Regrind/Powdering

Typical Regrind Process

Regrind technology, sometimes also described as powdering, is a process to reuse ground polyurethane waste as filler in PU foams or elastomers. It involves two steps:

1. grinding polyurethane material into a fine powder
2. mixing powder with the polyol component to make new polyurethanes
GRINDING

The first step in the regrind process is to reduce polyurethane production trim or post-consumer parts into small particles suitable for mixing and reuse. The optimum final particle size lies between 50 and 200 microns (0.05 - 0.2 mm), depending on the application.

There are a number of ways to produce small particles. One option, already operational for grinding flexible foam, is the two-roll mill process. It consists of two rollers, rotating in opposite directions and at different speeds to create shear forces in the very narrow gap between them.

Another grinding process, successfully used at pilot scale for flexible foams, is the pellet mill. It consists of two or more metal rollers, which press the polyurethane foam through a metal plate with small holes (die).

Other technologies, such as the precision knife cutter, are also under evaluation for the grinding of flexible foams. A particular process combining cutting and mixing involves a high shear mixer installed in the polyol tank. The added benefit of this process is the prevention of any thermal degradation of the powder during size reduction.

Glass filled RIM parts require special grinding methods. The impact disc mill appears to be suitable as technique for pulverising such very tough parts.

MIXING

At pilot scale, the high shear mixer appears to be suitable to provide the right mixing quality. The step to operational activity however, requires adequate metering of the powder alongside the polyol. The metering unit of the entire PU machine needs to be suitable for the handling of filled polyols. Such technologies do exist.

These were developed when glass filled RIM was first introduced into the market or when melamine powder was introduced into the flexible foam industry.

The moisture content of the powder is critical and drying of the powder could be necessary before mixing.

Regrind in flexible foams

Polyurethane foam in automotive seating has been successfully recycled using regrind technology. In laboratory tests, new moulded foam seats have been made containing between 15 and 20% recycled material and exhibiting excellent processing characteristics. Depending on foam type and filler loading, physical properties may be affected requiring an adjustment of material specifications.

The investment cost of the first generation equipment has limited the operational potential of this technology to slabstock. Current development is directed to provide economic technologies to smaller operations.

<table>
<thead>
<tr>
<th>Example: Cold Cure MDI Foam</th>
<th>Standard Seat</th>
<th>‘Recycled Seat’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part weight g</td>
<td>1320</td>
<td>1320</td>
</tr>
<tr>
<td>Powder content %</td>
<td>-</td>
<td>15</td>
</tr>
<tr>
<td>Indentation hardness N</td>
<td>360</td>
<td>360</td>
</tr>
<tr>
<td>Compression set (50%) %</td>
<td>5.6</td>
<td>7.0</td>
</tr>
<tr>
<td>Tensile strength kPa</td>
<td>152</td>
<td>144</td>
</tr>
<tr>
<td>Elongation %</td>
<td>132</td>
<td>103</td>
</tr>
</tbody>
</table>

The effects of 15 % regrind on the properties of moulded MDI foam.
Regrind in RIM parts

Painted polyurethane RIM parts are used by the automotive industry for highly visible vehicle parts, such as high-gloss, painted fascias, which require an excellent surface quality. These product quality requirements, when combined with the complication of using a recycled material made from painted parts, represented a real challenge.

The problem has been solved by a "three stream process", in which the polyol stream is split into two: one containing the RIM regrind and base polyols and the other containing the amine chain extender, other auxiliaries and glass filler. The diisocyanate stream remains unchanged.

ISOPA member companies, moulders and machine manufacturers have worked together to modify processing equipment in order to accommodate this new technique. It has now been demonstrated that recyclate powder made from painted RIM parts can be recycled back into the same products, at levels of around 15%, while still meeting the specifications of the automotive industry.

To achieve the optimum particle size of no more than 200 microns (0.2 mm) for this application, an initial granulation step is required before pulverisation.

Mixing the powder directly with the polyl component of the amine-extended RIM systems widely used by the industry can cause negative interactions between the filler and certain formulation components.

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>PROPORTION OF REGRIND</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0% weight</td>
</tr>
<tr>
<td>Density g/cm³</td>
<td>1.18</td>
</tr>
<tr>
<td>Hardness, Shore D</td>
<td>59</td>
</tr>
<tr>
<td>Flexural modulus N/mm²</td>
<td>900</td>
</tr>
<tr>
<td>Elongation at break %</td>
<td>160</td>
</tr>
<tr>
<td>Tensile strength N/mm²</td>
<td>28</td>
</tr>
</tbody>
</table>

The effects of 10% regrind on the properties of glass filled RIM
CONCLUSION

Regrind technologies make it possible to recycle a variety of polyurethanes, taking advantage of the characteristics of the two reactive components of the polyurethane process. Both production trim and post-consumer materials can be recycled back into their original applications substituting some of the virgin materials, while maintaining high standards of product performance.
SUGGESTED READING

"Effect of Post Consumer Automotive Seating Granulate on TDI Based Flexible Foam Properties"
D. Gibala, R. J. Cain, M. J. Salsamendi
Arco Chemical Company
SPI Proceedings Sept. 1995

"SPT recycling using PUR regrind"
Maschinenfabrik Hennecke GmbH,
D-53754 Sankt Augustin, 1992

"GrindFlex"
Product information (Pi) 113,
Maschinenfabrik Hennecke GmbH,
D-53754 Sankt Augustin, 1995

"Heutiger Stand der Recyclingsituation bei PUR"
W. Raßhofer Fachtagung:
Kunststoff-Recycling im Automobil,
Süddeutsches Kunststoff-Zentrum (SKZ),
Würzburg, 10. und 11.12.1992

"Automotive thermoset polymers - bringing recyclable solutions"
J. A. Vanderhider, H. R. Fransen Davos
Recycle 1992 Conference

"Recycling von Polyurethan-Kunststoffen",
W. Raßhofer (ed.)
Hüthig Verlag Heidelberg, 1994, ISBN 3-929471-08-6

"Recycling von Polyurethanen, Technologien, Möglichkeiten und Grenzen"
B. Krummenacher,
Swiss Plastics 14 (1992) Nr. 12, 15-23

"Recycling von Formteilen aus Polyurethan (PUR)"
Krauss Maffei Kunststofftechnik 1992

"The complete solution for polyurethane foam recycling" Mobius Technologies, Inc.
900-A Golden Gate Terrace,
Grass-Valley,
California 95945, USA,
Web site : www.mobiustechnologies.com

"Recent Technical Advances in Recycling of Scrap Polyurethane Foam as Finely Ground Powder in Flexible Foam"
Herman Stone, Robert Villwock and Bryan Martel,
Mobius Technologies, Inc.
Polyurethanes Conference, API 2000, Boston, MA (USA),
October 8-11, 2000.

" Real-World Economics of Polyurethane Foam Recycling"
Jeff Jensen, Mobius Technologies, Inc. Proceedings of
the Polyurethane Foam Association Conference,

"Recent Technical advances and Economic Evaluations in automotive Seat Recycling"
Bob Villwock, Bryan Martel, Mobius Technologies, Inc.,
and Paul Berthevas, Dow Europe S.A.
ISOPA has produced a brochure and a series of fact sheets on polyurethane recycling options.

The following are now available:

- Recycling Polyurethanes (Brochure)
- PU in Perspective
- Densification/Grinding
- Re-use of Particles
- Rebonded Flexible Foam
- Adhesive Pressing/Particle Bonding
- Regrind/Powdering
- Compression Moulding
- Chemolysis
- Feedstock Recovery
- Energy Recovery
- Energy Recovery from Flexible PU Foams
- Recovery of Rigid Polyurethane Foam from Demolition Waste
- Options in Practice

ISOPA - the European Isocyanates Producers’ Association - is an affiliated organisation within the European Chemical Industry Council (CEFIC).

Since the original polyurethane material has not been designed for use in articles in contact with food, relevant EU (such as Directives 90/128/EEC) and national legislations need to be consulted, if and when recycled materials are used to manufacture articles and goods for possible direct and indirect food contact.

The information contained in this publication is, to the best of our knowledge, true and accurate, but any recommendation or suggestions which may be made are without guarantee, since the conditions of use and the composition of source materials are beyond our control. Furthermore, nothing contained herein shall be construed as a recommendation to use any product in conflict with existing patents covering any material or its use.

June 2001