Phthalate Extraction from Waste Blood Bag PVC using Supercritical CO_2 is Effective

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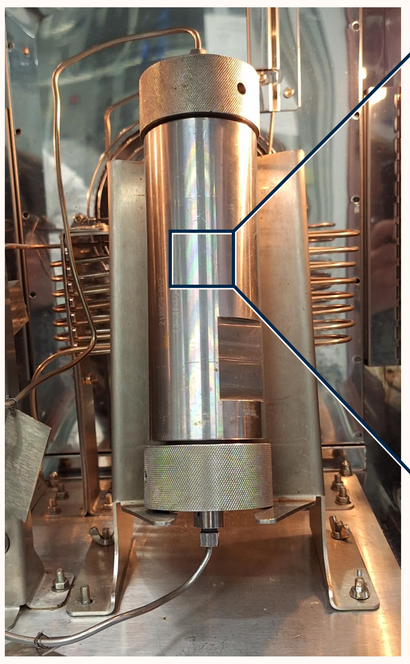
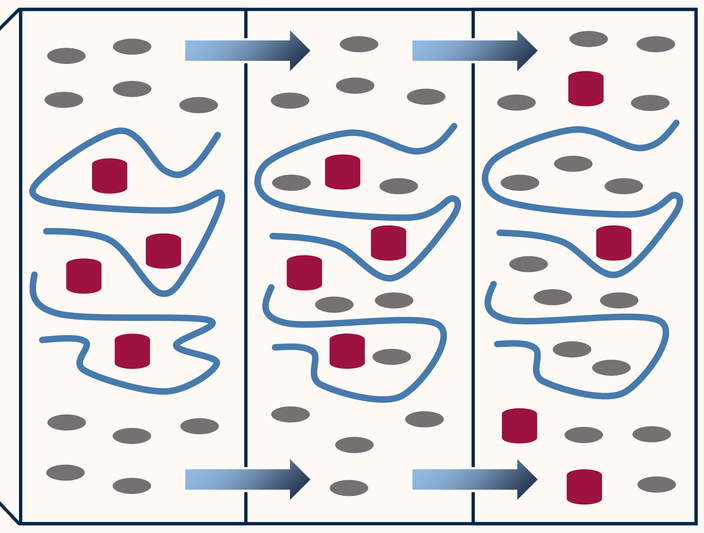


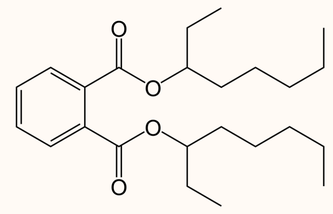


PVC chain
$scCO_2$
Phthalate

Introduction

- 0.1 wt.% EU phthalate limit for recycled PVC (2006) [1]
- Most flexible waste PVC still contains phthalates
  - Cables and blood bags
  - Up to 50 wt.%
- Supercritical CO_2-based extraction
  - Facile conditions: 74 bar, 31 °C [2]
  - Dissolves apolar compounds
  - Used in for example caffeine extraction [3]

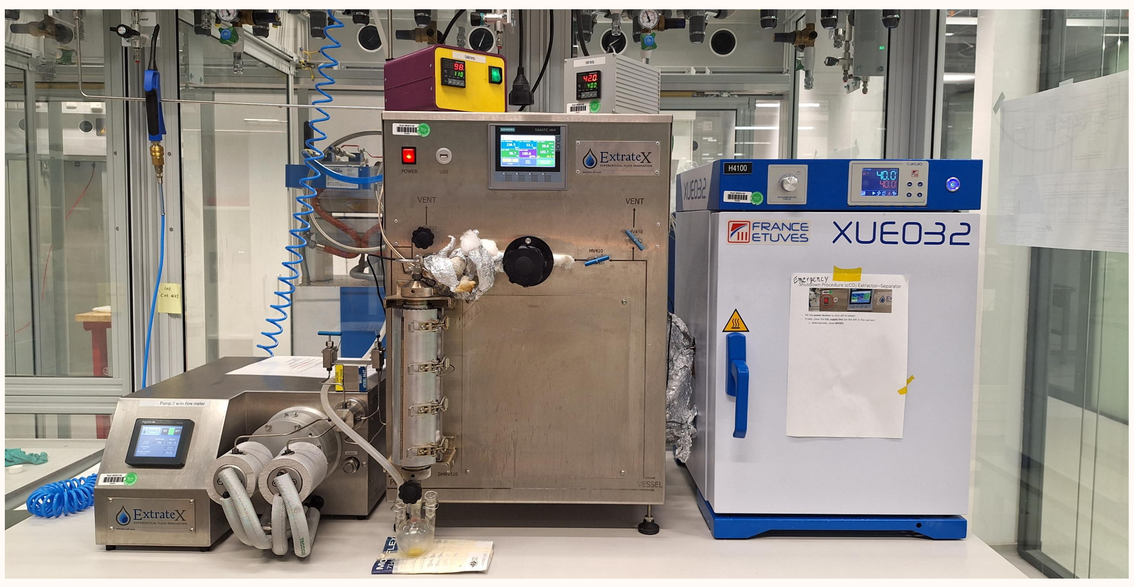
DEHP



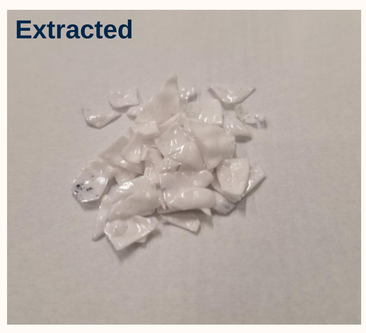
Key Findings

- Influence of **sample thickness** > **pressure** > **temperature**
  - Grinding step potentially viable
- Extraction efficiency (EE) versus time: stretched exponential decay
- Only minor increase in EE above **110 °C, 200 bar**, and **60 minutes**
- ^{1}H-NMR works as a method for determining EE

Methods



- Extractor 100 mL with 5.2 L/D, flow rate 30 g/min



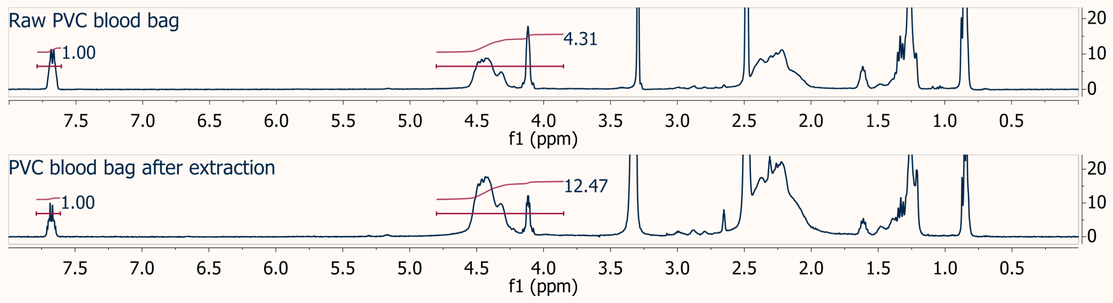
- Waste blood bag (BB) flake thickness 0.32 mm (+/- 0.01)

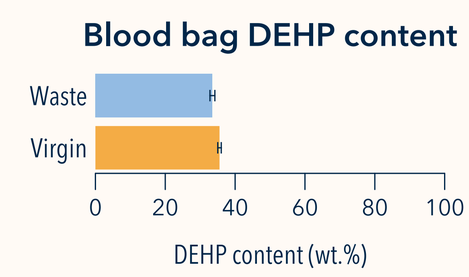
- Temperature and pressure study
  - 90, 110, 130 °C at 100, 200, 300 bar
  - ^{1}H-NMR with DMSO–d_6 (in triplo)
- Kinetic study
  - 130°C at 200 and 300 bar (in duplo)
  - ^{1}H-NMR with DMSO–d_6
  - Kinetic data fitting using phenomenological equation:

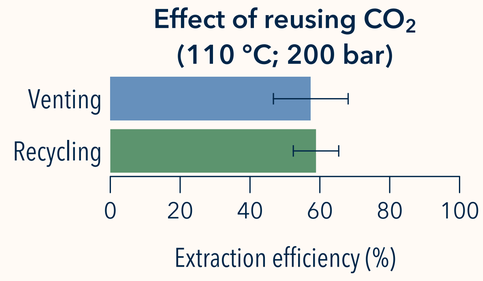
$$f(t) = A - Ae^{-\frac{(t+t_0)^C}{B}}$$

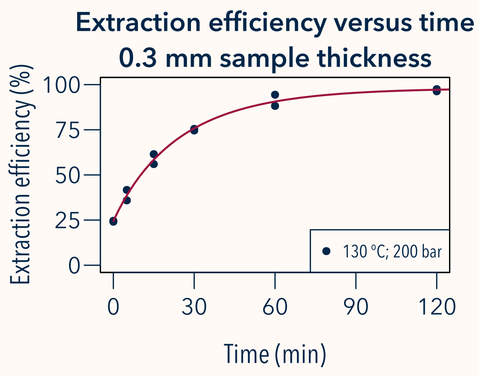
- The NMR spectra were made using MestReNova 12
- All other graphs were produced using R [4]

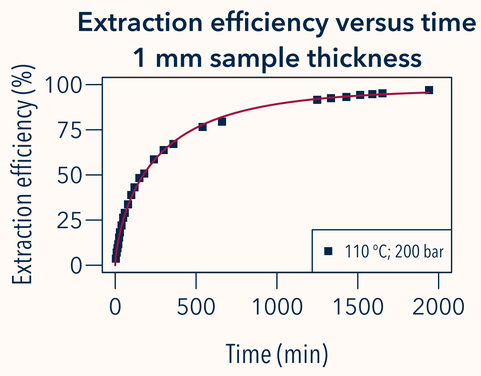
Results

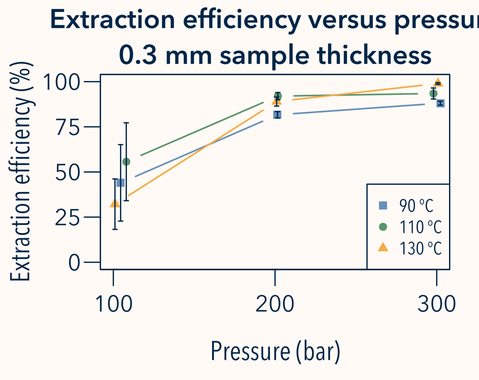












Fitting parameters EE versus time		
	0.3 mm	1 mm
A	98.1	97.5
B	23.3	278
C	0.91	0.70
t_0	5.90	0

Future Investigations

- Modelling of the extraction process
- Determining the solubility of DEHP in supercritical CO_2
- Understanding the effect of flow rate
- Confirming the quality of PVC after extraction
- Examining the effect of a grinding step
- Studying the rheological behavior (high pressure plate–plate)

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References