ID 3019

Effects of Alkaline Treatment Time on Plant Fibre Quality

Kadem Souhila[1*], Mohamed Amine Kacem[2], Bertouche Sadjia[1], Abchiche Hacina[1], Chekir Nadia[1], Bouchelkia Imene[1], Sabba Nassila[1] Mellal Mounir[1]

[1]Laboratory of Matter's Valorization and Recycling for Sustainable Development VRMDD, USTHB

[2]Faculty of Applied Sciences. University of Kasdi Merbah

*Corresponding author: s.kadem.78@gmail.com

ABSTRACT

Alkaline treatment is commonly used to improve the properties of plant fibres intended for composite applications. The aim of this work was to evaluate the effectiveness of the duration and concentration of the alkaline treatment on the mechanical properties (tensile strength and elastic modulus) of mechanically extracted fibres from agave sisalana. The plant fibres were immersed in sodium hydroxide solutions at concentrations of 5% and 10% for 0, 2, 3 and 5 hours. The results of the tensile tests showed that the 10% alkaline treatment for 5 hours gave the highest tensile strength and modulus of elasticity, while the percentage of deformation decreased significantly. The increased strength and modulus of elasticity mean that composites can be applied more widely to structures with higher load-bearing capacity.

Keywords: Plant fibres, Alkaline treatment, Duration of treatment, Tensile strength, Modulus of elasticity

1. Introduction

Plant fibres are widely recognised for their applications in various industrial fields, particularly in the manufacture of composite materials. Their use as reinforcements offers many advantages, including low weight, biocompatibility and abundant availability [1]. However, despite these intrinsic qualities, plant fibres often have limitations linked to their compatibility with polymer matrices and their mechanical properties.
Alkaline treatment is commonly used to modify the surface of plant fibres, thereby improving their adhesion to polymer matrices. This treatment method makes it possible to selectively modify the properties of the fibres by adjusting parameters such as the concentration of the alkaline solution and the duration of the treatment [2] [3].
This study focuses on the effect of the duration and concentration of the alkaline treatment on the mechanical properties of sisalana agave fibres. We present the results of our study, highlighting the optimum treatment conditions for improving their mechanical performance. These results could have important implications for the development of composites reinforced with plant fibres, opening up new prospects for their use in a wide range of industrial applications.Research Methodology and experimental

2. Materials and methods

2.1 Fiber preparation

Plant fibres were extracted from sisal (Agave sisalana) leaves. The leaves were subjected to a mechanical decortication process (Figure 1) to isolate the fibres. After extraction, the fibres were carefully washed with water to remove impurities and non-fibrous substances. The washed fibres were then air-dried.

2.2 Alkaline treatment

For the alkaline treatment, sodium hydroxide (NaOH) crystals were dissolved in distilled water to prepare alkaline solutions of different concentrations. The prepared sisal fibres were immersed in NaOH solutions at concentrations of 5% and 10% (Figure 2). The fibres were soaked for 2, 3 and 5 hours respectively.

DOI: 10.21467/abstracts.169 ISBN: 978-81-970666-4-1 (eBook)

After treatment, the fibres were thoroughly rinsed with distilled water to remove any NaOH residue, then air-dried at room temperature until completely dry. This process ensured that all the fibres were treated uniformly and that the results obtained were comparable.

Figure 1: Mechanical fibre extraction

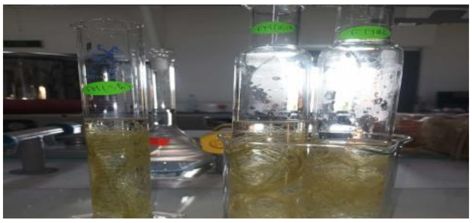

Figure 2: Alkaline treatment

2.3 Fibre characterisation

To assess the effects of alkaline treatment on the mechanical properties of sisal fibres, tensile tests were carried out on samples of treated and untreated fibres. The characteristics measured included tensile strength, modulus of elasticity and elongation at break. Tensile tests were carried out using a universal testing machine, in accordance with ASTM D3822-14 standards. Test results were analysed to determine variations in mechanical properties as a function of NaOH concentration and treatment time.

3. Results and Discussion

3-1- Mechanical properties of the fibre

The values of the mechanical characteristics (stress in N/mm², strain in %) are shown in Table 1.

Table 1: Mechanical properties of fibers

traitement	non traité	NaOH (C=5%)			NaOH (C=10%)		
t (h)	/	2h	2h30	3h	2h	2h30	3h
σr (N/mm²)	47.67	29.82	34.10	38.46	50.89	56.72	109.16
εr(%)	8.55	11.80	9.18	8.76	6.16	5.70	5.80

Untreated sisal fibres have a tensile strength of 47.67 N/mm² and an elongation at break of 8.55%. When treated with a 5% NaOH solution for 2 hours, the tensile strength decreased while the elongation at break increased. By extending the treatment to 3 hours, the tensile strength improved, but the elongation at break fell to 9.18%. A 5-hour treatment with the same concentration of NaOH continued to increase the strength to 38.46 N/mm², with an elongation at break of 8.76%. With a higher concentration of 10% NaOH, the tensile strength of sisal fibres shows a noticeable increase. After 2 hours of treatment, the strength reached 50.89 N/mm², with elongation at break reduced to 6.16%. Extending the treatment to 3 hours, the tensile strength continued to improve to 56.72 N/mm², and the elongation at break decreased slightly to 5.70%. A 5-hour treatment with 10% NaOH maximises tensile strength, although elongation at break remains stable at 5.80%. These variations indicate that higher concentrations of NaOH and longer treatment times tend to significantly increase fibre strength while reducing its ability to stretch.

4. Conclusions

The results show that alkaline treatment with NaOH has a significant impact on the mechanical properties of sisal fibres. A higher concentration of NaOH (10%) and a longer treatment time (5h) significantly improved the tensile strength of the fibres, but reduced their ability to stretch before breaking (elongation

ISBN: 978-81-970666-4-1
Series: AIJR Abstracts
DOI: 10.21467/abstracts.169

at break). For composite applications where high tensile strength is essential, treatment with 10% NaOH for 5h appears to be optimal. However, if a certain degree of ductility is also required, a compromise could be envisaged with a reduced concentration and/or treatment time.

References

[4] Ku, H., H. Wang, N. Pattarachaiyakoop, and M. Trada. A review on the tensile properties of natural fiber reinforced polymer composites. Composites: Part B, Vol. 42, 2011, pp. 856–873.

[5] Reddy, B. R. and S. H. Dhoria. Effect of alkaline treatment on mechanical properties of kenaf fiber reinforced polyester composites. AIP Conference Proceedings, Vol. 1943, 2018, pp. 1–7.

[6] Zuccarello, B. and G. Marannano. Random short sisal fiber biocomposites: Optimal manufacturing process and reliable theoretical models. Materials & Design, Vol. 149, 2018, pp. 87–100.

ISBN: 978-81-970666-4-1

Series: AIJR Abstracts

DOI: 10.21467/abstracts.169