



New methods to improve the artificial ageing of recycled plastics

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Background

Artificial, or accelerated, ageing is used to simulate the behaviour of materials in conditions close to the real world. Repetitive cycles of extrusion, thermal ageing, photoirradiation, chemicals, or the combination of these are typically used.

Outdoor PE film	Plastic PET bottle
• Photoageing 6 months	1. Grinding
Medical grade PEEK	2. Drying
• Gamma sterilization 75 kGy	3. Compounding
Rubber seal	4. Drying
• Thermal ageing 6 months	5. Injection moulding
HDPE bottle	6. Drying
• 10% NaOH ageing 6 months	7. Stretch blow molding to a new bottle
	8. Repeat X times!

Fig. 1. Five examples of artificial ageing.



Fig.2. TUT's self built UV chamber and Vötsch climate testing equipment

Limitations of artificial ageing

Artificial conditions are always simplifications of the real world. Differences in parameters like photo irradiation spectra, amounts of photoageing and thermal ageing, temperature, humidity, air pollutions, chemical concentrations, and impurities may cause inaccuracy between the real and artificial situations.

In the case of recycled plastics, contaminations may play essential role in the degradation process. Depending on the application, recyclates may contain impurities such as washing liquids, oils, or dirt which affect the properties and may accumulate over time.

Improvements to current methods

The new innovations originate from a studied recycled high density polyethylene (rHDPE) grade which has a strong odour of limonene perfume used in the washing liquids. The sorted rHDPE sample, mainly bottles, was washed and granulated by NGR, Next Generation Recyclingmaschinen GmbH, in Austria, but this did not totally remove the odour (impurities). Therefore reasearch was initiated to:

- 1.test different contaminants corresponding to real life situations and study their effect on the mechanical, thermal, and rheological properties of the material
- 2.study the health risks of these contaminants due to the accumulation and generation of toxic compounds during multiple cycles
- 3.improve the correlation between artificial and real life situations in recycled plastics

Results and conclusions

According to the results, addition of detergents during multiple extrusion cycles causes

- Reduced mechanical strength, increased elongation
- Changes in rheology
- New C-O stretch band observed with FTIR
- Generation of toxic 1,4-dioxane compounds observed with a mass spectrometer

In addition, interesting results have been achieved in reduction of volatile organic compounds (VOC's) by simply heating the plastics (Fig. 3). This result could be an easy alternative to improve the quality of recyclates.

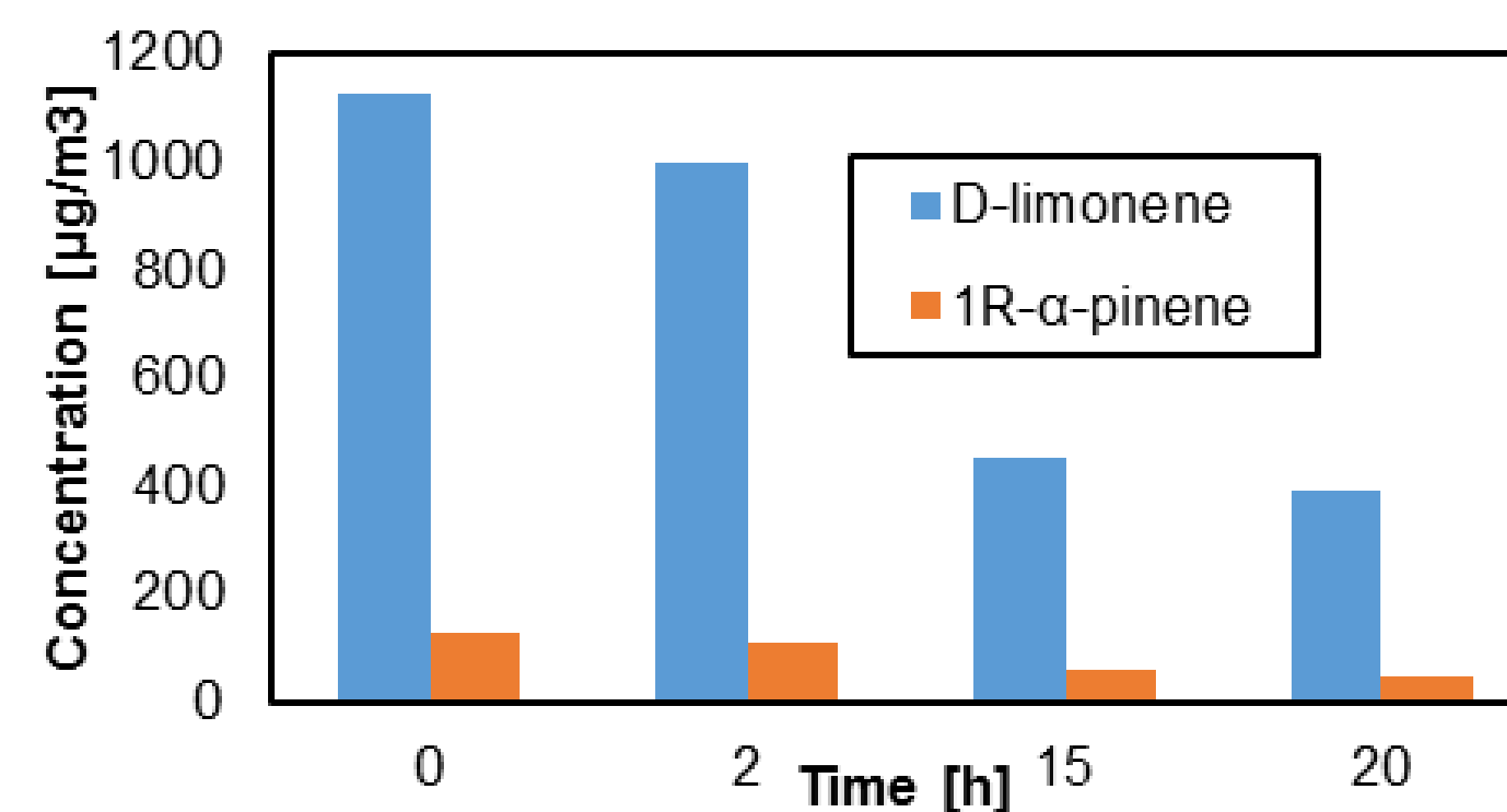


Fig. 3. Reduction of D-limonene and α-pinene emissions of the rHDPE after treatment at 50 °C with various times.