Structural Change in the Polyester Industry (in 2000) – Some Comments Eight Years After in 2008

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About eight years after edition of the paper "Structural Change in the Polyester Industry" the author read the text again **and added some comments about progress and current situation in BLUE**.

In the past 20 years, the techniques for the manufacturing and processing of polyester have developed as dynamically as the market itself has been. The capacity in polyester manufacturing using the traditional vacuum polycondensation process aims now for 800 t/d, it has thereby reached its physical limits according to present technology.
2008: Melt polycondensation technology developed faster than thought. Standard world scale plant size is 600 – 800 t/d and melt polycondensation plants dedicated to produce low IV (0,45 – 0,50 dl/g) precursor are able to produce 1600 t/d and the next generation for 2200 t/d is in preparation.

In solid phase condensation the capacities of around 400-600 t/d/line are coming to a point where growth is limited too.
2008: The capacity limit till now of traditional SSP-plants which exists of vertical tube reactor under gravity flow is about 700 t/d.

The new DuPont NG3 process, at present only demonstrated in a pilot plant is only destined for bottle chips or for general granulate production, offers future potential for capacity development.. Some process steps, such as granulation or SSP will remain limited to there present capacity level and, with a line capacity of, for example, 1000 t/d, will need to be set up in parallel operation.
2008: Unfortunately the NG3-process became never realized and was one of the biggest falsities of younger history of polyester engineering. Those companies who entered in such a process went back to traditional melt phase technology and might have lost money and time. The inventors of NG3 lost a lot of creditability.

In fiber production, plants with 200 t/d per line will become standard.
2008: with tendency to300 t/d.

In the spinning of POY, the use of additives (Teijin, Zimmer-AG, Inventa-Fischer, Acordis) and the intelligent design of the thread take-off (EVOSPEED of DuPont / Barmag) will allow for take-up speeds of between 4,500 and 5,000 m/min.
2008: The additive technology to increase spinning speed was (and is) practised by a few companies especially in India but finally this process reached not a broad industrial range and also the air forced spinning did not see a real break through till now. Main reasons are the fact that spinning becomes increasing non-linear instable by higher winding speed and the mechanical stability of the winder is also decreasing non-linear with increasing spinning speed.

The fully automatic transport, testing, packing and sending of the POY bobbins will only become lucrative if a considerable increase in the spinning speed with, at the same time, a continued maximum yarn breakage of<< 0.5 per ton and a long service lift of the spinnerets are achieved.
2008: Companies with advanced spinning technology achieving POY spinning break rates of 0,08 breaks per ton and pack life-time of > 150 days. The spinning speed of POY is constant over the years at about 3500 m/min.

With the new NG3 process on the one hand and the geometrical and capacity limits of the direct spinning plants on the other, it may be that filament yarns will begin be spun more in extrusion plants The general low product temperature of the NG3process and the removal of the volatile degradation products and oligomers, make itpossible to achieve a degree of purity in thus manufactured polyester, that makes itextremely interesting for the spinning process. Very high qualities can be achieved in compact extruder spinning mills, due to the very short melting time. The high degree of flexibility is another important factor in favour of granulate spinning.
2008: See above, NG3 was a dream only and became a nightmare finally. May be other technology will fill this gap in the near future.

The manufacturing of preforms is on a very high level, due to the perform machines with 96 cavities per tool and the process optimizations (e.g. the double tool by HUSKY) introduced in the past few years.
2008: Today preform machines of 144 cavities are in operation.

The direct processing of the PET granulate from SSP into performs using the solid phase condensation process, is a further step towards rationalization. Some preform manufacturers are already working with this technology.
2008: The application of this technology might be possible when SSP and preform production are located at the same production site which is very rarely the case.

The question does remain however, who will venture to take the first step towards direct performing. This process causes a build up of viscosity and de-aldehydisation during die melt phase. Just as during the introduction of direct spinning 25 years ago the move towards chemical process technology in perform production is still considered as being something to be wary of. The increasing number of patent publications is, however, a sure sign that things are beginning to change.
2008: Till now the direct preforming technology is not converted to industrial scale despite Uhde-Inventa-Fischer and Lurgi-Zimmer (former Zimmer AG) spent a lot of development work and money and further patents are published. One problem might be that a continuous chemical plant and a stochastically acting stop and go operation and the requested high flexibility of a preform machine do not fit properly together. These are seemingly the very different production logistics of melt and preform production which mismatches.

The question is, how the polyester industry‘s planning targets will change when the growth phase moves into a maturing phase. One thing is certain und that is that today, much more than five years ago, rationalized production with the lowest costs, high quality yields and flexibility are the basis for long-term survival. The key-points of development have therefore already been determined.

2008: Differently than thought 8 years ago we have a completely new SSP process today which is the horizontal kiln type SSP no-one thought about at that time. Together with the low IV melt phase polycondensation the new technology allows to build single plant lines of up to 2200 t/d (in planning) or 1600 t/d (in operation). This technology is proprietary to the M&G group.

If one has kept up with patent literature in the field of polyester over the past 20 years, it can be seen that especially over the past two years, the number of patent applications concerning core processes of the polyester industry has dropped considerably. At present, numerous patent applications concern themselves with the improvement of the barrier characteristics of PET, the manufacturing und processing of PTT und the development of antimony-free catalysts. Most of the patent applications come from Japan. In scientific literature the drop of the number of publications is even more noticeable. The reasons for this might be, on the one hand, the large number of ownership changes und the reduction in R&D as a connected effect. On the other hand it can be seen as an objective sign that the changeover from the growth phase to the ripening phase is already under way. It is interesting to note that scientific publications to date come mainly from Asia, mainly from Japan, Korea, China and Taiwan. It is of interest to the polymer chemist that polyesters used in toner for the electro photography, biologically decomposable polyesters und PLA are going through a period of high expansion.
2008: This trend is established and consolidated and the process of concentration of PET production in some core centres is ongoing.

Important goals in large-scale technical process development are still awaiting realization. In particular the process Integration OIL - p-xylene - PTA/EG - PET - fiber/bottle/film will play an increasingly important role in die next ten years with regards to earnings
2008: This prediction fulfilled with the announcement of the INTEGrex process of Eastman which is aiming to integrate the PET resin production from PX to resin on one production site.

The continued bonding oft he polymer prices to the prices of raw materials means that the vertical integration is **the** important prerequisite for the long term economic success of the polyester manufacturers. Connected to this is the growth in size of the various plant locations and companies, the most economically advantageous size in this vertical integration will be with a production capacity of **above** 1000 t./d per location. A pronounced concentration of the polymer industry in locations directly at the site of the oil fields or that of refineries will be a result of these developments.
2008: Good examples of this development are Reliance, Eastman, Sinopec or Sabic which are fully integrated meanwhile.

For process technicians and engineers this means most of all that the intersection points between die various processes must be examined with a view to cost-saving couplings. One idea might be to put PTA paste and slurry preparation together or esterification in PTA manufacturing. Another issue to think about might be the direct conversion of ethylene oxide and PTA. The number of process steps can thereby be reduced, transport and conveyance can be minimized considerably.

The growth in capacity of the various plants needs especially a consequent use of active process simulation which supports process controls and optimizes the operation of large-scale plants.
Another key-point is the change in chemical process controlling from wet-chemical, traditional laboratories to automatic on-line analysis. The idle time for sample taking, laboratory analysis and manual evaluation are simply no longer viable in plants with a daily capacity of 400 t and above. The enormous risk of possible low qualities in plants of this size is the motor of development for on-line analysis.

An important share in the dynamic development of the polyester industry in the last 20 years has been machine and plant engineering in Europe, USA and Japan.
With the growth in capacity of the individual plants, the market for plant engineering will become even more fought over. The annual growth in production of polyester that has been conservatively estimated at 6% or 1 .5 million tons PET is equivalent to approx. ten new plants of 400 t/d or seven plants with 600 t/d. Going from the estimation that plant size will increase to between 800 and 1000 t/d during the next ten years, this will mean four or five new plants annually by the end of this decade.
With the declining number of new units to be built per annum the market for services will grow considerably, this is caused by the increase of the number of companies that only produce polyester products and have no R&D of their own, by the aging process of the plants that exist at present, and by the continued trend towards outsourcing.
One prognosis for 2010 might be for 35 - 40 million tons of polyester to be produced and processed per year worldwide.
2008: This estimation was too pessimistic, in 2010 the polyester production will exceed 50 Mio t/a.

At the time the original article was written it was not foreseeable that China will build large numbers of polyester plants by itself and develop a powerful polyester engineering capacity which is erecting meanwhile about 80% of new plant capacities in China.

With the comments one can see that 8 years of industrial development is a rather long time and that there is for industrial developments every 4 years or even shorter a technology update required

May 30, 2008 Dr. Ulrich Thiele.