How to Close the Loop of Platinum from Heavy Vehicles Catalytic Converters?
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1. Context - Key Figures

- Emission regulations are increasingly strict
- Catalytic converters (CC) are mandatory devices
- Contain a non-negligible amount of Platinum (Pt)
- European dependency on "critical raw materials" such as Pt coming mainly from South Africa (EC, 12)
- No EoL regulations for heavy vehicles in Europe
- Boom of circular economy (CE) practices to explore

Tremendous Economic Cost: 1 kg of Platinum = 30 k€

Environmental Burden (GHG Emissions + Energy): 1 kg of Primary Platinum = 40 tons CO₂ eq. + 200 GJ

Technological Feasibility to Recycle Pt from CC > 95%

- Interest for European industrialists to recover the Pt of their systems
- Secondary Pt from EoL CC could divide by 20 the environmental cost

2. Objectives

- Make an inventory of influence parameters to close-the-loop & link the identified parameters to stakeholders’ action levers
- Quantify the impact of key actions levers on the CE performance by considering both environmental & economic parameters
- Propose and test a methodology to do so on an industrial system

3. Literature Review - Industrial Diagnosis

Current Value Chain of Platinum from Catalytic Converter

- Overall platinum recycling rate from autocatalyst = 50% (less for heavy vehicles)
- How to improve the end-of-life recycling rate of Pt & the recovery of CC in Europe?
- Many qualitative recommendations and opportunities are discussed in the literature
- But there is a lack of quantitative studies to evaluate the impact of possible solutions

4. A Multi-Tool Methodology

Material Flow Modeling

- Structural Analysis MIMAC
- Morphological Analysis MORPHOL

Fuzzy Cognitive Mapping

- Influence parameters and stakeholders
- Key actions levers

System Dynamics Simulation

5. Application - First Results

1. Material Flow Analysis + Stakeholders Mapping + Value Buckets

- 1 MFA for the Pt value chain from CC, at the European scale, data from [JM, 17]
- 1 MFA for the Pt need, use and recovery from the point of view of an European company manufacturing and selling CC
- Quantified information about the existing channels, with stocks and losses for the European Union and for one OEM

Value Bucket: Stock of CC in use in Europe: Annual Import > 36 tons of Primary Platinum

Value Bucket: Halve the import of Primary Pt

2. Fuzzy Cognitive Mapping + Clusters of Action Levers

- Topics of potential circular economy strategies
- Offer science-based arguments in CE decision-making

6. Perspectives - Next Steps

- Publication of the research work
- Presentation of key results to interested actors

- Dissemination

- Turnkey and simplified version to be applied on other components, by non-experts

References


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