



## Review

# An overview of chemical additives present in plastics: Migration, release, fate and environmental impact during their use, disposal and recycling



John N. Hahladakis<sup>a,\*</sup>, Costas A. Velis<sup>a,\*</sup>, Roland Weber<sup>b</sup>, Eleni Iacovidou<sup>a</sup>, Phil Purnell<sup>a</sup>

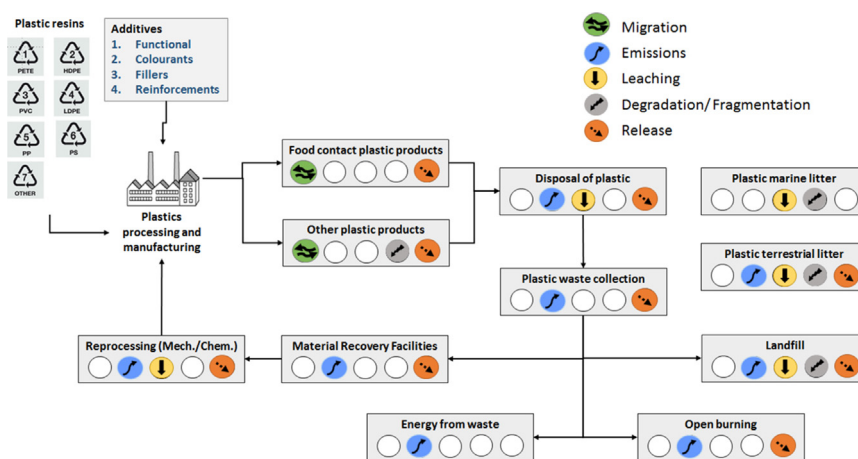
<sup>a</sup> School of Civil Engineering, University of Leeds, Woodhouse Lane, LS2 9JT, Leeds, United Kingdom

<sup>b</sup> POPs Environmental Consulting, Lindenfirststr. 23, D.73527, Schwäbisch Gmünd, Germany

## HIGHLIGHTS

- Plastics are important in our society providing a range of benefits.
- Waste plastics, nowadays, burden the marine and terrestrial environment.
- Additives and PoTSs create complications in all stages of plastics lifecycle.
- Inappropriate use, disposal and recycling may lead to undesirable release of PoTSs.
- Sound recycling of plastics is the best waste management and sustainable option.

## GRAPHICAL ABSTRACT



## ARTICLE INFO

## Article history:

Received 22 July 2017

Received in revised form 2 October 2017

Accepted 7 October 2017

Available online 9 October 2017

## Keywords:

Plastics

Additives

Migration

Recycling

Toxicity

Environmental fate

## ABSTRACT

Over the last 60 years plastics production has increased manifold, owing to their inexpensive, multipurpose, durable and lightweight nature. These characteristics have raised the demand for plastic materials that will continue to grow over the coming years. However, with increased plastic materials production, comes increased plastic material wastage creating a number of challenges, as well as opportunities to the waste management industry. The present overview highlights the waste management and pollution challenges, emphasising on the various chemical substances (known as “additives”) contained in all plastic products for enhancing polymer properties and prolonging their life. Despite how useful these additives are in the functionality of polymer products, their potential to contaminate soil, air, water and food is widely documented in literature and described herein. These additives can potentially migrate and undesirably lead to human exposure via e.g. food contact materials, such as packaging. They can, also, be released from plastics during the various recycling and recovery processes and from the products produced from recyclates. Thus, sound recycling has to be performed in such a way as to ensure that emission of substances of high concern and contamination of recycled products is avoided, ensuring environmental and human health protection, at all times.

© 2017 Published by Elsevier B.V.

\* Corresponding authors.

E-mail addresses: [john.chach@yahoo.gr](mailto:john.chach@yahoo.gr) (J.N. Hahladakis), [c.velis@leeds.ac.uk](mailto:c.velis@leeds.ac.uk) (C.A. Velis).

## Contents

1.	Introduction .....	181
2.	Methodology.....	181
3.	Plastic waste – a growing challenge.....	182
3.1.	Plastic waste management options.....	182
3.2.	Plastic waste leaking into the marine and terrestrial environment.....	182
3.3.	Plastic materials persistence and degradation .....	184
4.	Additives in plastic products .....	184
4.1.	The role of compatibilizers in the miscibility of polymers .....	186
4.2.	Use and application of most common additives .....	186
4.2.1.	Plasticizers .....	186
4.2.2.	Antioxidants.....	186
4.2.3.	Heat stabilizers.....	186
4.2.4.	Slip agents.....	187
4.2.5.	Residual or unreacted monomers and oligomers .....	187
5.	Migration, release and fate of PoTSs contained in plastics.....	187
5.1.	Migration of chemical substances present in plastics.....	187
5.2.	Migration of the most common additives in plastics .....	190
5.2.1.	Migration of plasticizers .....	190
5.2.2.	Migration of antioxidants.....	191
5.2.3.	Migration of monomers and oligomers.....	191
5.2.4.	Migration of light stabilizers.....	192
5.2.5.	Migration of slip additives .....	192
5.3.	Recycling of plastics: emission, release and fate of additives/other PoTSs .....	192
6.	Conclusions.....	194
	Acknowledgments .....	195
	References.....	195

## Nomenclature

ABS	Acrylonitrile-butadiene-styrene
ATBC	Acetyltributyl citrate
BADGE	Bisphenol a diglyceride ether
BAT	Best available technique
BBP	Benzyl butyl phthalate
BBP	Butyl benzyl phthalate
BEP	Best environmental practice
BHA	2- and 3-t-butyl-4-hydroxyanisole
BHT	Butylated hydroxytoluene
BPA	Bisphenol A
DBP	Dibutyl phthalate
DCHP	Dicyclohexyl phthalate
DDE	Dichloro-diphenyl-dichloro-ethylene
DEHA	Di-(2-ethylhexyl) adipate
DEHP	Bis (2-ethylhexyl)phthalate
DEHS	Diethylhexyl succinate
DEP	Diethyl phthalates
DHA	Diheptyl adipate
DHNUP	1,2-Benzenedicarboxylic acid, di-C7-11-branched and linear alkyl esters
DiBP	Diisobutylphthalate
DIDP	Diisodecyl phthalate
DIHP	Diisoheptylphthalate
DINP	Diisononyl phthalate
DL-PCBs	Dioxin-like polychlorinated biphenyls
DMEP	Bis(2-methoxyethyl) phthalate
DOA	Di-octyladipate
DOP	Diocetyl phthalate
DPP	Dipentyl phthalate
EEE	Electrical and electronic equipment
EfW	Energy from waste
EoL	End-of life

EPDM	Ethylene-propylene diene rubber
ESBO	Epoxidized soybean oil
EU	European Union
FDA	Food and drug administration
FR	Flame retardants
FS	Food simulants
HAD	Heptyl adipate
HALS	Hindered amine light stabilizers
HBCCD	Hexabromocyclohexane
HBCDD	Hexabromocyclododecane
HDA	Hexanediol adipate
HDPE	High-density polyethylene
HOA	Heptyl octyl adipate
LCA	Life cycle analysis
LCCP	Long chain chlorinated paraffins
LDPE	Low-density polyethylene
LLDPE	Linear low-density polyethylene
LOQ	Limit of quantification
MCCP	Medium chain chlorinated paraffins
MDA	4,4'- Methylene dianilin
MOCA	2,2'-dichloro-4,4'-methylenedianiline
MTBE	Methyl <i>tert</i> -butyl ether
MW	Microwave
NCTR	National center for toxicological research
PAEs	Phthalate esters
PAHs	Polycyclic aromatic hydrocarbons
PBDD/Fs	Polybrominated dibenzo- <i>p</i> -dioxins and furans
PBDEs	Polybrominated diphenyl ethers
PC	Polycarbonate
PCBs	Polychlorinated biphenyls
PCDD/Fs	Polychlorinated dibenzo- <i>p</i> -dioxins/furans
PET	Polyethylene terephthalate
PLA	Poly(lacti)cide
PMMA	Polymethyl metacrylate

Download English Version:

<https://daneshyari.com/en/article/4979042>

Download Persian Version:

<https://daneshyari.com/article/4979042>

[Daneshyari.com](https://daneshyari.com)