Investing in new or revamping existing polyester plants?

Polyester plants which were built in the 1980's and 1990's are step by step becoming inefficient, mainly because of low productivity. The revamping technology PETvantage by EPC Industrial Engineering GmbH, Alzenau/Germany, which has been introduced successfully to the polyester industry during the last 5 years, offers interesting solutions and supports those who would like to make their existing plants significantly more efficient.

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After intensive development work and stepwise up-scaling and introduction of new technology features to the industrial practice of polyester resin production, the EPC Group is offering complete polyester melt phase revamping packages. The basis of this technology is that most of the existing PET melt phase plants possess high capacity potential. The main feature for establishing a revamping project of high economical efficiency is a significant capacity boost by utilizing as much of the existing equipment as possible. The new concept is dedicated to bottle resin lines or to textile polyester plants which have been in operation for more than 5 years which will be converted from textile grade to bottle grade production.
The revamping concept consists of 3 steps:

- Step 1: feasibility study resulting in a business-technological conception of possible scenarios
- Step 2: pre-engineering, basic and detail engineering
- Step 3: construction and commissioning.

The first step is considered successful when the potential capacity increase is above 50 % and up to 100 %, and the total investment rate ranges from 0.02-0.1 US$/annual kg based on a capacity increase of e.g. 400 tons/day fiber grade polyester before revamping to 700-800 tons/day bottle grade after revamping. A new investment ranges compared to the revamping of e.g. an 800 ton/day bottle grade plant between 0.19-0.25 $/annual kg. From this, one can easily conclude the potential advantage of revamping compared to new investments.

Lifting the new agitator of the finisher

Technology

One of the most important innovations of PETvantage is the newly developed forced heat transfer system of esterification. About 90 % of the conversion from paste made of PTA and MEG to the precursor "esterification product" takes place in the first esterification reactor which makes this process the most important step in the process chain. Here the solid PTA and the liquid MEG undergo chemical conversion and physical changes in a state of aggregation under significant consumption of energy. Therefore, the wetting of solid PTA particle surface by MEG, the solution of PTA in esterification product and the removing of the generated water steam are boosted by forced mixing under high turbulence at highly efficient heat transfer. Besides improved reactivity in esterification, the prepolymer undergoes a special heat treatment to accelerate polycondensation reaction together with an active process control model (EPC inside PET), EPC succeeded to control the whole melt phase process in a way that even significant fluctuations of PTA quality such as particle size and particle size distribution are equalized successfully.
The understanding of the esterification and polycondensation process enables EPC on the one hand to boost line capacity of existing PET plants by more than 100 % and on the other hand to offer melt phase technology for target IV > 0.45 dl/g in a capacity range of 2,000 tons/day and higher out of one single melt phase plant.

Practical results

EPC started some polyester plant revamping projects in 2002. One of the early examples was renewal, capacity increase and melt distribution for direct spinning of special Trevira CS fiber production line. Trevira GmbH, later a member of the Indian Reliance Group, supported its leading market position through this successful revamping project. One major issue was the capacity increase from operating capacity from 120 to 175 % (based on name plate capacity).
The core of the VPI (Selenis-Hellas Greece) plant revamping was lifting name plate capacity of 56,000 tons/year PET resin to 84,000 tons/year PET resin and process optimization of PET polycondensation which also included the need for exchange of the complete finisher internals (see Fig.).
The project contained further process and mechanical re-design and the supply of a new finisher agitator including a sophisticated hydraulic drive system, vacuum system upgrade, polymer pumps and heat distribution. To improve resin quality, EPC implemented its predictive polycondensation process control for molar ratios, intrinsic viscosity and improved throughput control.
EPC recently executed a project of significant size in the Kingdom of Saudi Arabia where four existing polyester filament, staple fiber and bottle resin plants have been revamped. Original name plate capacity of these lines was 440 tons/day. This job contained the debottlenecking, conversion to bottle grade PET production of four lines PET production establishing a capacity of 1.000 tons/day of PET bottle resin. Included in the project was the new installation of an additional 900 tons/day SSP plant. However, the implementation of EPC's technology package PETvantage was the crucial part of the plant production capacity increase.

Service

In comparison to any new investments, revamping needs the detailed knowledge of the existing plant including maintenance history and process changes during elapsed life time. During the first step of the revamping project, the process team of EPC analyzes the actual condition of the building, process equipment and utility supply on site at the customer. At the same time the team keeps detailed records of the operational conditions as they are. The outcome of this first step is the base to elaborate a detailed feasibility study. Dependent on the plant owners need, this study is the basis for the pre-engineering with detailed offers and could contain tailored stepwise phases which fit exactly to the financial conditions and market behavior of the customer. Accordingly the second step incorporates all activities to establish the final revamping project. Especially during this step, EPC supports its customer to select the tailored concept. The third step mainly consists of the realization from plant stop and vessel cleaning until restart and guarantee run. However, utilizing full EPC services, marketing and resin sales support could also eventually be included. ■

PETvantage, Trevira CS = registered trademarks

Gentle production of carbon fibers

Over the past decades carbon fibers, alternatively graphite fiber, carbon graphite or CF, have become the embodiment of a stabile and light material for sports equipment and airplanes among many other applications. Difficulties in the production process of this fragile fiber and their solution are described.

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Holding carbon fibers in their raw state, however, it is surprising how fragile these fibers are. On the one hand this is due to the fiber fineness of just 7 µm of a single fiber, on the other hand there is a strong orientation of longitudinal stability resulting in a poor stability in cross direction. The combination of these two factors already demand extreme care in production in order to avoid buckling or other damage by friction. Care is necessary from the very start, i.e. before the raw fiber is processed to carbon fiber. The complete process chain is a complex combination of chemicals, technology and finally the mechanical engineering. It includes the formulation and preparation of the special polyacrylics composition, the preparation of a spinning solution based on the infusible polyacrylics with subsequent spinning to so-called precursors and finally their oxidation and carbonization.

As the quality of a spinning solution is a crucial factor in the whole process, producers of precursors have developed special recipes and set values of the polymerization. In addition, the purity and homogeneity of the raw materials as well as the solvent used for the subsequently produced spinning solution play a key role in the process. Therefore additional mixing and filter elements for the distribution of the spinning solution to the spinning heads as well as an even temperature distribution are necessary.
Any inhomogeneity in concentration or temperature would result in thick and thin segments or even yarn breaks at the showerhead like spinning nozzles during the spinning process which would cause further problems in the subsequent process chain and in the end product. As in any other spinning process, high attention must be paid to the requirements with respect to homogeneity between the single spinning heads. This applies to the complete fiber processing which could be called "multi-end wet spinning". An even and uniform fluid flow and concentration in all coagulation baths, reliably smooth-running deflection rollers, and the prevention of rubbing points, which could cause partial stretching, are indispensable. Here the quality of the stainless steel and the selection of other materials being applied depends on the solvent used in this process.
Furthermore, strict health and safety regulations have to be observed as the used solvents could be harmful to humans and the environment. At the same time, a good operability must be insured despite possible hindrance at work caused by the use of personal protective equipment. After several washing and drawing steps with the subsequent drying and sizing, the precursors are wound individually by precision winders onto bobbins having a package weight of up to 300 kg.
During the subsequent carbonization process, every single precursor is transformed into a separate carbon fiber tow. If, for example, it is intended to produce 240 carbon fiber bobbins in parallel, 240 precursor bobbins are needed as a forerunner. Already when unwinding the precursor spools at the beginning of the carbonization process, which is much slower than the precursor production process, certain risks may occur due to improper conveyance or storage. For high