

PRODUCTION OF RECYCLED PAPER REINFORCED CELLULOSE NANOFIBER (CNF)

Muhamad Firdaus bin Juhari, Atiqah binti Mohd Shahabuddin,
NurHamizah Adlin binti Abd. Halim
Khairatun Najwa binti Mohd Amin
Faculty of Chemical Engineering Technology and Process,
College of Engineering,
Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang,
Kuantan, Pahang, Malaysia



INTRODUCTION

- **68 Million** trees are **cutdown** every year (Pivnenko et al., 2014).
- **Paper waste** increasing from 15 to **35 Million** tonnes over **10** years.



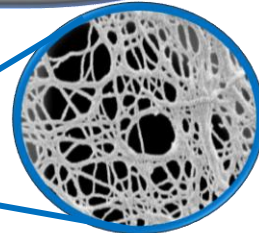
Environmental Friendly Approach of Paper Production



Recycle paper



Empty fruit bunch (EFB)



Cellulose Nanofiber (CNF)

Economic Potential and Environment

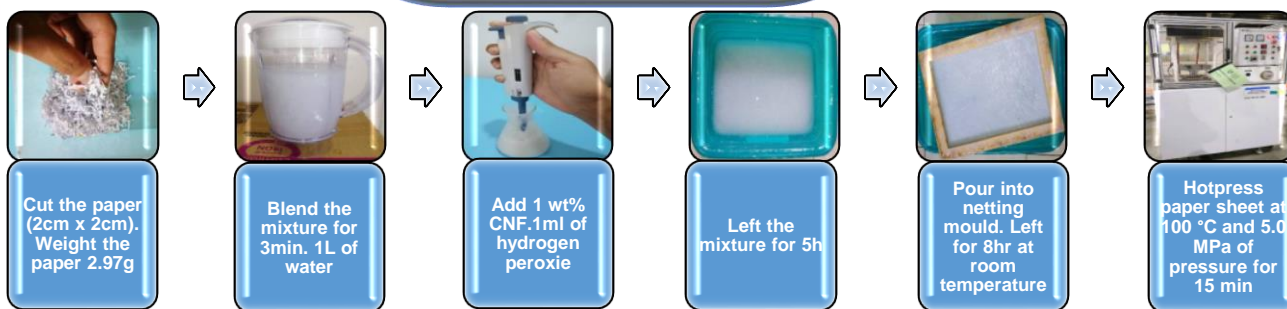
- **57 tonnes** of **paper waste** every months in Malaysia.
- **One tonne** of paper required **26,500L** of water and **17** trees.
- **Lowest** price of CNF.
- **Maintaining quality** of recycled paper.

Research Aims

1. To produce recycled paper reinforced with cellulose nanofiber (CNF)
2. To determine the best condition of CNF/recycled paper production.

METHODOLOGY

FABRICATION OF PAPER



CHARACTERIZATION



1. The tensile specimen cutting the paper into 70mm x 10mm. 2. Separated the tensile grips at a speed of 15 points per seconds.

The spectra obtained at wavenumbers ranging from 400 – 4000 cm^{-1} .

NOVELTY

- ✓ The novelty of this research is application of CNF (renewable) as filler to enhance properties of recycled paper.

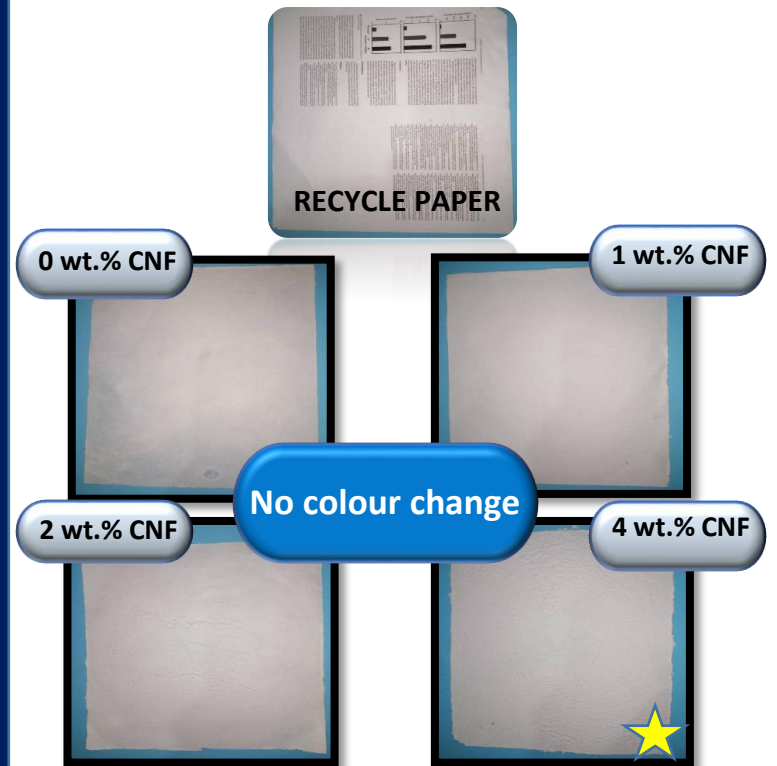
APPLICATIONS



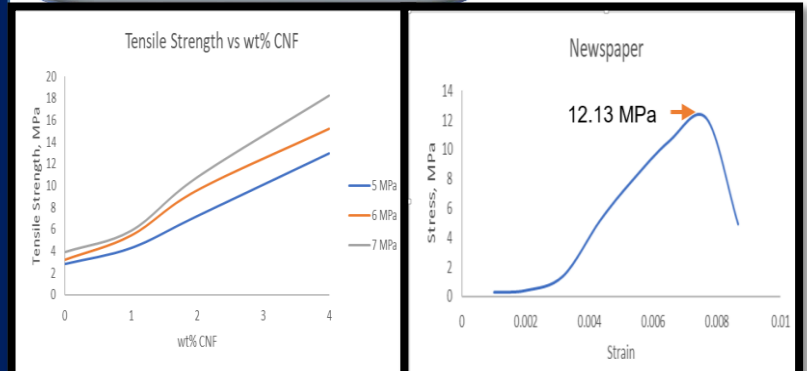
OFFICE PAPER NEWSPAPER TISSUE PAPER

RESULT AND DISCUSSIONS

PHYSICAL APPEARANCE



MECHANICAL TESTING



Parameter	Blank sample			1.0 wt% CNF			2.0 wt% CNF			4.0 wt% CNF		
	5.0 MPa	6.0 MPa	7.0 MPa	5.0 MPa	6.0 MPa	7.0 MPa	5.0 MPa	6.0 MPa	7.0 MPa	5.0 MPa	6.0 MPa	7.0 MPa
Load, N	0.96	1.23	1.62	1.79	2.14	2.38	2.87	3.78	4.22	5.27	5.89	7.04
Tensile strength, MPa	2.83	3.18	3.93	4.30	5.40	5.88	7.23	9.55	10.78	13.0	15.20	18.28

- ✓ The highest tensile strength was achieved at 4wt% CNF at 7 Mpa recorded 78.45%. The addition of CNF significantly improved the tensile strength of paper (Usachev et al., 2020).

CONCLUSION

- ✓ The recycle paper was successful produced by reinforced with cellulose nanofiber (CNF).
- ✓ The best condition of recycled paper production was paper 4wt% CNF at 7 MPa hot compress pressure.

REFERENCES

- ✓ Pivnenko, K., Eriksson, E., & Astrup, T. F. (2014). Waste paper for recycling: Overview and identification of potentially critical substances. *Waste Management*, 23 45(March), 134–142. <https://doi.org/10.1016/j.wasman.2015.02.028>
- ✓ Usachev, S. V., Zlenko, D. V., Nagornova, I. V., Koverzanova, E. V., Mikhaleva, M. G., Vedenkin, A. S., Vtyurina, D. N., Skoblin, A. A., Nikolsky, S. N., Politenkova, G. G., & Stovbun, S. V. (2020). Structure and properties of helical fibers spun from cellulose solutions in [Bmim]Cl. *Carbohydrate Polymers*, 235, 115866. <https://doi.org/https://doi.org/10.1016/j.carbpol.2020.115866>