Special Reprint of Kunststoff-Berater 1-2 | 2006

New technology with keen advantages over conventional colour addition methods

Fast Colour Change for Thermoplastics

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Time-consuming material and colour changes are the main impediment to a versatile approach to the production of thermoplastic articles. Material costs and machine downtimes are expensive and time-consuming. Responding to this problem, Klöckner Desma GmbH of Achim/Germany has now developed a method, which offers a variety of benefits for colour changes during the production of thermoplastic articles such as substantially shorter change-over times and lower material consumption.

During material discharge, the liquid colorant is injected directly into the hot thermoplastic melt and spread evenly by means of a special metering system. The processor has a choice of four different colours. The main benefit of this approach is the fact that the recirculation of the colorant between the metering system and the colour vehicle ensures perfectly stable conditions. Table 1 shows a comparison between Desma's method and colour addition by means of a conventional colour metering system.

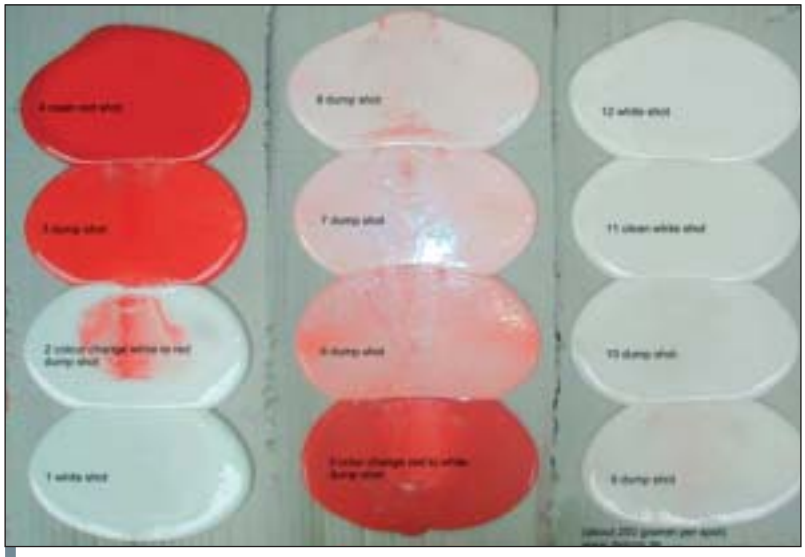

Fig. 1: Example of a colour change-over with Desma technology

Product variety requires versatility

A look at the development in different markets over the past few years reveals one common trend, namely the substantial expansion of product variety in combination with smaller batches. While customers have more influence on the design of the produced articles, the processing problems caused by this trend bring about increasing production costs. As customised mass production is emerging as the dominant approach, the industry is compelled to focus on highly economic production processes in conjunction with a high degree of versatility.

This criterion has crucial repercussions, as the very versatility of thermoplastic processing is limited by the addition of material. Generally, the product contains one colorant,

Conventional	Desma direct colour addition
– high storage cost for a variety of thermoplastic colorants	– one colour-neutral thermoplastic material
– colour change requires up to 60 minutes	– less than 10 minutes
– colour change generates up to 50 kg of waste scrap	– less than 5 kg of waste scrap

Table 1: Comparison between a conventional colour addition system and Desma's colour addition method

which coerces producers to colour the thermoplastic material prior to processing. Liquid colorant or masterbatch are fed from the feed section of the injection unit and mixed with the colour-neutral thermoplastic material. (Fig. 2).

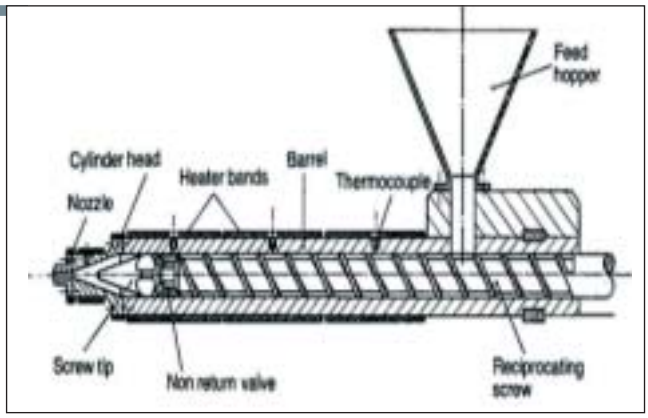

Fig. 2: Injection unit for thermoplastic processing

Thermoplastic processing

Desma offers two methods of thermoplastic processing. The first method involves injection of the thermoplastic material into the mould, while the second method uses the DESflow principle. Fig.3 shows a standard injection unit using the DESflow principle. This technique is based on the concept of injection into an open mould and subsequent compression of the hot thermoplastic melt within the cavity. Fig. 4 shows how the DESflow principle is used for the production of shoe soles.

Thermoplastic material is often sensitive to the high degree of friction and the prolonged thermal stress characteristic of plasticising or injection moulding. DESflow helps circumvent the required injection of material through runners, which prevents excessive stress as well as reducing the mechanical and thermal impact on the material to a minimum. In addition to obviating the need for hot runners and the corresponding reduction of waste scrap, this method offers other significant benefits such as a lower clamping pressure, which helps economise on machine and mould costs.

Expensive steel moulds can be replaced with their more cost-efficient aluminium alternative. Another asset of the DESflow principle is the elimination of flow marks, a frequent occurrence in hot runners during injection moulding. Desma uses a special screw for plasticising thermoplastic material with low friction and according to individual requirements.

Colour processing

Moulders have a choice of different colour metering systems for thermoplastics. The conventional methods involve colouring the thermoplastic material with masterbatch in a mixer. This process can be carried out by feedstock producers and moulders alike.

At present however, the use of liquid colour or masterbatch metering systems, which are connected directly to the machine, is becoming increasingly popular. Fig. 5 shows how masterbatch is added to the polymer.

The same principle can be applied to liquid colours. The colour addition process illustrated in Fig. 6 involves the introduction of 5% of

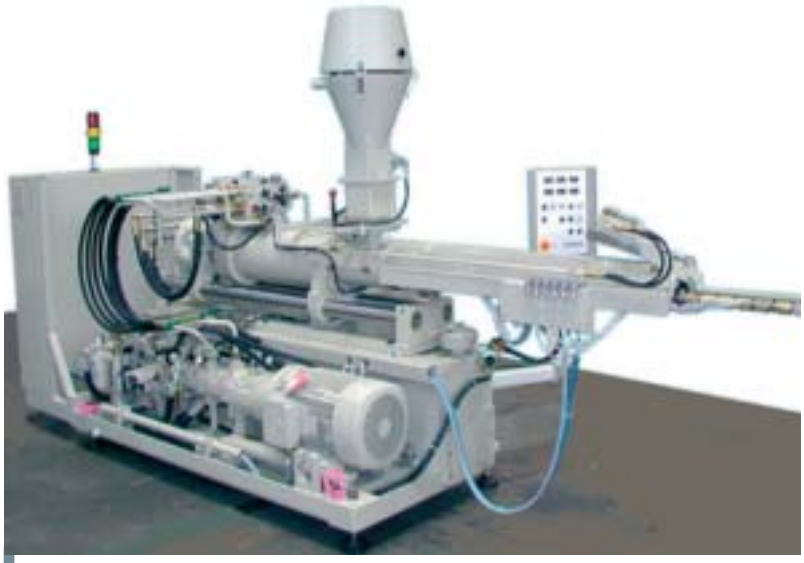

Fig. 3: Thermoplastic injection unit

Fig. 4: The DESflow principle

Fig. 5: Addition of dry colorant according to the masterbatch method

Fig. 6: Addition of liquid colorant according to the masterbatch method

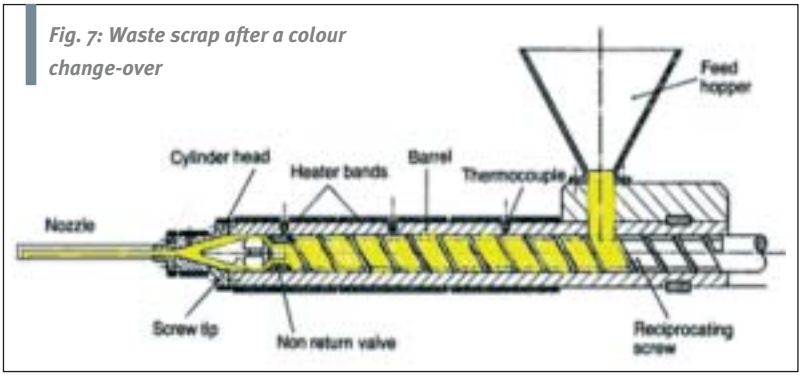

Fig. 7: Waste scrap after a colour change-over

Fig. 8: Pouring process according to the DESflow principle

liquid colour to the thermoplastic material by means of a feed tube pump, which is located directly at the feed throat.

The required amount of colorant is dependent on the processing method. All methods have one major drawback. They create a high volume of waste scrap and are very time-consuming. A colour change requires purging of every unit of equipment to remove any colour residue and refilling with new colorant. Colour changes while using the masterbatch principle with either liquid or dry colorant even requires purging of the complete injection unit from the feed throat to the injection nozzle. Fig. 7 shows purging zones (yellow), filled with coloured thermoplastic material.

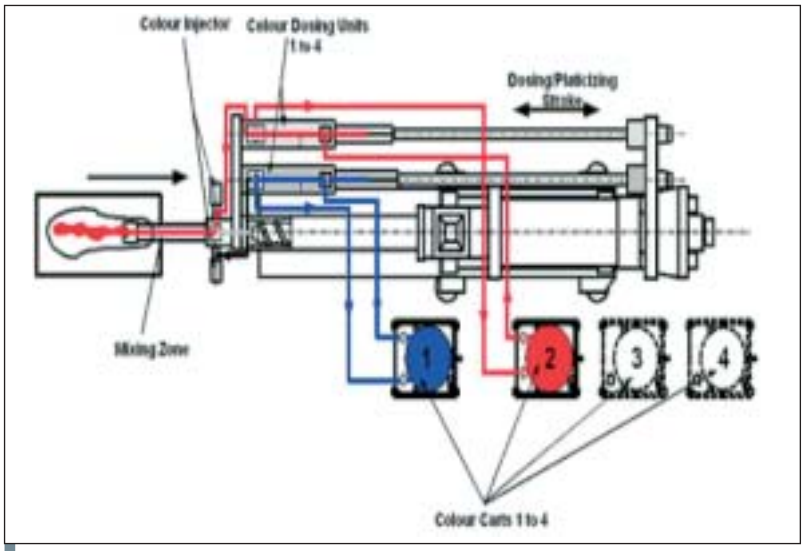

Fig. 9: Principle of the Desma colour addition method

Properties	Method	Unit	Value
Density	DIN53479	g/cm³	1.1 to 1.25
Hardness	DIN 53505	Shore A	55 to 90 (norm 65)

Table 2: Characteristic TPU properties:

Screw diameter	45 to 65 mm
L/D ratio	18/1 to 24/1
Screw revolution	70 to 100 rpm
Holding pressure	30 to 60 bar
Material temperature	170 to 200°C
Demoulding time	60 to 100 sec

Table 3: General TPU processing parameters

A new way of adding colour

During the new colour addition method, colour-neutral thermoplastic material is plasticised in the conventional way by means of a special 24D/65mm screw, which allows addition of a colorant independent of the injected thermoplastic material, i.e. the colorant can be introduced either by means of the DESflow technique or as part of the injection process. This method is illustrated in Fig. 8, which shows the injection of thermoplastic material into the open mould.

The liquid colorant is injected via a patented colour metering system, which ensures the precise distribution of liquid colour in the hot plasticised thermoplastic material within the injection unit. Fig. 9 provides an overview over the new colour addition method. Every injection unit can support the addition of up to four colours. In order to ensure a smooth operation, care must be taken that the liquid colorants recirculate in the attached portable colour vehicle. During the injection process

Fig. 10: Mixing and nozzle areas

proper, the colour injector must withstand the high pressure in the nozzle area. In order to ensure a precise metering of the colorant, the plasticisation plunger is coupled with the feed ram. During the injection process, the colour injector dispenses the liquid colour into the hot plasticised thermoplastic material. Prior to its discharge into the mould, the plasticised material passes a special mixing section where the selected colour is added. The mixing and nozzle sections are shown in Fig. 10. Both sections have a total length of 450 mm, and only these come into contact with the colorant. This substantially reduces the amount of waste scrap and the time required for colour changes. A colour change from red to white (240 s), for example, produces 1,500 g, while a change from white to red generates only 350 g of scrap.

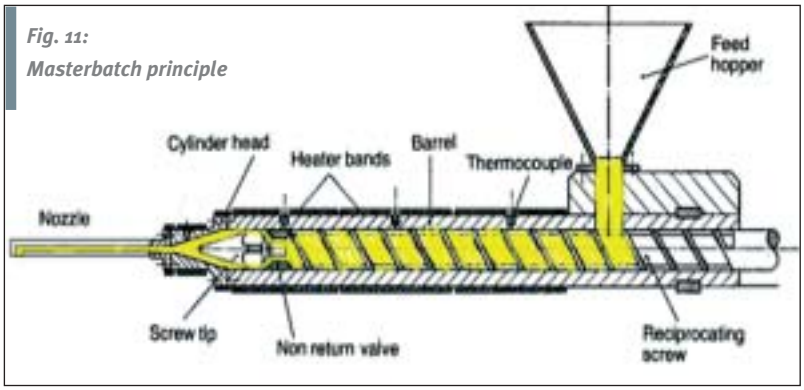

Fig. 11: Masterbatch principle

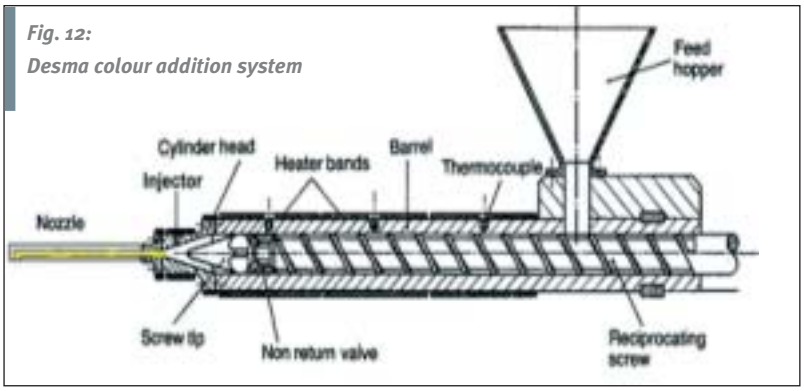

Fig. 12: Desma colour addition system

Summary

According to Desma, the new technology offers substantial advantages over the conventional colour addition in conjunction with thermoplastic injection units. The main benefits of colour addition described in this report are the reduction of waste scrap and the shortened change-over times.

Figs. 11 and 12 illustrate the differences between the two methods in proportion to the amount of coloured thermoplastic material. To sum up, the masterbatch method requires purging of the entire screw, while Desma's technology merely involves purging of the front mixing and nozzle sections. ■

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