Scientific Derivation of a realistic Polymer Threshold for fibre-based Products with Reference to Recital 11 of the SUPD

Scientific context for the derivation of a technically necessary polymer threshold in paper and board packaging with reference to the SUPD, average demand values, trace limits, and the establishment of a regulatorily robust threshold.

Research question:

What is the technically necessary polymer content in fibre-based packaging (paper, paperboard, cardboard) according to the scientific literature, and what threshold can be considered appropriate from a regulatory perspective, taking into account the scientifically recognised understanding of trace substances?

Scientific context and objective:

This methodical and scientific derivation serves to establish a realistic and technically substantiated quantitative threshold for the classification of paper-based materials under the Single-Use Plastics Directive (Directive (EU) 2019/904; hereinafter: SUPD), based on published data on polymer requirements. In addition, the concept of trace contents (e.g. < 0.1 %), as recognised in environmental analytics and food law, is systematically taken into account.

The polymer contents reported in the literature for paper- and board-based materials predominantly refer to functional polymer-based additives that are technically required to achieve defined product properties. These include, in particular, polymer-based sizing agents used for hydrophobisation such as alkyl ketene dimers (AKD) or alkenyl succinic anhydrides (ASA), polymer-based wet-strength agents such as polyamide-epichlorohydrin resins (PAE), as

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well as optical brightening agents, which are in most cases low-molecular stilbene-based fluorescent compounds[1]. These substances are applied either within the fibre suspension (internal sizing) or via surface applications (e.g. size press or coating application).

Relevant papermaking literature describes typical application levels for these additives in the range of a few tenths of a percent to slightly above one percent, relative to the dry solid content of the paper. These polymer contents are functionally necessary but do not fulfil a structure-forming role in the sense of an independent plastic matrix. Rather, they act as functional additives within a predominantly fibre-based material and constitute an integral part of established papermaking manufacturing processes.

Analysis of literature data:

The following overview presents the average quantities of polymeric additives used in fibre-based products (relative to dry weight):

• Francolini et al. (2023):	0.3 – 1.0%	→ Average:	0.65%
• Bajpai (2015):	0.1 – 0.5%	→ Average:	0.30%
• Hubbe (2006):	0.2 – 1.0%	→ Average:	0.60%
• KTH (2023):	0.5 – 2.5%	→ Average:	1.50%
• Gullichsen & Paulapuro (2000):	1.0 – 2.5%	→ Average:	1.75%
• T. d. Papiertechnik (8. Aufl.):	0,4 – 1,2 %	→ Average:	0,80 %
Arithmetic mean of all average values:		→	0.93%

The mean values reported for the individual literature sources are each derived as the arithmetic mean of the lower and upper application limits for polymeric additives specified in the respective publications. To derive a representative overall value, the arithmetic mean of these individual mean values is subsequently calculated. This approach allows for an appropriate consolidation

1 Optical brightening agents based on stilbene structures are generally low-molecular organic compounds and do not fulfil the polymer definition pursuant to Article 3(5) of Regulation (EC) No 1907/2006 (REACH). They are therefore not considered as polymer content within the meaning of the present threshold assessment.

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of heterogeneous yet comparable literature data and corresponds to a commonly applied statistical approximation in the evaluation of technical application ranges.

The calculation exclusively considers polymer-based additives within the meaning of the REACH polymer definition; low-molecular functional additives (e.g. optical brightening agents) are not included in the polymer mass assessment.

Supplementary note on scientifically recognised trace levels:

In environmental analytics, contents below 0.1 % are generally regarded as "trace levels"; this threshold is reflected, inter alia, in publications of the German Federal Institute for Risk Assessment (BfR, 2018), the German Environment Agency (2020), and within the REACH Regulation.

In papermaking practice, polymer-based additives are likewise regularly present in the range of tenths of a percent relative to the dry solid content. In addition, process-related variations as well as analytical uncertainties in the quantitative determination of very low polymer contents must be taken into account. Against this background, the consideration of an internationally recognised trace threshold of < 0.1 % as a conservative allowance is methodologically appropriate in order to integrate technically unavoidable trace contents into a regulatory robust threshold definition, without calling into question the functional nature of these additives.

→ Scientifically recognised trace allowance:	→ + 0.10 %

Example calculation:

Technically determined mean value:	→ 0.93 %
+ Scientifically defined trace value:	→ 0.10 %
= Total threshold value:	→ 1.03 %

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Conclusion:

The derived threshold of 1.03 % polymer content is based on recognised scientific sources and methodologically established trace-level approaches. It enables a regulatory robust, technically justified and environmentally sound delineation within the framework of the SUPD, without unnecessarily classifying paper-based packaging containing functionally required minimal amounts of polymer-based binders and additives as plastic products.

The polymer-based additives used in paper and board materials primarily serve to adjust functional properties such as surface stability or optical performance. They are incorporated into the fibre matrix or applied near the surface, without forming an independent, continuous plastic structure. Accordingly, these polymers do not fulfil a structure-forming function in the sense of a plastic matrix but rather act as functional additives within a predominantly fibre-based material.

Furthermore, this scientifically derived threshold is consistent with the legal interpretation of Directive (EU) 2019/904 (SUPD), which explicitly states that paints, inks and adhesives (polymer-based binders and additives) are not covered by the definition of plastic under Article 3(1) (cf. Recital 11): “Paints, inks and adhesives should not fall under this Directive and therefore should not fall under the definition of plastic set out in point (1) of Article 3.”

This interpretation is confirmed by the official guidelines of the European Commission, which clarify that functional additives such as adhesives, binders and inks are excluded from the scope of the Directive. Consequently, polymer-based binders and additives in paper, board or cardboard that do not fulfil a structure-forming function are not to be regarded as falling under the SUPD. The scientifically substantiated minimum requirement of 1.03 % polymer-based binders and additives in paper, board and cardboard products demonstrates that functional, non-structure-forming additives are technically necessary but not SUPD-relevant. The threshold of the flustix label “LESS PLASTICS PRODUCT – MIN. 99.25 % PLASTIC-FREE”, allowing a maximum polymer mass fraction of 0.75 %, is therefore well below this level and therefore remains clearly below the technically derived polymer threshold relevant for SUPD classification, providing for the first time a clear quantitative benchmark that offers manufacturers and authorities legally reliable guidance for product classification.

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About the Author:

The flustix initiative has been collaborating for over five years with independent, accredited testing and certification bodies — including renowned laboratory partners specialised in polymer analytical methods, foundations, and a federal institution in the field of material and product safety. To date, more than 150 analyses of fibre-based packaging have been carried out. These tests are based on combined analytical systems, including thermoanalysis, TED-GC/MS, extraction methods, and other internationally recognised and validated procedures.

The result: flustix and its accredited partners possess extensive and reliable testing expertise in the field of polymer analysis for paper-based packaging and/or microplastic detection. The flustix threshold of 0.75% is not only more stringent than many legal or international regulatory requirements, but also reflects a high scientific standard backed by practical testing experience.

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