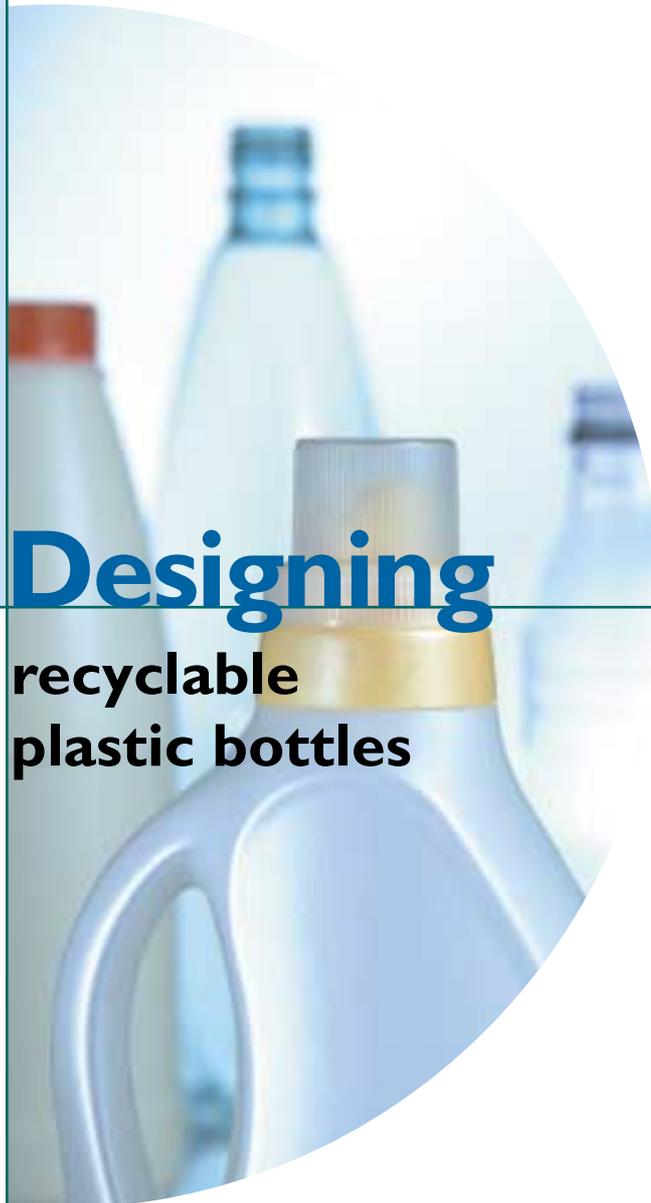


COmité
Technique de
Recyclage des
Emballages
Plastiques



Designing
recyclable
plastic bottles



Valorplast

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Introduction

Prevention is one of the major area of focus in waste management. It creates responsibility and demands awareness from everyone involved – from the manufacturer that designs the product to the consumer who makes the purchase.

EC Directive 94/62 on Packaging and Packaging Waste sets out the essential requirements for packaging put on the market in the European Community. This Directive was transposed into French law by Decree 98-638, "consideration of the environmental requirements related to the design and manufacture of packaging".

The essential requirements are as follows:

- Prevention by reduction at source and minimisation of substances that are harmful to the environment.
- Reuse (for reusable packaging).
- Conversion: by material recycling, energy conversion, composting or biological degradation.

For plastic bottles, the French system opted for material recycling. The results speak for themselves: in 2003, nearly 30,000 districts took part in the Eco-Emballages programme, enabling 53 million people to sort their packaging¹. From a pool of 400,000 tonnes of household plastic bottles, 160,000 tonnes were recycled.

Taking the recycling requirement into consideration at the design stage...

It is therefore essential to consider the impact of a plastic bottle or container on the recycling sector, right from the design stage.

It was against this background that the COTREP (the technical committee for the recycling of plastic packaging) was founded in 2001, on the joint initiative of the CSEMP (French plastic packaging manufacturer's trade association), Eco-Emballages and Valorplast. These three partners represent the household plastic packaging chain and are therefore proof of the responsible attitude of industrials in considering the management of the end-of-life of household packaging.

COTREP's mission is to facilitate the introduction of new packaging into the existing collection, sorting and recycling systems. This is divided into two activities: making the knowledge and tools for assisting design available to everyone involved in the packaging chain and when requested by industrial companies, assessing the "recyclability" of their packaging.

The objective of this document, which is aimed at packers, plastic packaging manufacturers, process owners and plastic producers, is to share the knowledge and provide the essential tools to help them design plastic bottles by taking their recycling into consideration.

¹ Eco-Emballages annual report

Understanding recycling to improve packaging design

In seeking to understand the process by which a packaging is recycled, a few simple rules emerge, which should be followed at the time the packaging is designed.

In France, what happens to a household plastic bottle at the end of its life ?

Plastic bottles, with their caps, are put in a selective sorting container or bag by the consumer and collected and transported to the sorting centres. The collection and sorting operations are carried out under the responsibility of the local authorities and Eco-Emballages.

The bottles are sorted according to three streams, the quality of which is set by minimum technical specifications (set out in contracts signed between the local authorities and approved companies), then processed into bales. Sorting in these centres can be manual, mechanised or automated to varying degrees.

Currently, the three streams are: coloured PET², clear PET and HDPE³.

The plastic bales are collected and sold by Valorplast, which transports them to a manufacturer that regenerates or recycles them.

². PET: Polyethylene Terephthalate

³. HDPE: High Density Polyethylene



Sorting by inhabitant

Collection

Sorting at the sorting centre

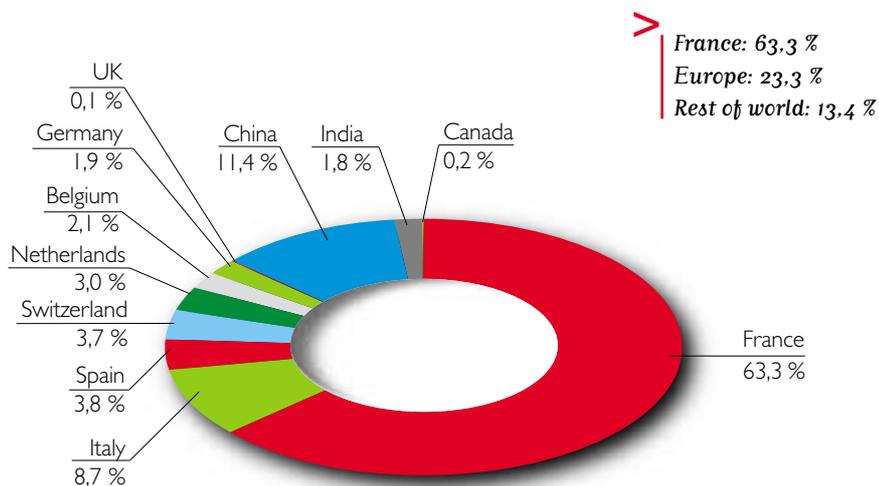
HDPE bales

Clear PET bales

Coloured PET bales

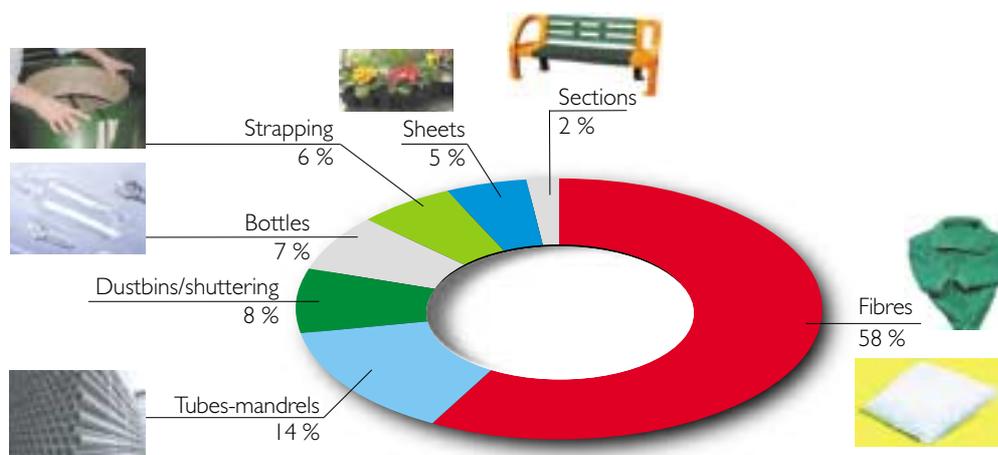
The plastic recycling market is a French, European and even international market, as demonstrated by the diagram below.

Destinations of tonnes collected in France in 2003



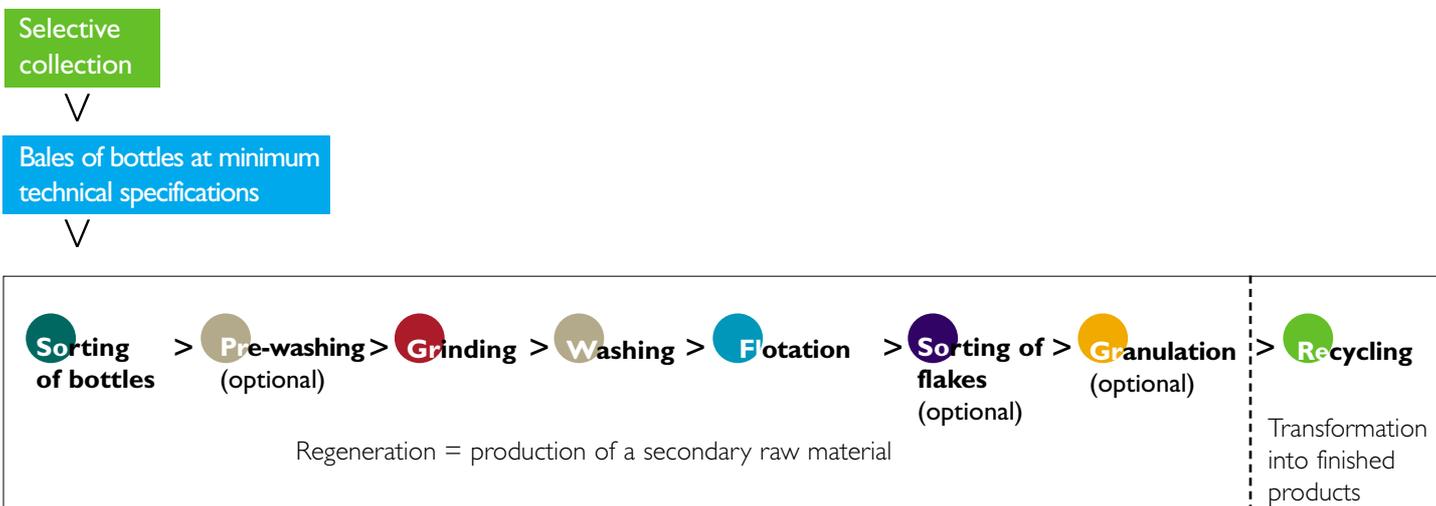
The diversity of outlets depends on the nature of the plastic material in question and the existing industrial techniques and applications: textile fibres, new bottles, tubes, sheets etc. Thus any brand new plastic bottle put on the market becomes part of the existing system of French collection and sorting and European regeneration and recycling.

Applications in 2003



The key stages

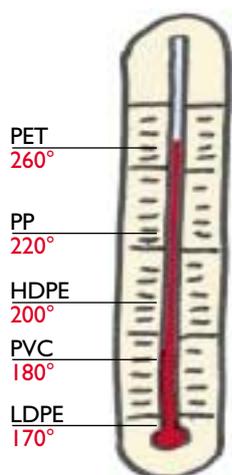
The industrial processes required for recycling all have key stages.



Details of the recycling stages

Sorting of bottles

Conversion temperature



This first stage, which in most cases is essential, refines the quality produced by the local authorities' sorting centres. This is because, in compliance with the minimum technical specifications, the bales are likely to contain:

> **bottles made from a plastic material that is different from the principal stream**

Why remove these ?

Some plastic materials are incompatible with each other. They also have different properties such as melting temperature and conversion temperature. During the conversion stage, these differences result in differences in behaviour (degradation of certain polymers at high temperature, or inability to melt at low temperature, resulting in serious quality defects).

Advice

Check compatibility between the plastic materials. Consult the compatibility table in the Annex.

“Source: CSEMP Guide.”

Thus, manually or automatically using sorting machines, “other” plastic materials are ejected from the stream to be recycled.

Example: in a PET stream, HDPE, PP or PVC bottles or bottles with a PVC label will be ejected from the stream.

> packaging of another material (steel or aluminium cans, bricks etc.)

Cans and bricks will be identified by metal detectors, which will remove them from the stream to be recycled, as these metal elements will significantly disrupt the subsequent industrial process.

In the same way, a bottle with a metal element in its composition will be ejected from the stream to be recycled

Example: an aluminium cap on a PET bottle will result in the ejection of the bottle from the PET stream.

> paper and other impurities

These elements are likely to be present in the stream to be recycled and will significantly disrupt the subsequent industrial process.

Advice

Check the nature and compatibility of the materials present in the packaging.



Bottle sorting at the recycling plant; manual selection.

Pre-washing and washing

These stages enable the bottles or flakes (once ground) to be cleaned, in order to remove internal and external stains (remains of liquid food, detergent, various organic and mineral pollution etc.) and remove the paper labels, some printing inks and the glue. All these impurities must be removed in order to regenerate the bottles into high quality secondary raw materials.

Depending on the equipment and quality requirements for the application in question, the washing conditions vary from cold water without detergent, to hot water (up to 90°C) with detergent. The processing costs and environmental impacts are higher for hot water treatment with detergent.

Advice

Minimise the amounts of glue and ink used. The choice of glue should be guided by its technical performance and cost but also by its water solubility. The choice of inks is related to the choice of supports (plastic or paper): consult the COTREP general advice.

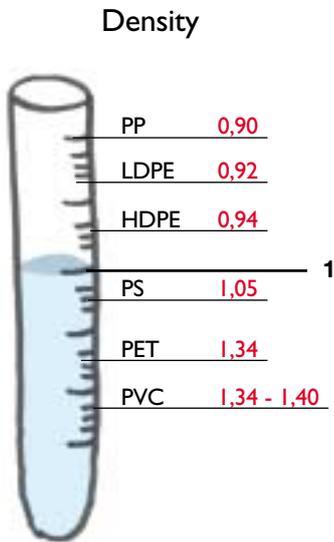
Grinding

The bottles are ground into "flakes", a suitable format for subsequent processing.



HDPE flakes

Flotation



Advice

For packaging components made from incompatible materials, check the densities of the materials used and therefore the possibility of separating them by flotation.

This is an important stage in which the plastic flakes are separated according to their density. For example, on water or soda PET bottles the caps are made from HDPE or PP, plastics belonging to the “polyolefin” family. PET and polyolefins must be separated as they are not compatible. The presence of polyolefins in PET flakes will disrupt the recycling processes, resulting in quality defects, waste to be processed, even making it impossible to manufacture the finished products.

Industrials are equipped to be able to separate the caps from the body of the bottle by using the density differences. The same process is used for polyolefin labels.

Density

How much does my material weigh in a given volume?

- The density of water is 1 gram per cm^3 (i.e. one kilo per litre of water).
- The PET density is $1.34\text{g}/\text{cm}^3$: it is “heavier” than water.
- Polyolefins are “lighter”, with a density lower than $1\text{g}/\text{cm}^3$.

Example: for coloured and clear PET streams: after the bottles are ground and the flakes have been washed, they are put into tanks filled with water and only the polyolefin flakes (mainly caps) will stay on the surface. The PET is recovered from the bottom of the tank, separated from the polyolefins, and ready for the next stage. The polyolefins will be recycled in other applications.

Thus when plastic bottles are designed, the use of several plastic materials is not a problem as long as these materials are either compatible or can be separated by density according to existing technologies. Plastics with a density close to 1 are more difficult to separate by density (for example polystyrene, PS, which has a density of 1.05).

Sorting of flakes

A final sorting stage, which is optional, refines the quality of the plastic material even further. Any impurity (metals, other polymers, colour) not removed during the previous stages and detected at this stage will cause an increase in waste to be processed.



PET Flakes

Granulation

This optional stage converts the flakes into pellets by melting them, passing them through a die (a plate pierced with holes) then cutting them into pellets. This form is more suitable for certain methods of converting plastic into finished products. The success of this stage depends on the quality of the flakes.

This stage includes a filtration process that enables final purification of the material. There is a maximum particle size that can pass through the filters. Unmelted material obstructs the filters which then have to be changed, causing production stoppages and generating waste to be processed.



The PET is extruded in wires which are then cut into pellets

PET pellets

Recycling

This final stage converts the secondary raw materials, through melting and forming, into finished products. This also includes a filtration stage similar to granulation, with the same comments as above. The maximum level of concentration of impurities (other materials and other types of incompatible plastic) is defined by the application. Beyond these levels, the process is disrupted and the finished product will be of lower quality, which could turn out to be unacceptable.



Recycled HDPE product

Recycled PET product

Two essential concepts: concentration and compatibility

Packaging or packaging components ejected from the stream for reasons of *incompatibility* with this stream generate losses which reduce the recycling efficiency.

From an environmental point of view, they also produce waste, which then needs to be processed. The recycling stages accept levels of *concentration* of other plastics or other incompatible materials that

are variable and defined in accordance with the final application. The performance of the sorting, washing and flotation stages depends on this required quality level. The more incompatible the materials, the lower the tolerated levels of concentration, making the methods used to separate them more expensive.

Eco-design of plastic bottles

Good reflexes

Essential questions

Is my bottle easily identifiable?

Is the principal material compatible with the existing streams in France?

Are the components of my bottle compatible with each other?

What type of material is the cap or sealing system?

What type of material is the label or sleeve?

If the components are incompatible, can they be easily separated?

During the bottle sorting stage? During flotation?

How will they behave during regeneration and recycling?

Will the glue be easily removed during the washing operations?

How will the ink behave during the washing operations?

Tools

COTREP's general advice: these are available as technical datasheets on the websites of the COTREP members. They give information on the compatibility of each packaging component with the available recycling techniques.

The CSEMP compatibility table: this indicates the compatibility between materials and can be found in the Annex to this document.

COTREP: we are at your service

COTREP, the committee at the service of industrials

COTREP, the technical committee for the recycling of plastic packaging, was founded in March 2001, on the joint initiative of the CSEMP (French plastic packaging manufacturer's trade association), Eco-Emballages and Valorplast.

These three partners represent the household plastic packaging chain and are therefore proof of the responsible attitude of manufacturers in considering the management of end-of-life household packaging.

COTREP's activities take place within the regulatory framework of EC Directive 94/62 and French Decree 98-638 on consideration of the environmental essential requirements related to the design and manufacture of packaging. Standard EN 13 430 enables industrials to achieve compliance with the recycling requirement.

In order to govern its operations, COTREP has drawn up a charter, signed by the Presidents of the three organisations.

COTREP provides industrials with a knowledge base on the recycling of plastic bottles. This base consists of GENERAL ADVICE on the impact that packaging components have on their recycling.

COTREP works with all the participants in the plastic packaging chain to examine the impact that different packaging components have on their recycling.

The aim of this knowledge base, which is supplied in the form of technical datasheets, is to serve as a tool for companies that are designing new packaging. COTREP therefore issues recommendations.

The datasheets become available on the websites of the COTREP members as and when they are produced.

They are dated and may be revised in line with any technical and technological developments that come to COTREP's knowledge.

COTREP's principles

COTREP is aware of the constraints - technical, commercial or economic - placed on all the participants in the chain.

The aim of COTREP's activities is to assess the impact on recycling whilst at the same time allowing for innovation.

COTREP takes account of the functional aspect of the packaging or its components: the packaging must protect the product it is selling and also sell the product for the consumer benefit.

COTREP abides by the confidentiality requirement for information received in this way and by professional communication deontology.



**COTREP responds to companies wanting to know how feasible it will be to recycle a new bottle.
It then issues a TECHNICAL ADVICE on the entire packaging.**

A company that wants to know how feasible it will be to recycle its plastic bottle applies to COTREP. COTREP examines its case, in the context of an agreement between the company and COTREP.

Examination of the case may require regeneration and recycling tests, which will be carried out among a European network of regenerators and recyclers, following a common methodology recognised by the profession.

COTREP therefore helps the company to assess how compatible its new type of packaging is with the French collection and sorting systems and European recycling systems, and to construct its argument in relation to compliance with the materials recycling standard EN 13 430. If any difficulties occur during examination of the case, the applicant will be informed immediately.

At the end of the examination, COTREP will issue a technical advice on the feasibility of recycling this packaging in the context of the French legal and organisational system, in reference to the known, relevant recycling options available industrially in Europe at the time of the application. This opinion is published on the websites of the three members of COTREP after the product is put on the market.

What guarantees does the company have ?

All the cases examined are governed by a contract between the applicant and COTREP, in which the latter undertakes to examine the case in complete confidentiality. The technical advice, as specified in the charter, is only published once the packaging has been put on the market.

The advice issued by COTREP will take account of changes made to the packaging, including during the investigation of the case.

The advice is dated and may be altered to take account of technical and technological changes in packaging, collection, sorting and recycling.

COTREP will provide you with a number of documents :

- The charter
- The amendment to the charter
- A standard contract
- The list of items required to examine the case
- The list of available test procedures
- Technical advice (updated regularly)
- General advice (updated regularly)

These documents are accessible on each of the three partners' websites:

CSEMP: www.packplast.org - COTREP, direct access

Eco-Emballages: www.ecoemballages.fr/docotheque - 'Prévention' page

Valorplast: www.valorplast.com - COTREP, direct access

Assessing the recyclability of a plastic bottle

COTREP's methodology

Of every 4.7 million tonnes of household packaging, 1 million are plastic. Of these, 400,000 tonnes are bottles involved in selective sorting. A new plastic bottle must be able to "integrate" into this pool, something that can be done at various levels:

- collection (adaptation to inhabitants' sorting guidelines)
- sorting (identifiable packaging)
- regeneration and recycling (adaptation to the existing technologies and markets in Europe).

The general methodology applied by COTREP for assessing recyclability involves four steps.

1. Analysis of packaging components, general idea of compatibility

The components are listed and the materials identified (types of plastic, paper, metal etc.). Some initial observations concerning compatibility can be issued:

- compatibility of the principal material with the plastic streams currently sorted in sorting centres;
- compatibility of the packaging components with the principal packaging material.

2. Concentration

In cases where the packaging or the packaging component is incompatible with the stream to be recycled, COTREP calculates its theoretical concentration in the stream. The calculation rules are applied according to the sorting performances of inhabitants and the origin of the packaging (sale for consumption at home or outside the home).

Successful recycling depends on the concentration of incompatible elements in the stream to be recycled. This concentration depends on:

- the market share predicted for this packaging in the French feedstock;
- the existing system in France based on the minimum technical specifications and in particular on the current decomposition in three streams: HDPE, clear PET (colourless and blue-tinted), coloured PET.

There are then several levels of concentration:

- very diluted, the recycling processes are not disrupted;
- a little diluted, the recycling processes are disrupted if impurities are not removed during the regeneration stage;
- very concentrated and, in sufficient quantities, the system can be adapted to create a specific stream in order not to disrupt the recycling of the other streams.

A packaging type may be recycled in one European country and refused in another, depending on the systems in place and the concentrations observed. It is advised to check with the competent institutions in each country.

3. Tests

On the basis of the theoretical concentration calculations and if necessary, tests are carried out on samples with concentrations that are representative of the feedstock, according to procedures validated by the profession. These tests apply the various regeneration and recycling methods currently practised in Europe.

The observations made during the tests show the behaviour of the packaging under examination and list the potential anomalies discovered in the different stages of recycling:

- sorting (inseparability, obstruction of the sorting equipment etc.)
- washing (specific pollution of washing water etc.);
- transformation (disruption of the process, quality defects etc.).

4. Results

On the basis of the results for each stage, COTREP issues either a technical advice for a given type of packaging, or a general advice for a component.



Annex

Compatibility table

This table comes from the guide prepared by the CSEMP.

It is important to note that any material listed in the table below is considered solely from the viewpoint of materials compatibility.

This has no relation to the capacity and quality of the materials to fulfil intrinsically, in their respective applications, a large number of functions and properties.

The criteria are divided into three categories:

1. Compatible.
2. Compatible under certain conditions
(in certain quantities and for certain applications).
3. Incompatible.

	Body of packaging	Minority materials										
		HDPE	LDPE	PP	PVC	PS	PSE	PET	EVOH	PAN	PEN	PA
Dominant materials	HDPE	1	1	2	3	3	3	3	2	3	3	3
	LDPE	1	1	2	3	3	3	3	2	3	3	3
	PP	2	2	1	3	3	3	2	2	3	3	3
	PVC	2	2	2	1	2	3	3	2	3	3	3
	PS	2	2	2	2	1	1	3	3	3	3	3
	PSE	3	3	3	2	1	1	3	3	3	3	3
	PET	2	2	2	3	3	3	1	2	3	2	2
	PAN	3	3	3	3	3	3	3	3	1	3	3
	PEN	3	3	3	3	3	3	2	3	3	1	3
	PA	3	3	2	3	3	3	3	3	3	3	1
	PC	3	3	3	3	3	3	1	3	3	2	2

More detailed tables per component are contained in the CSEMP guide.⁴

⁴. Conception et fabrication des emballages en matière plastique pour une valorisation optimisée – CSEMP – déc 03

Contacts

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CSEMP: Françoise Gérardi
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www.packplast.org - COTREP direct access



- You are a packer or an importer

Eco-Emballages: Laure Vidal
vidal@eco-emballages.fr - Tel +33 (0) 40 89 99 62
www.ecoemballages.fr/docotheque
'Prévention' page



- You are a plastic material manufacturer or a recycling company

Valorplast: Robert Bonnefoy
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