This project has received funding from the European Union's Horizon 2020
research and innovation programme under Grant Agreement No 821136

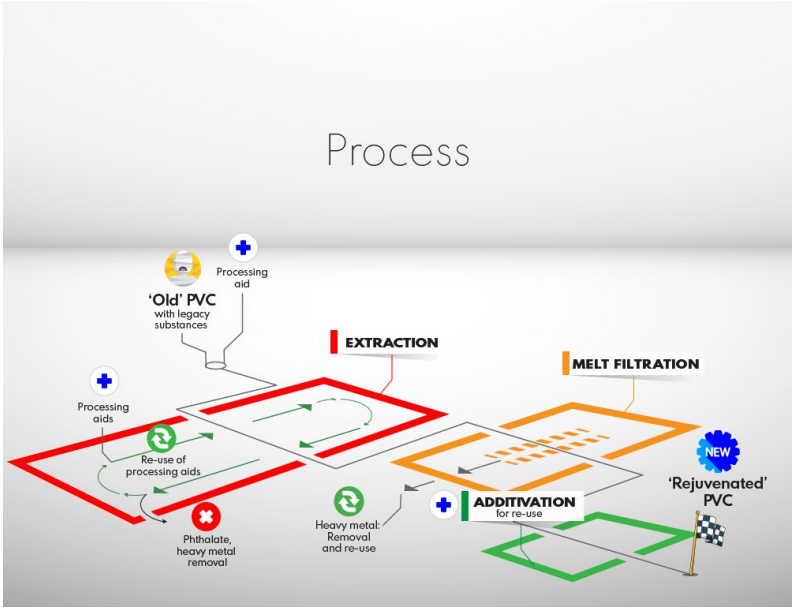
Summary of Key Results

Duration: 48 Months (2019-2023)

Project website: https://www.remadyl.eu/

Contact: Laurens Delva - LDE@vkc.be

REMADYL's core innovations are novel detection, sorting and extraction technologies to tackle one of the most persistent problems in post-consumer PVC recycling: the removal of Legacy Substances (LS).



The main LS of concern are **lead** and **DEHP**. Both LS pose a serious problem for the future recycling of PVC products. Therefore, to remove these legacy substances, REMADYL investigated three different extraction technologies:

I. supercritical carbon dioxide ($scCO_2$) cleaning technologies for phthalate removal from plasticised PVC

II. use of layered double hydroxides (LDH) as scavengers for lead in the PVC melt

III. extraction and improvement of accessibility of LS in the PVC matrix using natural deep eutectic solvents ((NA)DES) and green solvents. A prototype for the detection and sorting of lead-containing PVC was also developed.

Achievements at the end of the project:

- Three lab-scale processes for rejuvenating PVC have been developed and tested: (i) supercritical carbon dioxide ($scCO_2$) cleaning technologies for phthalate removal from plasticized PVC with achieved extraction rates of 70% for granulates and 99.9% for micronisate; (ii) use of Layered double hydroxides (LDH) as scavengers for lead in the PVC melt achieving a reduction of lead content of 60%; (iii) extraction and improving accessibility of the LS in the PVC matrix via Natural Deep Eutectic Solvents ((NA)DES) and green solvents with extraction rates up to 91%.
- Detection and sorting process for PVC containing legacy substances: a lead monitoring and sorting prototype was developed and validated in industrial site.
- Pilot line development for a continuous extractive extrusion process for rejuvenating PVC: first steps for upscaling all processes were taken, a detailed report was composed pinpointing the lacking elements to further increase the TRL of the technologies.
- Demonstration of the re-use of rejuvenated PVC materials streams: the feasibility of using rejuvenated PVC in water proofing membranes was shown. The use of rejuvenated PVC was proven in injection moulding for cable grommets. The principals of inline sorting of Pb containing materials have been proven by IRIS and Deceuninck.
- Safe handling and re-use of the by-products: successful recovery of high purity metallic lead from comparable lead salts, and conclusive evaluation of contaminants and guidelines and methodology for the safe handling of by-products.
- The final LCA results indicate that the production, preparation, and disposal of solvents represent the key sources of environmental impacts. The reuse of solvents significantly reduces the environmental impacts of the REMADYL processes, up to 50% compared to the scenario where they are not recycled. In addition, the comparative results between the mechanical recycling process of PVC + REMADYL and a hypothetical reference scenario, namely incineration and landfill plus primary PVC production, show that PVC recycling outperforms the reference scenario in most environmental categories.
- In terms of economic feasibility, the cash flow analysis revealed that the payout period of PVC rejuvenated via sCO_2 with a sales price of 4€/kg reaches a breakeven point after 6.1 years, whereas PVC rejuvenated, via organic solvents, with the same selling price reaches the breakeven point already after 2.8 years. Overall, the results suggest that the process of rejuvenation of PVC using levulinic acid is very interesting, while the investment in the process of extracting plasticizing phthalates from PVC via supercritical CO_2 is less attractive.
- Regarding social impacts the results of the S-LCA revealed that both processes proposed in REMADYL have a social performance in line with the laws and safety standards of the geographical area considered.

Who's who?

Project Coordinator: Dr. Guy Buyle (CENTEXBEL) gbu@centexbel.be

Research & Technology Manager: Ms. Mapi Diego Bielsa - pdiego@aimplas.es

Demonstration & Innovation Manager: Mr. Johan Pauwels (Deuceunink) johan.pauwels@deceuninck.com

Exploitation & Dissemination Manager: Dr. Marco de la Feld (ENCO) m.delafeld@enco-consulting.it

Quality Manager: Dr. Jan Diemert (Fh-ICT) jan.diemert@ict.fraunhofer.de