European Isocyanate Producers Association

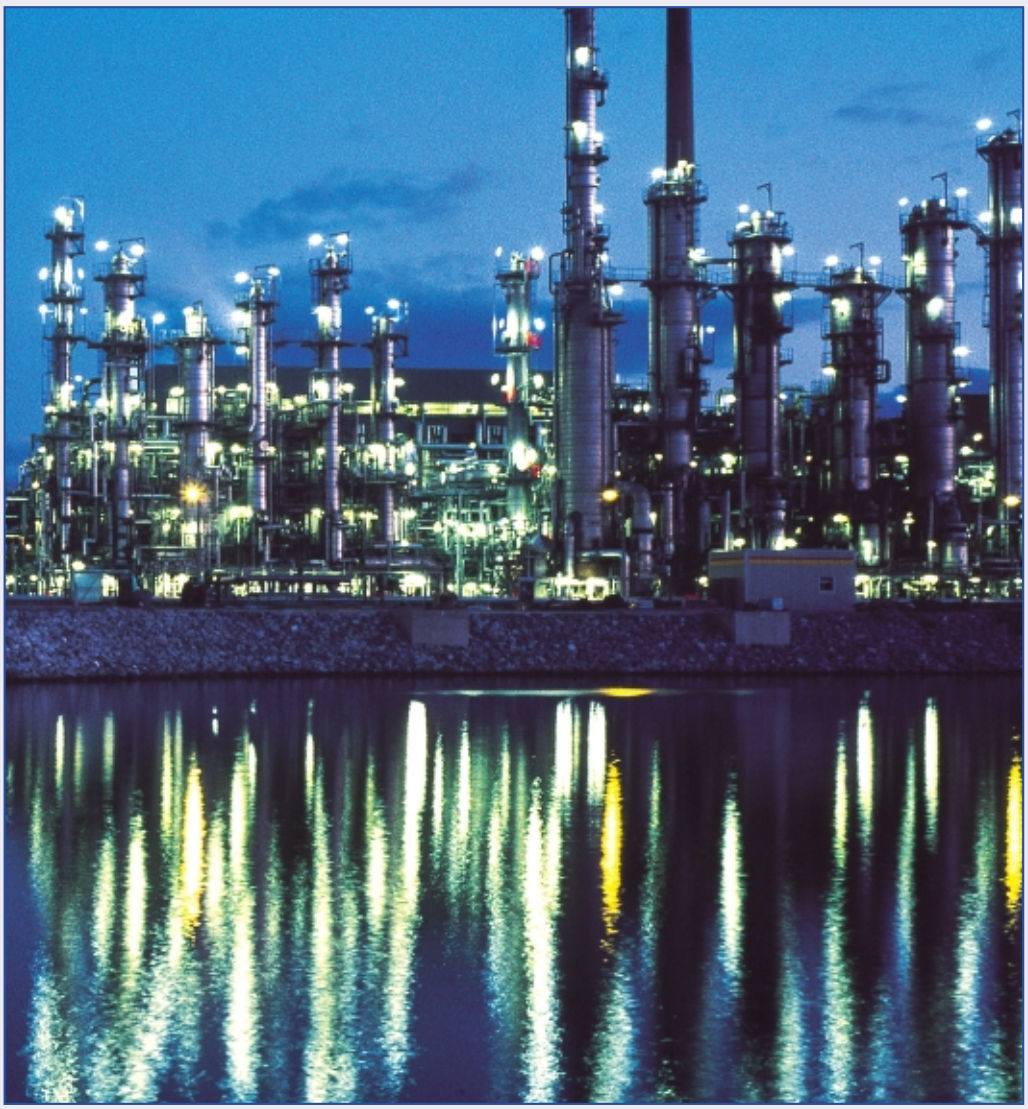
Fact Sheet

RECYCLING AND RECOVERING POLYURETHANES

Feedstock Recycling

INTRODUCTION

Feedstock Recycling covers a range of chemical processes by which plastics can be broken down to basic hydrocarbon units or constituent monomers which can then be used again as raw materials in chemical or petrochemical processes. A range of technologies is available.



Oil refinery Edmonton, Alberta, Canada

ONE voice

JUNE 2001

AVAILABLE TECHNOLOGIES

Chemical Recycling by Depolymerising Pure Polyurethanes Waste

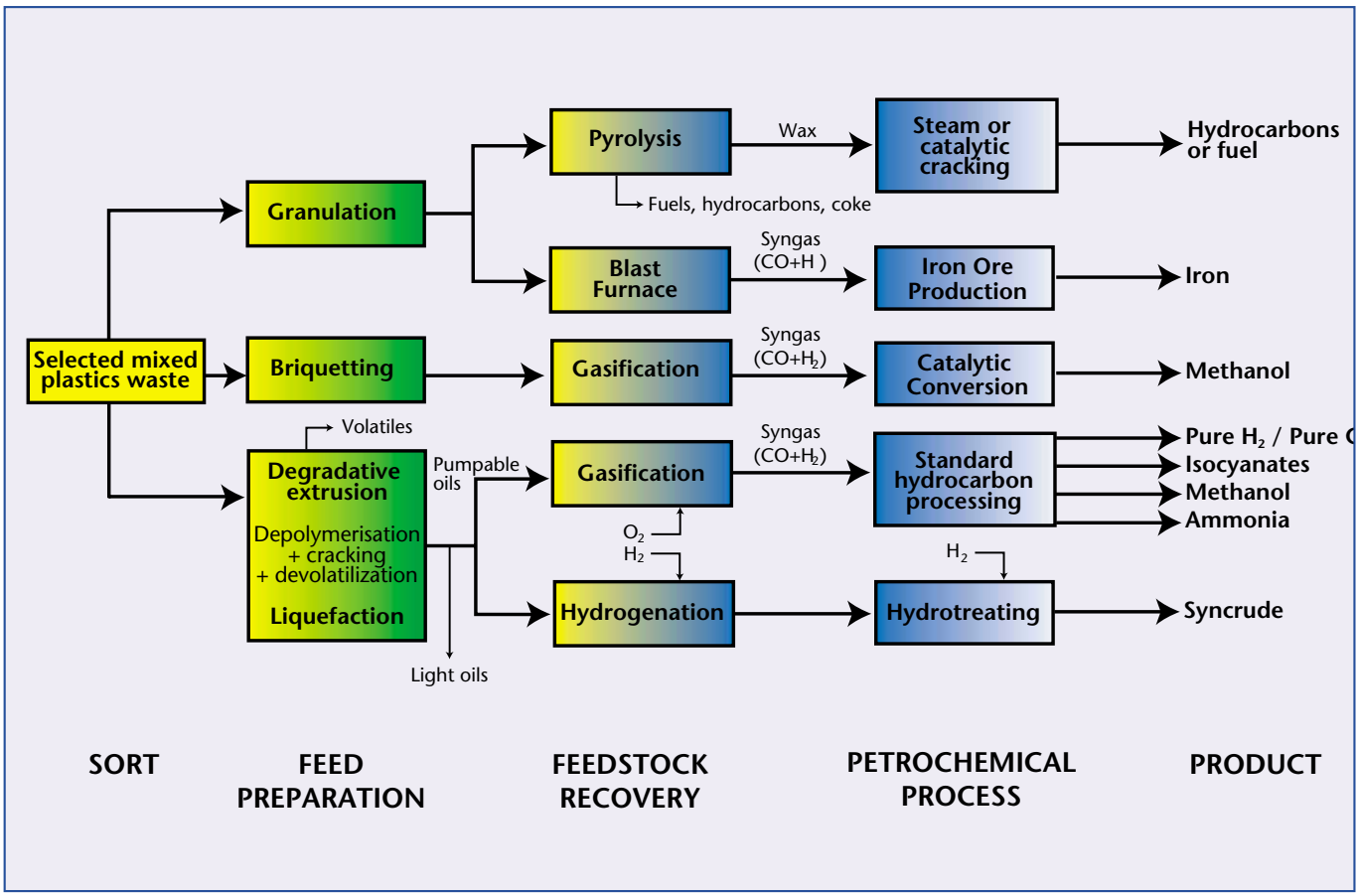
Often termed "chemolysis", depolymerisation can be applied when pure streams of particular polymers are available. Polyesters, polyamides, and polyurethanes can all be broken down to their original building blocks, which can then be repolymerised into the original plastics. This important process for segregated polyurethanes is the subject of the fact sheet "Chemolysis", available from ISOPA.

In reality, polyurethanes waste materials are more often found in mixed waste streams. So other feedstock recycling processes have been developed to recover oil and gas products from these mixed plastics wastes, of which polyurethanes materials could be one constituent.

Petrochemical Products from Pyrolysis

In a pyrolysis process, the mixed plastics are heated in an inert atmosphere and the molecules broken down into liquid and gaseous hydrocarbons. Pyrolysis, in this context, is a feed preparation step. The products would be further processed in a range of petrochemical processes to obtain a variety of different products.

A consortium of companies built a pilot plant in the UK trying to optimise the design for running a range of mixed plastics materials including packaging, electronic and electrical wastes and plastics from the automotive sector.



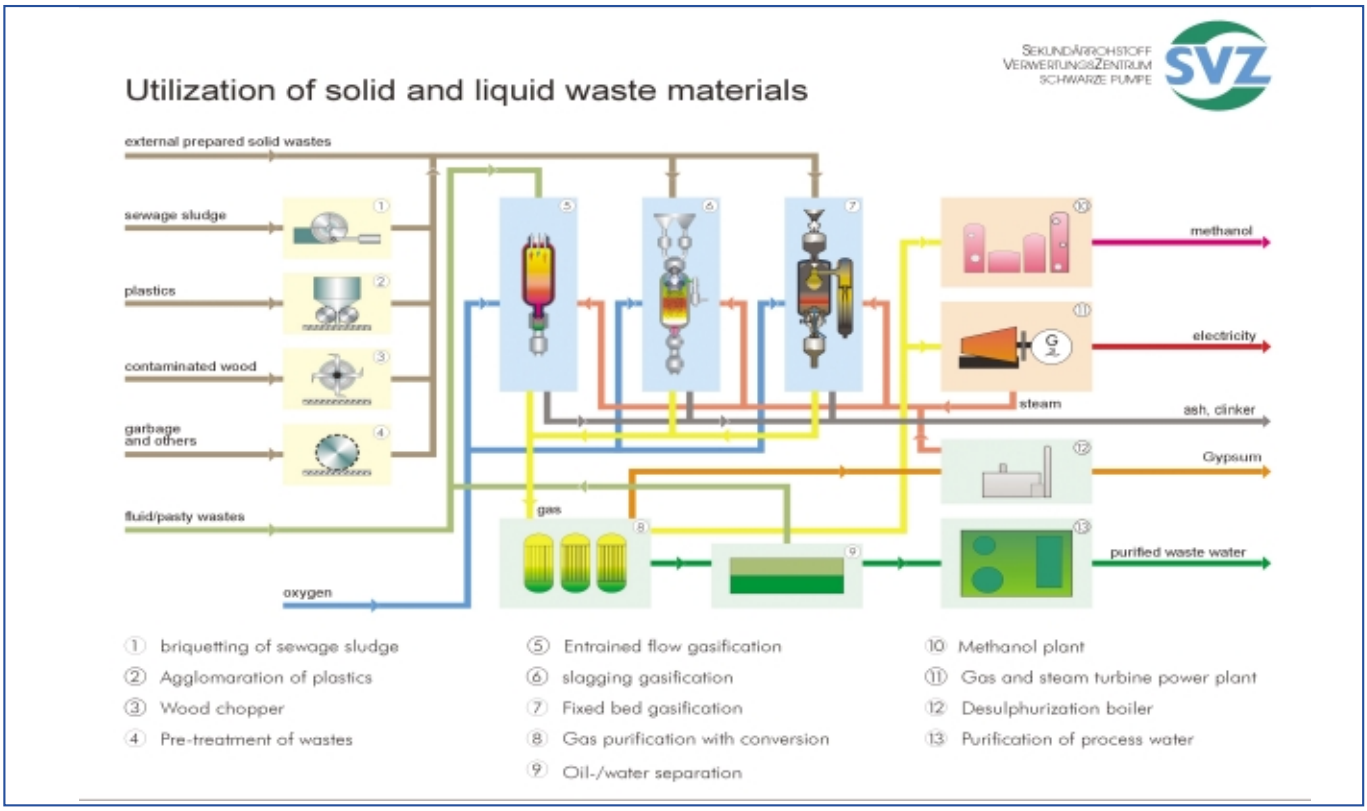
Possible chemical products obtained through feedstock recycling

Syngas Production through Gasification

Of all the feedstock recycling processes, the gasification process is likely to prove the one of most interest for polyurethanes materials. In a two stage process, mixed plastics are heated, then combined with air or oxygen. A synthesis gas, consisting of carbon monoxide and hydrogen, is produced. This gaseous product can be used in a wide range of refinery processes as well as in production of methanol, ammonia, and oxo-alcohols.

In trials, with polyurethanes materials forming a small part of the mixed plastics waste feed, the nitrogen inherent in polyurethanes has proved beneficial in the acid gas neutralisation process and thus improved the economics of the process.

Commercial gasification units, running on a range of feed sources, are in operation all over the world.

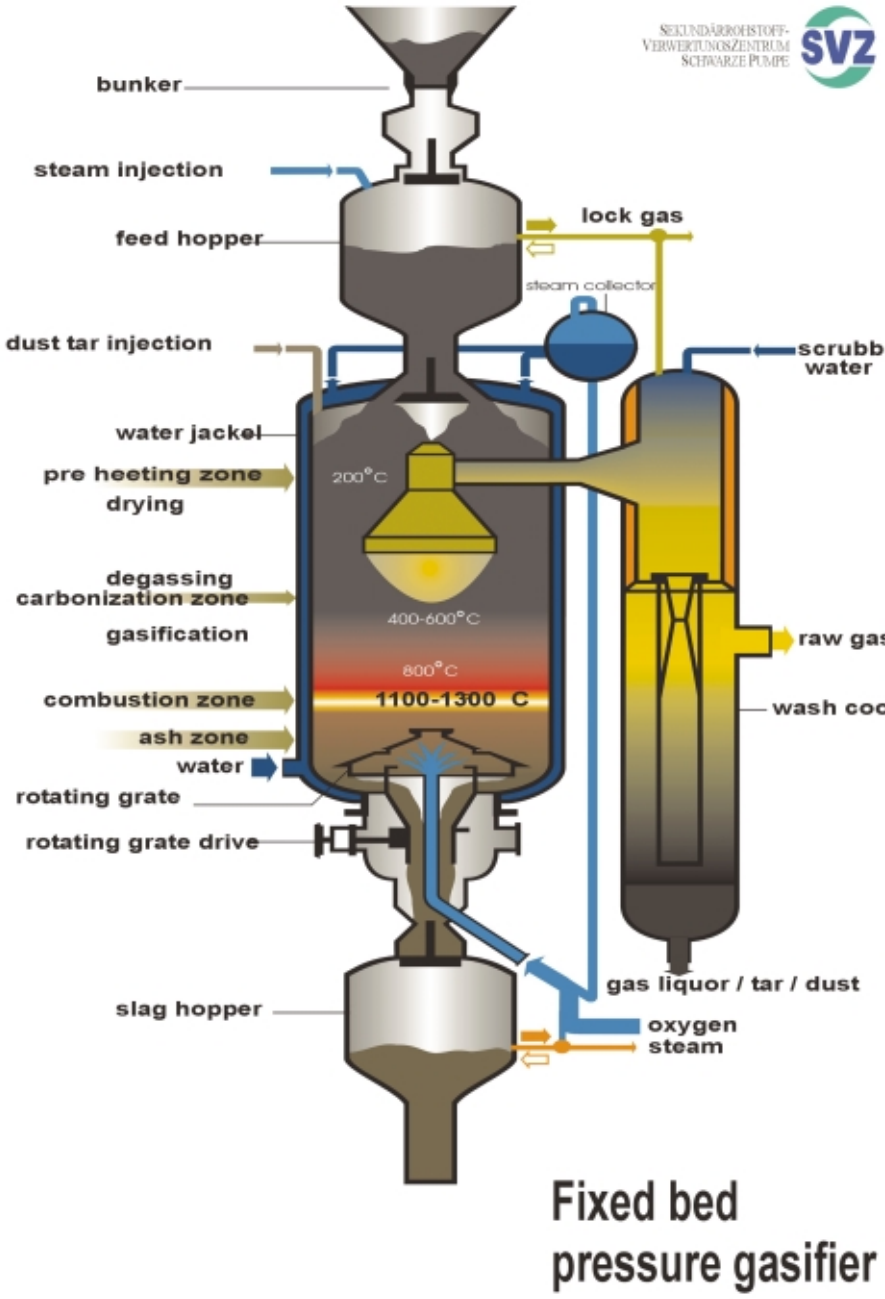


Schematic of the SVZ plant, Schwarze Pumpe, Germany

More specific

Plastic waste and other streams like sewage sludge, wood, coal and residual municipal waste is pretreated by size reduction, inert removal and compaction into a pellet, which has good physical characteristics for feeding and sufficient thermal stability. All input streams are fed into the top of the gasifiers. The two existing gasifiers: old/medium pressure and new/high pressure of the British Gas-line's type produce a synthesis gas with carbon monoxide and hydrogen which is cleaned and cooled for the catalytic conversion into methanol. The inert residues have a very high stability and do not allow leakings of heavy metals at even long time exposure.

A significant amount of shredder residue from automotive sector and white goods eg. refrigerators, freezers is used for the production of methanol. This chemical recycling route is very flexible accepting many types of different feedstocks and also robust and reliable. The integrated unit includes an additional gasification for small dust like particles which are removed from the gas. This step increases the overall efficiency of the gasifier, which produces all necessary steam and electricity for operation through the use of waste gases.



Schematic of the SVZ fixed bed pressure gasifier

Syncrude Production by Hydrogenation

The plastics are treated with hydrogen under high temperature and pressure conditions causing the cracking of the polymer chains to liquid and gaseous hydrocarbons. These products can again be used in refineries and chemical plants.

This process has been used in the past to upgrade refinery waste products and is now being applied to mixed plastics waste from the packaging waste stream in Germany. It is being trialled for non–packaging waste streams.

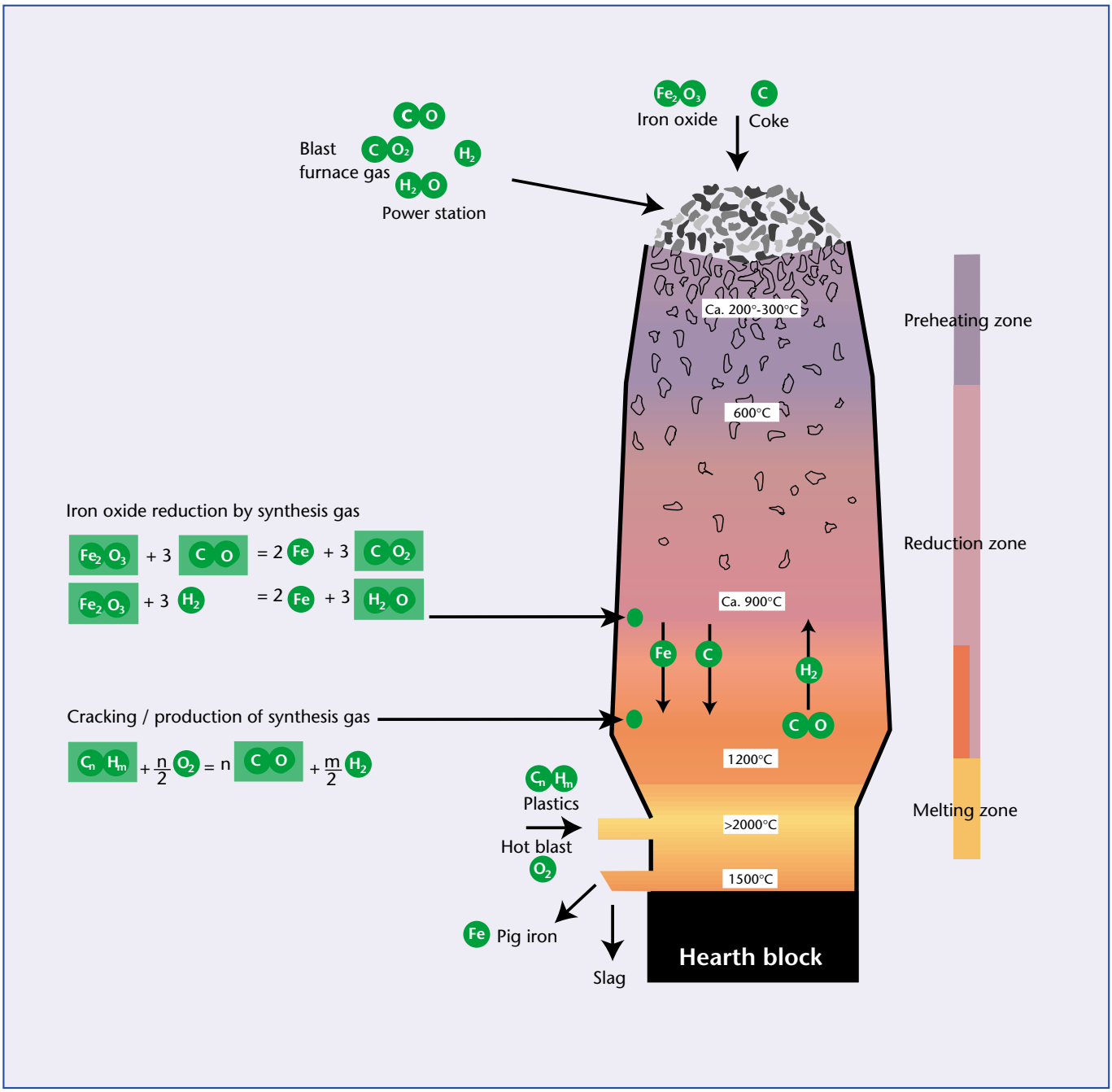
The Steel Industry - a New Solution

The most recently developed option has been spearheaded by the Bremer Steelworks in Germany, using mixed packaging plastics collected in Germany.

In the past, heavy oil or coal dust has been used as a reducing agent in the blast furnace for converting the iron ore to metallic iron. Now up to 30% of these materials can be replaced by mixed plastics, which are injected into the furnace.

At temperatures in excess of 2000°C, the plastics are broken down into mainly carbon monoxide and hydrogen. These capture the oxygen from the iron ore, producing carbon dioxide, steam and pig iron.

Other blast furnace operators are now showing an interest in a range of mixed plastics waste streams, and it is likely this option will provide a large volume solution for much of the waste which will become available in the near future.



Plastics as reducing agent in the blast furnace process

ECONOMICS

Many of the developing feedstock recycling technologies are uneconomic at present. Under these conditions, mixed plastics waste, of which polyurethanes can be one component, will be sent for feedstock recycling where legislation prevents cheap disposal, the other recovery options are neither technically possible nor economically viable.

As the technology matures and competition increases, gate fees will gradually fall and there may even come a point where the waste streams have a value.

CONCLUSIONS

Feedstock recycling offers an alternative materials recycling option for mixed plastics waste which cannot otherwise be mechanically recovered due to technical or economic considerations. Polyurethanes materials in a mixed plastics waste stream can be successfully incorporated into many of the existing feedstock technologies.

SUGGESTED READING

"Impact of Rigid Polyurethane Post Consumer Waste on the Texaco Gasification Process"; Hicks et al: Utech 96.

"Die Wiederverwertung von Kunststoffen";
J. Brandrup (Publ.): Hanser. München. Wien. 1995.

"Verfahren zur Erzeugung von Metall aus Metallerzen";
Patent Bremer Stahlwerke: Patent No. EP 0 622 465 A1.

"Production of Iron with Plastic Waste";
Duales System Deutschland GmbH – Der Grüne Punkt – Facts and Figures. Köln. May 1995.

"Recycling of Polymeric Waste by Pyrolysis";
W. Kaminsky: Makromol. Chem. Makromol. Symp. 48/49. 1991. pp. 381–393.

"Recycling von Polyurethan - Kunststoffen";
W. Raßhofer. Heidelberg. Hüthig. 1994.

"Kunststoff - Kann man wieder verwerten: rohstofflich, werkstofflich, energetisch"; Verband Kunststofferzeugende Industrie e.V., Frankfurt.

"Fact Sheet: Energy Recovery from Flexible PUR Foams";
ISOPA-EUROPUR, June 1996, J. Stoute,
05-96-REC.-0009-FACT SHEET.

"BP: Project Polsco, Polymer Cracking in Scotland";
Pre-Feasibility Study by BP, VALPAK and Shanks with ENTRUST UK Landfill Tax Credit Scheme under SCORE Environment at Grangemouth, Scotland, 1998-2000.

"Festbettdruckvergasung gekoppelt mit Flugstromvergasung in der Sekundär rohstoffverwerdungszentrum Schwarze Pumpe GmbH (SVZ)";
Dr B. Buttker und D.-I. W. Rabe, VIK Berichte Nr. 208, Okt. 1996.

For list of available fact sheets, see back page.

Recycling companies are kindly invited to submit to ISOPA their references in case they are active in practicing PU recycling and recovery.

European Isocyanate Producers Association

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
Avenue E. van Nieuwenhuyse 4, Box 9
Brussels B-1160
Belgium
Tel: +32 2 676 74 75
Fax: +32 2 676 74 79
E-mail: main@isopa.org
website: www.isopa.org

ISOPA - the European Isocyanates Producers' Association - is an affliated 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.

June 2001

ONE voice