



# PROTOCOL – MEASUREMENT OF PS DENSITY

## Measurement of PS packaging density to ensure recyclability

### COTREP

The mission of the Technical Committee for the Recycling of Plastic Packaging (COTREP) is to help designers and decision-makers develop recyclable plastic packaging while also providing scope for innovation. The committee includes various stakeholders in the plastic household packaging chain (Citeo, Elipso, SRP and Valorplast) and works on all types of plastic packaging (bottles, dispenser bottles, pots and trays, films and flexible packaging). Protocols for tests performed by COTREP are devised based on work with stakeholders in plastic household packaging end-of-life management.

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## 1. CONTEXT AND PURPOSE

The purpose of this protocol is to specify tests to be performed for measuring the density of polystyrene (PS) packaging to check its compatibility with regeneration. This step forms an essential part of the overall recyclability assessment for packaging.

Results obtained from tests performed based on this protocol are insufficient for determining packaging recyclability. This protocol can only be used to ensure material capture at the packaging flotation stage during its regeneration and channelling. It provides no basis for judging the suitability of packaging for sorting or the feasibility of transforming such regenerated granulate into new products.

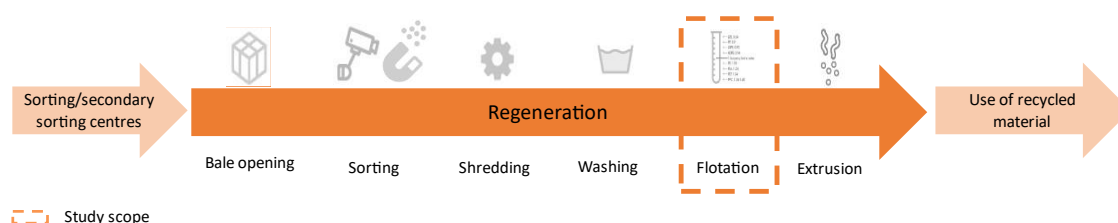


Figure 1: Scope of the measurement of PS density protocol

This protocol is intended for producers and manufacturers of PS packaging wishing to check that the density of the PS used in their packaging meets the guidelines of the “additive and density” row of COTREP’s PS table.

An important feature for guaranteeing the recyclability of PS packaging is its density. PS density must be greater than 0.8 and less than 1.1 in line with the applicable guidelines:

|                      |                                          |                                            |                           |                                                                                                                                                                                            |
|----------------------|------------------------------------------|--------------------------------------------|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ADDITIVE AND DENSITY | - PS with a density of between 1 and 1.1 | - PS with a density of between 0.8** and 1 | - PS with a density > 1.1 | - Not enough is known about how XPS and EPS with a density < 0.8 behave at sorting. COTREP is waiting for the outcomes of the sorting trials underway before emitting any recommendations. |
|                      |                                          |                                            |                           | ** For measuring the density of PS, please refer to the COTREP protocol <u>Measurement of PS density</u>                                                                                   |

Figure 2: Extract of the COTREP rigid PS packaging guidelines table

The methods described below can be used to do quick tests directly at the production facility or in a laboratory with the necessary equipment.

## 2. OVERVIEW OF METHODS

COTREP identified two standardised methods that provide reliable and reproducible measurements of the density of PS used in packaging. These two methods work independently; you do not need to use both.

This protocol is not a substitute for reading the standardised methods mentioned below. You must adhere to the guidelines in terms of conditioning and test atmosphere to ensure the reliability of the density measurement results.

To identify the method that best suits you, the following two questions can help you make your choice:

- Do I have the equipment needed to perform the test?
  - Method 1: Laboratory glassware and liquids of known density for the density gradient column
  - Method 2: Punch tools for taking size-controlled samples: 12 mm in diameter and larger; 10<sup>-5</sup> precision balance for mass measurements; caliper or micrometer for dimensional measurements.
- What degree of precision do I need for my result?
  - Method 1: Value between two known densities providing a binary answer (Yes/No) as to whether or not the density of the tested PS packaging meets COTREP guidelines
  - Method 2: Precise density value.

### Method 1: NF EN ISO 1183-2

*Methods for determining the density of non-cellular plastics  
Part 2: density gradient column method*

This method consists of determining the density of a sample by immersion in a density gradient column containing different liquids of known densities. The sample's density is determined by the density of the liquid in which it is immersed. Liquid density increases from the top to bottom of the column.

This method does not precisely determine the density of a material, but estimates its density between two known densities.

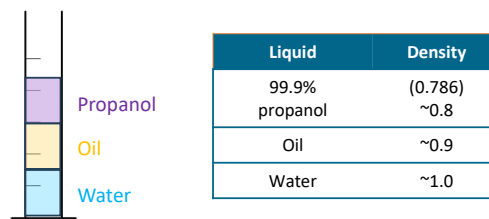


Figure3: Example of a density gradient column

To be representative, the PS sample must be collected from a surface that is as even as possible.

→ It is therefore preferable to use a sample taken from the bottom of a pot, for example, or to directly use the PS sheet prior to thermoforming

Using 99.9 % propanol which has a density close to 0.8 (check this as it depends on purity), this method can identify PS with a density greater or less than 0.8.

- If the product floats above the propanol: its density is  $< 0.8$ .
- If the product is immersed in the propanol: its density is close to 0.8.
- If the product sinks in the propanol: its density is  $> 0.8$ .

Using water which has a density of 1, this method can identify PS with a density greater or less than 1.

- If the product floats above the water: its density is  $< 1$ .
- If the product is immersed in the water: its density is close to 1.
- If the product sinks in the water: its density is  $> 1$ .

## Method 2: NF EN ISO 845

### Rubber and cellular plastics – Determining bulk density

This method consists of calculating the density of a sample by measuring its mass and volume.

It is used to measure a precise value of PS density.

To be representative, the packaging sample must:

- Be exclusively made of PS. The presence of a paper band affects the density calculation for example.
- Be of even thickness, as any irregularity can affect the result (e.g. CE mark, uneven thickness).
- Have a volume greater than  $85\text{mm}^3$  (equivalent to sampling with a minimum 12 mm diameter punch tool).

→ COTREP recommends taking measurements directly **on PS sheets prior to thermoforming and taking a sample with a minimum 12mm diameter punch tool.**

### Please note:

- Thermoforming of a PS sheet of roughly 0.85-0.9 density slightly increases the density of the end packaging by roughly 0.02-0.1. This does not significantly change the result of the density measurement with method 2 (NF EN ISO 845) which will be within the target range of COTREP guidelines, between 0.8 and 1.1.
- Measurements can also be taken with “end packaging” as mentioned in the tables of the CEN (European Committee for Standardisation) PS standard – in the interest of representativeness of packaging behaviour in the PS recycling stream – but sample cutting seems more complicated for meeting the 3 sampling guidelines mentioned above.