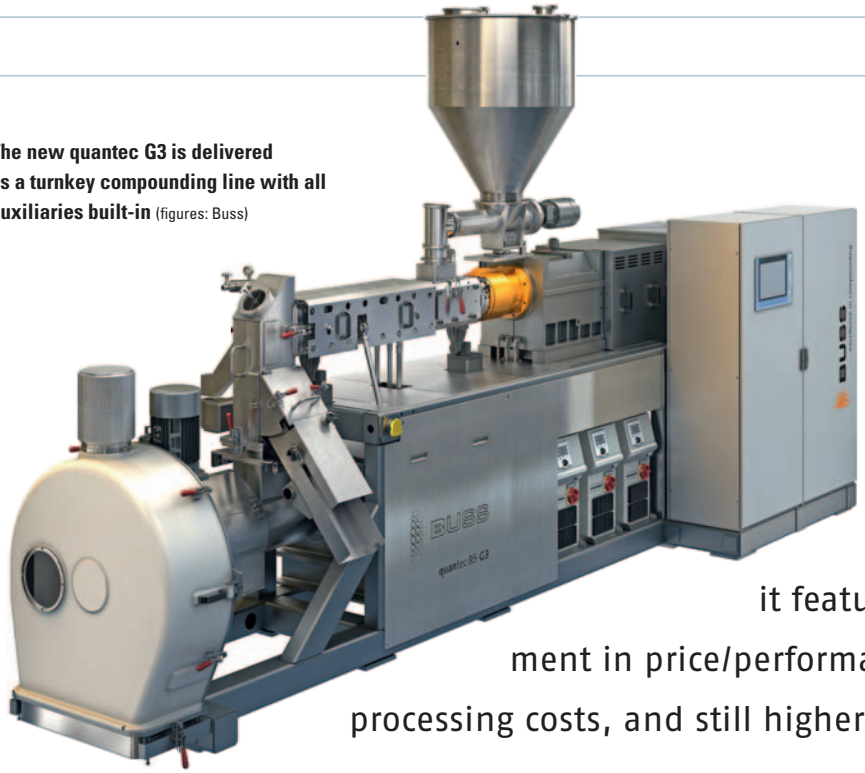


The new quantec G3 is delivered as a turnkey compounding line with all auxiliaries built-in (figures: Buss)

PVC Compounder.

The new quantec G3 is the third generation of this Buss Kneader series. For processing polyvinyl chloride (PVC) into high-grade pellets, it features a further improvement in price/performance ratio, lower specific processing costs, and still higher throughputs.

Throughput up, Costs down

HANS-ULRICH SIEGENTHALER
STEFAN NÄGELE
WOLFGANG WALTER

Buss Ltd, Pratteln, Switzerland, first presented its quantec four-flight Kneader series at the K 2001 [1]. These machines attained considerably higher throughput and better product quality for PVC compounding and pelletizing, furthermore at lower cost than previous 3-flight Buss Kneaders of the same size. Decisive for this breakthrough was the combination of high flow rigidity, high speed and high drive power – an innovation only attainable then with 4-flight technology [1].

After launching the quantec twelve years ago, Buss followed up with the second-generation quantec EV. This featured a larger barrel capacity and greater throughput, as well as considerably more application possibilities. These improvements spawned various different versions, such as of barrel length and screw configuration [2].

In course of this ongoing innovation process, Buss has intensively reworked the quantec Kneader, taking account thereby of own findings as well as the operating experience and suggestions of users. The new quantec G3 **(Title figure)** as third generation of this high-performance Kneader has a larger process window, covers a wider range of products, handles higher throughputs, and also costs less. Buss has achieved all this through numerous targeted improvements, as explained below.

Bundled Improvements to Detail

The quantec G3 retains the Buss Kneader's well-proven working principle, basic design and successful 4-flight technology. This machine is now largely standardized as a result of reworking, but it can nevertheless be adapted more easily, and at lower cost than before, to various different compounding applications. Decisive for this are the innovations it embodies in kneading technology, housing design, screw elements and their configuration, as well as the extensive range of standard accessories.

The new Buss Kneader series covers throughputs from 500 to 6,000 kg/h with screw diameters of 46 to 110 mm. All these machines are very compact, because the processing section with main drive and the discharge extruder with pelletizer are built into the mainframe, as well as all the auxiliaries **(cf. Title figure)**.

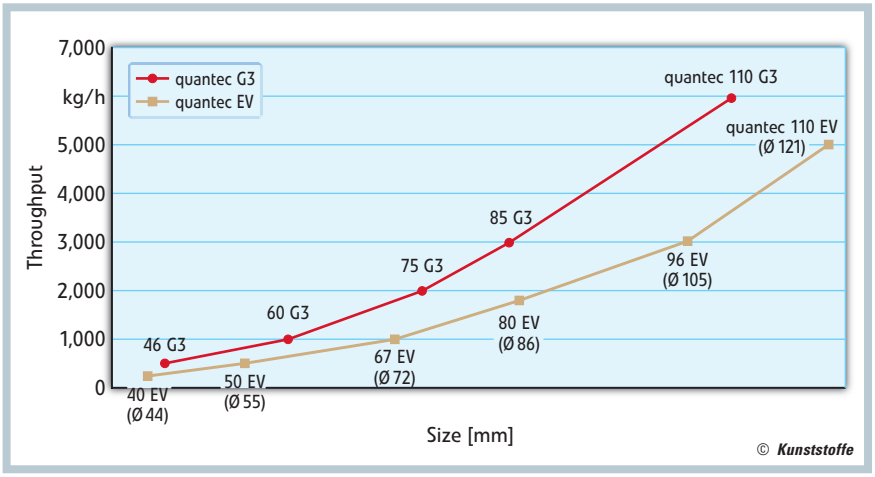


Fig. 1. Throughput of the quantec G3 is up to 70 % higher than that of the quantec EV

Translated from Kunststoffe 10/2013, pp. 215–218
Article as PDF-File at www.kunststoffe-international.com; Document Number: PE111499

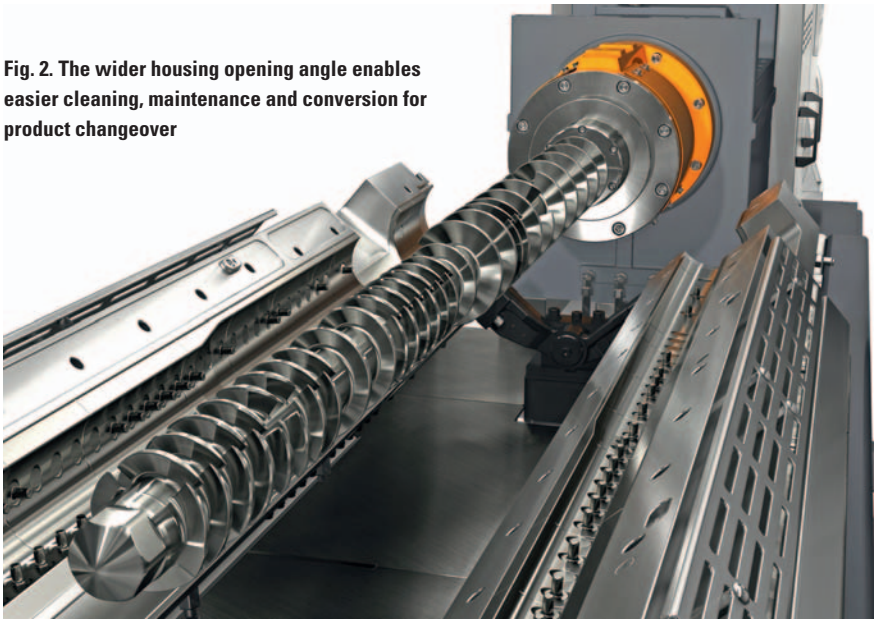


Fig. 2. The wider housing opening angle enables easier cleaning, maintenance and conversion for product changeover

Process Technology – the Key to Throughput and Quality

This new machine works on the well-proven single-shaft Buss Kneader principle, whereby the mixing/kneading screw rotates in the barrel and oscillates axially once per revolution. The interplay of screw flights with kneading pins fixed inside the barrel mixes and conveys the product efficiently, without applying excessive energy (see **box** for details).

The outside to core diameter ratio D_o/D_i of the mixing/kneading screw has been increased to 1.62. This provides additional processing space in the barrel, enabling greater throughput at the same screw speed.

The standard barrel length/diameter ratio of the quantec G3 has been increased from 10 L/D to 14 L/D. This improves mixing and throughput **(Fig. 1)**, as well as PVC compound quality.

Barrel Casing – Standardized but still Variable

The revised barrel casing geometry plays a decisive role in the higher throughput of the quantec G3. Firstly, the intake opening is 20 % bigger than before. This greatly facilitates feeding the PVC dry-blend, usually in voluminous bulk material form; moreover the well-proven eccentric intake shape has been further improved with feed pockets. Secondly, the intake diameter is also 20 % larger than that of the mixing/kneading zone. This further improves feed behavior.

Smooth transition from the larger intake diameter to the smaller mixing/kneading zone diameter is facilitated by two tapered half-shell liners, which can be freely positioned along the processing zone. This design solution enables easy adaptation of the transition length between intake and mixing/kneading to suit product-specific requirements. Generally this solution enables a great variety of functional elements on the screw shaft – for easy and efficient adaptation to different customer needs or processing requirements.

The lengthwise casing opening angle has been increased to 130° **(Fig. 2)**. This enables even better access for inspection, cleaning and maintenance of the processing zone, or for adapting the screw configuration to new product requirements.

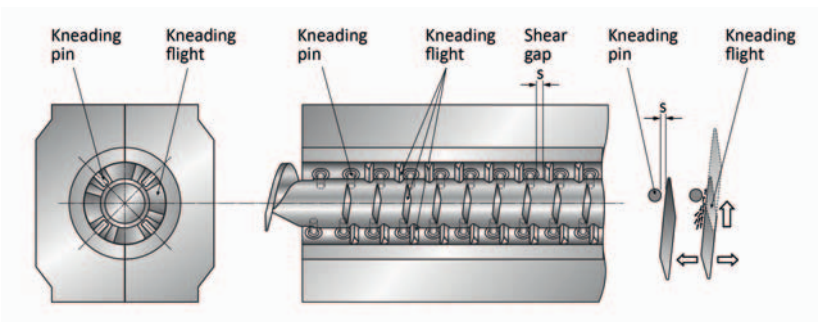
Screw Elements with Patented Flights

The quantec G3 series features the patented screw flight design [3] that is a key distinguishing feature of all Buss 4-flight Kneaders. These flights have an optimized free-form surface geometry that ensures a constant shear gap between them and the kneading pins over the entire screw flight length. Their innovative geometry guarantees uniformly intensive shear force on the product, thereby eliminating any risk of local overheating. This is decisive for the outstanding product quality, such as required for medical applications.

The mixing and kneading screw is divided into segments that can be configured according to requirements. By arranging various different screw elements on the shaft, the best cost-quality balance can be found for producing each PVC compound. **Figure 3** shows a typical screw shaft configuration for PVC compounding.

Dependable feed of raw materials, consolidation and transport to the mixing and kneading zone is ensured by conveying elements in the intake zone. For homogenizing the product, various mixing and kneading elements are available with suitably shaped kneading flights for efficiently and gently applying the necessary energy. The mating surfaces between all elements are straight in order to simplify assembly of the mixing and kneading screw. This also reduces the number

! The Buss Kneader Operating Principle



In the Buss Kneader the screw simultaneously executes an axial oscillating motion with every rotation. The screw has kneading flights, and kneading teeth or pins are fixed in the barrel at locations corresponding to the gaps between the kneading flights. The combination of rotation and axial motions of the screw generates between the kneading pins and the flanks of the kneading flights the shear gradient so important for the compounding process. Critical for this is the shear gap s, which extends over the entire flight pitch. Thanks to this technological design feature, the product is subjected in the processing section to extremely uniform shear force without any local peaks. Furthermore, the shear gap is proportional to the screw diameter. This decisively simplifies scale-up and process transferability to machines of various sizes.

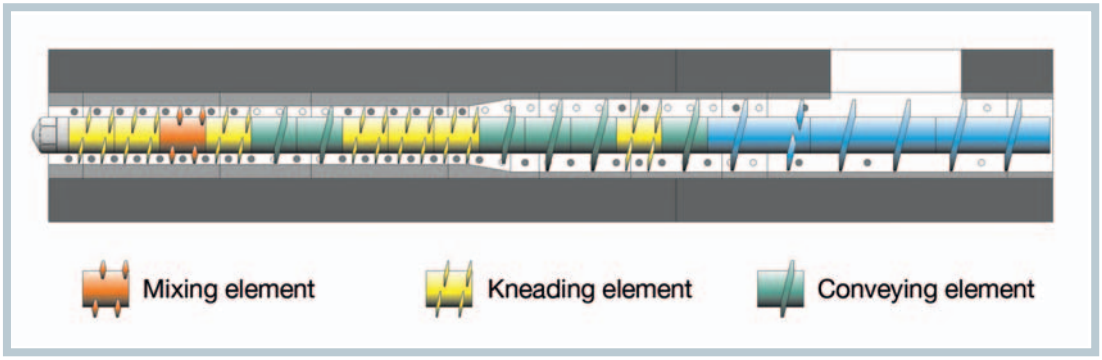


Fig. 3. Typical screw shaft for PVC compounding, showing the conveying, mixing and kneading elements. The tapered transition from mixing to kneading zone can be varied within certain limits

of different screw elements, thereby reducing stock keeping outlay and maintenance costs.

Stronger Materials

The higher drive torque required by the quantec G3 is provided by a more powerful motor. Accordingly, the splined shaft on which the screw elements are mounted is made of stronger high-tensile steel in order to transfer this torque. The splined shaft is shape-optimized, and undergoes an innovative heat treatment process to ensure excellent strength and toughness.

Upstream and Downstream Systems

Incorporated for the first time is a proprietary feed system optimized over the entire line. It is specifically tailored to industrial user requirements, and more cost-effective than previously. This new feed system is included fully wired and calibrated in the kneader line control and switchgear cubicle. It can be swung away from the filling opening to facilitate system emptying, and enables fast and precise determination of the throughput characteristic.

The temperature control units are built into the machine during works assembly, including all piping and wiring. While the mixing/kneading zone and discharge extruder screw temperatures are regulated with water as thermal medium, all other zones are electrically heated.

The line control system is installed in a switchgear cubicle mounted on the machine. All wiring is pre-installed and tested in the works, and no additional wiring is required on site. The separate control cubicle enables greater flexibility for plant installation.

Also included is a single-shaft discharge extruder optimally adapted to throughput, and a downstream pelletizer. Both of them are likewise built into the machine and integrated in the control system.

The machine is delivered as a turnkey compounding line fully assembled and tested in the works, including all upstream, downstream, and control systems. This saves several weeks of on-site manpower for installation and commissioning. Only the power, water and compressed air supplies have to be connected before starting production a few days after delivery.

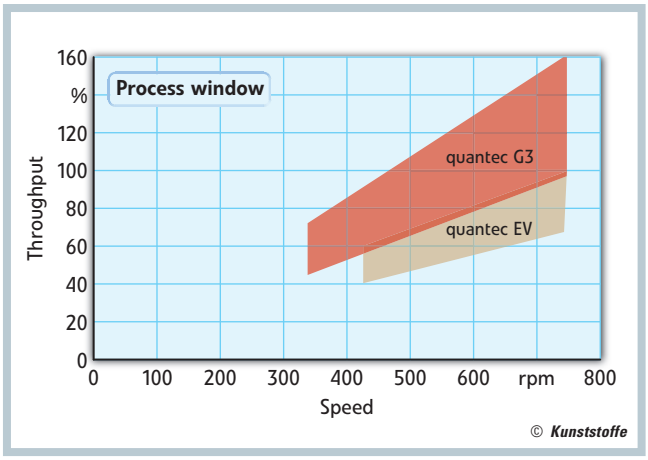


Fig. 4. The new kneader has a much larger process window than the quantec EV. This enables higher throughputs and wider coverage of PVC formulations

New Benchmark in Technology and Costs

Based on twelve years of experience and know-how in four-flight kneader technology, the quantec G3 is now state-of-the-art for all PVC compounding needs and user requirements. The manufacturer not only sets a new technological benchmark thereby for this heat and shear sensitive product, but also lowers the cost threshold for compounding lines.

Applications cover PVC formulations ranging from unfilled soft to high-filled hard PVC. The aforementioned improvements have resulted in a significantly larger process window **(Fig. 4)** meaning a wider throughput range and coverage of different formulations. Furthermore, a smaller and correspondingly lower-cost quantec G3 can be used for a given throughput. Last but not least, the simplified design of the processing zone reduces time outlay for product changeover – if at all necessary in view of the larger process window. ■

→

REFERENCES

1 Franz, P.: High-output Compounding. Kunststoffe international 92 (2002) 2, pp. 15–17

2 Nägele, S.; Siegenthaler, H.-U.; Trachsel, R.: 10 Jahre Vierflügel-Technologie, Teil 1: Durchsatz und Compoundqualität gesteigert, Produktionskosten gesenkt, Extrusion 6/2012, pp. 26–29; Teil 2: Innovative Kneterbauweise mit großem Zukunftspotential, Extrusion 7/2012, pp. 50–55

3 Patent No. EP 1 185 958 A1: Mixing and Kneading Machine. Applicant: Buss Ltd, Pratteln, Switzerland. Inventor: Hans-Ulrich Siegenthaler.

THE AUTHORS

DIPL.-ING. HANS-ULRICH SIEGENTHALER, born in 1965, joined Buss Ltd, Pratteln, Switzerland in 1989 and is now Director of Process Technology; hansulrich.siegenthaler@busscorp.com

DIPL.-ING. STEFAN NÄGELE, born in 1968, joined Buss Ltd, Pratteln, Switzerland, where he is currently Operations Manager Process Technology and quantec G3 project manager; stefan.naegele@busscorp.com

DIPL.-ING. WOLFGANG WALTER, born in 1956, joined Buss Ltd, Pratteln, Switzerland in 2012 and is currently Chief Engineer; wolfgang.walter@busscorp.com