Ribbon Decortication (RD)Technology

A NEW ERA IN HEMP PROCESSING

PKHarrap | Portable Processing of Stalks | April 30, 2018

ABSTRACT

With a recorded use back over 10,000 years, hemp has built empires through its legendary strength & broad utility of use. The process of hand peeling the outer bast was- and still is the easiest way to obtain pure bast fibres. Since 1999, the hemp seed market in Canada has grown steadily. The same can't be said for the leftover fibre & hurd which, for the most part are burned to the ground- or worse, bred to have shorter stems. Why?

Large decortication operations cost $5-9 million to produce clean fibre less, if run through the machinery a couple times. This action doubles the raw cost, compared to cheaper fiberglas & cotton. Hemp fibre will remain a niche market without revolutionary change.

What if processing machinery was available that could produce a high quality fibre without the need for expensive dust collection systems?

After nearly 10 years in development, Canfiber Inc. has received a patent for its breakthrough ribbon decortication process that mechanically peels leftover stalks. The system works like how a nail gun operates. Using the legendary fibre against itself, the bast is mechanically freed from its hurd, leaving a peeled stick that is drawn into a chipper.

For the system to be scaled effectively, a modified double-cut windrower, combine, flax turner, flax baler & bale unwinder must be employed in conjunction with the ribbon decorticator. Assistance from the NRC led to the discovery of carding of the fibres and is now under development, along with collection to provide spooled rolls of sliver fibres.

The Problem with Hemp

What is the problem with hemp? It has been with us for a millennia, first used in Taiwan over 10,000 years ago for clothing, shelter & fuel, then brought to India where its genome was split into what is today commonly referred to as 'pot' (marijuana).

- It wasn't until plastic made from petroleum came on the scene in 1937 that the line between hemp & marijuana was distorted & then cast out of society- Only it wasn't. It was protected by the counter-culture who had maintained the knowledge that hemp could produce the same products as that of petroleum. As the smoke cleared in the late 1970's, WW2 propaganda films came to light that featured 'Hemp For Victory'. Slowly, word spread about a potential world made of hemp products that could usher in a sustainable 'Circular Economy'. It wouldn't be until the late 1990's when hemp would become legal again to grow within the Commonwealth nations, including Canada in 1998. At last, in 2014 the Hemp Farm Bill was raised by the US government which allowed hemp to be grown once again on American soil. With the current 2018 Hemp farm bill, it will finally recognize hemp as a utilitarian crop & remove it from the Controlled Substances Act of 1970. If passed (currently fast-tracked to be heard), it would be a signal to the world that the Circular Economy can become a reality. Hopefully, we still have fighting chance of combatting man-made climate change due to the burning of petroleum products.

- Containing 60-70% cellulose by weight, it is an ideal feedstock for the rapidly emerging Bioplastic & Green paper industries. Single-use items & plastic bags have come under scrutiny & demand is growing for a biodegradable alternative. The company LEGO plans to phase out fossil-based plastic by 2030 & plant-based PET pellets are being developed. What's even more exciting, Transportation & Aerospace industries both favor hemp fiber primarily for its strength to weight ratio & rigidity under pressure. What's more, is its considered a technical fiber that stands above energy intensive fiberglas. Hempcrete walls & bricks are becoming more popular, with 1 square meter of hempcrete capable of storing 35kg of carbon. Its adoption has been growing rapidly in the Construction industry for its great energy efficiency, natural breathability & that it does not crack over time. The roots of the plant sequester roughly 20% of the above-ground biomass. HGS calculates each ton of hemp grown represents 1.63 tons of CO_2 absorption, which equals a whopping 32 tonnes of heat-trapping carbon stored per hectare every 90-100 days. So what are we waiting for you ask?

PROCESSING FOR A CLEANER TOMORROW

The hemp industry was crippled by politics & the rise of fossil-based synthetic fibers. In 1937, the federal government passed the Marijuana Tax Act, aimed at regulating the narcotic varieties of cannabis. Interestingly, this law turned over the regulation of hemp production to the Department of Revenue, which was then responsible for licensing all hemp growers. The industry continued its decline until WWII, when a surge in cordage & fiber for military clothing was needed for the war effort. As the war ended, so too did hemp's utility as a textile, with the last major hemp crop grown & processed in 1958.

Enter 2018. Hemp has been legal to grow in Canada since 1998, & demand for the perfectly balanced seed has been growing consistently year over year with stores carrying everything from shelled seeds to bars & cereals. The fiber industry has been deafeningly quiet though, with leftover stalks from seed crops being largely burned the following spring, spewing its stored carbon back into the atmosphere. The primary reason is the risk/cost calculus. It would cost $6-9 million dollars to build a stationary processing plant that could produce clean fiber- if passed through the machinery a couple of times, bringing the cost of the fiber way up. Compared to cheaper fiberglas & cotton, hemp fiber will remain a niche market.

What if portable processing machinery was available that could produce a high-grade fiber without the need for expensive dust-collection systems?

-It would break the logjam that has been stalling the explosion of this extremely useful plant.

RIBBON DECORTICATION (RD) TECHNOLOGY

I would like to take this opportunity to introduce you to an evolution in hemp processing called ribbon decortication (RD). It has not yet made it into Wikipedia's lexicon, but it will as the benefits of this new processing technology unfold. The concept is simple; By using the legendary strength of the fiber against itself, the bast is mechanically peeled from its hurd, leaving a peeled woody stick that is drawn into a chipper.

To work effectively, leftover stalks are cut & left in the field to dry, then turned midway to allow both sides to dry consistently using a OL-140 from Belarus or similar. When ready, the stalks are baled using a flax baler such as a Claas Variant-360RF with flax package which feeds a parallel twine continuously so that the flax is wound in layers like a swiss-roll. This allows for easier processing of the stalks by an operator who employs a bale unwinder to guide the stalks onto a green chain. From here, the stalks are brought into final alignment before being fed between a pair of drums that draw the stalks up each cycle. The resultant bast fiber is up to 48" long; coarse on one side & smooth on the other. Through the guidance from NRC's Advanced Biomaterials Division, immediate carding of the collected fiber is being incorporated into the design. Resultant rolls of carded sliver are distributed worldwide for further downstream processing into composite & textile products- If treated by a whitening enzyme, developed in partnership between Crailar & the NRC in 2010 (Confirmed by Denis Rho of the CNRC in 09/13 & CIC in 2015 after providing samples of prototype-peeled fibers). Other methods can be employed, such as hydrogen peroxide to achieve a consistent color prior to manufacture. A major benefit of using the licensable NRC enzyme that Denis Rho helped create, is its ability to remove all pectin from the fiber, resulting in a softer feel.

Further Research

The separation of fibre and core components of hemp stem is a fundamental step in hemp decortication, mechanical separation of fibre and core. Research aimed to enhance the understanding of fibre-peeling behaviour of hemp will only serve to improve current decortication technologies. Peel tests were performed on retted and unretted hemp samples for each of two hemp varieties, USO 14 and Alyssa. Results showed that force and work required to peel did not vary with the retting condition, but with the hemp variety.

The average peeling force for the Alyssa variety was 0.39 N and that for the USO 14 variety was 0.87 N. Within the Alyssa variety, the work required to peel the fibre from the core was 193 J m-2, and the work required to peel the fibres of the USO 14 variety was 431 J m-2.

There is increasing interest from many potential end-users of hemp-based products, especially hemp fiber (Brook et al. 2008). Hemp (*Cannabis sativa* Linnaeus) fibers are

among the strongest natural fibers, which is a desirable characteristic in applications such as bio-composites and textiles. Hemp produces phloem fibers, which are cemented into place by a complex mixture of pectins, hemi-celluloses and lignin (Booth et al. 2004). The cambium layer is also known as the fiber-core interface layer. The pith layer provides structural support and is widely identified as the core of the plant. The male hemp stem & fiber only variety females alike possesses a hollow centre through its length, except for the joints between internodes. Dual-purpose females are thicker by necessity to support their own weight at maturation. In modeling of mechanical properties of hemp it is considered to have two distinct components: fiber and core.

The process of mechanically separating fiber and core is commonly known as decortication. Traditional decortication requires the use of machinery such as hammer mills and roll crushers. Fiber and core debond during decortication. Current decortication machines are not energy efficient and yield low purity product due to lack of knowledge about the mechanical properties of hemp (Baker 2009). Energy requirement and effectiveness of the decortication process depend on the adhesive energy bonding fiber and core together. Therefore, understanding the bonding strength between fiber and core is essential for the design and improvement of decortication processes.

Acknowledgements due;

The National Research of Canada, IRAP. Harrap & Pathman families,

CC, AB, JH, CR, RP, CH- You know who you are, thank you for your assistance & generosity in driving this generational project forward.