

## Production of benzene from polyethylene terephthalate (PET)

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### Abstract

Benzene is the simplest aromatic hydrocarbon, being of great economic importance for the current industry, so the present work proposes an alternative route for the recycling of PET producing benzene using a simple and inexpensive process (decarboxylation) in which it removes the carboxyl function of an organic salt yielding its respective hydrocarbon. Based on the results obtained on the experiments, it was possible to produce with this method, reaching relatively high yield (approximately 60%), demonstrating the great economic potential that this recycling technique would have if applied on a large scale.

### Key words:

Benzene, Polyethylene terephthalate, decarboxylation.

### Introduction

Polyethylene terephthalate, also known as PET, is a semi-crystalline, thermoplastic polymer of the class of polyesters; Its molecular structure consists of an aromatic and an aliphatic part, which correspond respectively to the terephthalate ion, and the diethyl radical<sup>[1]</sup>.

This polymer is the most commercially important member of the polyester family. Due to the high demand, its production from petroleum becomes increasingly unfeasible, with this several ways have been developed, to make PET a more sustainable material<sup>[1]</sup>. In this way, this work proposes a different type of recycling that mixes the known chemical recycling of the PET producing ethylene glycol and terephthalic acid with the hot alkali decarboxylation process, the objective of this work is therefore to carry out the decarboxylation of a terephthalic acid salt obtained from PET, to recover the benzene, raw material with great added value, and with a plethora of applications in various sectors of the industry.

Benzene is the most simple and important aromatic hydrocarbon, it is mainly used to produce various kinds of chemical substances. Its most widely produced derivative is styrene, which is used to produce polymers and plastics<sup>[3]</sup>. Currently, 45 million tons of benzene are produced annually<sup>[4]</sup> from non-renewable and highly polluting sources.

### Results and Discussion

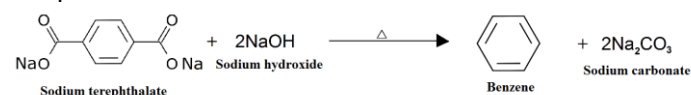
First, the formation of sodium terephthalate and ethylene glycol was observed by heating the 20 grams polyethylene terephthalate system with sodium hydroxide. The synthesis of these substances occurs from a process called depolymerization by alkaline hydrolysis (image 1).



**Image 1.** Alkaline hydrolysis reaction of Polyethylene terephthalate.

Thereafter, decarboxylation of sodium terephthalate occurred. Thereby, a biphasic mixture formed in the collection flask, one oily and one aqueous. Image 2

shows the decarboxylation equation of sodium terephthalate.



**Image 2.** Equation of decarboxylation of sodium terephthalate.

At the end of the procedure 4.1 g of benzene was obtained, that is, about 60% yield for the process.

### Conclusions

With the results obtained it was possible to confirm the possibility of recycling of polyethylene terephthalate to produce benzene, from a simple and inexpensive method (decarboxylation of organic salts); Knowing that nowadays most of the benzene is derived from petroleum, we can see the great economic potential of this technique to reduce the environmental impacts caused by both the use of petroleum and the inadequate disposal of PET plastic.

It is concluded, therefore, that this process has improved even more, it has a great potential to generate high gains both in the financial aspect and in the environmental aspect.

### Acknowledgement

The author thank the support and tutoring of Prof. Dr. André Martins Senna.

The author is also grateful for the support of CNPq, Conselho Nacional de Desenvolvimento Científico e Tecnológico - Brazil

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