

Waste fishing nets thermal decomposition and valuable products recovery

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Introduction

Many scientific and industrial institutions are researching advanced waste-to-energy technologies. Biological and plastic wastes contain high levels of hydrocarbons that can be converted into valuable energy products, supporting the development of a circular economy. However, the wide variety of waste sources with energy potential requires further research into suitable feedstocks.

Fishing nets are one such promising feedstock for pyrolysis. Marine plastic waste, including discarded fishing gear, is a major source of water pollution and severely impacts marine ecosystems. Over 600,000 tons of fishing gear are lost or abandoned in oceans each year, harming aquatic life through entanglement and restricted movement. Fishing nets are commonly made from synthetic polymers such as nylon, polypropylene (PP), and polyethylene (PE).

This research investigates the pyrolysis of waste fishing nets and the effect of catalysts and temperature on process outputs, contributing to circular economy solutions

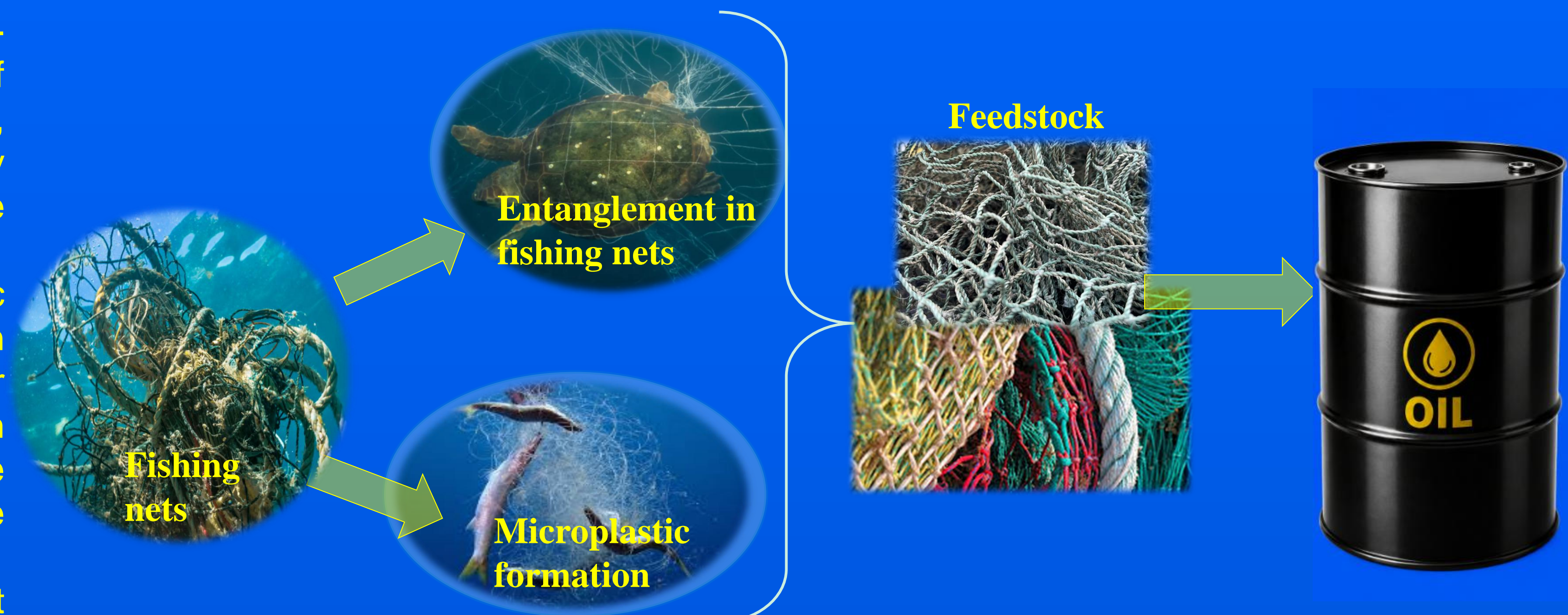
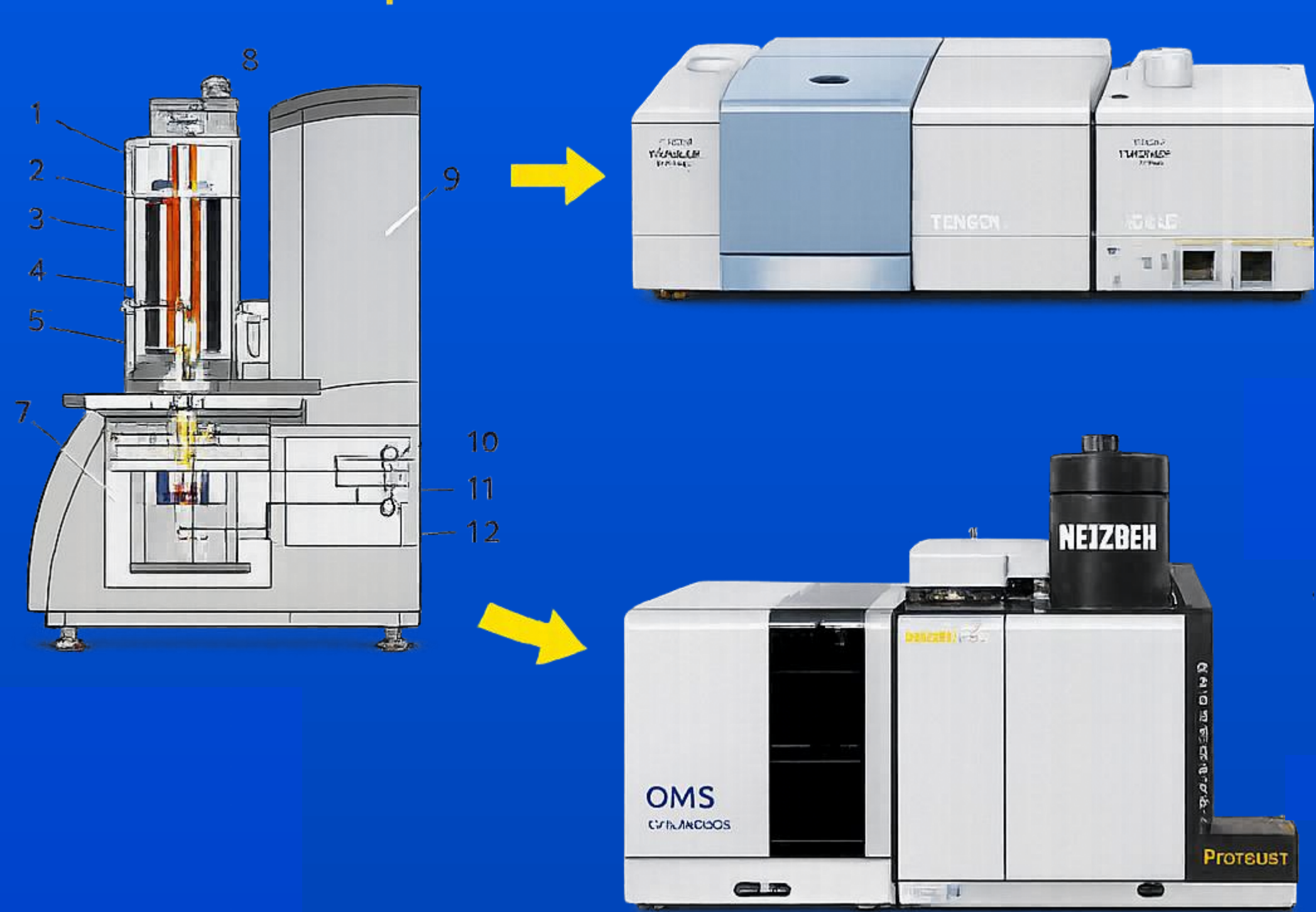


Figure 1: Graphical abstract

Methodology

Netzsch STA F3 Jupiter



1 – furnace thermocouple, 2 – heating element, 3 – sample carrier, 4 – protective tube, 5 – radiation shield, 6 – evacuation system inlet, 7 – balance system, 8 – gas outlet valve, 9 – hoisting device, 10-12 – gas inlet.

Figure 2: Micro-scale experimental setup

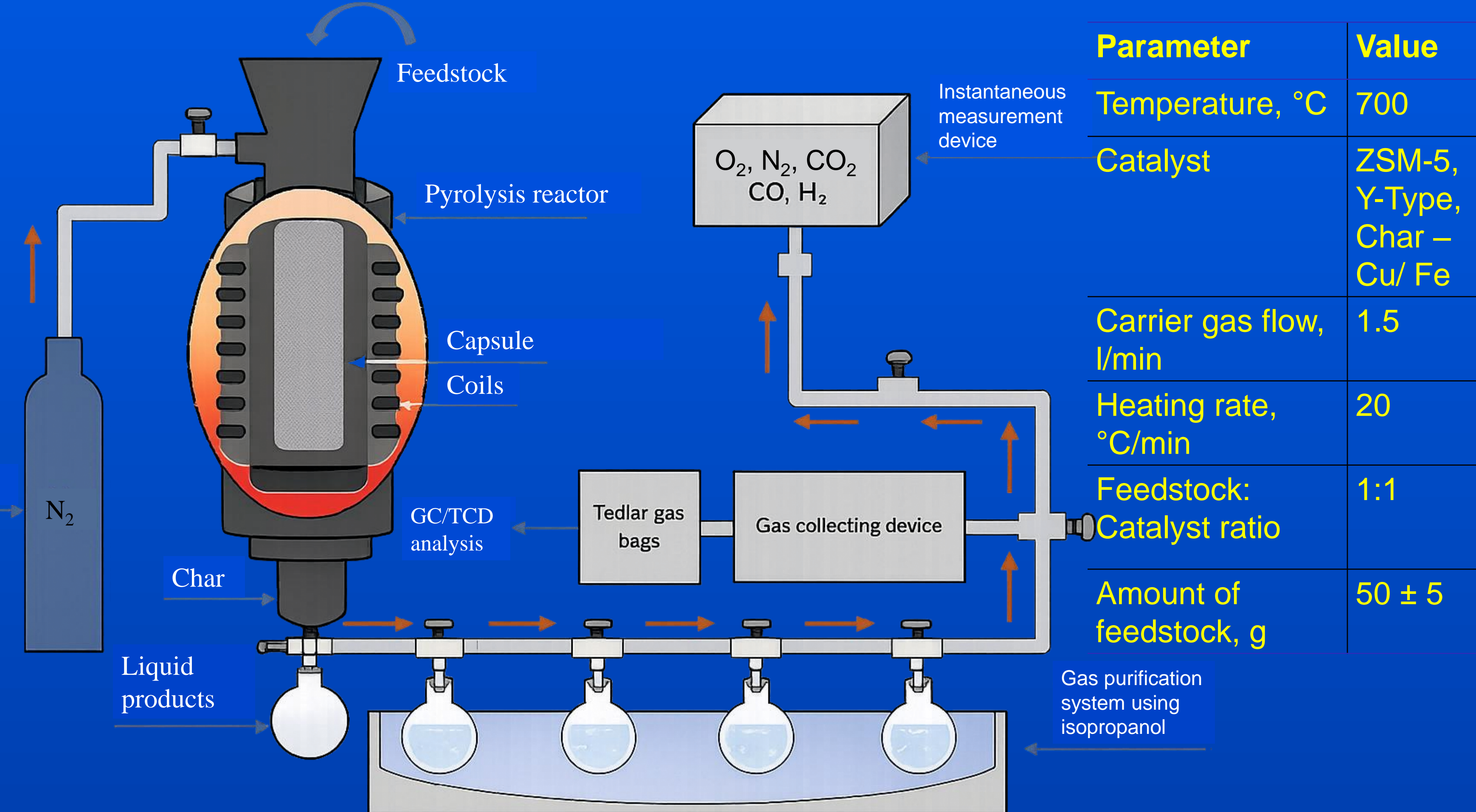


Figure 3: Laboratory scale experimental setup

Results and discussion

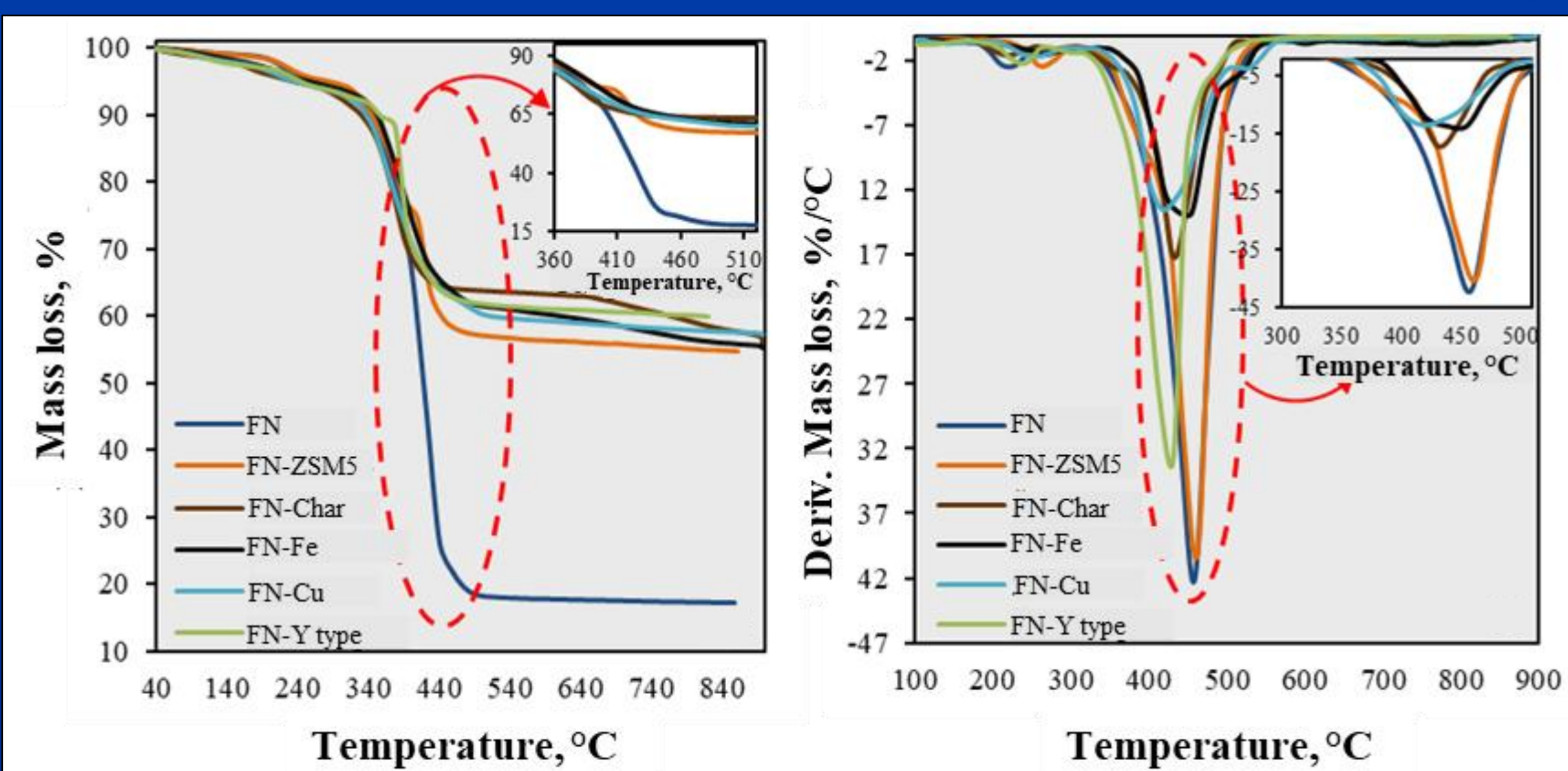


Figure 4 : Thermal decomposition curves on a micro-scale

Microthermal analysis results identified the primary decomposition curves of fishing net wastes. It is clear, that feedstock undergo a major thermal degradation stage between approximately 400-450 °C. The non-catalytic sample (FN) exhibited the sharpest mass loss and the highest degradation rate, indicating rapid decomposition of the polymer matrix. Among the catalysts, ZSM-5 promoted earlier thermal degradation. In contrast, Fe-, Cu-, Char-, and Y-type catalysts slowed decomposition, as indicated by smoother mass-loss profiles and lower DTG peak intensities. Nevertheless, the catalysts had only a little influence on the residual mass, as the catalysts themselves remained thermally stable and did not undergo decomposition during the pyrolysis process.

Conclusions

TGA-DTG results shows that fishing nets decomposes around 400-450 °C. Catalyst did not significantly change the residual mass, due to inability to decompose itself. Product yield analysis further revealed that catalytic pyrolysis enhanced liquid product formation while altering the composition of aromatic compounds, with ZSM-5 and Y-type catalysts providing the highest liquid yields and the lowest aromatic content, but significantly increases caprolactam recovery. Overall, the results confirm that catalyst selection plays a key role in optimizing both the pyrolysis process and the quality of liquid products obtained from waste fishing nets.

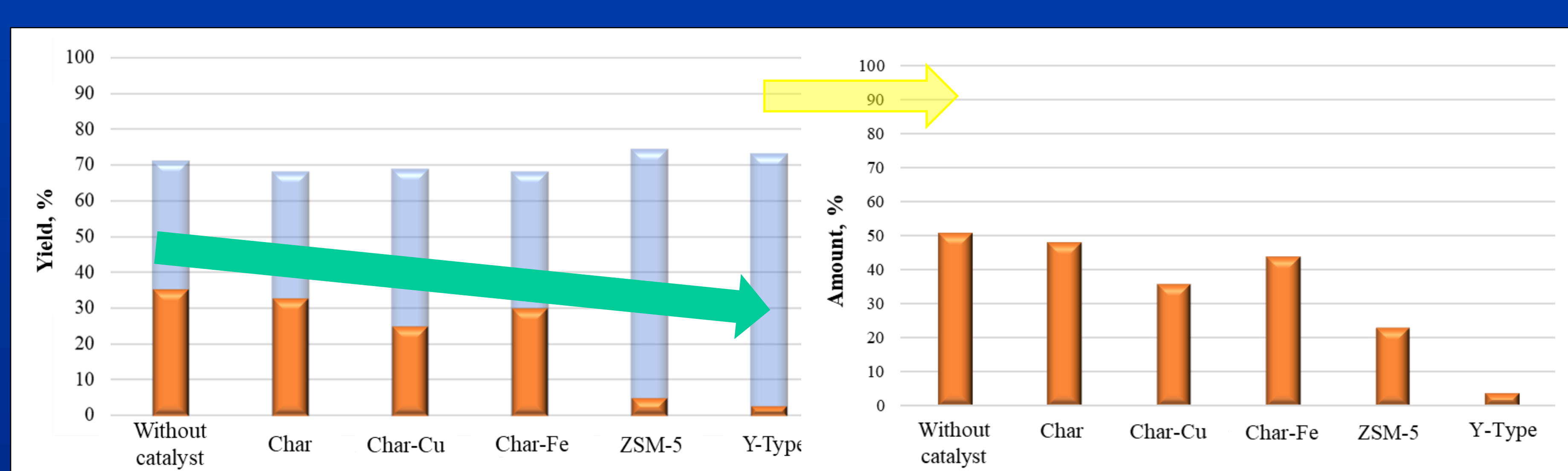


Figure 5 : The yield of liquid products from fishing nets and the content of aromatic compounds within them

The results demonstrate that catalyst selection strongly influences both the liquid product yield and the formation of aromatic compounds during waste fishing net pyrolysis. Non-catalytic pyrolysis produced the highest aromatic content (~50%), while catalytic systems generally reduced aromatic formation due to secondary cracking and reforming reactions. The remaining fraction predominantly consisting of caprolactam (main monomer of nylon-6). Among the catalysts, Char and Fe-based catalysts maintained relatively high aromatic contents, whereas ZSM-5 and Y-type catalysts significantly decreased aromatic concentration to below 25% and 5%, respectively (recovering caprolactam monomer). This outcome is particularly valuable as it enables the recovery of both energy-rich aromatic products and caprolactam, a chemical compound with clear applications in industries such as textiles and fishing net production.

Acknowledgement

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