
Polyester polycondensation process flow sheet



Available plant capacities

Plant capacities		Tons/day	
Medium viscosities IV 0.50-0.66 dl/g	Vertical cascade reactor and disc ring reactor	90-1,500	Textile filaments, staple fibers, BCF carpet yarns Feed materials for solid state polycondensation for specialties
High viscosities IV >0.66-0.96dl/g	Vertical cascade reactor and double drive disc ring reactor	< 1,000	Industrial yarns, engineering plastics
IV >0.66-0.85dl/g	DAH tower	< 1,000	packaging
Very high viscosities IV 0.90-1.00 dl/g	Vertical cascade reactor, disc ring reactor and self-cleaning reactor	< 100	Tire cord, rigid engineering plastics
Products	Polymer melt or chips		

The net energy balance results in a 5% reduction of fuel oil/gas.

The two-reactor process requires less energy than the conventional four reactors. Heating energy is reduced because of the new vacuum system. Additionally the integrated evaporators and the compact reactor design gives less heat losses.

Since less equipment is used (less agitators, pumps, HTM pumps and smaller liquid ring pump) the electric power consumption is also reduced.

The overall benefits are:

- high available capacities up to 1,500 tons/day
- investment reduction by 5-10%
- reduced engineering task and erection scope
- considerable reduction of energy consumption
- less equipment results in lower maintenance efforts and increases the reliability
- less space requirements
- low raw material consumption
- very good operating economics.

Available plant capacities are given in the table.

Product quality is kept at the highest market standards:

- low DEG formation
- bright color
- convenient L-value
- low oligomer content
- very good TiO2 and additives distribution
- low acetaldehyde content
- reduced reformation of acetaldehyde in further processing
- very uniform product with excellent rheological behavior. ■

Zimmer = registered trademark