



PROCEEDING

ICOMIERA

**INTERNATIONAL CONFERENCE ON MECHANICAL ENGINEERING
RESEARCH AND APPLICATION**

**"INNOVATIVE RESEARCH IN ENGINEERING FOR THE 21ST
CENTURY"**

7 - 9 OCTOBER 2020



**MECHANICAL ENGINEERING DEPARTMENT
UNIVERSITAS BRAWIJAYA, MALANG - INDONESIA**

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PREFACE

I would like to express my gratitude to all participants, from the researchers to the industrial partners, who were joint the online iCOMERA 2020 conference. Special recognition should be given to Mr. Hastono Wijaya who strongly supported this second iCOMERA 2020 as he already did during the first edition of the conference in 2018. To all committee members who worked hard to bring this conference to life, a profound gratitude should also be addressed. Shifting the event to virtual format due to the COVID-19 pandemic is hard, and not having any previous experience on this makes it even more complicated. Only the committee's strong commitment and dedication made this event possible.

The Mechanical Engineering Department organizes the iCOMERA conference every other year, taking turn with the National Conference SAINTEK. Therefore, postponing iCOMERA to the 2021 would have destroyed the already fixed agenda of ME conferences. We also had commitments already taken and signed, such us publication with IOP – Material and Science Engineering, UB Alumni and with some colleagues who wanted to joint this conference. For all these reasons the iCOMERA committee kept the original schedule by shifting to virtual format.

It was then quite a surprise that despite all those problems, the number of participants to the conference has reached more than 221 contributors, which is even a higher number than what was registered for the previous iCOMERA edition in 2018. This is telling us that the iCOMERA conference is becoming popular in the engineering community. I believe this is the result of the good service given in the previous iCOMERA 2018 by the organizing committee. All this hard work should be preserved to make the iCOMERA conference series sustainable and make it a fixed event in the engineers' international conference agenda.

Those 221 papers then publish in varied plat form such as: International Journal of Integrated Engineering, IoP conference series proceeding: Materials Sciences and Engineering, Jurnal Rekayasa Mesin, International Journal of Mechanical Engineering Technologies and Applications, Varied journals indexed by SCOPUS (in progress) and this iCOMERA proceeding.

In this occasion, we also invite you to contribute to the next 2022 iCOMERA conference.

Head of Mechanical Engineering Department
Brawijaya University

Prof. Ir. Djarot B. Darmadi, MT., PhD.

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CERTIFICATE OF PARTICIPATION

The 2nd International Conference on Mechanical Engineering Research and Application

“Innovative Research in Engineering for 21st Century”

October 7-8, 2020

The Mechanical Engineering Department of Brawijaya University, Indonesia

This is to certify that

Mokh. Hairul Bahri

Have presented a paper entitled

Effect of Natural Zeolite on Biomass Pyrolysis

Head of the Mechanical Engineering Department



Ir. Djani Sugeng Darmadi, MT., Ph.D.

Chairman of Conference



Dr. Ing. Victor Yuardi Risonarta, ST., M.Sc

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Effect of natural zeolite on biomass pyrolysis

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Abstract. Study the pyrolysis of biomass with the addition of natural zeolite to determine the enthalpy required to become gas, oil, and char. The materials used were *Sengon* (S) sawdust and natural zeolite type *Clipnotilolite* (Z). The pyrolysis process used STA *Iliensies* PTA 1600. The test samples S, S + Z1, S + Z2, and S + Z3 were heated at a heating rate of 20 °C min⁻¹ and an air flowrate (Argon) of 0.5 liters min⁻¹. The result shows that the enthalpy of pyrolysis S decreases with the increase of Z. The greater the percentage of Z the decrease in enthalpy is getting sharper, while the decrease in mass is relatively small.

Keywords: *Sengon* sawdust, *Clipnotilolite*, pyrolysis, enthalpy

1. Introduction

The search for energy sources to replace fossil fuels was a world trend today. Energy sources that were easily available and abundant availability were priority searches. One of the alternative energy sources was biomass. Biomass energy sources were easily available and widely abundant in Indonesia, such as straw, wood chips, and sawdust. One way to obtain biomass energy was pyrolysis. The result of pyrolysis was in the form of bio-oil which becomes liquid fuel. One of the challenges in the pyrolysis process was the amount of activation energy [1]. Various methods were used to reduce activation energy. One of them was by adding a catalyst during the pyrolysis process. The addition of a catalyst has been shown to accelerate the thermal degradation process of biomass [2]. This research uses sawmill waste which is abundant in the province of East Java, Indonesia. Meanwhile, the catalyst used was natural zeolite obtained from traditional mining in the South Malang area. Several researchers have conducted biomass pyrolysis experiments by testing bioenergy potential using thermogravimetric analysis techniques, including [3] using camel grass (*Cymbopogon schoenanthus*) and [4] using Para Grass (*Urochloa mutica*). This experiment has studied the effect of adding natural zeolite (Z) as a catalyst to *Sengon*'s sawdust (S) using thermogravimetric analysis techniques.

2. Methods

The biomass used in this experiment was wood sawdust waste from *Sengon* (*Albizia Falcataria*). The characterization of the catalyst used after XRD testing was the *Clipnotilolite* type. Both materials are ground until they pass 100 mesh size. Testing samples using an initial mass of 20mg. The variation of the addition of natural Zeolite (Z) with the addition of 5.10 and 15% of the initial mass (S) subsequently called Z1, Z2 and Z3. The test equipment used was STA *Iliensies* PT1600. The



test procedure is by operating the STA at an Argon flowrate of 0.5 liters min^{-1} and a heating rate of 20 $^{\circ}\text{C}^{-1}$. The data recorded by the computer were time, temperature and relative mass decline. The results displayed are graphs of mass loss rate and heat flow to temperature. The composition and constituent elements of S are shown in Table 1.

Table 1. Characterization of *Albizia Falcataria*

Ultimate analysis	(dry basis, wt.%)	Proxymate analysis	(dry basis, wt%)
Carbon	45.53	Moisture	7.2
Hydrogen	6.49	Volatile matter	74.9
Nitrogen	0.31	Fixed Carbon	16.46
Sulfur	0.1	Ash	1.44
Oxygen	46.13	Gross Caloric Value (J/g)	18.229

3. Result and discussion

The results were shown in graphical form in Figure 1. In each image, there are 2 graphs. The first graph has shown mass loss relative to temperature (which was at the top) and the second graph has shown heat flow relative to temperature. The graph of mass loss relative to temperature has shown the percentage loss of relative mass due to an increase in temperature. In Figure 1, it can be seen that the percentage of mass loss was relatively greater than in Figure 2. The STA reactor has heated the exothermic S because there was no subzero value. So that the heating from the STA reactor was used to remove moisture and volatile matter from S (Sengon's sawdust).

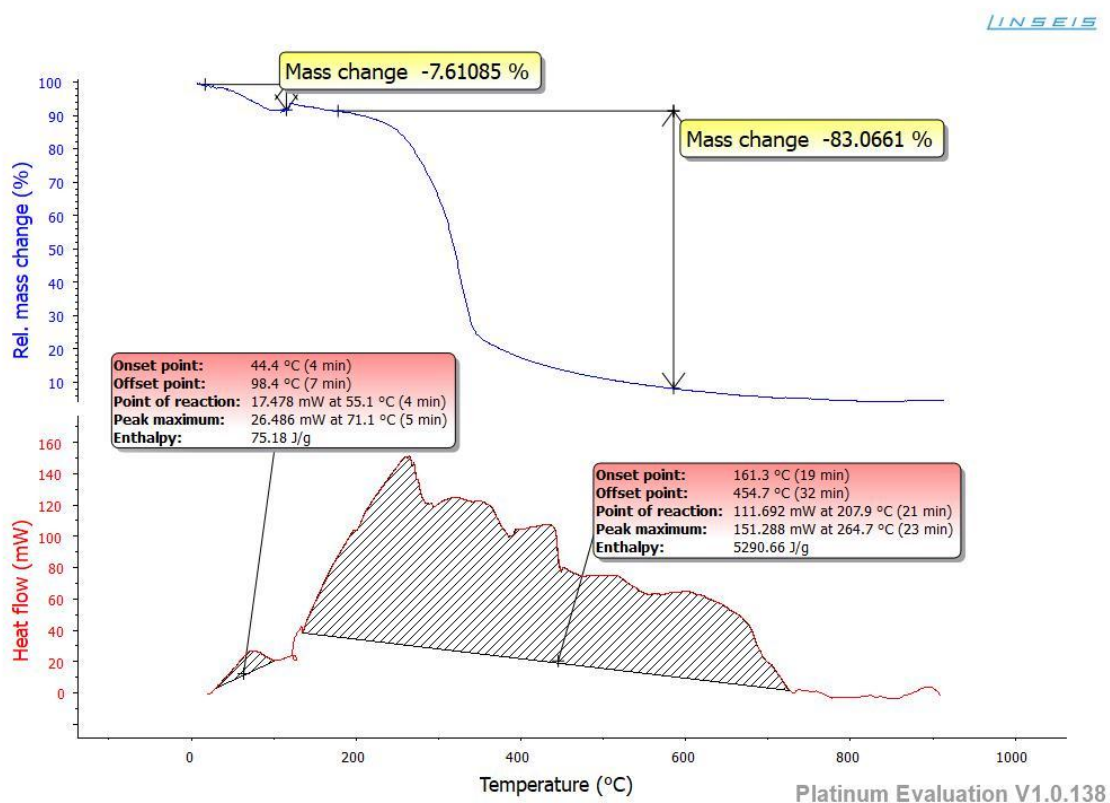


Figure 1. Graph of Sengon's sawdust pyrolysis

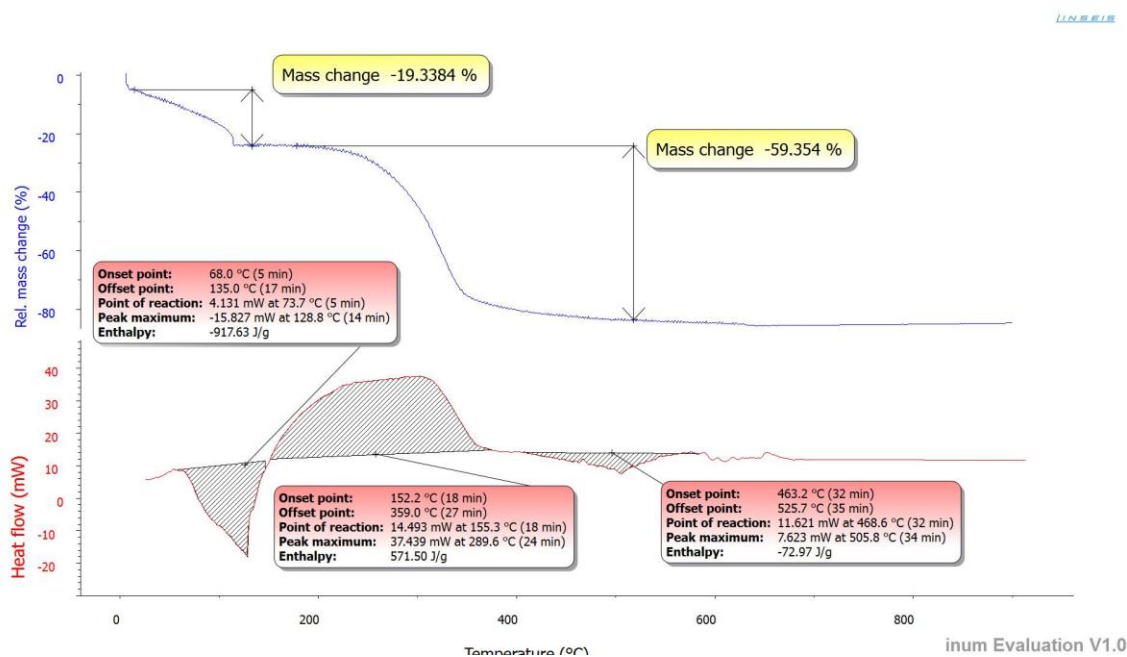


Figure 2. Graph of Sengon's sawdust + Z1 pyrolysis

Figure 2 shows the relative mass loss that occurs less than Figure 1. In this second test sample (S+Z1), endothermic and exothermic heating has occurred. Likewise, for the third and fourth samples, the results were shown in graphical form in Figure 3-4. The addition of Z (natural zeolite) affects the pyrolysis process at the beginning of heating. Z with dominant Si and Al content absorbs more heat than other elements. The more Z was added, the more heat will be absorbed during preheating. But not all of the heat on preheating was absorbed by Z. At an appropriate increase in the percentage of Z, there was a balance between heat absorbed and heat released.

The difference in heat absorption between S and S + Z may be due to the thermal conductivity of the material. Z as a mineral has a higher thermal conductivity than S so that at the beginning of heating it will first absorb heat from the STA reactor. When Z has met its heat absorption, Z will be released to S so that the percentage of mass loss is relatively less (shown in Figure 2-4). It also causes less heat to be used than the pyrolysis S in Figure 1.

The enthalpy shown in Figure 1-4 indicates the energy that has been consumed by S, S + Z1, S + Z2, and S + Z3 during the pyrolysis process, to turn into several products, including bio-oil, gas, and charcoal.[5].

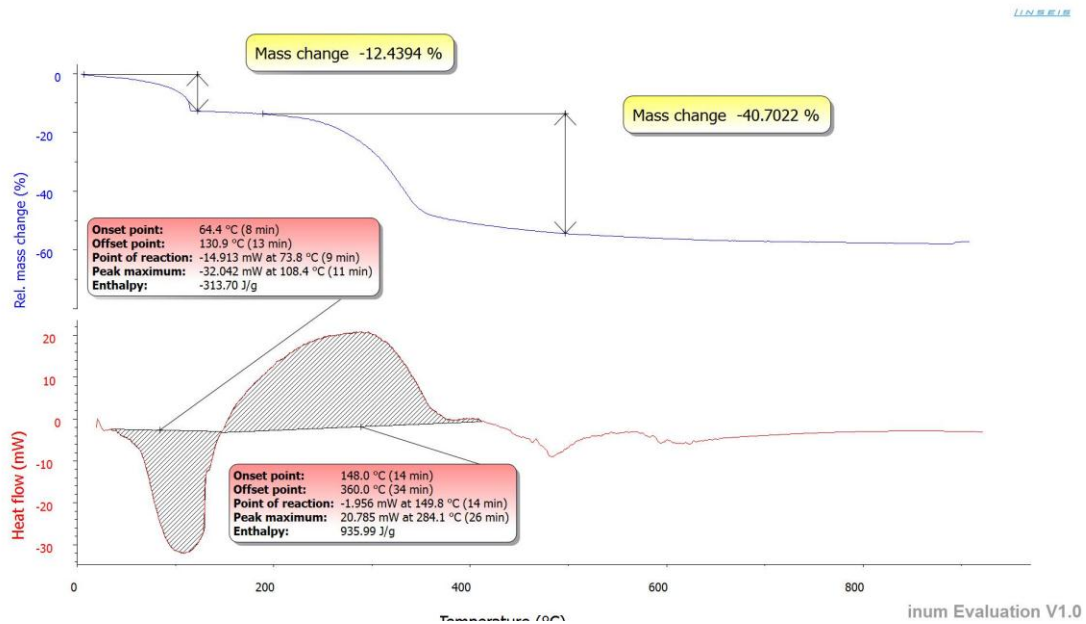


Figure 3. Graph of Sengon's sawdust + Z2 pyrolysis

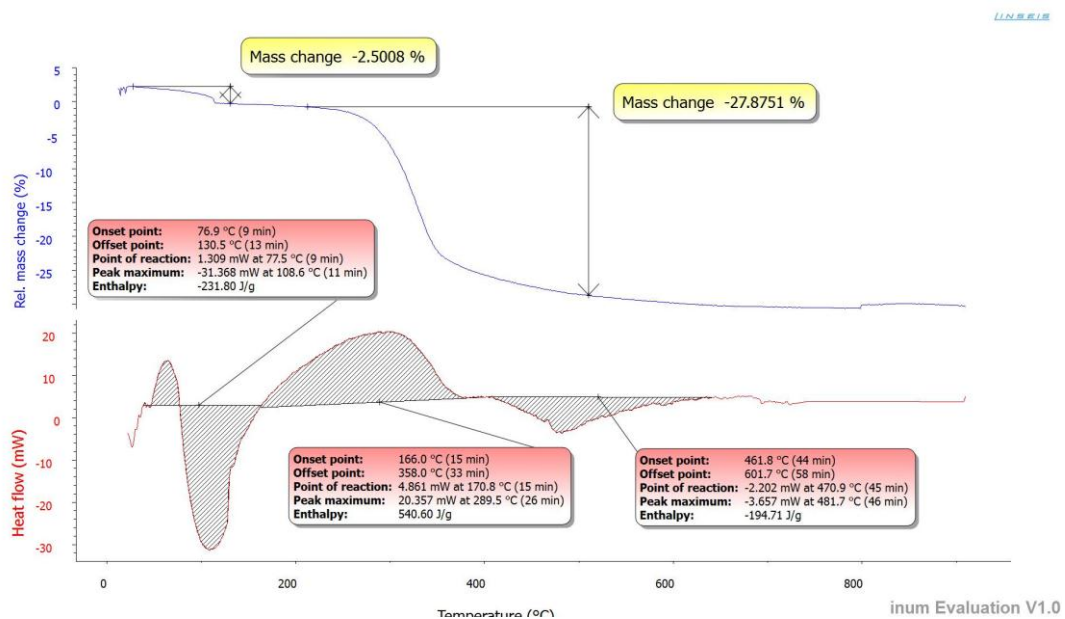


Figure 4. Graph of Sengon's sawdust + Z3 pyrolysis

4. Conclusion

This study has obtained data on the effect of natural zeolites on the pyrolysis of S biomass. It has been shown that the greater the percentage of Z, the lower the energy required to convert S into product yield. Furthermore, it is necessary to optimize the right mixture of S and Z so that the product yield becomes maximum and high quality.

5. Acknowledgement

The author would say thank a lot to Dean of Engineering Faculty and Head of Mechanical Engineering, *Universitas Muhammadiyah Jember* for financial supporting in this manuscript.

6. References

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