Rebonded foam from PUR shoe soles

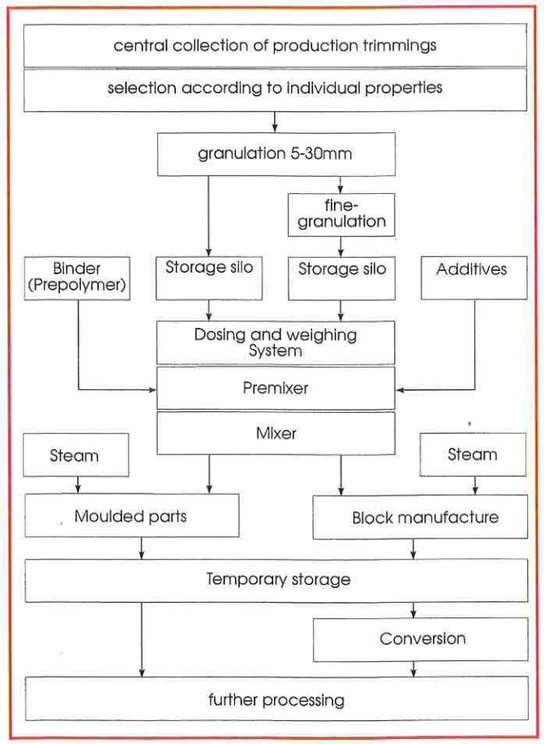
D.-E.Hein

The use of microcellular polyurethane-elastomers (PUR) for manufacturing soles is largely restricted to higher quality footwear lines. These soles are specially popular in the sports shoe sector but are also widely used for industrial footwear and hard-wearing leisure shoes.

PUR is the ideal material for shoe soles and may be specially modified to provide it with certain highly desirable properties. It is extremely hard-wearing, very flexible and light in weight. All this plus good insulation and a high degree of comfort for the wearer provides optimum solutions to a whole range of footwear design problems.
During the last few years, in addition to further improving these special properties, major efforts have been made to provide the footwear industry with a made-to-measure recycling concept for polyurethanes.

Recycling

When manufacturing shoe soles about five to ten per cent of the PUR raw material remains as trimmings, sprues and rejects. Now, as with other polyurethane materials, microcellular shoe sole systems may be recycled chemically or physically to provide valuable new raw materials. And, as a final step, what remains at the end of the optimised recycling chain can be used as thermal energy, sparing fossil fuel reserves and reducing waste disposal problems.
Microcellular shoe sole systems, specially the ester-based polyurethanes, can be chemically recycled by means of glycolysis (2). When correctly processed the resulting recycled polyolefins may be their original application (3) in limited quantities. Polyurethanes are ideal as a raw material for manufacturing shoe soles because of their special physical properties. That they can now be recycled into PUR rebonded foam, is a further good reason for using them.



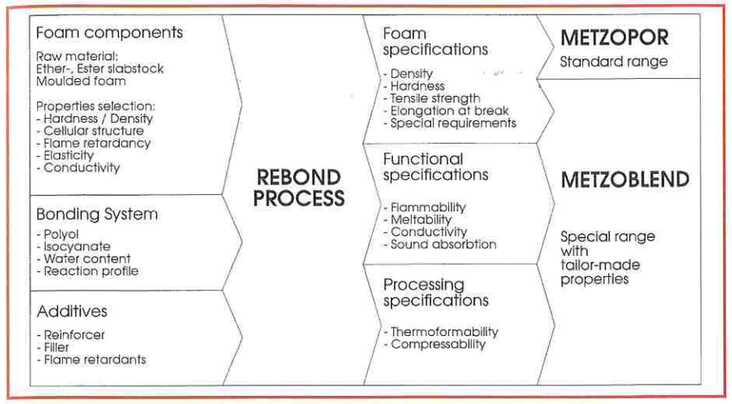
Manufacturing process for Rebond-systems

PUR rebonded foam

The classic method for recycling polyurethane foam is to convert it into rebonded foam. Over the last twenty years specialised, sophisticated technology has arisen from the original simple necessity of recycling PUR foams. Nowadays production parameters are surprisingly flexible.
The greatest advantage of 'Rebond' foam technology is the availability of a new, high quality material, combining the full range of special qualities of polyurethane foam with increased density and additional special features. This considerably extends the range of applications for it.

Raw materials

Sophisticated technology has now been developed for producing particle foams. A very wide range of recyclable raw materials is thus available; apart from the classic use of PUR flexible foam trimmings, textile remnants, compact plastics, microcellular



Factors influencing bonded foam technology

polyurethanes and thermoplastic foams, etc. are also commonly used. The vital factor affecting the consistent production of high quality goods with specific, predetermined properties is the initial use of carefully selected, homogenous raw material.
To ensure this, PUR rebonded foams like our Rebond-Systems are produced from the surplus material left from PUR slabstock production and from further manufacturing processes.

Manufacturing process

Rebond-Systems are only produced from carefully selected polyurethane trimmings which are reduced to the required size using standard cutting equipment. Depending on the final properties required, granules of between 1-30 mm dia. are employed. To ensure that the special characteristics applying to Rebond-Systems are rigorously maintained, the various PUR foams and other raw materials are pre-treated separately (see fig. 1).
According to the formulation selected, exact proportions of different granule types are mixed together with an optimised binder system. The polyurethane prepolymers used ensure thorough moistening of the granulate, thus providing a homogenous mix. This mixture is used for both block and moulded foam production. These two processes are basically similar. For block foam production the prepared mixture is fed into square moulds and its surface is compressed. The filling height in the mould depends on the properties required for the finished product.
On completion of the curing process, the block foam is removed from the mould and stored for several days. It is then either cut into sheets or to whatever shape is required.

Special, selected properties

Rebond-Systems not only permit the economical recycling of surplus PUR-foams. By employing an extensive range of special additives a number of important, additional properties become available thereby considerably increasing the range of potential applications. Thus new raw material systems with consistent, clearly-defined properties are now available on demand.
The main applications for bonded foams in Europe are for upholstered furniture, for high quality, reusable packaging systems, in the automotive industry, mats for gymnastics and as special flooring elements in gymnasiums and sports centres. A major use in the U.S.A. is as carpet underlay.
Standard Metzopor bonded foams are available with densities of between 60-300 kg/m^3. In addition standard parameters such as hardness, tensile strength and elongation at break are specified (see fig. 2).

Special bonded foams

Metzoblend bonded foams are manufactured from selected raw materials. The varying specific gravities of between 40-400kg/m^3 are achieved through initial selection of the raw material. They may be further modified with suitable additives for special applications. Good examples are the thermo-formable parts used for sound absorption in the automotive industry or for insole applications in the footwear industry. Another common function is as sound absorption elements to combat structurally-transmitt electro/electronics industries. Some other uses are as anti-slip mats, for flexible, weather-proof paving elements and as special safety surfaces for children's' playgrounds.

Bonded particle foam from shoe sole trimmings

There are many advantages to be gained by introducing an economical raw material recycling concept

Rebonded foam as an insole-application

Rebonded foam used for heel inserts

into the production cycle for footwear. Recycling not only cuts raw material costs but also helps to reduce the ever-increasing charges for waste disposal. It has also become a major factor in environmental protection and thus an important public relations line for all successful companies. Substantial savings of raw material and energy coupled with reduced quantities of industrial waste are now vital arguments in persuading critical, environmentally-oriented customers to purchase a product.

Bonded particle foam systems provide the footwear industry with numerous, innovative options for ultra-modern shoe design. Through the incorporation of particle foam in the total shoe design concept numerous, highly advantageous characteristics are now readily available to footwear designers. A relatively small quantity of recyclable material normally remains from shoe sole production. The possibility of combining this with other materials to produce particle foams provides the ideal method for recycling initially. Numerous, successful applications for Metzoblend bonded foams fully confirm this new recycling concept.

For example the sprues remaining from shoe sole production are granulated and then mixed with selected PUR flexible foam under controlled conditions. The result is a very hard-wearing, shock-absorbing bonded foam with a density of 350-450 kg/m^3. This is employed in the footwear industry as reinforced heel inserts (see fig. 3).

Apart from the successful exterior use as footwear soles, high quality bonded particle foam systems incorporating a high percentage of recycled material are also used for shoe interiors. Here Metzeler Drytec systems for insole design deserve special mention. These have been developed to provide optimum porosity, moisture absorption and breathing properties. They are also very comfortable, hard-wearing and occupy very little space (see fig. 4).

Conclusion

Over the last few years PUR-based raw materials have greatly changed their image. This important group of synthetic materials, with its very wide range of properties, can now be economically recycled using special techniques. These are now firmly established as standard, cost-saving procedures.

The advanced technology employed has numerous advantages in the production of state-of-the-art footwear. Modern bonded particle foam technology is firmly established as an effective recycling method. It now provides a practical means of recycling unused synthetic materials employed for manufacturing footwear in ways that are highly advantageous, both economically and ecologically.

Bibliography

1. D.-E. Hein, E. Struck, Flockenverbund von PUR Schuhsohlen, Schuh Technik International, 5/6 1995, 89, S. 9-11.

2. M. Modesti, F. Simioni and S.A. Renzi, Recycling of microcellular polyurethane elastomer waste, SPI Conference, Nizza, September 1991, p.370-376.

3. M. Kugler, Polyurethan-Recycling am Beispiel von PUR-Schuhsohlen; in: Recycling von Polyurethan-Kunststoffen, S.417-423, Hrsg. Dr. W. Raßhofer, Hüthig Verlag Heidelberg 1994.

Rebond Systems, Metzopor and Metzoblend are the registered trademarks of Metzeler Schaum GmbH, Germany.