FACULTY OF
BIOSCIENCE ENGINEERING

DEPARTMENT OF GREEN CHEMISTRY AND TECHNOLOGY
LABORATORY FOR CIRCULAR PROCESS ENGINEERING

TOWARDS IMPROVED DEODORIZATION OF POST-CONSUMER PLASTIC WASTE: IDENTIFYING THE INDUSTRIAL HURDLES

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OUR GOAL: ACHIEVING CLOSED-LOOP RECYCLING

Closing the loop

Mechanical and chemical pre-treatment processes

- **Inks**
- **Adhesives**
- **VOCs**
- **Additives**
- **Residues**
- **Contaminants**
- **…**

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Who are we?

LCPE
Laboratory for Circular Process Engineering

Started in 2016 by prof. Steven De Meester

Now a team of around 25 PhD students & 4 technicians

Focus on organic waste, plastics, and textiles

https://www.lcpe.ugent.be/

OVERVIEW RESEARCH

https://doi.org/10.1016/j.scitotenv.2021.152467

Quantification method

Benchmarking industrial washing efficiency

https://doi.org/10.1016/j.resconrec.2020.104907

https://doi.org/10.1016/j.wasman.2020.10.021

Kinetic study on deodorization

Comparing ≠ washing media for ≠ polymers

Effect of temperature and ≠ process parameters

https://doi.org/10.1016/j.resconrec.2022.106267

Modelling and optimizing water treatment

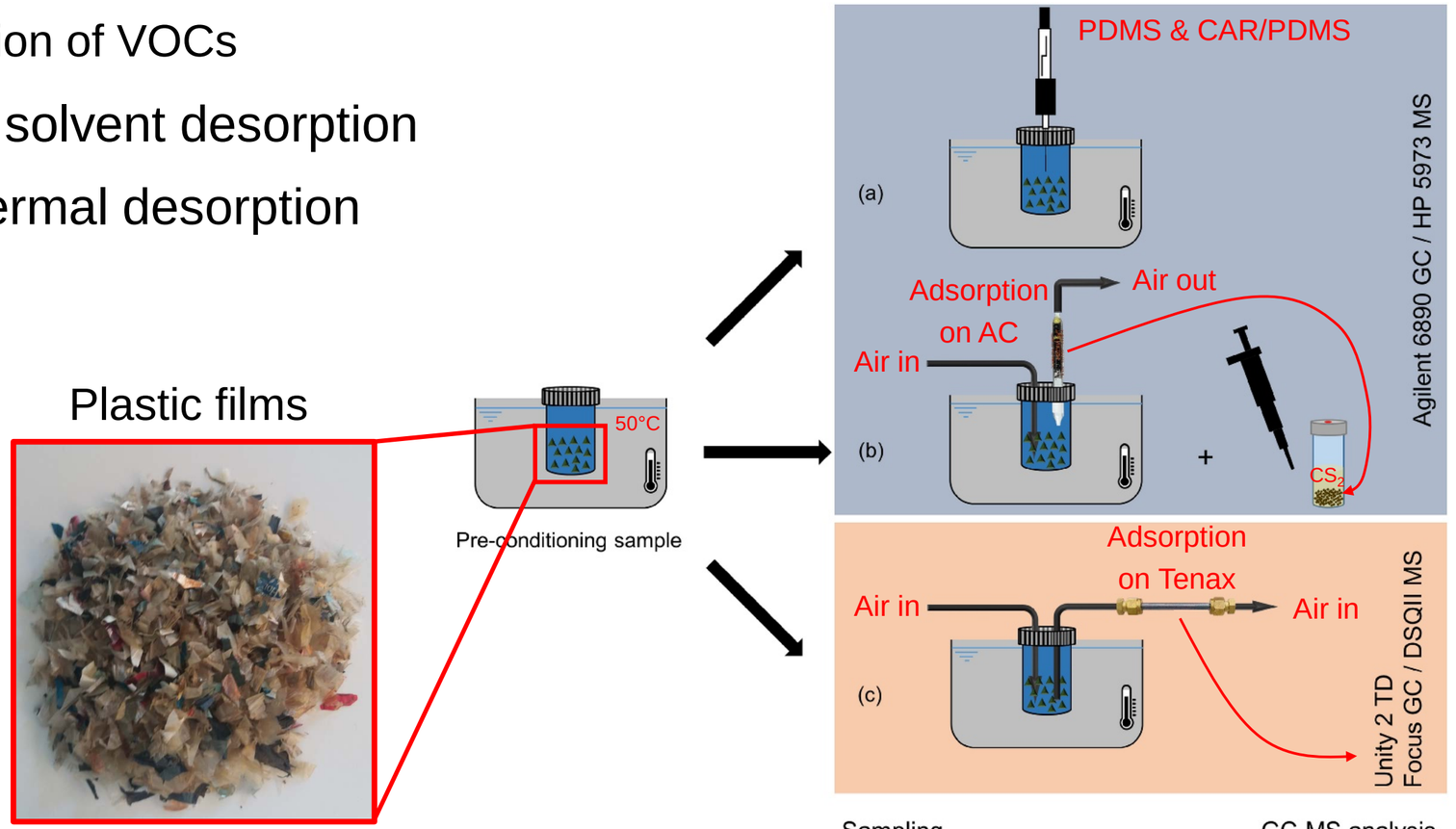
2018 2020 2022

QUANTIFYING DEODORIZATION

- Development of an analytical method to quantify odour removal in plastic waste recycling processes
- 3 different sampling techniques followed by GC-MS analysis

1. SPME ⇨ Identification of VOCs
2. Activated charcoal + solvent desorption
3. Tenax-TA tubes + thermal desorption

Quantifying VOC removal efficiencies



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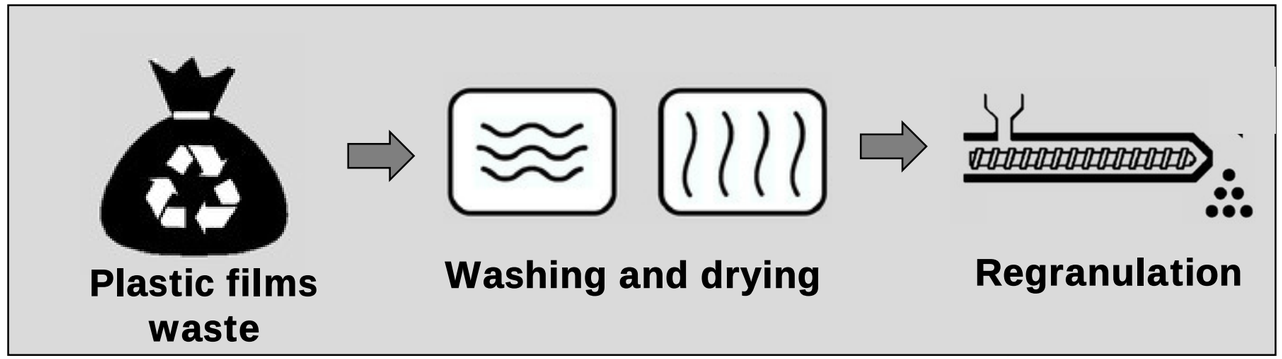
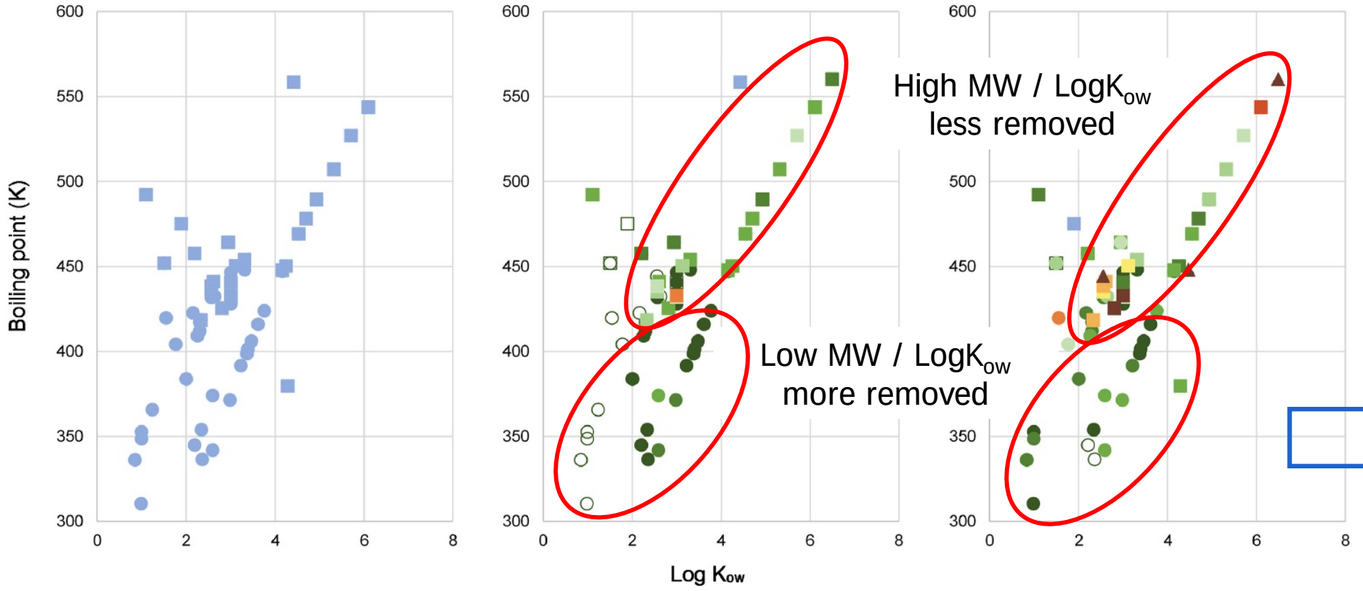
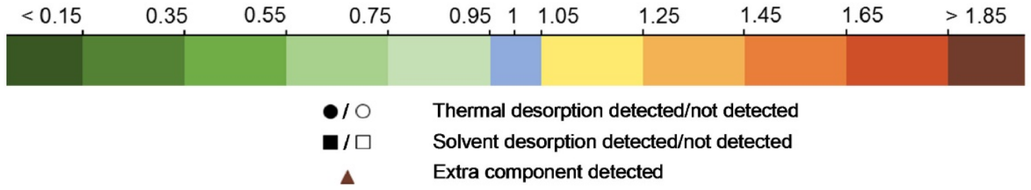
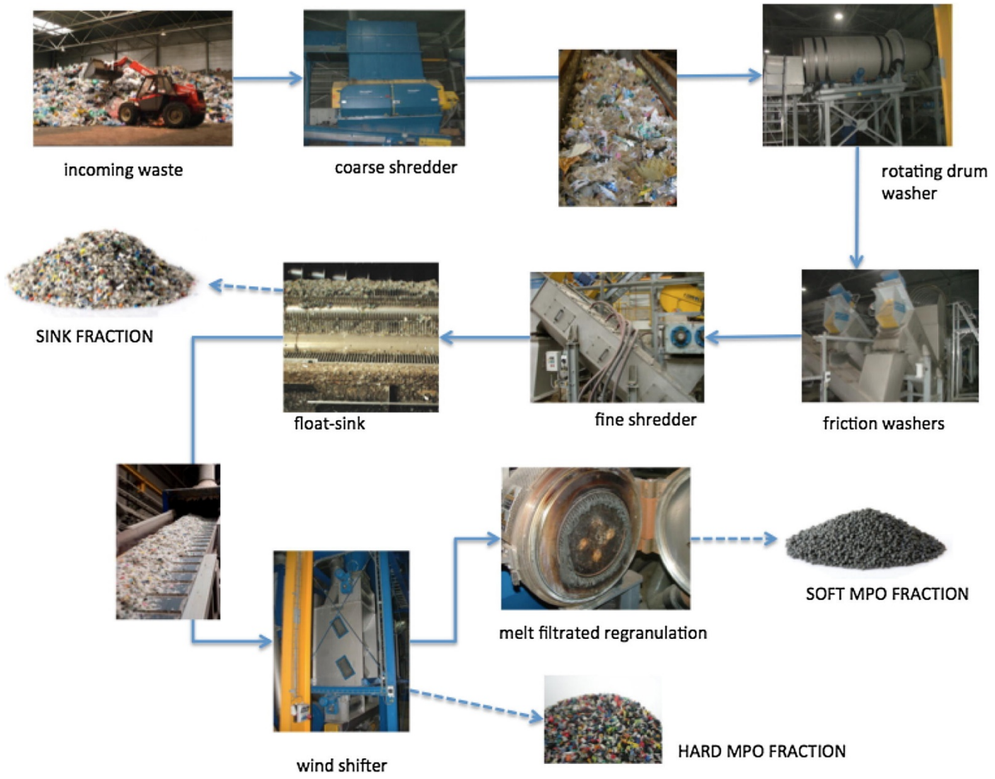
Benchmarking current industrial washing





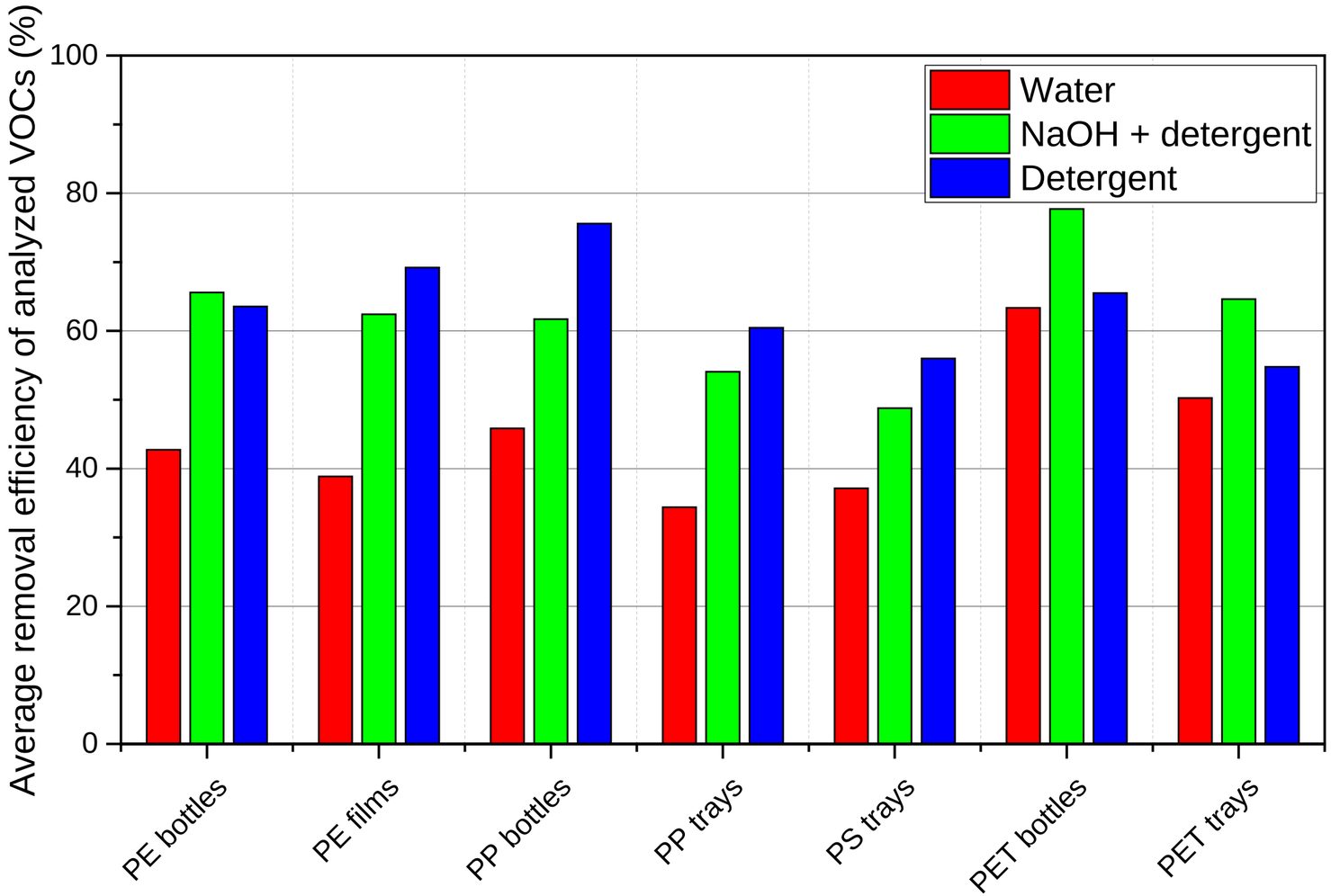




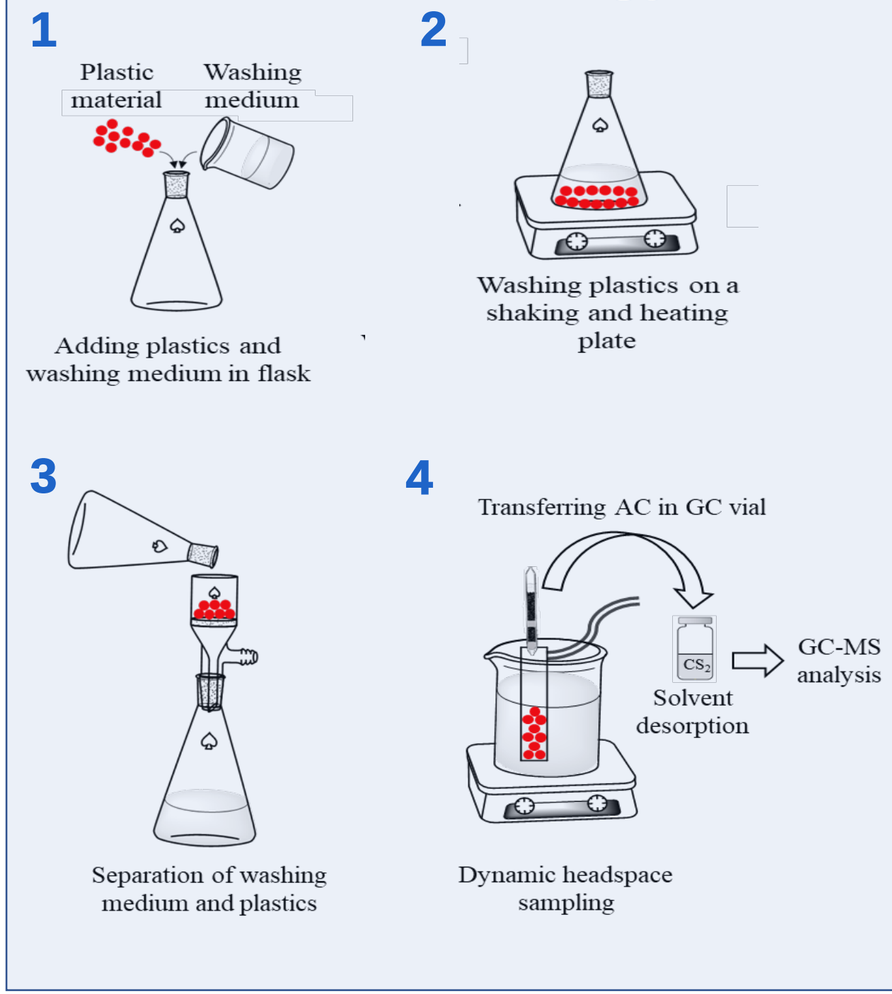
Conclusion:

- Apolar and high-boiling components are still present after washing
- After extrusion, most of the components are again detected

Lab-scale washing



Methodology



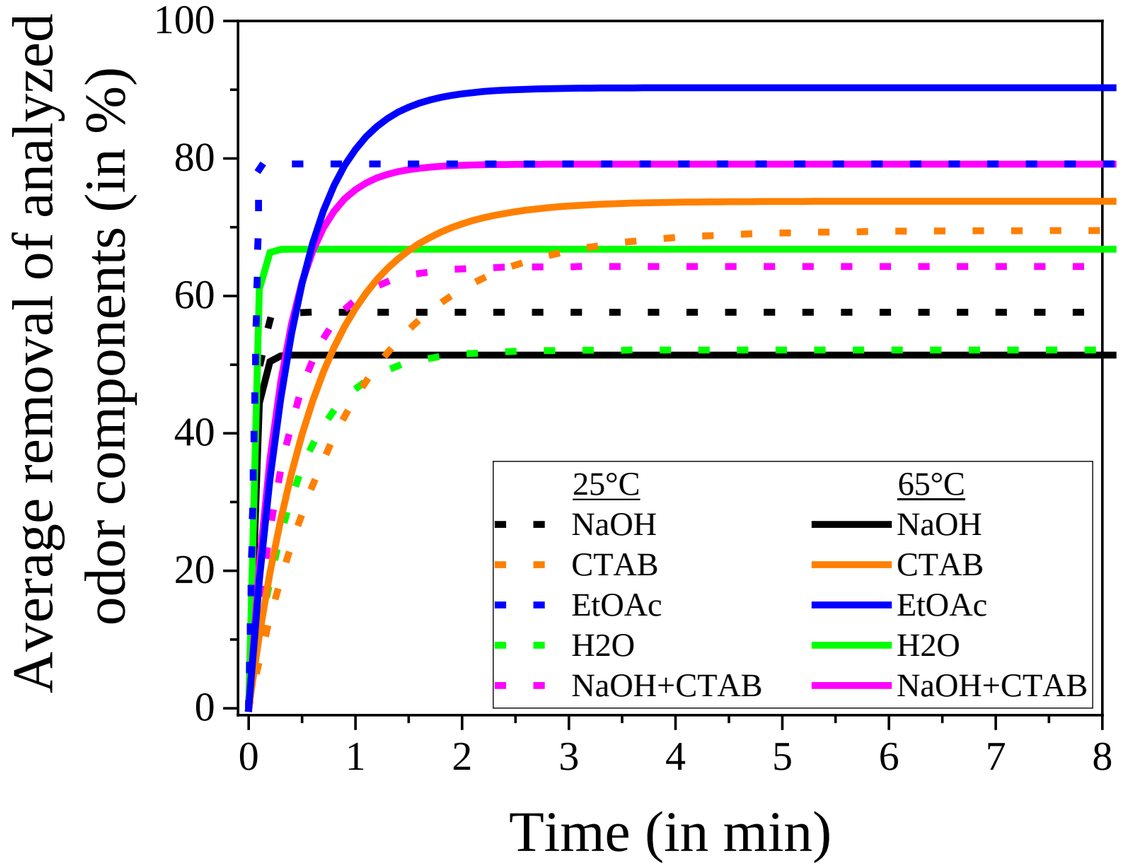
- Water is least efficient
- NaOH + detergent is efficient for PET based packaging
- Detergent is efficient for PO based packaging (mimicking PET recycling is not the best option)

Kinetic study on deodorization

Kinetic study for PE films with different media at different T°

Linking isotherm and kinetic models to experimental results

	Names	Equations
Isotherm models	Langmuir	$q_e = \frac{K_L * q_{m_l} * C_e}{1 + K_L * C_e}$
	Freundlich	$q_e = K_F * C_e^{\frac{1}{n_F}}$
	Temkin	$q_e = \frac{R * T}{b_T} \ln(A_T * C_e)$
	Dubinin-Radushkevish	$q_e = q_s * e^{-K_{ad} * \varepsilon^2}$
	…	
Kinetic models	Zero order	$\frac{dq}{dt} = -k_{0,des}$
	First order	$\frac{dq}{dt} = -k_{1,des} * q$
	Second order	$\frac{dq}{dt} = -k_{2,des} * q^2$
	…	



Efficiency:

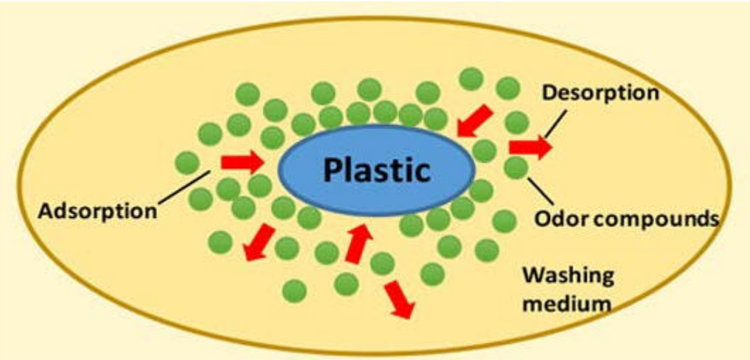
NaOH < H_2O < CTAB = NaOH + CTAB < EtOAc

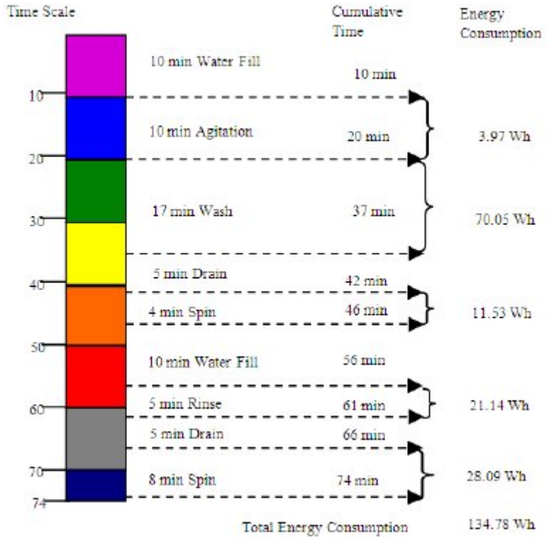
Kinetic study on deodorization

Reversible first order model best-fitted kinetic model

- Desorption AND adsorption determine the efficiency of the deodorization process via reversibility of the sorption process

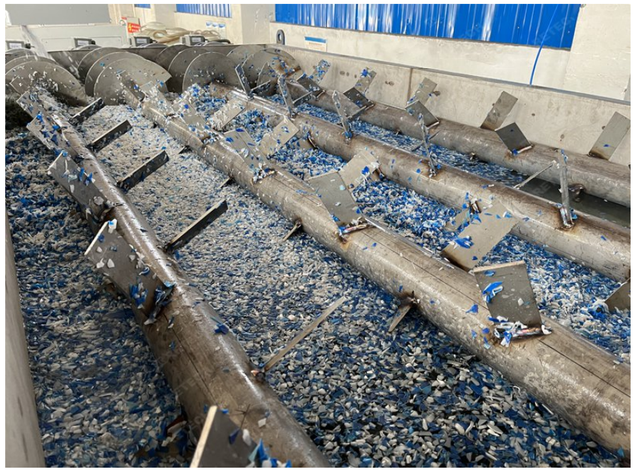
$$\frac{dq}{dt} = \underbrace{-k_{RFO,1} * q}_{\text{Desorption}} + \underbrace{k_{RFO,2} * C}_{\text{Adsorption}} \leftrightarrow \frac{dq}{dt} = -k_{RFO,1} * q + k_{RFO,2} * \frac{(q_0 - q) * m}{V}$$



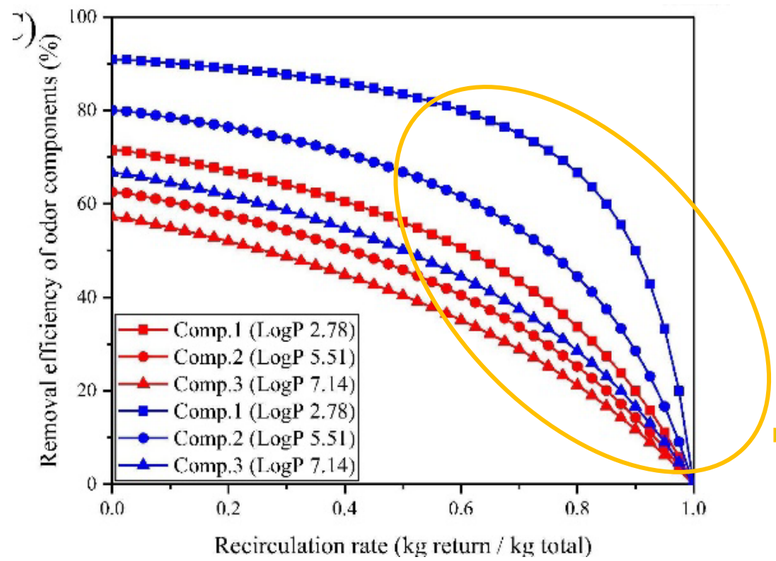


Washing with ‘dirty’ medium will not result in high removal efficiencies, even at high temperatures and with caustic

But: often high recirculation rates of water



ASPEN simulation:



RR > 60% → drop in removal efficiency (currently >90%)

Current research

Recycling plant → Medium treatment

Medium treatment → Recycling plant

Take home messages

1) Washing medium should be **tailored** on plastic type

2) Washing with **dirty water** does **NOT** result in **odour-free plastics**

3) **Water management** is key towards efficient and cost-effective washing

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