TPE PROCESSING : MULTI-COMPONENT

2K

HEXPOL TPE

CONTENTS

INTRODUCTION

It used to be a complex and costly affair producing details made of thermoplastic that included soft-touch qualities or had integrated seals. With our adhesion TPEs, since the materials are bonded together at the production stage, no separate primer or adhesive is needed. This makes the process faster and more cost-effective.

There are two main processing procedures used to achieve bonding, overmoulding and co-extrusion. In this guide we give an overview of the different techniques, please contact us for further information.

A general TPE processing guide is also available to download from our website →

HOW DOES ADHESION HAPPEN?

When overmoulding with soft components, the surface of the hard component softens and a diffusion of the molecules in the outer layer takes place. A prerequisite for this is that the two materials, i.e. the TPE compound and the engineering plastic, must be compatible with one another, meaning that they must not reject one another's molecules. As the molecule mobility increases, the molecules of the two materials will diffuse and this gives rise to so called melt adhesion. The molecules of the two materials form a network at the surface layer and the network forms a cohesive bond between the materials.

Engineering plastics, to which Dryflex and Mediprene TPE compounds have documented good adhesion, include PP, PE, PA 6, PA 66, PC, ABS, PC/ABS, ASA and SAN. Polyamides and ABS may be either reinforced or non-reinforced. The adhesion between the TPE Compounds and the engineering plastic may differ, depending on the manufacturer that supplied the engineering plastic. The adhesion of PA in particular, varies widely. So it is important that adhesion tests are done on the relevant materials.

The following sections provide recommendations how to improve the bonding in the overmoulding as well as in the co-extrusion process.

OVERMOULDING

The best processing method, to ensure good adhesion in the overmoulding process is the use of an overmoulding machine in which the whole process takes place automatically, i.e. the engineering plastic is first injected, the mould is then turned and the TPE Compounds are finally injected into the mould.

It is also possible to inject Dryflex and Mediprene TPE compounds in the first step and in the second step the engineering plastics.

Another option is to first produce the engineering plastic part and then manually move the part over to a different mould, into which TPE compounds are injected. The latter method is much more work-intensive than the first and does also demand external contact with the engineering plastic part when it is moved between the moulds.

OVERVIEW OF SETTING PARAMETERS

The following recommendations are intended to improve the adhesion between the TPE compound and the engineering plastic. The parameters are applicable when the TPEs are moulded onto the engineering plastic, but they may also be applicable if the procedure is reversed.

The setting parameters in 1 to 6 are easiest to implement, since they involve only the machine settings. The parameters in 7 to 9 are pre-treatment stages, which are also simple to perform. These stages can be simplified if production of the engineering plastic part and the application of TPE take place in a continuous process in an overmoulding machine. The parameters in 10 to 12 concern the mould and should be considered at the mould design stage.

1. High mix temperature
2. High injection rate
3. The mould temperature of the TPE part should be in the range 20 - 60°C
4. Avoid excessively high holding pressures
5. Avoid shrink marks
6. Highest possible injection pressure
7. Pre-drying of hygroscopic (moisture absorbing) materials
8. Homogeneous preheating of the engineering plastic (approx. 100°C)
9. Dry, clean and smooth surface of the engineering plastic. The surface should not be structured
10. Sufficient thickness (at least 1.5 mm) of the TPE part
11. Venting of the mould
12. Location and design of the gate

DETAILED SETTING PARAMETERS

1. The mix temperature is the temperature of the TPE compound melt when it leaves the gate or the thermoforming channel. If this temperature is high, the melt will have time to melt the surface layer of the engineering plastic before solidification has taken place and the adhesion will be improved. An excellent way of maintaining a high mix temperature is to provide the mould with hot runners. Recommended temperatures of the melt are given in the table below.

MATERIAL	TEMPERATURE °C
ABS, PC	190 - 220 or 220 - 240 [1]
PP, PE	190 - 230
PS	190 - 220
PA	240 - 260

[1] Several 2K series to ABS / PC have been developed with different temperature profiles

2. A high injection rate raises the mix temperature due to the increased friction.

3. The mould temperature should be higher than 50°C so that the melt temperature drop will not be too high. If the mould temperature is increased, the cooling time will have to be increased and this will lead to longer cycle times, which in turn will increase the product cost. The effect will decline at temperatures above 60°C and the adhesion will not be improved if the temperature is increased further.

4. If the holding pressure is too high, deformation will occur at the gate.

5. Shrink marks impair the adhesion since the pressure between the materials will be lower at the shrink marks than it is on the remainder of the material. Reduced shrink marks can be achieved through increasing the shot volume or lowering the working temperature in the injection moulding machine.

6. A high injection pressure increases the pressure between the engineering plastic and the TPE, which leads to better adhesion since the surfaces are forced together more firmly. If the injection pressure is increased, the clamping forces also have to be increased to avoid leakage in the mould. However, an excessively high injection pressure will lead to deformation at the gate.

7. Moisture impairs adhesion since it gives rise to a thin condensate film between the two materials. As a result hygroscopic materials, such as polyamide, should be pre-dried. For detailed particulars of the pre-drying time and temperature please consult the manufacturer of the raw materials for the engineering plastic. Under normal storage conditions, pre-drying of the Dryflex or Mediprene TPEs is not necessary.

8. If the engineering plastic is preheated to the highest possible temperature (preferably up to 100°C), the adhesion in two-stage production will be improved. Pre-heating of the engineering plastic must be homogeneous, i.e. no area may be at a higher temperature than others, since adhesion will otherwise also be non-uniform.

9. Dirt and impurities, particularly substances with fatty surfaces such as oils and greases, impair the adhesion and should therefore be removed from the surface of the engineering plastic. Manual handling of the engineering plastic should also be avoided as far as possible.

10. Material thickness refers to the contact surface to which the TPE must adhere on the engineering plastic and the actual thickness of the two materials. If the contact area is too small the adhesion between the materials may be inadequate.

11. Any air present between the melt and the engineering plastic will prevent effective adhesion. This can be avoided by providing venting channels in the mould to expel any air that may have entered the mould.

12. The location of the gate is always important in injection moulding. Depending on where the gate is located, the formation of air pockets and flow lines can be avoided. If the gate is small the mix temperature will rise due to the friction when the melt flows through a narrow channel.

The common denominator for these parameters is that both the molten mix temperature and the engineering plastic temperature must be high. This is because the higher the temperature of the material, the higher the mobility of the molecules in the material.

The temperature in the injection moulding machine must not be too high, since the TPE would begin to degrade. The decomposition temperature depends on the composition of the TPE. If the residence time in the injection moulding machine is short, the temperature used may be higher, although degradation of the material inside the injection moulding machine may then start in the event of a stoppage. This applies particularly to TPE with good adhesion properties to PC, ABS and PC/ABS. The recommended temperatures are shown in the previous table.

OTHER MEASURES TO IMPROVE ADHESION

Other measures that can help to improve the adhesion are related to the design of the engineering plastic part:

MECHANICAL ADHESION

To facilitate melt adhesion the design could include through holes, the TPE compound can be injected into these holes and thereby form an additional bridge between the materials.

SURFACE STRUCTURE

If the surface is coarse the surface area will be larger, so the materials will have a larger area to adhere to. However, the melt may not penetrate into all cavities and small air pockets may be formed between the materials. The reduction in area that takes place when the surface is smooth is of less importance than the avoidance of air pockets. As a result, a smooth surface is preferable.

CO-EXTRUSION

Unlike the conditions in overmoulding, both materials in co-extrusion are in the molten phase when the surfaces come into contact with one another. As a result the adhesion will be much better in co-extrusion than it is in overmoulding in which the molten material must melt the solid material in order to achieve adhesion.

The molecules of the two materials diffuse into one another’s surface layers when the materials are in the molten phase. The molecules thus lock the materials to one another when solidification takes place.

SETTING PARAMETERS

In co-extrusion there are also certain parameters that can improve the adhesion. However, these are not as many as in overmoulding.

It is still the high temperature of the melt which is the most important factor. The materials are the same as in overmoulding, i.e. an engineering plastic and Dryflex or Mediprene TPE Compound.

1. The mix temperature is the temperature of the melt when it leaves the gate or the thermoforming channel. If this temperature is high, adhesion will be improved.

2. A high pressure at the nozzle increases the mix temperature, which leads to better adhesion.

3. Moisture impairs adhesion. So all hygroscopic materials, such as polyamide, should be pre-dried. An extruder with venting is capable of drying plastics with slightly hygroscopic properties. For more accurate times and temperatures for pre-drying the engineering plastic, please contact the raw material manufacturer. Under normal storage conditions, pre-drying of the Dryflex or Mediprene TPEs is not necessary.

ABOUT HEXPOL TPE

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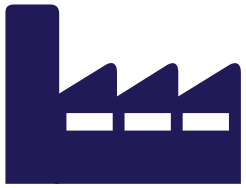
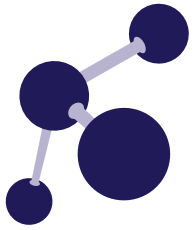
300+ EMPLOYEES WORLDWIDE

PRODUCTION PLANTS
Sweden, UK, Germany, China, USA



GLOBAL CAPACITY
> 80,000 tonnes p.a.

HEXPOL GROUP HEADQUARTERS
Malmö, Sweden



34,796+ PROPRIETARY FORMULATIONS

KEY MARKETS
Consumer, automotive, medical, construction, industrial

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