Comparison of MTR versus SSP

Concepts for bottle grade PET

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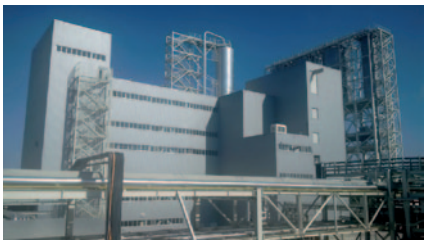
The challenges for the producers of PET are numerous including maturing consumption levels and the trend to light-weight bottles, the uncontrolled fluctuation of prices for raw materials and energy, the competition of mega-plants and regional protection duties. Uhde Inventa-Fischer in 2007 has given an answer to those challenges named Melt To Resin (MTR) technology.



MTR is a completely integrated one-stage process providing bottle grade IV PET melt directly from the Discage reactor (finisher). PET is produced from the raw materials purified terephthalic acid (PTA), isophthalic acid (PIA) and ethylene glycol (EG) using a melt polycondensation process. Conventional routes have in common that they require a second, subsequent solid-state post-condensation (SSP) step to further increase the molecular weight of the polymer. During this solid-stating, PET precursor chips are typically subjected to a temperature above 220°C under a counter-flow of purified nitrogen. However, the SSP stage is energy-consuming and, as it is an extra step, it also has the disadvantage of requiring additional plant equipment and operating personnel.

Execution of MTR

MTR technology requires a special design of the melt distribution system from the outlet of the Discage reactor to the cutters and a solid processing step called Chips Conditioning to achieve the final low acetaldehyde (AA) content of the resin.

MTR technology is proven, since there is more than 3m t/a of PET resin capacity in operation. With MTR customers are able to produce at or over nominal capacity and downstream users of PET make use of specific features of MTR resin like low heat of fusion, low dust content, uniform IV in pellets and dust and low AA re-generation. Recently the leading supplier for SSP technology introduced the use of an under-water cutting system to keep the temperature of the PET pellets on a high level. For the sake of easy distinction we shall name this process "new style" SSP, which will definitely reduce energy consumption compared to the "old style" SSP. However, even the "new style" SSP is using external energy input at the crystallisation stage and is operated at high temperature and under nitrogen atmosphere, which requires the operation of huge blowers, additional conveying systems and a nitrogen purification.

In the subsequent diagrams the MTR technology is compared to "old style" and "new style" SSP technology. Investment (Capex) and Operational Cost (Opex) are based on realistic consumption figures published by the technology suppliers and site conditions for the case of a 750t/day site located in South-East Asia. The main driver for the lower Capex cost of the MTR technology is the fact that no investment is required for the SSP equipment, SSP building and SSP erection.

Production cost savings and flexibility

The production cost comparison in fig. 2 shows that MTR still has a big cost advantage in the rage of 15% compared to "new style" SSP

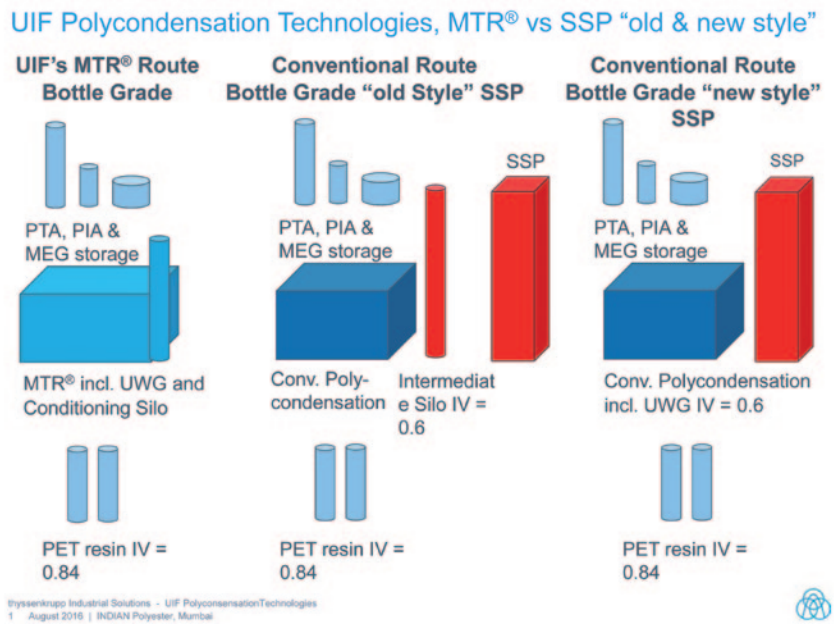


Fig. 1: Process block diagram of the three competing concepts for production of bottle grade PET resin

and more than 20% compared to “old style” SSP. The reason behind this is that MTR technology makes total use of the latent heat of the chips and does not require any energy input for the final AA-removal step. This results in great Opex savings for MTR, because even the “new style” SSP requires heat input into the crystallisation, massive energy input to the SSP reactor and lots of electrical energy for running the huge nitrogen circulation blowers and nitrogen cleaning systems. The biggest cost factor that contributes to the production cost is the raw material with approximately 90% of the cost. Other contributions to production cost are capital-, energy-, maintenance- and labor cost.

Additionally MTR technology provides higher flexibility noticeable in the fast transition time from one product grade to another (e.g. IV change) and low respectively zero inventory in the system.

Dust content and IV uniformity

The MTR Technology provides low dust content of the product, even without installation of a de-dusting device, because of the use of an under- water cutting system and because of considerably fewer solid transport and handling steps. Furthermore in the MTR Technology the IV of dust particles and the IV of the PET pellets is identical, because there is very little IV-increase in the chip-conditioning system.

AA content resin and AA content preform

Comparing the AA content of MTR technology resin with SSP resin typically shows lower AA content for SSP chips. The reason is obviously the different focus of the final process step of the two technologies:

- MTR technology: Chips Conditioning => focus on AA removal
- SSP technology: SSP reactor => focus on IV increase
- With long residence time at a temperature of approximately 220°C in the SSP reactor, the AA content will automatically drop to very low values.

UIF has run numerous trials at industrial scale preform machines, which all showed a significant lower AA content in preforms from MTR technology resin:

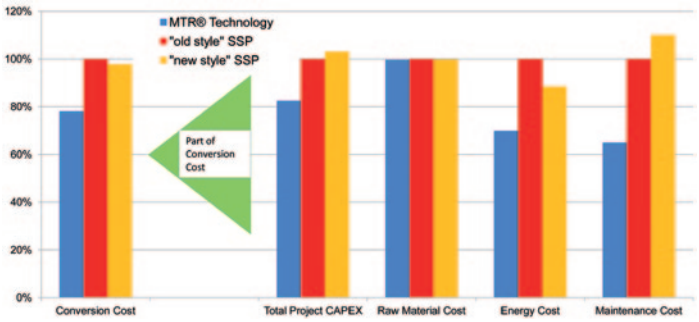


Fig. 2: Cost comparison MTR technology versus “old style” and “new style” SSP technology

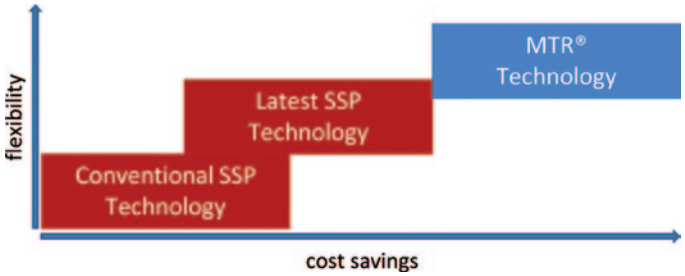


Fig. 3 Comparison of cost savings and flexibility

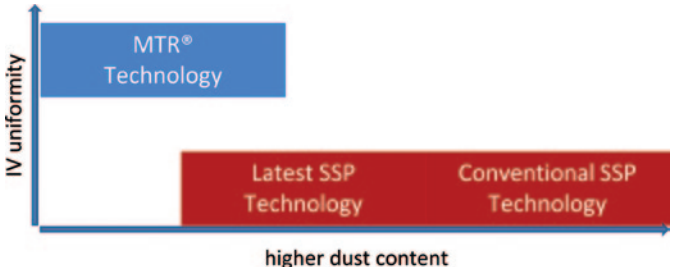


Fig. 4 Comparison of dust content and IV uniformity

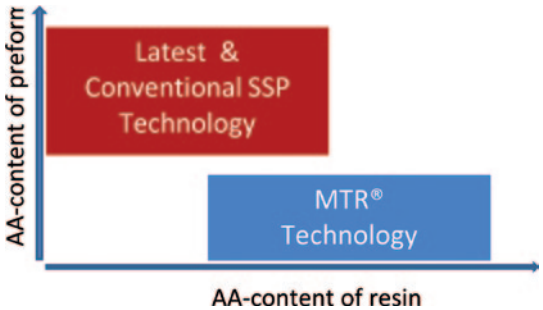


Fig. 5 Comparison of AA content of resin and AA-re-generation in preforms

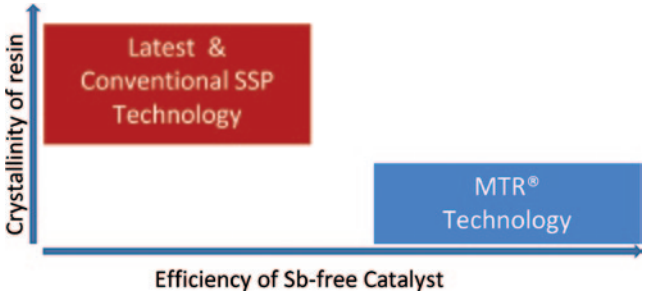


Fig. 6 Degree of resin crystallinity of MTR and SSP technology

	MTR	SSP
IV resin [dl/g]	0.83	0.80
AA resin [ppm]	0.75	0.6
AA preform [ppm]	**1.7-1.9**	**2.9-3.2**

Table 1: Comparison of AA in preforms, Husky Hypet 300 72 cavities, 21.3g preforms, 285°C

The reason for the lower AA content in preforms from MTR resin is the lower specific energy input during preform making, which has its explanation in the lower degree of crystallisation and the overall lower thermal stress of the MTR production process.

Summary

The latest development of "new style" SSP technology has definitely reduced the energy consumption compared to previous SSP technology. In one way it can be said that the SSP technology has finally followed the path that UIF has started with the use of the latent heat crystallisation in the MTR technology in the year 2007. But MTR is claimed to be still ahead of the competing technologies for the production of bottle grade PET resin with respect to total project cost, energy consumption, plant flexibility, fixed cost, raw material utilisation and maintenance cost. Additionally MTR technology is said to offer a variety of benefits for downstream users of PET resin, which include lower energy of fusion due to lower degree of crystallisation, low dust content and no difference in IV between normal size pellets and small size pellets or dust.

MTR is intended to be one of the most economical ways to produce bottle grade PET resin fulfilling high product quality standards.

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