COLLECTION OF CONDENSED VAPORS FROM BIOMASS SLOW PYROLYSIS PROCESS

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Background and objective

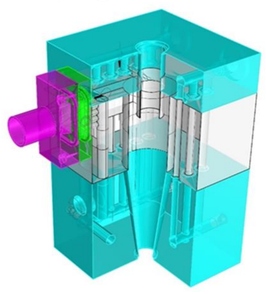
The "Biomet" project studies how to transform the wood waste of the furniture industry into a renewable char for metallurgical use. If condensed, the vapors released during the pyrolysis of wood sawdust can provide bio-oil with market value. The liquid obtained from slow pyrolysis is a high-value by-product because it minimizes the unwanted post-pyrolysis reactions. The bio-oil is a natural fungicide. It can control plant disease and avoid the massive use of pesticides.

Wood sawdust undergoing slow pyrolysis

Experimental investigation

We built a prototype to demonstrate how the FumeCatch technology helps accomplish the goal above. The prototype purifies exhaust fumes and recovers vapors effectively by promoting their condensation. The rapid cooling produces a liquid aerosol collected by a cyclone. A portion of the purified stream is cooled through a heat exchanger and reintroduced into the flue gas in a continuous and closed-loop cycle.

We used two refrigeration approaches to study its behavior: a reservoir with ice and water and a chiller providing water at 5 °C. We evaluated the impact of a chiller on pyrolysis products, such as biochar, bio-oil, and syngas.

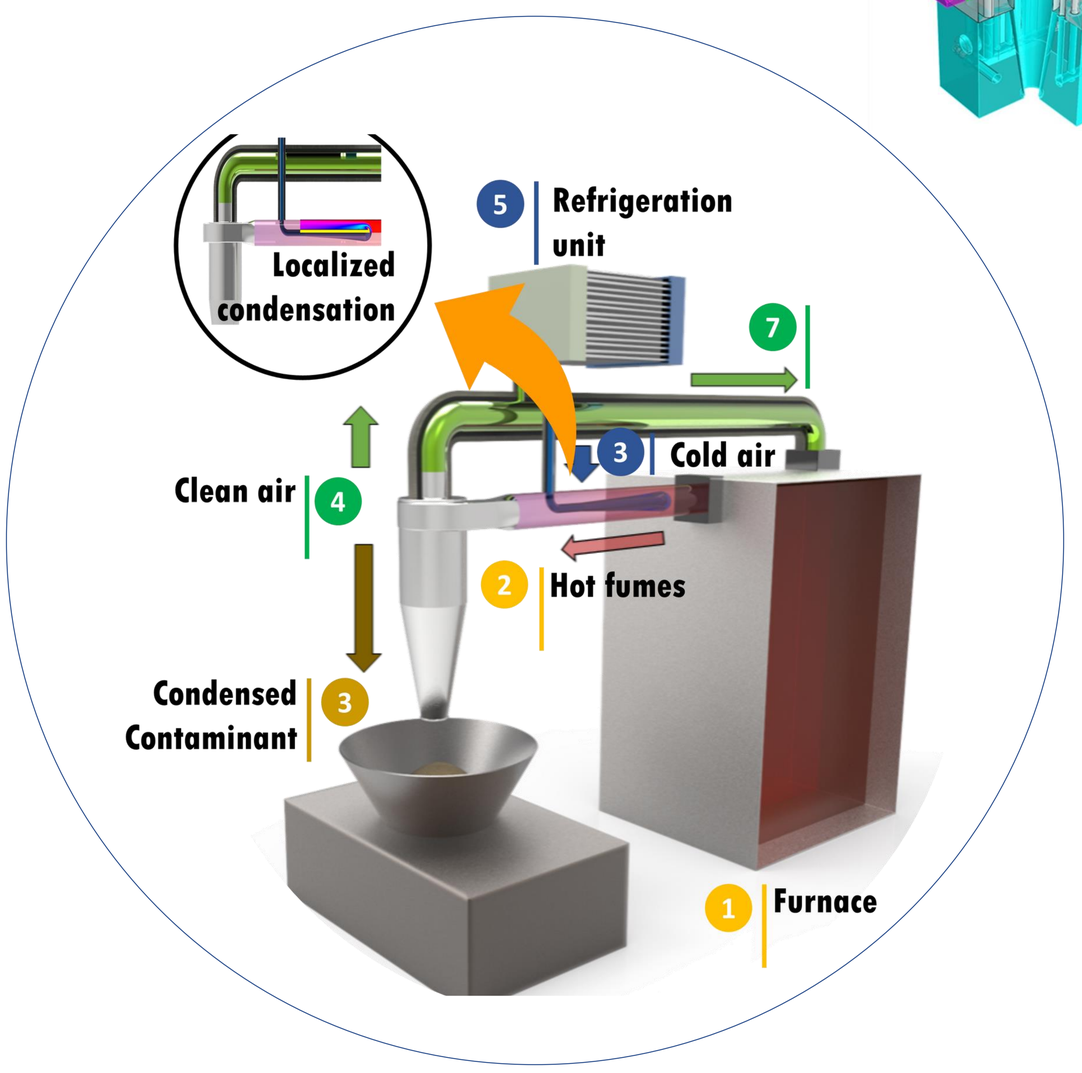


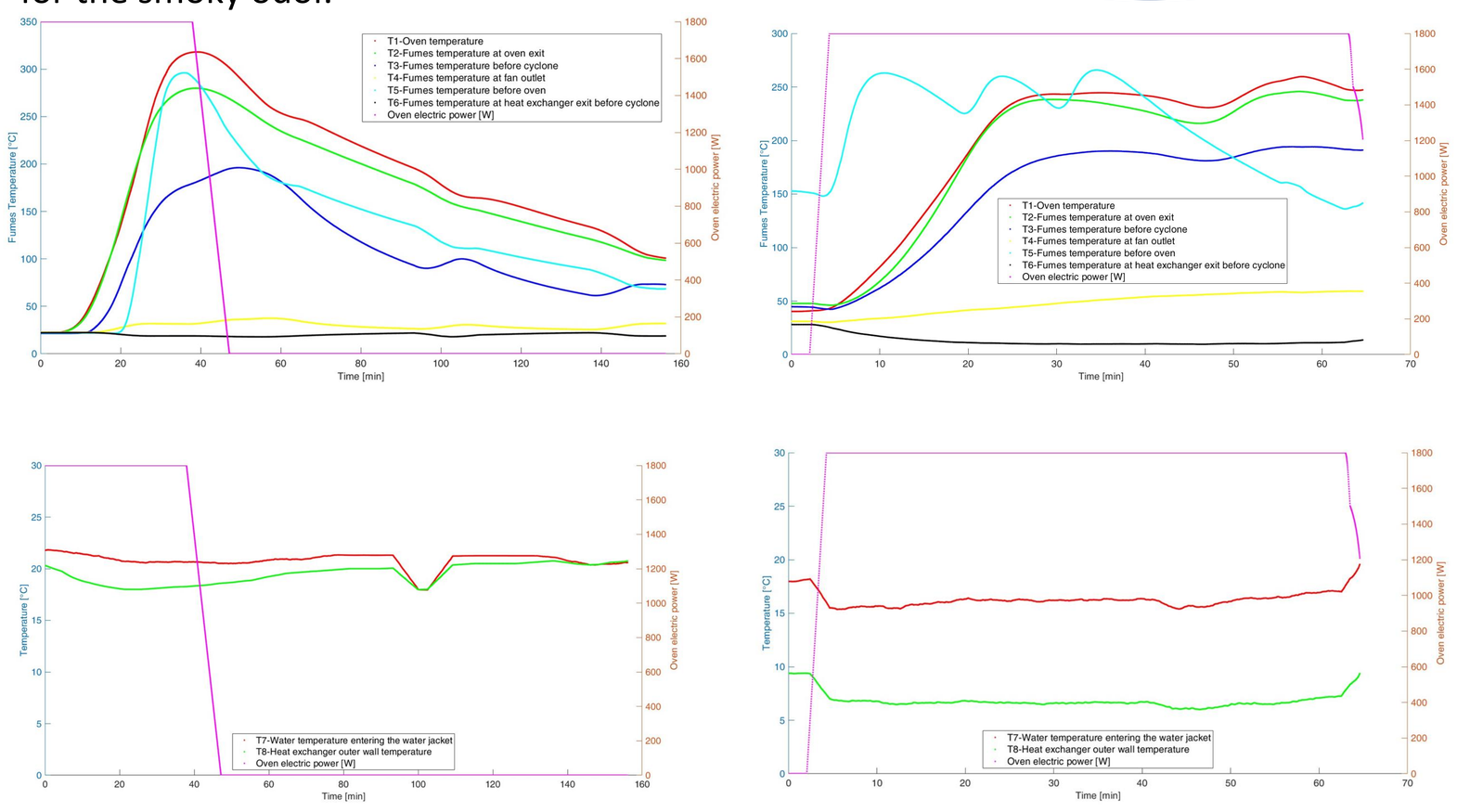
Cyclone with water jacket

Results

The collection efficiency of the prototype using ice was 47%. Using the chiller, it increased to 52%. The ice brought the temperature of the heat exchanger wall to around 20 °C while the chiller decreased it to 7 °C.

The chemical analysis of the bio-oil provided 66.9 wt.% water and 33.1 wt.% chemical derivatives from wood, with acetic acid accounting for 4.5 wt.%. While the chemical profile matches bio-oils obtained from slow pyrolysis, the lower yield suggests a slower process. Headspace gas chromatography-mass spectrometry revealed volatile compounds like light organics, furanic, and phenolic derivatives, with phenols responsible for the smoky odor.





Temperatures of streams during experiments with ice and with chiller

Results

	With ice	With chiller
Biomass initial mass [g]	122.1	140.4
Char mass [g]	37.4	52.6
Bio-oil mass [g]	19.9	20.8
Total by-products mass [g]	57.3	73.4
Collection efficiency [%]	46.9	52.3

Conclusions

- The prototype based on FumeCatch technology can serve as a slow pyrolizer
- The adoption of a chiller improves the collection efficiency
- Pyrolyzing wood sawdust at a slow heating rate and a maximum temperature of 340 °C resulted in more biochar than pyrolysis oil
- Future improvements include boosting cyclone efficiency, sealing the fan unit, and increasing the heating rate. This technology is promising for converting furniture industry waste into useful char and bio-oil, aiding in sustainable waste management.

This study was carried out within the MICS (Made in Italy– Circular and Sustainable) Extended Partnership and received funding from Next-GenerationEU (Italian PNRR– M4 C2, Invest 1.3 – D.D. 1551.11-10-2022,PE00000004).