

Introductory Technical Sheet**1) Closure systems used on plastic bottles**

(Source: cap manufacturers)

Closure systems have developed enormously to adapt to increasingly diversified containers and different contents. A vast range of products are available, from single to multi-part caps as seen in the table below.

Factors in the choice of closure system:

a. *Product and consumer protection*

If the product is sensitive to oxygen, UV or gas loss – of special concern in the case of long logistical circuits or particular cap-to-bottle surface area ratios – the closure system must take these parameters into account to provide maximum product protection, which may make the cap more complex.

Aluminium seals, a very good UV barrier, are used for long-life milk, fruit juice and soup. As the lip is not perfectly smooth on HDPE bottles, a cap encompassing the bottle neck edges is needed to guarantee sterility.

Legislation imposes safety caps for semi-hazardous products that children are likely to handle.

b. *Filling techniques*

Hot filling, pasteurisation and aseptic packaging are all techniques requiring temperature resistance constraints for closure systems as well as specific equipment (adapted filling lines).

Seals can be fitted through two techniques (conduction and induction) that affect peel-off quality for the consumer.

c. *Closure system functionality*

The closure is given features that make it more convenient to use for the consumer.

Examples: resealing by hinge or screw; push and pull systems (sports drinks, washing-up liquid); product spraying; dosage or anti-drip systems; safety caps.

d. *Marketing*

Effects can be obtained by playing on colour, feel, gloss and shape, requiring the presence of other materials in some cases.

e. *Economy*

Raw material prices can lead manufacturers to opt for PP or HDPE.

Systems are also chosen according to production throughput.

Single-part systems are economically advantageous compared with multi-parts, so are systematically preferred if their technical performance is sufficient.

		SEGMENT							
		Still water (flavoured or not)	Sparkling drinks (soda, sparkling water)	Oxygen-sensitive sparkling drinks (beer, cider, shandy)	Juice, tea, energy drinks	UHT milk, soup, juice	Fresh milk, drinking yoghurt	Personal care products: shower gel, shampoo	Household products: detergents
Bottle body		PET	PET	PET	PET	HDPE	PET or HDPE	HDPE, PP or PET	HDPE, PP or PET
CLOSURE SYSTEM	Single-part cap	◇◇	◇◇	∅	◇◇	∅	◇	◇◇	◇◇
		99% HDPE cap. marginal PP	100% HDPE cap. Possible development in PP	May exist for very short lifespans (HDPE)	100% HDPE cap		HDPE cap for PET bottle	HDPE or PP cap. Hinged caps are PP.	Screw caps are HDPE. Hinge caps are PP.
	Multi-part cap	◇	◇	◇◇	◇	◇◇	◇	◇	◇
		- HDPE shell (PP minority) + aluminium seal for long logistical circuits. - Sports cap - Caps with silicone valve	- PP shell + seal: mostly EVA, PVC and silicone in a few cases. – Concerns small bottles.	- PP or HDPE with a seal (added or in-mould). - Many active or passive barrier developments.	- HDPE or in some cases PP shell (depending on need to resist heat), with: - an aluminium (induction) or other seal (many active or passive barrier developments). Push and pull closures exist with an aluminium seal that must be removed before consumption.	- HDPE or PP shell with aluminium seal fastened by conduction.	- HDPE shell with HDPE-based seal. Some aluminium seals.	PP + use of specific additional materials for feel and gloss: - TPE (Santoprene) or silicone components, - niche: ABS, anti- shock PS, gilding... Pumps are developing*.	Development of functions: - gas removal: - Teflon, silica gel + carton seal, - service: pumps, push & pull, valves, etc.

Key: ∅ = system not used ◇ = system used in few cases ◇◇ = system used in most cases

**Additional information from cap manufacturers*

2) Closure systems and recycling plastic bottles

Generalities

The key criteria in plastic bottle recycling are:

- Legislative: compliance with decree 98-638.
- Compatibility with bottle body: The cap may be considered as:
 - o Product in the HDPE stream (and recycled with it if compatible),
 - o By-product in the PET stream (separated by density) or
 - o Waste (if the material is a different kind and incompatible in recycling terms).

3) Studies carried out on closure system behaviour

a. **Single-part aluminium cap => See sheet FT 01.**

b. **Two-part cap**

- with aluminium seal => See sheets FT 02 and FT 11
- with EVA, silicone, etc. seal => See sheet FT 25

More complex pump or push & pull-type closure systems will be studied after contact with the relevant professionals.