# Understanding the behavior of chitin in Sub- and Supercritical Water continuous reaction systems

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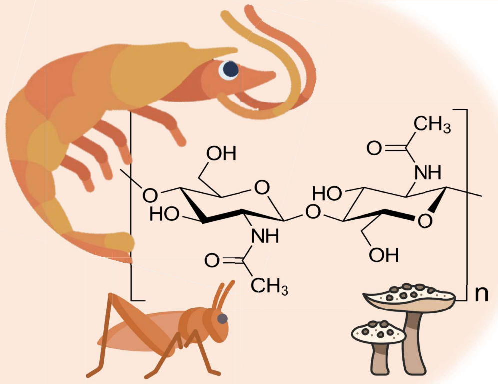



## *How to use sub- and supercritical water to get the most out of chitin in a fast and sustainable way?*

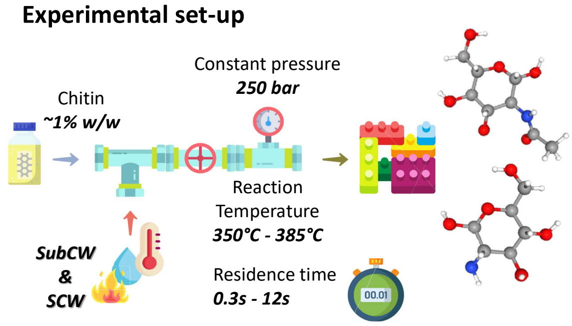
***(1,4)-β-N-acetylglucosamine*** ($(GlcNAc)_n$), commonly known as chitin, is the ***second most widespread*** bio-polymer worldwide. Its ***high crystallinity*** and ***low solubility*** limit the exploitation of its antimicrobial, non-toxic and biodegradable properties, among others [1].

***Depolymerization*** of chitin ***improves its solubility*** and ***reduces the size of the polymer chain***. Chitin oligomers ***$(GlcNAc)_{2-7}$*** are attracting attention in various fields such as biomedical and agricultural[2].

Chitin oligomers can also lead to the production of ***N-containing building blocks***: furan-base monomers, and amines[3].

So far, ***batch reactors*** and residence ***times longer than 1 min*** with ***sub- and supercritical water*** have been tested to ***depolymerize chitin***. Yet, the ***presence of side-reactions*** competing with depolymerization has been reported when using these technologies (formation of ***humic compounds***, ***char***, and ***gasification***)[1].

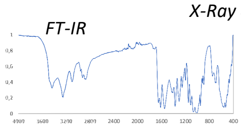
## Experimental set-up




## Analytical methods

***Water insoluble products***

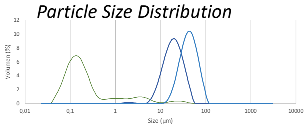
*FT-IR*



*X-Ray diffraction*

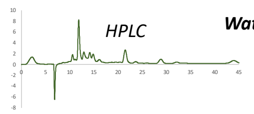
*Molecular Weight (Intrinsic Viscosity)*

*Particle Size Distribution*




*Elemental Analysis*

*HPLC*



***Water soluble products***

*Total Nitrogen*

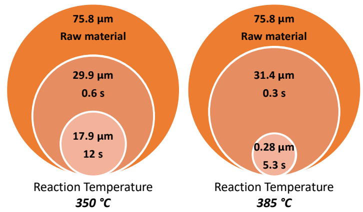
*Total Organic Carbon*

*pH*

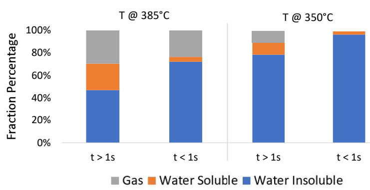
## Outcome

- ✓ At constant temperature and residence time greater than 1s, an increase in the water-soluble fraction of the products was observed. From 4.3% (t > 1s) to 23.5% (t > 1s) @ 385°C and 3% (t > 1s) to 11% (t > 1s) @ 350°C.
- ✓ A greater influence of temperature than residence time on the intensification of the gasification process[1] (***>10%***) and particle size reduction was observed.
- ✓ The composition profile of the water-soluble product is independent of the reaction conditions. The presence of ***glycolaldehyde***, ***acetic acid***, ***5-HMF***, ***dihydroxyacetone*** was detected.

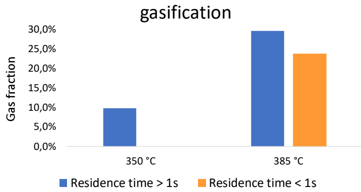
Residence time and reaction temperature influence on particle size



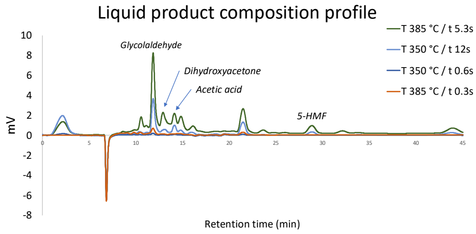

Residence time influence




Reaction temperature influence on gasification

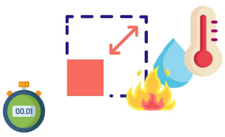



Liquid product composition profile

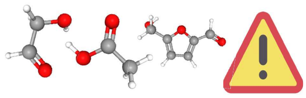



## Conclusions & On track

***Reaction temperature*** has a greater effect on ***particle size*** than residence time.

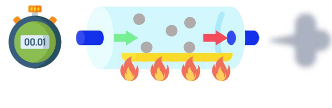


Glycolaldehyde, 5-HMF, Ammonia, Acetic Acid presence indicate ***predominance of side-reactions***.



Solid product characterization is necessary to detect possible production of humic compounds.

***Gasification was observed*** at high temperature and long residence time.



Ongoing development of a protocol for gas phase capture and characterization (GC-MS).

Structural transition from ***β to α*** chitin in the solid product was observed at every condition. (FT-IR technique)


***References.***
[1]T. M. Aida et al., Carbohydr. Polym., 2014, vol. 106, no. 1, pp. 172–178. / [2]G. Villa-Lerma et al., Bioresour. Technol., 2013, vol. 146, pp. 794–798. / [3]X. Cai et al., Renew. Sustain. Energy Rev., 2021, vol. 150, no. June, p. 111452. / M. Osada, et al., Carbohydr. Polym., 2015, vol. 134, pp. 718–725.

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