Composites Innovation Centre

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SOURCES OF FLAX SUBMITTED FOR COMPOSITE AND FIBRE CHARACTERIZATION

Prepared by:

Mercedes Alcock B.Sc., P.Eng.
Engineer, Composites Applications
Composites Innovation Centre
Manitoba Inc.

Co Authored by:

Jonn Foulk, Ph.D.
Research Scientist, USDA ARS CQRS
Clemson, SC
.

and

Chad Ulven, Ph.D.
Assistant Professor, Mech. Eng. Dept.
North Dakota State University
Fargo, ND

Approved by:

Sean McKay B.Sc., P.Eng.
Executive Director
Composites Innovation Centre
Manitoba Inc.

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EXECUTIVE SUMMARY

Biofibre variability due to different cultivation techniques, retting conditions, and processing techniques is one of the main concerns for the composite industry to incorporate biofibres into production parts. Presently, the impact of most fibre characteristics on thermoset composite performance and the range of variability within different fibre sample sets are unavailable. Understanding the relationship between fibre characteristics and composite performance is an important aspect in creating test standards, developing treatments to improve composite performance, achieving consistent composite products, contrasting different fibre processing techniques, and establishing value for quality in the supply chain.

In order to evaluate fibres holistically, a preliminary investigation of fibre characteristics and their impact on composite performance was developed. The approach was to evaluate a wide variety of fibre quality variables and when available, use multiple test methods to determine if trends could be established between variables, test methods, fibre sources, and most importantly, composite performance. Identified trends could then be used to determine the direction of subsequent research to substantiate relationships.

Flax (linseed) and hemp are bast fibre plants that are grown commercially in Canada for seed. Both plants contain fibres that have the potential to replace E-glass in composite parts. Based on availability, commercial supply, international support, and to limit the work scope of the project, flax was chosen for the study. Eighteen flax samples were selected based on the perception that the samples would contain a representation of the large spectrum of influencing variables on fibre characteristics including mechanical processing methods, degree of ret, method of ret, variety (fibre or linseed), and year of harvest.

Attempts were made to quantify attributes of the eighteen fibre samples that were selected based on processing variables that may influence fibre properties. In total, 22 different test groupings were performed: adsorption, colour, conductivity, cuticle content, density, fibre length, fibre strength, image analysis, fineness, glucose content, hollowness, hydrophobicity, metals content, microorganisms, moisture content, openness, organoleptic testing, pectin content, ph, polarity static decay, shive content, and wax content. Each of the test groups was hypothesized to measure variables that directly, indirectly or acted as an indicator for a property that did have a direct or indirect influence on composite performance. Indicator values, while not direct measurements of the properties, could prove to be a more cost effective method than direct testing once the relationship between indicator and fibre quality was determined.

To correlate the fibre properties to composite performance, a series of composite tests were undertaken to provide comparative analysis. All composite specimens were fabricated using Hydropel R037-YDF-40, a low viscosity, thermosetting vinyl ester resin, suitable for resin infusion processing. This resin was chosen due to its suitability for ground transportation parts and good adherence to the fibres as compared to other resins of similar purpose. A fibre pullout test and an interlaminar shear strength test were chosen to evaluate interfacial bond strength. Impact performance (ASTM D4812) was selected to determine if certain fibre properties contributed to impact performance more than interfacial bond strength. Fibre diameter and the percentage of shive in the biocomposite were suspected of being strong influences based on previous research and composite theory. Fibre diameter and shive content were investigated via tensile testing (ASTM 3039) in absence of other masking parameters to determine their influence on composite performance.

This report provides a comprehensive description of the background of the fibre samples, the variables that were tested, the hypotheses that were made, the rationale behind the tests chosen, and the differences between tests that investigated the same variable. Some analysis has been performed and is reported separately from this report. Further data analysis is ongoing while additional investigation of detected trends is required.