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Coperion Press Conference at K 2007

ZSK: a 50-year-old success story – to be continued

Stuttgart, 25th October 2007. – In 1957, exactly fifty years ago, the firm of Werner & Pfleiderer delivered its first ZSK twin-screw compounder for the compounding of plastics. The story actually began a few years before, in 1953, with the acquisition of an exclusive licence from Bayer, Leverkusen, where Rudolf Erdmenger, working in the "High Viscosity R&D Group", had at the end of the war resumed the work he had already begun in 1943 together with Walter Meskat at the IG-Werk Wolfen. The result of this development project was a self-wiping profile for co-rotating, intermeshing twin screws and marked the birth of the first self-cleaning twin-screw compounder, which could reliably handle material of any viscosity and friction coefficient. The prototype of the machine developed by Erdmenger, in other words the "ancestor" of all twin-screw compounders (in those days the screws were positioned one above the other), will be exhibited in the "Nostalgia Lounge" on Coperion's exhibition stand (C33 in Hall 14). A further 4 years of development work were invested by Werner & Pfleiderer before the machines were finally ready for regular production.

At K 2007, Coperion Werner & Pfleiderer will be presenting the ZSK MEGAvolume PLUS. Making its debut at this exhibition, this compounder has a capacity that would have been inconceivable not only fifty years ago, when the first ZSK was launched, but also for a long time after. Given the same distance between the screw axes, a modern compounder is capable of a throughput 35 times that of a compounder fifty years ago – that corresponds to an annual increase in capacity of 7.5%. Moreover, modern compounders have to meet a considerably greater number of

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processing requirements. The decisive factor is the length of the processing section, which today can be extended from former 6D (D = screw diameter) up to 56D.

The performance and flexibility today achievable with ZSK series compounders are the result of the intensive efforts of the development engineers at Coperion Werner & Pfleiderer. Sometimes this development work was continuous and gradual, while at other times, following exhaustive trials in the pilot plant, and often in close collaboration with the customer, it resulted in a significant step forward. The following developments may serve as typical examples:

- The development of a processing section with variable segments and with screws consisting of different screw elements furnished the necessary flexibility and versatility for the economically efficient processing of widely differing materials.
- The nature of the connection between the screw shaft and the screw flights is a decisive torque transmission factor. Development progressed from the simple taper and keyway to the spline shaft, and then to an involute toothing optimized with the aid of the FEM and produced in a special manufacturing process. This type of connection is capable of transmitting extremely high torque.
- Improved materials and production processes have enabled the development engineers to gradually increase the ratio of the outer screw diameter to the inner screw diameter ($D_o : D_i$) from the original 1.22 to 1.55 (on the ZSK Supercompounder and the ZSK MEGAcompounder) and now to 1.80 (on the new ZSK MEGAvolume PLUS), thus decisively increasing the free volume in the barrel.
- Another factor that is so important to the compounding process is the specific torque, which was increased from 3.7 Nm/cm³ to 13.6 Nm/cm³ (for the ZSK MEGAcompounder PLUS) and 11.3 Nm/cm³ (for the ZSK MEGAvolume PLUS) respectively. This increase in the specific torque was the prerequisite for an increase in screw speed from 150 rpm. to 1200 and 1800 rpm. respectively in order to achieve a considerable increase in output. This development was viewed quite critically by some experts in the beginning.
- The steadily increasing demand on the performance of the screw shafts made it necessary for the suppliers of drive units to develop not only high-performance drive mechanisms for twin-screw systems with only negligible distances between the screw axes but also – but not until

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more recently and then in collaboration with manufacturers of large electric motors – variable-speed drives with up to 20 MW output.

- The increases in output necessitated the installation of peripheral and downstream units that were able to keep pace. Typical examples are the twin-screw lateral feed system and the underwater pelletizer.
- For those surfaces of the screws and the barrel that come into contact with the product there are several available means of protection and types of coating that ensure both a prolonged service life and a high purity of product.

These developments also found their way into a process patent. For Coperion, the combination of the three parameters

- Screw diameter ratio ($D_o : D_i$) between 1.5 and 1.6 (at least 1.5 in the USA, China and Turkey),
- specific torque at least 11 Nm/cm³ and
- screw speed at least 800 rpm.

has been protected by patent since 1995. But time has not stood still since then, as the development of the aforementioned ZSK MEGAvolume PLUS shows. The new bimodal polyolefins have proved to be so difficult to compound that Coperion Werner & Pfleiderer have developed the two-stage ZSK NT for these materials. The first, relatively fast-rotating stage serves as a plasticizing unit, while the second, slow-rotating stage offers enough dwell time for the complete homogenization of the melt. The first two compounding systems of this type are currently being installed and will go into service at the beginning of 2008.

The twin-screw compounders have gone through a development that would have been inconceivable 50 years ago – from what one would today consider to be a relatively simple compounder with an output of only 170 kg/hr through to the versatile, high-tech, high-performance compounding lines with screw diameters of between 18 and 380 mm for output rates of up to 86 t/hr (polyethylene). The end of this success story is not in sight: the development engineers at Coperion Werner & Pfleiderer are already setting their sights on the machines of tomorrow, for an even wider range of applications, for new tasks both in and outside the plastics industry, and the output rate for polyethylene will certainly reach the 100 t/hr mark in the very foreseeable future.

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The Coperion Group (www.coperion.com), together with the companies Coperion Werner & Pfeiderer, Coperion Waeschle, Coperion Keya, Coperion Hartmann and 20 sales and service companies, is an international market and technology leader for compounding systems and bulk-material systems. Coperion designs, supplies and maintains systems, machines and components for the plastics, chemicals, pharmaceuticals and food industries. In the 2006 financial year, Coperion achieved sales to the tune of 450 million euros, and employs around 2,100 staff as at 31.12.2006.

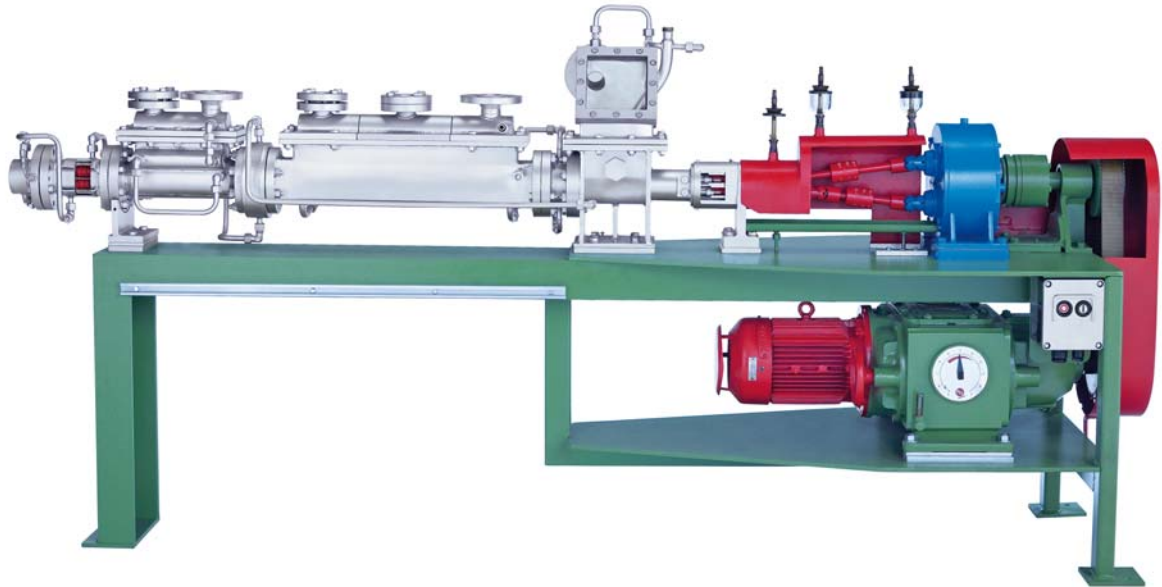
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the English and German text of this press release, as well as a printable-grade copy of the colour images, are available for download on the Internet at [**http://www.coperion.com/technicalpress**](http://www.coperion.com/technicalpress)

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The "ancestor" of all twin-screw compounders, the prototype built by Rudolf Erdmenger, will be exhibited by Coperion in the "Nostalgia Lounge" on its exhibition stand at K 2007. Note the cardan shaft transmission and the numerous venting domes.

Photo: Coperion, Stuttgart

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The ZSK 18 MEGAlab with its 18 mm diameter twin screws is the "Benjamin" of the ZSK MEGAcoumpounder PLUS family and works with the same tried-and-tested technology as its "bigger brothers" – it permits product development with the smallest possible quantities followed by a reliable scale-up

Photo: Coperion, Stuttgart