CREATOR
COLLECT • PURIFY • REUSE

Deliverable report

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TABLE OF CONTENTS

Abbreviations

B&C	Building and construction
BFRs	Brominated flame retardants
CENELEC	European Committee for Electrotechnical Standardization
EASA	European Union Aviation Safety Agency
ECHA	European Chemicals Agency
EU	European Union
HBCD	Hexabromocyclododecane
ISO	International Organization for Standardization
QMS	Quality management system
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SCP	Sustainable consumption and production
SLS	Smart labelling system
UN	United Nations
WEEE	Waste from Electrical and Electronic Equipment

DOCUMENT HISTORY AND CONTRIBUTION OF THE PARTNERS

Table 1: Version management

VERSION NR	REVISER	CONTENT
V0	Christina Dalla, Rocco Lagioia (ITB)	Deliverable template
V1	Francisca Gaona (ITB)	First draft
V2	Justina Devoto (ITB)	First review
V3	Gwen Dons, Els Herremans (OVM)	Review
V4	Irma Mikonsaari (ICT)	Review and submission
V5	Francisca Gaona (ITB)	Revision after review of the 2nd project period
V6	Irma Mikonsaari (ICT)	Review

Table 2: Partners' contribution to the deliverable

PARTNER	SHORT NAME	ROLE IN THE WP	CONTRIBUTION TO THE DELIVERABLE
ITRB Group	ITB	Leader WP7 (task 1.7)	Author of deliverable 7.3
Coolrec BV	CLR	Contributor	Information generated in WP2 & WP1 (Characteristics that the waste input materials must fulfil to be used in the purification process)
Fraunhofer-Gesellschaft zur Foerderung der angewandten Forschung e.V.	ICT	Contributor	Information on the purification process and on procedures to be followed in the laboratory (information generated in WP10 in D10.2 EPQ – Requirement no. 2)
Openbare vlaamse afvalstoffenmaatschappij	OVM	Contributor	Reviewer

INTRODUCTION AND OBJECTIVES

The CREAToR project is focused on process and material development and demonstration to sort and remove hazardous, already banned bromine-containing flame-retardants from waste streams using continuous sorting and purification technologies: LIBS technology for sorting and supercritical CO_2 and natural deep eutectic solvents (NADES) for continuous extraction in twin-screw extruders.

CREAToR will cover the whole value chain, starting with the collection of thermoplastic waste streams from building and construction and from waste electrical and electronic equipment. The project will implement ways to identify the presence of hazardous flame retardants and to sort the polymer material accordingly, to remove these contaminants from the materials and finally to reuse the materials in new applications.

Brominated flame retardants (BFRs) are a large group of substances used in several products to prevent fire hazards. Due to the abundance, low cost and high performance of bromine, brominated flame retardants (BFRs) have had a significant share of the market for years. Some BFRs are toxic and pose a risk of causing adverse effects to human health and the environment. They are capable of long-range transport, persist in the environment[1] and in foods[2], and bioaccumulate in human[3] and animal tissue.

As case studies, the purified polymeric materials will be reused as valuable secondary raw materials for new B&C insulation panels (generating a circular economy), for automotive interior applications, and for producing 3D-printed parts for aerospace applications.

To further increase the economic feasibility of the approach, an optimised logistic concept and a harmonised material quality classification scheme will be developed and applied. CREAToR will develop a circular economy solution, transforming waste streams that are currently incinerated into value-bringing secondary raw materials. The economic viability of CREAToR will be validated through material benchmarking and the assessment of the whole value chain and its costs, resulting in next generation products.

The objective of this document is to elaborate a Certification Assessment Report targeting a non-specialist audience. It serves to inform about the project objectives and results concerning the most appropriate quality assurance system, and to map existing certification schemes.

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[1] Salamova and Hites, A. Salamova, R.A. Hites; Discontinued and alternative brominated flame retardants in the atmosphere and precipitation from the Great Lakes basin; Environ. Sci. Technol., 45 (2011), pp. 8698-8706

[2] Ashizuka et al., Y. Ashizuka, R. Nakagawa, S. Murata, D. Yasutake, T. Hori, M. Horie, C. Nishioka, T. Takahashi, I. Tamura, T. Teshirogi, K. Sasaki; Daily intake of brominated dioxins and polybrominated diphenyl ethers estimated by market basket study; Organohalogen Compd., 69 (2007), pp. 2769-2772

[3] Abdallah and Harrad, M.A. Abdallah, S. Harrad; Polybrominated diphenyl ethers in UK human milk: implications for infant exposure and relationship to external exposure; Environ. Int., 63 (2014), pp. 130-136

1 CREAToR PROJECT

1.1 PROBLEM

There is an urgent need to address the sources of plastic pollution during the plastic's life cycle (Figure 1). In Europe, energy recovery is the most common way to dispose of plastic waste, followed by recycling. Some 25 % of all generated plastic waste is landfilled.[4] Half of the plastic collected for recycling is exported for treatment in countries outside the EU.

The plastic compounds used in most products contain different additives. Additives change the characteristics of a plastics material to give it new properties. They can help to make plastics more colourful, stronger, cleaner or safer.

Awareness of these additives is important to avoid the presence of banned toxic chemicals in products made from recycled materials, and to reduce the risk to human health and the environment. The objective is to develop a proper implementation of circular economy strategies in the whole plastic supply chain, improving the material quantity that can be recycled.

Figure 1 Life cycle management of plastics in circular economy

CREAToR will develop routes to reliably identify the presence of hazardous substances in the waste streams, to remove these contaminants, and to provide a high quality secondary raw material. CREAToR will develop novel logistics networks and deploy breakthrough extractive extrusion technologies to remove hazardous substances at multiple points of the value chain, to finally reuse the purified materials as valuable secondary raw materials in the automotive, building & construction and aerospace industry.

[4] https://www.europarl.europa.eu/news/en/headlines/priorities/circular-economy/20180328STO00751/eu-waste-management-infographic-with-facts-and-figures

1.2 CREAToR SOLUTION

The CREAToR project is developing a new extractive extrusion technology to remove hazardous substances from plastics waste in a continuous manner (Figure 2). The waste streams used in CREAToR are insulation panels from the building and construction industry, electronics/ electrical and electronic equipment, and polymers from disassembled aircraft.

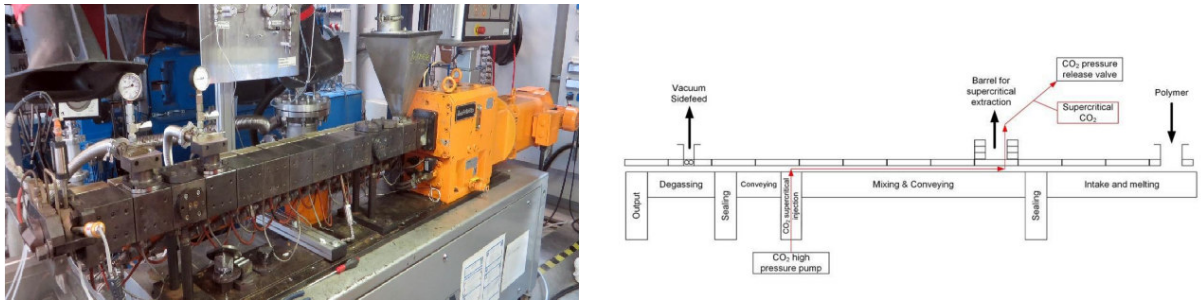

Figure 2 CREAToR extrusion process (real process on the left and schematic view on the right)

The purification process developed in CREAToR will increase the purity, quality and therefore commercial value of secondary raw materials.

These recycled plastics will be reused in new products like automotive interior components, in insulation panels for buildings and in airplane components to demonstrate the reusability of the recycled material. The demonstrators are presented in Figure 3.

Figure 3 CREAToR's demonstrators

Furthermore, in CREAToR a harmonised material quality classification and a smart labelling system have been set up, classifying the secondary raw material streams available, proving the effectiveness of the purification technologies and giving end-user customers a transparent overview of the material qualities.

Moreover, a quality assurance system for the new purification process has been elaborated to ensure that the necessary standards and guidelines are followed and the quality of the purified material is maintained.

2 CURRENT EUROPEAN STANDARDS AND CERTIFICATIONS REGARDING RECYCLED PLASTICS

Certification is the provision of written assurance (a certificate) by an independent body that the product, service, or system in question meets specific requirements. Certification schemes consist of two key elements:

- The criteria, i.e. specific requirements
- The audit methodology and testing methods used by the certification body

There are currently two voluntary certification schemes in Europe for recycled plastics: EuCertPlast and Recyclass.

2.1 EUCERTPLAST

This organisation aims to establish a European certification for post-consumer plastic recyclers. It has defined requirements based on the European Standard EN 15343:2007 "*Plastics - Recycled plastics - Guidelines for the development of standards for recycled plastics*" and guidelines to encourage recycling of plastics, particularly focusing on the process for traceability and assessment of conformity and recycled content.

This scheme assesses the good practice, the output quality and the gain in terms of greenhouse gases achieved by the audited recycler. The intention is that the waste collectors have a harmonised European tool to guarantee that the waste they deliver will be recycled in a sustainable manner by the recycler.

2.2 RECYCLASS

In August 2020, RecyClass[5], a cross-industry initiative that works to advance plastic packaging recyclability within Europe, launched the Recycled Plastics Traceability Certification. This is an audit scheme aiming to guarantee the transparency and integrity of claims regarding recycled content in plastics. This certification complements the EuCertPlast traceability scheme for recycling processes.

These are certifications that can be obtained with reference to the recycling process (EuCertPlast), the content of recycled material included in a plastic product and the level of recyclability of the plastic product (RecyClass).

Figure 4 presents the scope of each one of the certifications within the recycling supply chain.

[5] https://recyclass.eu/recycled-content

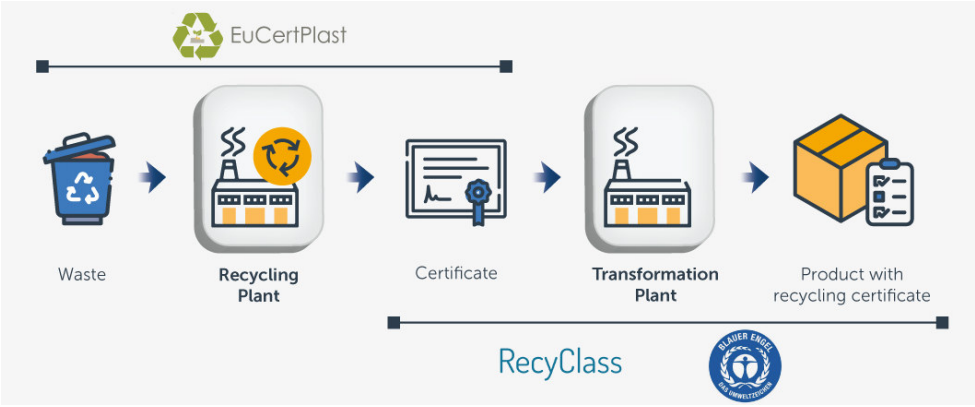

Figure 4 Certification scope within the supply chain[6]

[6] https://www.aimplas.net/blog/infographic-ecolabels-and-certifications-applicable-to-the-recycling-of-plastic-materials/

3 CREATOR'S CERTIFICATION CASE

3.1 CREATOR'S QUALITY ASSURANCE SYSTEM

In the CREAToR project, a new process is being developed for the purification of plastics. While waste containing hazardous materials must follow legislation (i.e. REACH legislation), CREAToR's process does not fall under any industry standards. Because of this, the decision was taken to create an internal quality standard for this new process. This standard will be developed following the principles of common **quality assurance**.

We need to differentiate between quality assurance (QA), quality control (QC) and quality systems (QS). QA refers to actions taken to design and manufacture a safe and effective product by implementing quality controls in the product life cycle. QC refers to test procedures used to verify that a product is safe and effective after the manufacturing is complete (Figure 5).

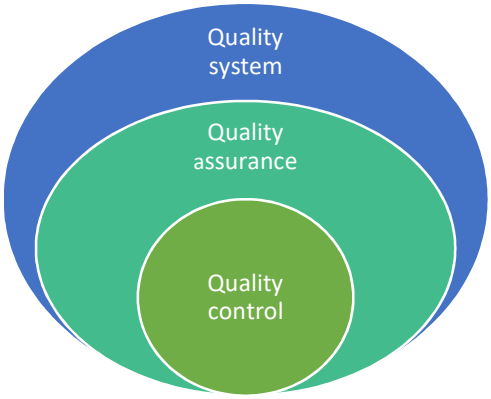

Figure 5 Quality system, quality assurance, and quality control relationships

In the **QA**, the necessary procedures will be established for recycling organisations that wish to implement the purification process developed in CREAToR. These will be based on the quality procedures followed by the partners during the project.

The **quality management system** shown in Figure 6 specifies four levels of documentation that an organisation must observe to document its quality management: a manual, procedures, work instructions and records & documents :

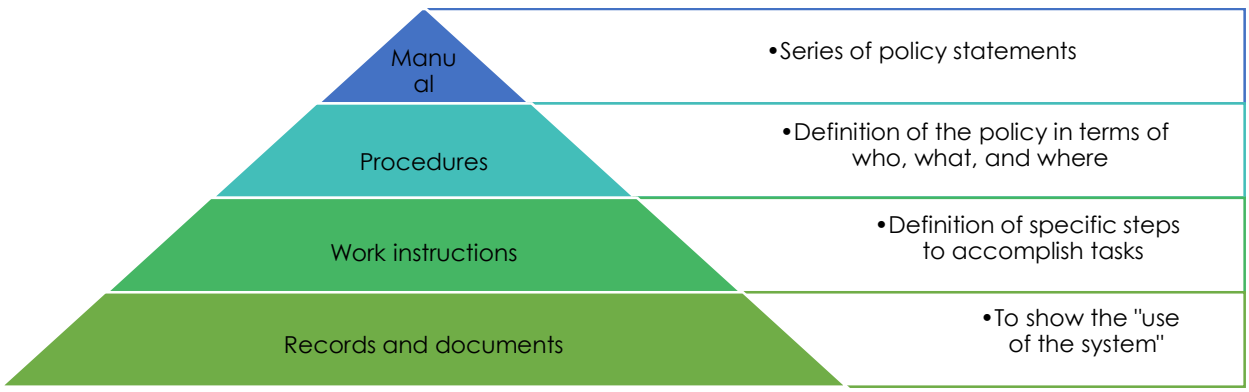

Figure 6 Four levels of QMS documentation

The quality manual includes end user requirements for the output materials. Moreover, it includes a qualification procedure for waste material inputs. This procedure is very important because the purification process is only viable when the input materials (plastic waste and contaminants) meet certain requirements.

Moreover, for the CREAToR process, the health and safety procedures are imperative because the researchers/workers will be in contact with hazardous materials. The purpose of this section is not to develop a health and safety protocol, but to provide some guidelines for the safety of workers who are exposed to these hazardous materials.

A **ROE (recycling organisation exposition)** for early adopters has also been established. The first draft proposed for the structure of this document is presented in the public deliverable 1.4 Analysis of recycling agents' conceptions & beliefs on SLS methodology[7].

3.2 CREATOR'S LABELLING

The label developed in CREAToR will be implemented in the recycling material bags and will collect important information regarding material specifications that will be useful for the end-users. The end-users will be companies from different supply chains that use plastics to produce their products (i.e. construction & building companies, airplane production companies or automotive production companies).

Figure 7 shows the label skin draft and the specifications that it will contain.

TECHNICAL SPECIFICATIONS
Density
Melt -flow rate
Charpy impact strength
Tensile modulus
Tensile strain at break
Flexural modulus
Flexural strength
Flame rating
Flame retardant content

Figure 7 CREAToR's label draft and end-user specifications for labelling

These labels will be placed in a place where they can be easily read by the end-users. They will be stuck on the containers that are used to send the recycled material from the recyclers to the end-users (buyers).

The code could also be placed inside the material bags. This would ensure that the code would only be readable by the receiver of the package. It would only be visible when the package was opened and the information would be confidential (Figure 8 and Figure 9).

[7] *https://creatorproject.eu/publications/*

Figure 8 Packaging for sold material

Figure 9 Codes inside the bags.

The label is intended to be merged with the quality assurance system to create a future certification for materials that have passed through the purification process developed in CREAToR.

The label creates an added value, since its sole purpose is to give end-users (recycled plastic buyers) confidence in the quality of the product they are buying, knowing in advance some characteristics that are important for the manufacturing of final products[8].

[8] https://creatorproject.eu/creators-smart-labelling/

4 CONCLUSION

CREAToR's developed technologies aim to **increase the recycling rates**. Achieving the purification of plastics containing hazardous components and improving the sorting of waste are two necessary improvements in the upgrading of recycling technologies. In addition, a level of quality must be maintained in recycling companies that would implement these new technologies. For this, CREAToR is developing a quality assurance system which, together with the label that is being established for the recycled material, will enable certification. This will be a quality seal for both the company and the recycled material.