Underwater pelletization: Abrasion and corrosion combine where cutting blades come into contact with the die plate. A new wear protection alloy significantly reduces the effects of both mechanisms (© Coperion)

Better Pelletization under Water

Die Plate Wear Protection Doubles Service Life

A new development in wear prevention on underwater pelletizer die plates is opening up the way to significant reductions in production costs, in particular for the production of polyolefins. This new wear protection is now available for the first time for the die plate of an increased capacity underwater pelletizer for throughputs of up to 70 t/h.

Underwater pelletizers (UG) divide the melt stream obtained during the production of thermoplastic polymers or compounds into a number of individual strands and then cut them into pellets. The heart of such systems are die plates with numerous holes through which the product melt is pressed. Blades which cut the strands into pellet length as they emerge from the holes rotate over the surface of these plates. This process usually involves metal-to-metal contact between the plate and blade and hence abrasion and cohesion phenomena. Moreover, the water which cools the melt, makes it cuttable and conveys the pellets away, has a corrosive action on the metals.

It is important, despite these mechanisms, to ensure that the sometimes very low viscosity melts continue to be cut cleanly, so enabling largely uninterrupted operation of the pelletizing lines. This entails keeping both the cutting edges of the blades and the edges of the die holes sharp for as long as possible. The cutting surface of the die plates for underwater pelletizers of the UG300 to UG1250 series from Coperion, Stuttgart, Germany, has previously been protected either by hard metal or by ferrotitanite (grade: Nikro128, manufacturer: DEW Deutsche Edelstahlwerke GmbH,

Krefeld, Germany). Both materials have their own pros and cons.

Properties of Common Wear Prevention Materials

Hard metal is characterized by high resistance to abrasive and cohesive wear, but has limitations in terms of corrosion resistance. Its high thermal conductivity leads to a relatively hot cutting surface, which can complicate cutting and results in high energy losses into the pelletizing water. Hard metal's low thermal expansion in comparison with the base material limits the size of the wear protection inserts and so restricts design options with regard to the distribution and density of the die holes. Coperion uses single-row die plates equipped with hard metal in the production of polypropylene. Typical features here are caterpillar-shaped wear protection and very intense heating.

Nikro128 ferro-titanite has a lower hardness and lower wear resistance than hard metal but, thanks to the special steel matrix, is highly resistant to corrosion. Its low thermal conductivity reduces energy losses into the pelletizing water and allows the cutting surface to remain cold, as a result of which even very low viscosity polymer melts can be cut without any problem. Its thermal expansion, which is very similar to that of the base material, means that wear protection inserts can be very large. As segments, they can cover up to 100 % of the cutting surface. Such inserts also permit great freedom with regard to the distribution and density of the die holes. Typical applications are underwater pelletizers for polyethylene melts. Such pelletizers can have very large numbers of die holes, which in the largest models (UG1250, **Fig. 1**) may be as many as 10,000 or more in number.

Fig. 1. The current upper limits of feasibilities: The UG1250 pelletizer is designed for throughputs of up to 120 t/h (© Coperion)

High Resistance to Wear and Corrosion

Coperion, working jointly with DEW, has now developed a new wear protection material based on Nikro128 (grade: NikroDur) for underwater pelletizer die plates which is now ready for industrial production and means there is now no longer any need to choose between these properties. Like Nikro128, this new metal matrix composite (MMC) is manufactured using powder metal technology which permits variations in terms of the nature and proportion of both the hard phase and the matrix [1]. As a result of these optimizations, NikroDur offers

- at least 50 % higher wear resistance than conventional ferro-titanite (**Fig. 2**),
- over one third higher corrosion resistance (**Fig. 3**) and
- one fifth lower thermal conductivity (**Fig. 4**) to optimize die plate temperature management and ensure optimum cuttability of even low viscosity melts.

This combination of properties means that NikroDur matches or surpasses the respective strengths of both of the previous alternatives. In addition, its thermal expansion, which is comparable with that of the base material, means the wear protection elements can be arranged in segments.

These findings were initially based on laboratory measurements which Coperion has since been able to confirm in in-house corrosion testing under close to practical conditions. This testing revealed no corrosion for either the known fer- »

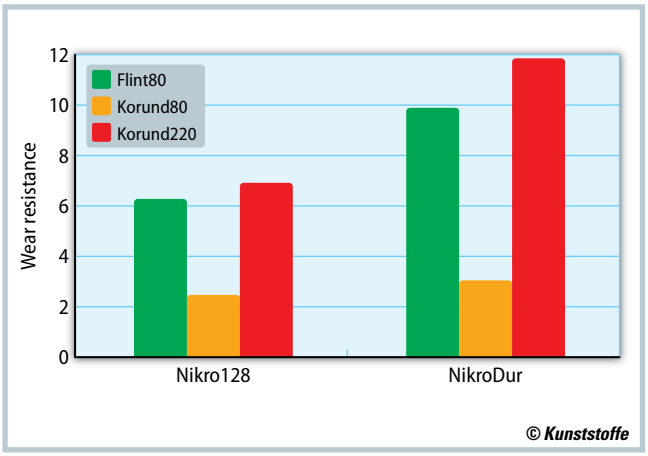

Fig. 2. Wear resistance: Under practical conditions, the wear resistance of the newly developed NikroDur alloy is up to twice that of the previous standard grade Nikro128, which is likewise based on ferro-titanite (50 % demonstrated by pin-on-paper wear test) (source: Coperion)

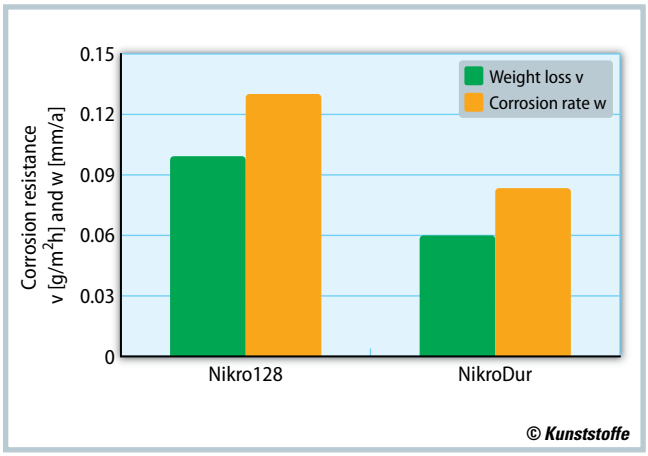

Fig. 3. Weight loss and corrosion rate: The corrosion resistance of the newly developed NikroDur alloy is up to one third higher than that of the existing standard grade (source: Coperion)

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Service

References & Digital Version

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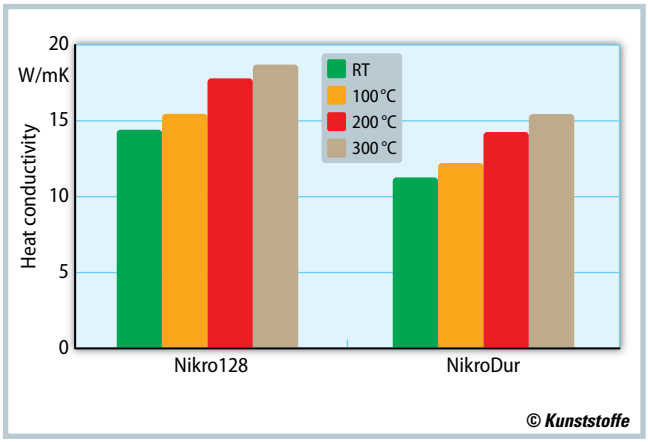

Fig. 4. The thermal conductivity of the newly developed alloy is 20 % lower than that of the Nikro128 (source: Coperion)

ro-titanite or the new NikroDur. In parallel, processability by both thermal and mechanical methods was tested in manufacturing trials. Since these trials uncovered no differences from the known ferro-titanite grade, it was decided to produce a commercial sized underwater pelletizer die plate.

Prototype Proves and Exceeds Expectations

To confirm the measured advantages in practice, Coperion manufactured a die plate prototype for the underwater pelletization of polypropylene, which normally places higher requirements on the plate in terms of cut quality and temperature management. Practical testing was carried out on the premises of a customer who has stringent requirements in terms of corrosion resistance and the width of the melt viscosity range and already had a die plate with conventional ferro-titanite wear protection in service in order to meet these requirements. This customer was very satisfied with the existing quality of the pellets, but wanted to extend the service life of the wear protection. Once the new die plate had been jointly commissioned, it was capable right from the first cycle to remain in service not only 50 % longer but instead almost twice as long as the reference plates with the known ferro-titanite grade and approximately equally as long as die plates with hard metal wear protection. This is also in line with experience with smaller pelletizers in the field of engineering plastics.

This initial, very positive practical experience demonstrates that this novel wear protection material provides an ideal combination of the characteristics of hard metal and known ferro-titanite grades and is thus ideally suited to use in underwater pelletizer die plates. Moreover, the further potential arising from the lower thermal conductivity has not yet been fully explored.

First Application for Medium-Capacity

Coperion has come to a multi-year exclusivity deal with the wear protection manufacturer and applicates the new material for the first time in the die plate (**Fig. 5**) for a new underwater pelletizing system (type: UG750W).This addition to the product range covers throughputs ranging from 60 t/h to 70 t/h. It bridges the previous gap between the UG750 (throughput of 55 t/h) and the very much larger UG1000 (throughputs of up to 82 t/h).

The new developed machine is based on the UG750, but is equipped with the extended cutting surface from the UG1000. The system accordingly makes use of components which have proven themselves over many years both for the die plate/blade system (UG1000) and for the mechanical components knife shaft bearing, pelletizer hood and drive train (UG750). Due to the wider cutting circle and an optimized arrangement of the die holes, it has been possible to increase the number of holes in comparison with the UG750 by just about 27 % to over 5700. As a result, it is possible, depending on the product, to achieve the desired increased throughput of up to 70 t/h. Thanks to the use of products from an existing range, UG750 users now have the option to achieve a distinct increase in throughput by replacing just a few components in a procedure involving predictable costs and technical effort. ■

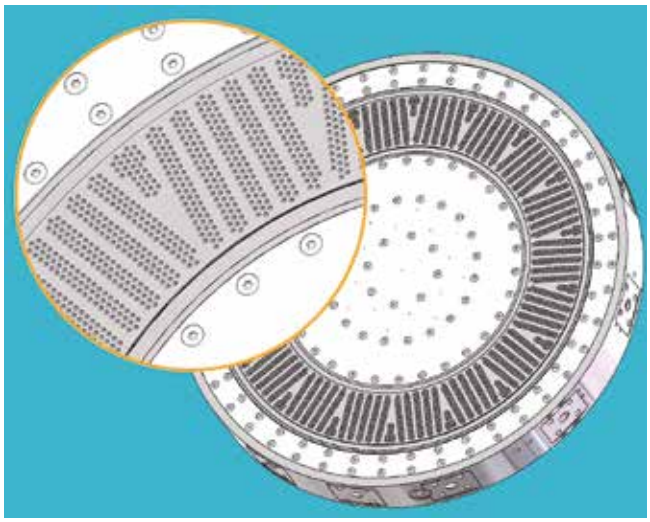

Fig. 5. Optimized arrangement: The large die plate of the UG750W has a larger number of die holes, so enabling an increased output capacity in comparison with the UG750 (© Coperion)