Cotrep
Comité Technique pour le Recyclage des Emballages Plastiques

PET

Body

# Preliminary note 2

## Impact of the increase in opaque PET packaging on the recycling of coloured PET packaging

**COTREP's research into the inclusion of opaque PET bottles in the coloured PET recycling stream (their natural channel) dates back to 2010. Tests examining the behaviour of dairy-sector PET packaging during the recycling process illustrated the difficulties of incorporating this material in current coloured PET bottle recycling streams. COTREP published an initial note in December 2013 reporting the findings of this study and giving its recommendations for the design of opaque bottles.** [1]

**Since that time, the impact of the steady rise in the use of opaque PET, due in large part to its extension to other industries besides dairy, has been such that the majority of recycling operators remove and reject bottles made of opaque PET.**

**In response, COTREP has continued its research into potential new recycling outlets suitable for opaque PET. Hitherto limited to PET packaging for dairy products, the scope of the PET stock included in the study was expanded to encompass all other opaque colours in use. A number of potential applications were identified and tested, but none were sufficient to absorb the entire stock of opaque PET currently on the market in France.**

**COTREP continues to explore different potential outlets to improve recycling of opaque PET, while also preparing for probable further growth in the fraction of opaque PET on the market.**

## 1/ Context and stock

For the last five years or more, milk beverages (long-life milk, cream and drinking yoghurts) were generally packaged in HDPE bottles and cartons, but the market recently gained access to another material, i.e. white opaque PET. At the same time, use of opaque PET spread from the cooking oil market (yellow, green or red bottles) to other product categories, including personal hygiene, household cleaning, beauty, fruit juices and the DIY market. The opaque PET market is evenly distributed between dairy products and these other categories.

According to COTREP estimates, the volume of white opaque PET used by the ultra-high temperature milk, processed milk and fresh cream sectors is around 4,000 t. This estimate is confirmed by the proportion of 'dairy' white PET found in the bales of coloured PET. The studies of the composition of bales conducted in 2014[2] show that 'dairy' opaque PET accounts for 5% of the coloured PET streams (up from 3% in 2012), which represents a stock of approximately 2,000 t. This ratio equates to the average for French households: half of all bottles are sorted.
Although more difficult to assess, the tonnage of mixed-colour opaque PET for the other markets (fruit juices, detergents and household cleaning products) is estimated at between 4,000 and 6,000 t.

Hence, despite the lack of certainty about the exact tonnage on the market, all the data available to date confirm the increase in opaque PET of all colours. The proportion of opaque PET measured in coloured PET bales rose 45% in the space of two years, from 7% in 2012 to 10% in 2014.

Opaque PET is being embraced by a large number of marketers because of the advantages of its characteristics for packers, particularly:

- potential for processing compatible with scaling up production;
- lighter bottle with the same capacity;
- elimination of the seal on the bottle caps (which is usually aluminium);
- shiny, aesthetically pleasing appearance making for good visibility in retail display spaces;
- lower total production cost compared to HDPE bottles.

It also has UV and gas diffusion barrier properties that are required for the conservation of some products.

[1] *Preliminary note "The impact of the increase in white opaque PET on the recycling of PET packaging", COTREP, December 2013.*
[2] *Results of campaigns to assess the characteristics of dark-coloured PET bales in MRFs, Eco-Emballages, 2014.*

## 2/ IMPACT ON THE RECYCLING PROCESS

Opaque PET is coloured or white PET that contains opacifiers introduced in varying concentrations, either alone or mixed with other additives, such as carbon black, mica or silica.

Without opacifiers, the recycling chain is both well established and efficient for PET resin. Nonetheless, once opacifier particles are introduced, even in small quantities[3], they affect recycling of coloured PET[4] and significantly disrupt the recycling process. Tests conducted by COTREP in the laboratory and under industrial conditions demonstrated the negative influence of the opacifiers on the physical-chemical characteristics of the recycled products, including their rheological and mechanical properties. According to the target application, the consequences for the recycling operator are:

- **In the case of sheet and banding outlets:** eliminating opaque bottles from the recycling process and rejecting them, since their systems are completely unable to cope with them;

- **In the case of fibre outlets:** checking a maximum acceptable concentration of opaques in the coloured PET stream. While the proportion of opaque PET in coloured PET bales is currently around 10%, tests conducted by COTREP showed that this proportion must be kept at 15% or less to maintain the integrity of the recycling process.

However, due to variations in the ratio of opaque PET and the effect of an accumulation in the system, this maximum acceptability threshold is sometimes reached in recyclers' incoming bales. Moreover, some market forecasts predict a continued steady rise in the volume of coloured PET on the market. Many companies have already modified their packing lines. The shift to opaque PET is particularly marked at dairy product distributors, and manufacturers of personal hygiene and beauty products. For the moment on the other hand, the major packers of dairy products are still using HDPE or cartons, in some cases. Nonetheless, should packers decide to switch over completely from HDPE to opaque PET, the proportion of the latter in bales of dark-coloured opaque PET bottles could exceed 40%, which would create unmanageable difficulties for recycling operators under current industrial conditions. Tonnages entering the HDPE recycling stream would also fall as a result.

## 3/ OUTLETS IDENTIFIED, TESTS AND FINDINGS

On the basis of these data, COTREP decided to supplement its research into specific markets, taking into account the characteristics of opaque PET bottles. The addition of opacifiers and the wide range of colours used in opaque PET bottles (including white bottles with carbon black) limit the potential markets to products where a certain quantity of opacifier additives is tolerated in the manufacturing process, and to what are known as "hidden" applications, using dark colours or with no visual criteria requirements.

COTREP identified a number of potential applications in the course of this study:

- Fibres for "nonwoven" applications and "cut" fibres: virgin or recycled fibres are used in a wide variety of products, from pillow filler materials, roof insulation and geotextile membranes to carpet underlays;
- Industrial thermoformed plates and dark-coloured (brown and black) interlayers;
- Strapping for packaging;
- Injection-moulded parts in the office automation and automotive industries (hidden parts);
- PET foam, used in construction and padding applications;
- Miscellaneous products: floor tiles and monofilament material for industrial brushes, amongst others.

Following several discussions with companies in the relevant sectors, only two types of applications were found to offer interesting potential for opaque PET, but neither would absorb all the tonnage on the French market:

- ***Fibre applications***

As explained above, the study of fibre applications covered in the previous Note issued by COTREP concluded that recycling of opaque PET bottles is feasible provided a consistent quality level is maintained in the opaque stream and the maximum concentration of these bottles in the coloured PET bales does not exceed 15%.

- ***Foam applications***

The second application is based on incorporating opaque PET in the manufacture of PET-based foam. While polyurethane and PVC remain the most commonly used polymers in the manufacture of foam, the characteristics of PET in foam form meet the requirements for this type of product, namely light weight, stability, flexibility and thermal resistance.

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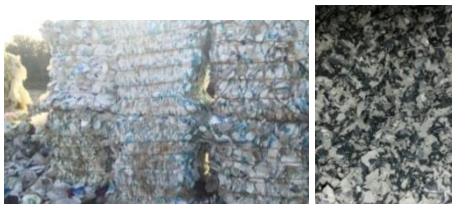
*[3] The case of yellow, orange, red and bright pink detergent or oil bottles where the product level is visible to users.*
*[4] The coloured PET stream remains the natural outlet for opaque PET. Nevertheless, PET bottles for dairy products can find their way into the clear PET stream. Some sorting technologies still have difficulty differentiating between white opaque bottles and transparent bottles. Work is under way to improve detection of white opaque bottles.*

Tests were conducted in the laboratory and under pre-industrial conditions to confirm or refute the feasibility of this potential recycling market. The material tested was primarily PET used in dairy product packaging (***see photos 1 and 2***). It was washed, crushed and dried for addition in the form of flakes to the raw material. The level of dilution was set by the recycler at 10-15% of the normal flow.



***Photos 1 and 2: opaque PET flakes tested in the manufacture of PET foam***

Identical results were obtained in the laboratory and under pre-industrial conditions. Hence, up to a concentration of 10-50% of opaques in virgin PET:

- Opaque PET demonstrated good reactivity to the foaming agent;
- The properties and chemical structure of the foam remained unchanged relative to the control sample;
- The viscosity index was slightly lower, but nonetheless remained within the range of expected values.

As a result, these observations confirm that at least 10 to 15%[5] of white or coloured opaque PET could be introduced into a foam manufacturing process. Other tests on a larger scale are required to confirm these hypotheses.

For this type of application, the annual consumption of 100% opaque PET feedstock by the recycling operator would be 500 to 800 t. When we consider that the stock amounts to a little over 5,000 t (and growing rapidly), this market will not absorb sufficient tonnage of the material, especially if the shift to opaque PET continues.

New reclamation solutions must be found.

## 4/ Outlook and new guidelines

The implications of the findings presented above point to the need for new markets to consume more than 800 t of opaque PET per year. The sectors that use or could use PET foam constitute a potential outlet. In particular, the energy, automotive, aquatics and construction and public works sectors—all users of plastic foams—could be interested in the technical and economic advantages of PET foam, especially as a means of diversifying their sources of supply.
To further this goal and supplement COTREP's work, Eco-Emballages decided to include issues related to opaque PET in its latest request for proposals, "Sorting and recycling of household plastic packaging waste to improve recycling and recovery rates". In tandem, COTREP will also make contact with potential industry users.

If a new, technically and economically viable recycling channel is identified, it could be based on the production of a mixed-colour opaque PET stream, which is not only specific, homogeneous and consistent, but also available in far greater tonnages.

## Conclusion

**The presence of opaque PET in the coloured PET stream limits the potential outlets and, in the medium term, will disrupt the recycling process for fibre bottles. Therefore new markets must be identified to absorb the rapidly growing stock of this material.**
**COTREP has highlighted the key factors for recycling of opaque PET bottles, in terms of both packaging design and the potential applications. To date, two types of industrial processes involved in the manufacture of fibres and foam would appear to be promising, provided certain conditions are met. They have the potential to absorb a certain quantity of the material, but not enough if the amount of opaque PET on the market continues its steady rise.**

**COTREP, backed by a request for proposals issued by Eco-Emballages, is continuing to look into new outlets and additional recycling solutions. The conclusions of these studies will form the basis for the preparation of a model for sorting and recycling opaque PET packaging.**

*5 Since the tests were conducted at maximum concentration of 15%, we cannot currently predict the influence of opaque PET introduced in concentrations of greater than 15% on the physical-chemical characteristics of the resulting foam.*