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# Thermal Catalytic Cracking – Amination of Circular Feedstock for Renewable Amine

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## Background

Closed carbon cycle in plastic industry has become one of the solutions to reduce dependency on fossil feedstocks and cut CO<sub>2</sub> emissions. This can be achieved by using bio-based feedstocks or converting end of life products to raw materials. Thermal Catalytic Cracking – Amination (TCCA) process is used to convert biomass and/or polyurethane waste to aniline which is a building block to synthesize monomer for polyurethane synthesis.

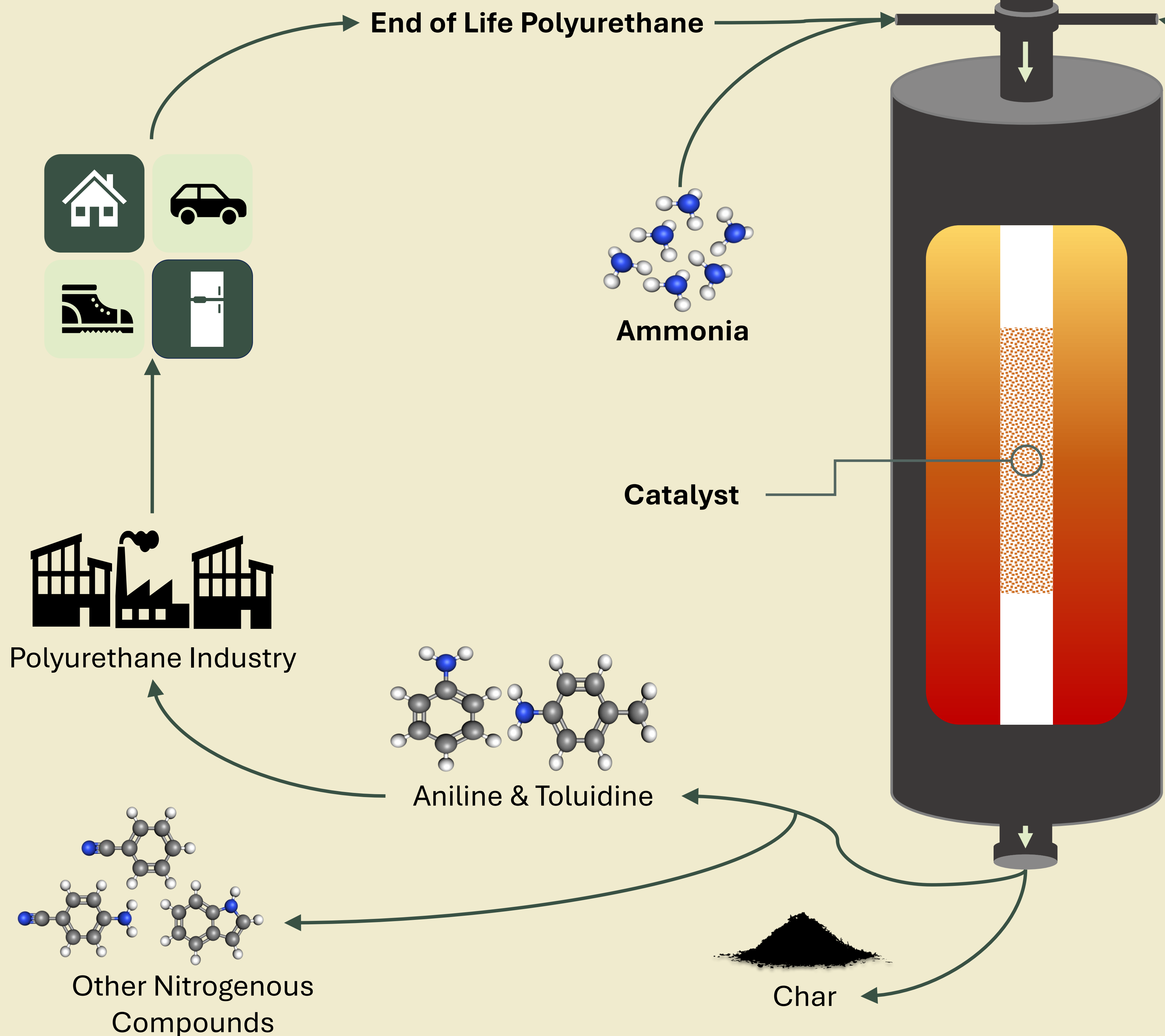
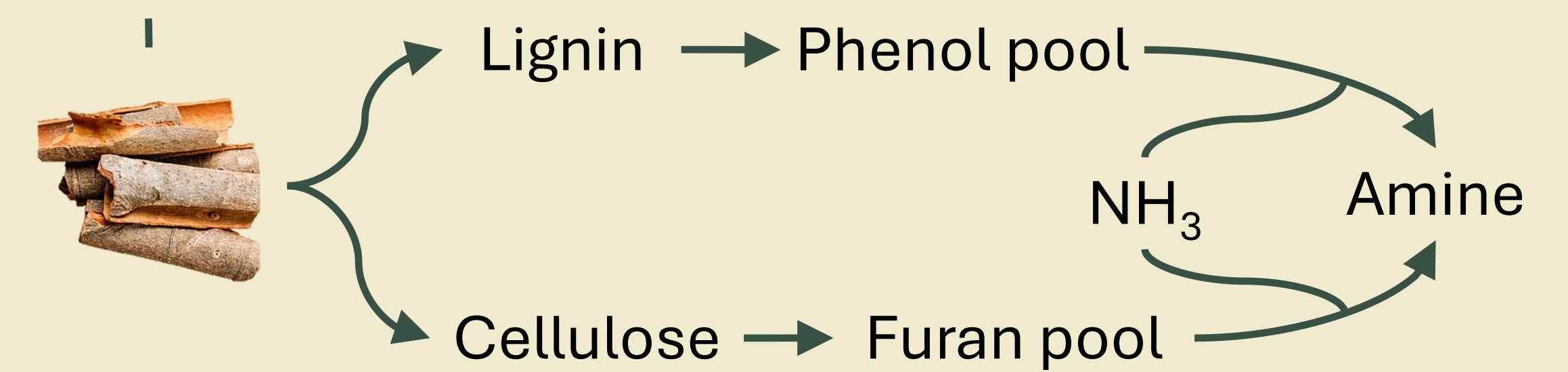
## Polyurethane Foam (PUR – PIR)

Polyurethane is a heating insulator material that is commonly found in automobiles, refrigerators, and house insulators. Polyurethane is composed of nitrogenous hydrocarbon with urethane (carbamate) links.

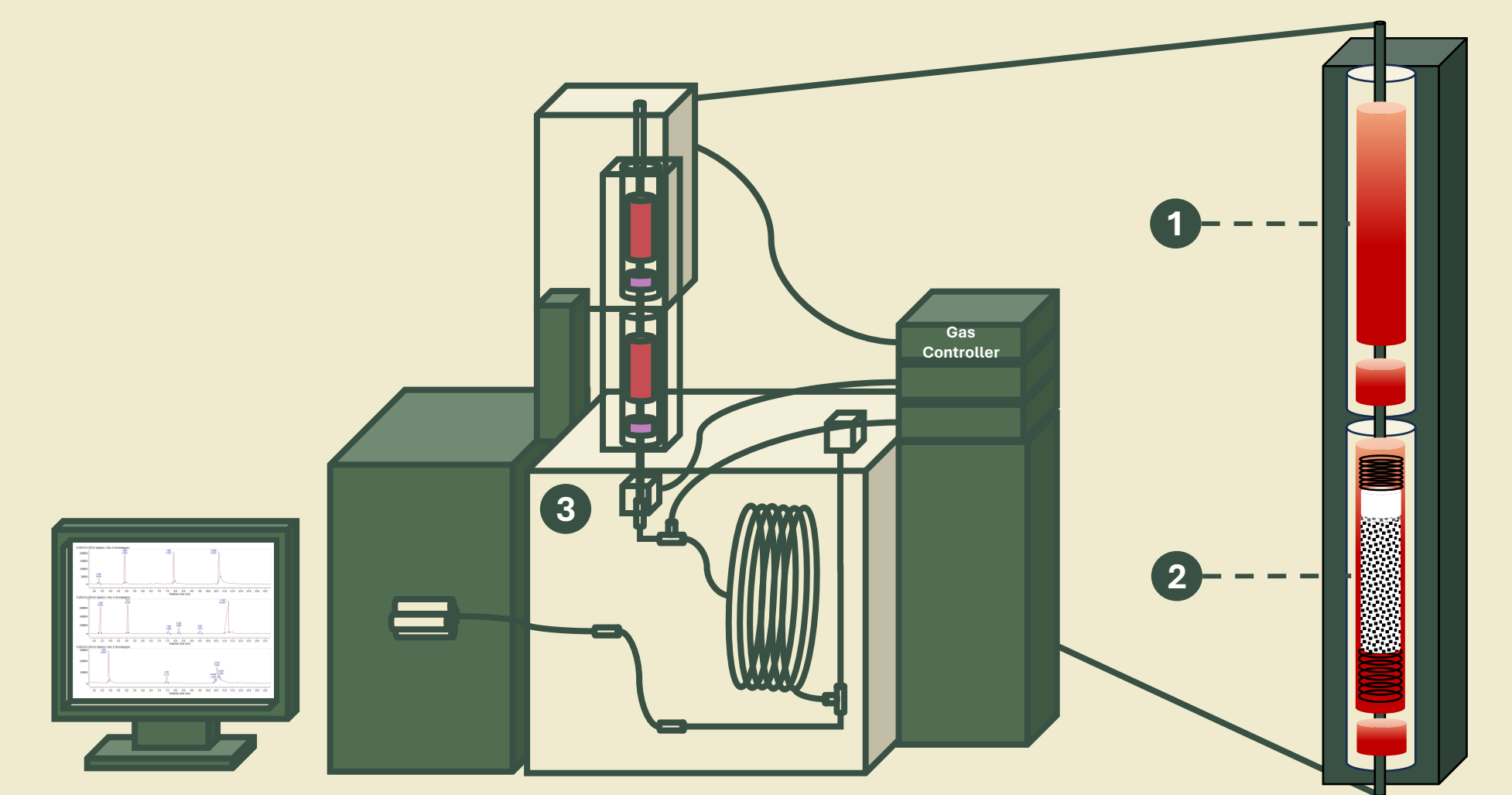


## Lignocellulosic Biomass (Birch Bark)

We are exploring biomass as an alternative feedstocks. Phenol and furan derived from biomass are expected to be aminated by ammonia to produce amine with specific type of catalyst.



## Experimental Set - Up

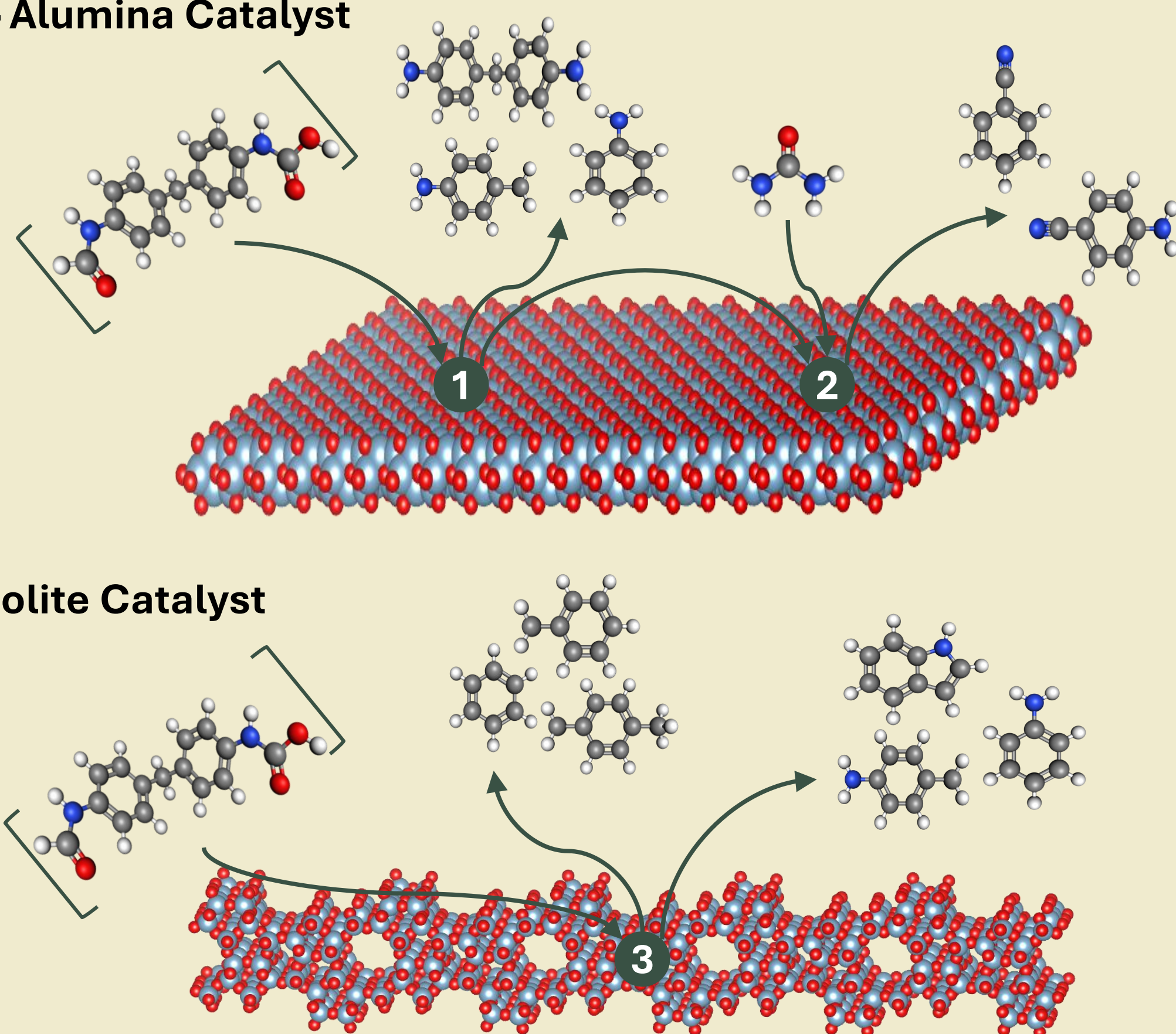


Tandem  $\mu$ -reactor (Py-GC/MS-FID)

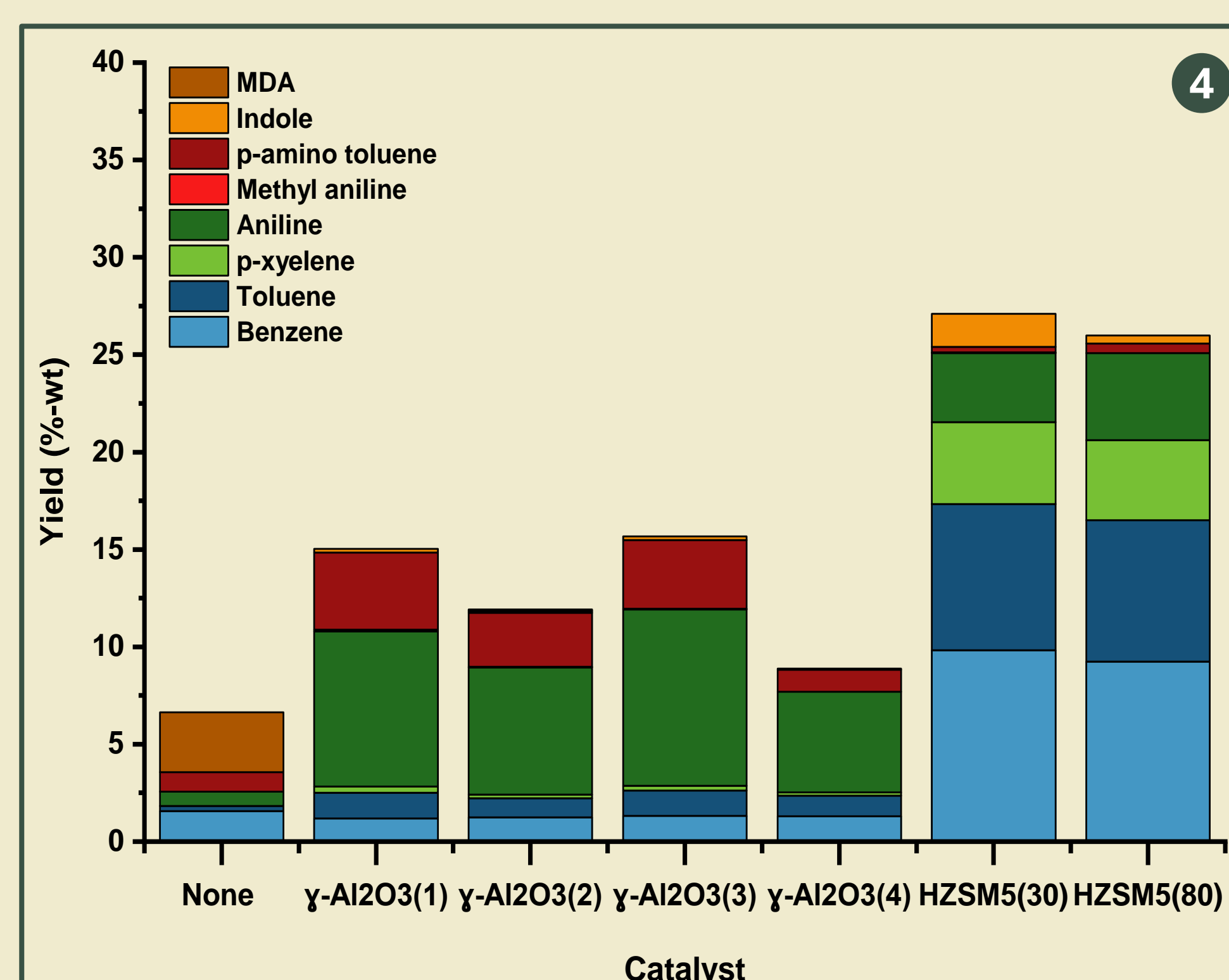
1. Pyrolysis reactor (400-600°C); 2. Catalytic upgrading reactor (400-600°C); 3. GC with FID and MS detector

## Results and Lesson Learned so far ...

### $\gamma$ - Alumina Catalyst

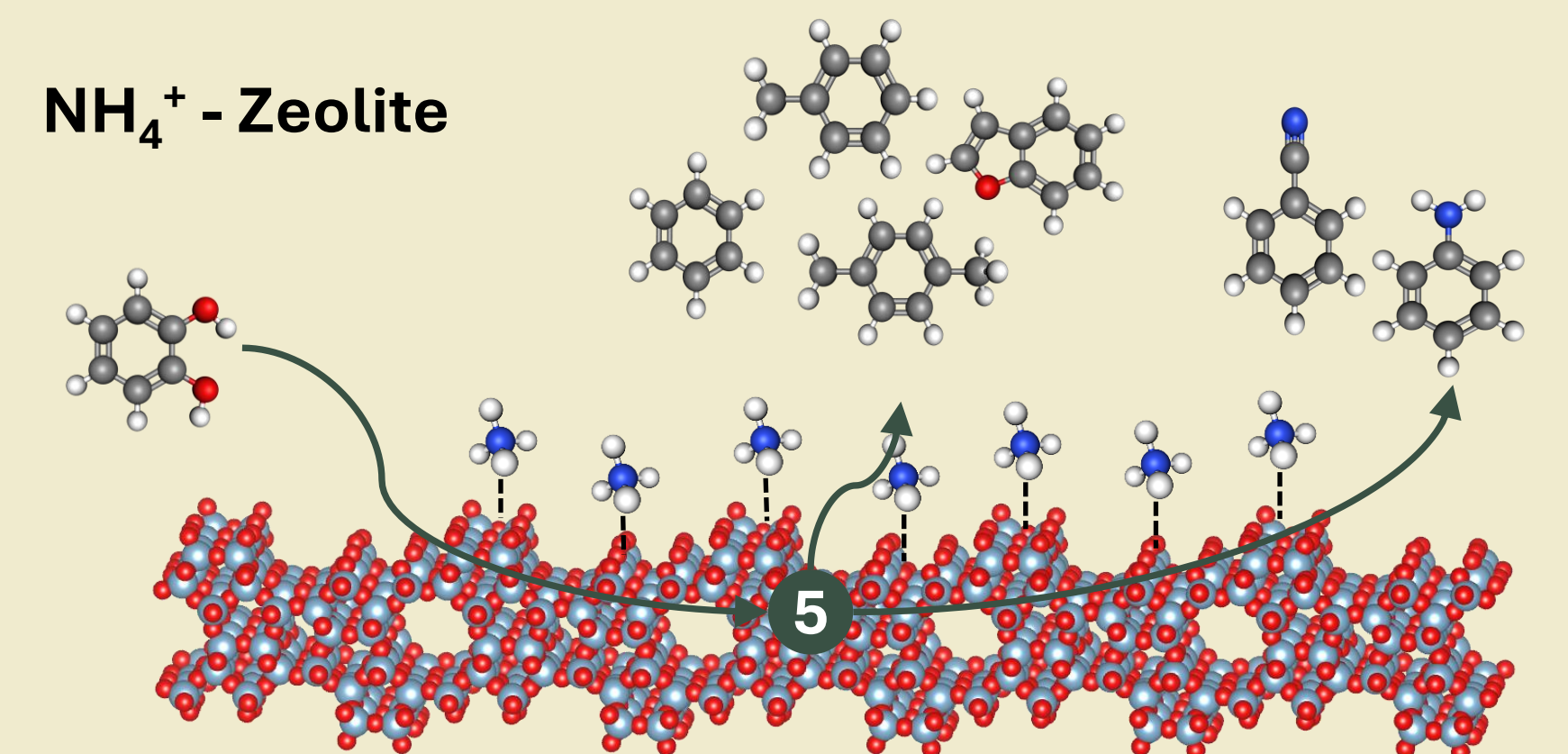


- 1 Polyurethane (PU) pyrolysis produces MDA by hydrogen transfer which went through further fragmentation to produce aniline and toluidine
- 2 By introducing urea during pyrolysis, PU pyrolysis products react further with nitrogen, producing amines, nitrile, and amino-nitrile



- 3 Zeolite type catalyst in polyurethane (PU) pyrolysis produce more BTX than nitrogenous hydrocarbon. Indole was specifically found in this case due to aromatization ability of zeolite
- 4  $\gamma$  - Al<sub>2</sub>O<sub>3</sub> catalyst is proven to be able to crack polyurethane to MDA, aniline, and toluidine

### NH<sub>4</sub><sup>+</sup> - Zeolite



- 5 Experiments using catechol (model compound for lignin) with ammonium type zeolite produced amine and nitrile compound

## Acknowledgement:

This project has received funding from RVO MOOI project 'Close Carbon Cycles with Renewable Amines'

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**3CRA** Close Carbon Cycle  
 with Renewable Amines

