

Process for back-injecting decorated films

The invention relates to a process for back-injecting decorated films with a thermoplastic polymer, in which the
5 decorated film is protected from erosion.

Back injection of films (in-mould decoration) is a widely used surface finishing process. In this process, a decorated film is shaped, trimmed and then laid in the
10 injection mould and back-injected. In the case of reverse-printed films, while the decoration is indeed protected by the external transparent film, when such films are back-injected the decoration is exposed to elevated temperatures and shear stresses which result in erosion in the area of
15 the gates. In order to avoid erosion, it is known to cover the decorative layer with a protective layer such that the melt does not come directly into contact with the decorative layer. Such a protective layer consists, for example, of polycarbonate (PC),
20 acrylonitrile/butadiene/styrene (ABS), polymethyl methacrylate (PMMA), acrylonitrile/styrene/acrylate (ASA). Said layer is either applied directly during production of a component by coextrusion or is subsequently laminated with the assistance of coupling agents. This process is
25 described, for example, in P. Enewoldsen, H. Braun, Folienhinterspritzen - Dekorieren in der Spritzgießmaschine, KU Kunststoffe 89 (1999) 9, pages 102-104.

One disadvantage of this process is that protection of the
30 entire surface is not actually necessary since erosion only occurs locally at the gates. More material is thus used than is necessary. Moreover, this multilayer structure may overall result in reduced adhesion of the decorative layer to the complete component. One substantial disadvantage,

- 2 -

however, is the inadequate three-dimensional forming. Thermoforming is only possible under certain conditions as, in most cases, the coupling agent with which the protective layer is applied onto the decorative layer results in the formation of gas bubbles between the layers.

Furthermore, such multilayer films can only be formed below the softening point. However, the area which can be formed by the high pressure forming process used for this purpose is limited.

It is furthermore known, in order to improve heat dissipation, to chill the decorated film prior to back injection with a cooling spray. In this case, the film is at least so strongly chilled that the heat of the melt is insufficient to cause the printing ink to melt and be displaced. The disadvantage here, however, is that relatively thin films of a thickness of approx. 100 μm cannot be sufficiently chilled as they absorb heat again too rapidly. Alternatively, the injection mould may be adapted in such a manner that the shear rate and throughput, e.g. volume throughput, per gate are lower. However, this entails a larger number of gates which in turn results in an increased number of weld lines and, consequently, reduced strength at the weld lines.

A process is furthermore known in which the decorative layer is partially overprinted in the area of the gates with a clear lacquer, for example a two-component polyurethane lacquer. However, said process cannot be used in the vicinity of formed portions as, once cured, the lacquer can no longer be formed.

- 3 -

The object of the invention is accordingly to provide a process for back-injecting decorated films, in which erosion phenomena on the decorated film are avoided in the area of the inlet orifices for the melt into the mould cavity of the injection mould.

The present invention accordingly provides a process for back-injecting decorated films with a thermoplastic polymer, wherein the film lies with its entire surface against the internal wall of the mould cavity, which process is characterised in that, prior to back injection, the decorated film is provided with a protective element in the area of one or more inlet orifices for the thermoplastic polymer into the mould cavity.

The protective element is applied onto the decorative layer of the decorated film opposite one or more inlet orifices, such that, on injection into the mould cavity, the polymer melt does not come into contact with the decoration in the area of the gate. On the one hand, the protective element provides thermal insulation. During back injection, it prevents the heat of the thermoplastic polymer from melting the printing ink and causing it to flow with the melt. On the other hand, the protective element also provides mechanical protection by preventing the melt from coming into direct contact with the decorated film. In this manner, the protective element protects the printing ink from the elevated shear stresses in the area of the gates during back injection.

The area of the protective element depends upon the area of erosion. The size of the inlet orifice, through which the thermoplastic polymer passes into the injection mould, substantially determines the area of erosion. The area of

- 4 -

the protective element is preferably at least twice, preferably at least ten times, the cross-section of the respective opposing inlet orifice.

5 The protective element is preferably a mesh, woven, braided or nonwoven fabric of metal, polymer and/or natural material and/or a foil/film of metal and/or polymer. Metals which may, for example, be used are aluminium, copper, alloys or steel. Polymers which may be used are elastomers
10 or thermoplastics. The polymers may optionally also be provided with reinforcing materials and/or fillers, for example glass fibres. The protective element may, for example, consist of the following polymers: polycarbonate (PC), acrylonitrile/butadiene/styrene (ABS),
15 styrene/acrylonitrile (SAN), polybutylene terephthalate (PBT), polyamide (PA), thermoplastic polyurethane (TPU), polyethylene terephthalate (PET), polystyrene (PS), polyoxymethylene (POM), polyolefins, in particular polypropylene (PP), polyester, polymethyl methacrylate
20 (PMMA), thermoplastic polyvinyl chloride (PVC) or mixtures of thermoplastic polymers.

Natural materials which may be selected are, for example, cotton, cellulose, hemp, flax or cork. A combination of the
25 stated sheet materials and/or materials is also possible.

The thickness of the protective element depends upon the quantity of polymer injected through the inlet orifice. The protective element preferably has a thickness of at least
30 50 μm .

The protective element is preferably applied onto the decorated film by means of an adhesive bond. Adhesives which may, for example, be used for this purpose are

- 5 -

aqueous polyurethane dispersions, aqueous acrylate/copolymer dispersions and polyurethanes dissolved in organic solvents. Alternatively, the protective element may also be applied by heating the film and then
5 compressing the protective element with the film. The protective element may moreover be applied onto the decorated film by welding.

The process according to the invention makes it possible to
10 achieve direct gating without erosion. Gating via tabs or pins is thus unnecessary. Direct gating moreover has the advantage that it is possible to make use of the cascade method, i.e. time-delayed actuation of the inlet orifices. Furthermore, no structural changes to the injection mould
15 are required, such as for example the introduction of additional gates to reduce the volume throughput per gate. The protective element may furthermore be adapted to the local shape of the decorated film. Moreover, less material is consumed and processing is less complex in comparison
20 with conventional processes as the quantity of material required for protection is reduced to a minimum and, instead of a protective layer covering the entire area, only a local protective element need be applied.

25 The decorated films are back-injected by the process according to the invention using thermoplastic polymers which are unfilled or provided with reinforcing materials and/or fillers, such as polymers comprising polycarbonate, acrylonitrile/butadiene/styrene (ABS),
30 styrene/acrylonitrile (SAN), polybutylene terephthalate (PBT), polyamide (PA), thermoplastic polyurethane (TPU), polyethylene terephthalate (PET), polystyrene (PS), polyoxymethylene (POM), polyolefins, for example polyethylene (PE), polypropylene (PP), polyester,

- 6 -

polymethyl methacrylate (PMMA), elastomer-modified blends, thermoplastic PVC or mixtures of thermoplastic polymers.

The thickness of the back-injected thermoplastic polymer varies greatly as a function of the application. The thickness of the polymer layer is preferably 1 to 6 mm, but may range from a few tenths of a millimetre to greater than 10 mm (thermoplastic foam casting).

The decorated film consists, for example, of polycarbonate, ABS, cellulose ester, polyethylene (PE), polypropylene (PP), polyethylene terephthalate (PET), polybutylene terephthalate (PBT), polymethyl methacrylate (PMMA), PVC, polyester, polysulfones, polyethersulfones, polyetherether ketones (PEEK), polyarylethersulfones, polyurethane (PU) and polyamide (PA). Functional multilayer films, films made from polymer mixtures or blends or films provided with reinforcing materials and/or fillers may furthermore be used.

The films are decorated, for example, by screen printing. Further possible methods for decorating the film are lacquer coating, laminating, pad printing, offset printing, thermal transfer printing, relief printing (including flexographic printing), planographic printing, gravure printing, inkjet printing, photography, thermography, magnetography, ionography or electrography.

The printing inks conventional for the particular method, for example screen printing inks, are used for decorating the film.

The invention is illustrated in greater detail in the attached Figure 1.

- 7 -

Figure 1 is a schematic diagram of a film 2 with decorative layer 6 laid in the mould cavity 7 of an injection mould 1, said film lying with its entire surface against the internal wall of the mould cavity 7. The decorative layer 6 is provided with a protective element 4. The thermoplastic polymer for back-injecting the film 2 which has been provided with a decorative layer 6 enters the mould cavity 7 via the inlet orifice 5 of the injection mould 1.

Example

The Example describes back injection of a decorative film for an engine cover. The film comprises a polycarbonate (PC) film which has been screen printed on the reverse with a solution of synthetic resins in organic solvents (Noriphan[®] HTR from Pro 11, Germany). Once it had been printed, the film was shaped by thermoforming and then trimmed. Protective elements of polycarbonate with an area of 24 x 75 mm² were then applied onto the printed film in the area of the gates. To this end, the protective elements were provided with a coupling agent prepared from polyurethane dissolved in organic solvents (Mecotherm[®] L110 from Kissel & Wolf, Germany). Once provided with protective elements, the film was laid in the mould cavity of the injection mould and back-injected with polyamide 6. The size of the gate was 50 x 3.6 mm². The mass of thermoplastic polymer per gate was 80 g.

Claims:

1. A process for back-injecting decorated films (2) with
a thermoplastic polymer (3) in a mould cavity (7) with
5 one or more inlet orifices (5) for the thermoplastic
polymer (3), wherein the film (2) lies with its entire
surface against the internal wall of the mould
cavity (7), characterised in that, prior to back
injection, the decorated film (2) is provided with a
10 protective element (4) in the area of at least one
inlet orifice (5).
2. A process according to claim 1, characterised in that
the area of the protective element (4) is at least
15 twice, preferably at least ten times, the cross-
section of the opposing inlet orifice (5).
3. A process according to one of claims 1 or 2,
characterised in that the protective element (4) is a
20 mesh, woven, braided or nonwoven fabric of metal,
polymer and/or natural material and/or a foil/film of
metal and/or polymer.
4. A process according to one of claims 1-3,
25 characterised in that the protective element (4) is
applied onto the decorated film (2) by means of an
adhesive bond.
5. A process according to one of claims 1-3,
30 characterised in that the protective element (4) is
applied onto the decorated film (2) by means of
heating and subsequent compression.

- 10 -

6. A process according to one of claims 1-3,
characterised in that the protective element (4) is
applied onto the decorated film (2) by welding.