

Chemi-Thermo Mechanical Pulping of Non-Wood Fibres

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Keywords : Mechanical Pulping, Nonwood Kraft, Rice Straw, Bamboo

Importance of high yield pulps in paper industry cannot be over emphasized. Research done in this area to produce high yield pulp for test liner and corrugating medium paper is of great importance to paper industry. Packages Ltd in Pakistan pioneered in the world when it built the first high yield pulping plant based on wheat straw using a unique pulping technique that produce a pulp ideally suited for manufacturing of test liner and corrugating medium paper. The process is based on Chemi Thermo Mechanical pulping usually called CTMP process. In this paper an overview of process is described with pulp properties. Different pulp properties are plotted at different SR values. Using this unique process agricultural waste is used for producing high strength paper. CTMP pulp obtained from straw has lower yield that from wood because it has more water-soluble compounds and lot of fines are generated during processing. The straw pulp obtained from CTMP process is characterized by high shives, high long fibre fraction, high bulk, high stiffness, high ring crush strength and low smoothness. High stiffness and ring crush make it extremely suitable for high compressive strength bearing corrugated containers.

INTRODUCTION

In 1991, packages limited pioneered in the world when it built the first high yield pulping plant based on wheat straw using unique pulping process that produces a pulp ideally suited for the manufacture of test liner and corrugating medium paper for corrugating containers. It is based on a pulping process called Chemi Thermo Mechanical pulping (CTMP) and is named after the process as CTMP pulp.

In CTMP process a combination of chemical and mechanical pulping process is involved. Pre-steaming is done to soften the lignin followed by mild chemical cooking and then refining in the presence of residual chemicals. The CTMP process originated basically as an innovation in Thermo Mechanical pulping process (TMP), essentially a mechanical process by incorporating a mild chemical cooking stage. TMP fibre generally consists of long stiff fibres that do not bond to each other. A mild chemical pretreatment makes it possible to increase the

softness of wheat straw, rendering it more receptive for the subsequent mechanical treatment while still maintaining a high yield. It also helps producing fibre with a very high flexibility that can be refined with minimum of fibre cutting.

Wheat straw is a major raw material for CTMP plant in packages. There are number of Non-wood fibres like River kai, Rice straw, Bamboo, Bagasse, Reeds and Jute which are used for chemical pulping. But for CTMP pulping the only experience we have at packages is with River kai and Rice Straw. Pulping with River kai was very difficult, especially the blockage problem of pumps and pulper, as River kai raps around the impellers and cause blockage. Rice straw and bamboo can be used as raw material for CTMP, depending on the cutting size of material. The cutting size must be less than 1 inch, so it will not cause any operational problems. Looking at River kai experience it is believed that Reeds and Jute are difficult to use for CTMP pulping.

The CTMP plant at packages Ltd is modernized and fully computerized with a production of 80 tons/day of CTMP pulp. Series of dry cleaning stages are used to clean wheat straw, as straw contains lot of sand and dirt, which causes a serious wear and tear of plant equipment. Dry cleaning stages are followed by wet washing to maximize removal of sand and dirt. Wet cleaned straw then passes through a series of dewatering and compressing stages. Here pre-steaming is also done to soften the wheat straw before cooking. This helps chemical impregnation in subsequent cooking stage. Cooking is done in a specially designed horizontal continuous digester at specific temperature, for required time.

After cooking wheat straw is refined in the presence of residual chemicals in a pressurized refiner and is then sent to a blow tank. Pulp is dewatered to 25-30% in a twin roll press and then processed in second stage of high consistency refining. Due to chemical pretreatment,

refining energy is remarkably reduced. Two-stage refining ensures better control of final pulp freeness. One stage of refining generally gives a low freeness pulp and second stage gives a high freeness pulp. In this way pulp properties can be tailored to suite the end use. Refined pulp is screened at lower consistency, using both slot and hole screen baskets.

Typical Loses And Yield Of CTMP Pulp

During CTMP pulping we take typical losses for dry and wet cleaning and then calculations are done for final yield. Break up of these calculations is

Dry cleaning losses estimated: 5-10 %

Wet Cleaning losses estimated: 5-10 %

Estimated yield after digester tube: 80-85 % of OD Straw.

Estimated yield in final chest after cleaning losses: 80-83% of OD Straw.

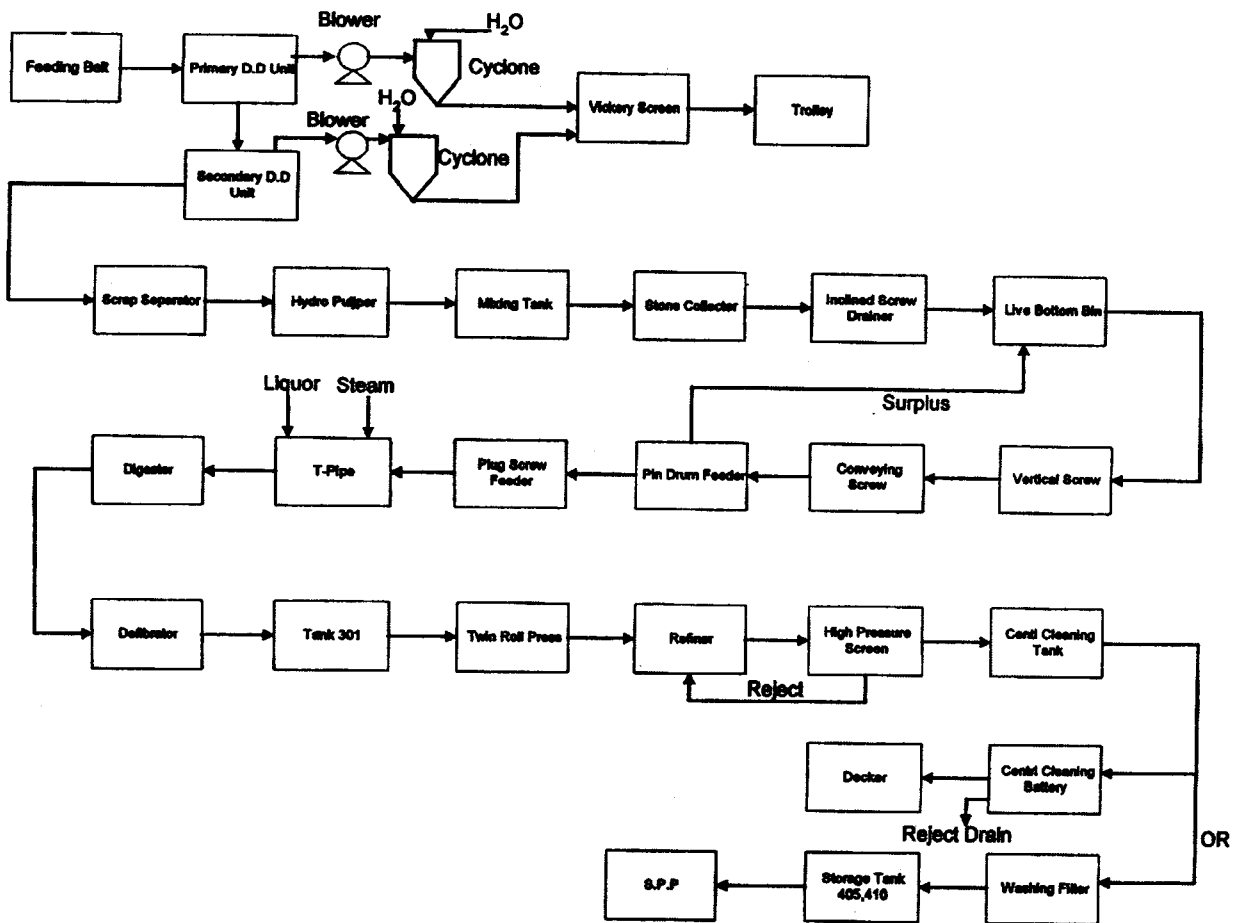


Figure 1 : Flow Diagram of CTMP Process

Test Linear:

Pulps	DCC	Unbleach Straw	2nd quality waste	CTMP
Top Layer %	35	15	15	35
Back Layer %	20	10	30	40

Corrugated Medium Paper:

Pulps	DCC	Unbleach Straw	2nd quality waste	CTMP
Top Layer %	15	25	25	35
Back Layer %	10	15	30	45

Pulp Properties

CTMP pulp from wheat straw is characterized by low freeness; high shives, high bulk, high stiffness and high ring crush strength. Low freeness requires paper machine wet end to be designed specifically with greater consideration. Retention and drainage aids can be added to improve the freeness properties. High stiffness and ring crush make it extremely suitable for high compressive strength bearing corrugated containers. At lower shives levels, pulp is excellent for imparting stiffness to White

Duplex Board by addition in the middle layer. In the middle layer of folding boxboard and liquid packaging boards, CTMP provides extremely high bulk necessary for high stiffness and economy of fibres cost.

CTMP from wheat straw is very difficult to bleach for high brightness values because wheat straw itself has very low initial brightness value. A very high dosage of bleaching chemicals is required to get high brightness value in straw CTMP.

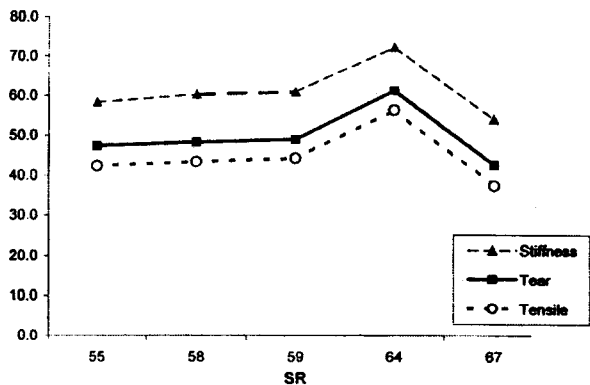


Figure 2 : CTMP pulp stiffness (mN), Tear (mN) and Tensile (kN/m) Properties.

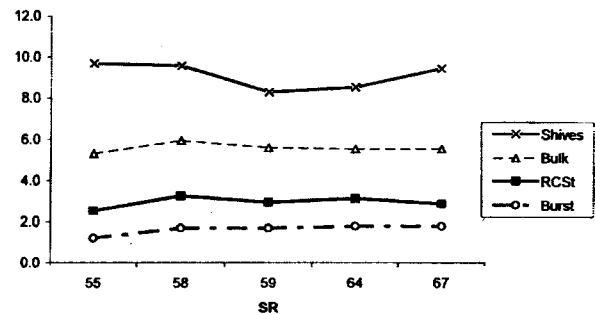


Figure 3 : CTMP pulp stiffness (%), Bulk (cm³/g), RCSt (kN/m) and Burst (kPa) Properties.

Grammage (gm/m ²)	Bursting Strength (kPa)	Edge Crush Strength (kN/m)	Flat Crush Strength (kPa)	Moisture (%)
413	402	3.9	122	6.2
414	619	4.4	293	4.2
418	603	3.7	170	6.2
426	668	4.6	174	6.0
427	612	4.0	142	5.3

This pulp is normally used in combination with waste paper and unbleached softwood Kraft pulp for manufacturing test liner. As the fluted layer provides much of the stiffness required in corrugated box construction, the major requirements of the corrugating medium paper such as stiffness and resistance to crushing are amicably met by the use of this pulp as its rigid fibre contributes high stiffness and crush resistance. Typical furnish for Test liner and Corrugating medium paper is given as

CTMP straw pulp is analysed intensely in RD&C facility of packages Ltd, results for Stiffness, Tensile, Tear and Ring Crush strength (RCSt) is plotted against different SR or freeness values in Fig 2&3.

Test Methods For Measurement

Following are the test methods followed for measurements

Bulk : It is Scandinavian Test method No. Scan-P 7:75

Ring crush strength : It is Scandinavian Test method No. Scan-P 34: 71

Burst : It is a Tappi Test No. T 807 om-94

Stiffness: It is Scandinavian Test method No. Scan-P 29:95

Tensile : It is Scandinavian Test method No. Scan.-P 16:76

Tear : It is a Tappi Test No. T 414 om-88

Shives: It is Scandinavian Test method No. Scan-M 13:83

Corrugated containers made from CTMP straw pulp is tested in RD&C lab of packages, results of Bursting strength, Flat crush, Edge crush and Moisture of boxes is given below.

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