Rejuvenating Secondary Fibers - A New Concept and Results

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ABSTRACT

One of the major problems with recycling is the gradual loss in fiber strength properties in successive recycling. While some of the strength properties like burst, tensile etc., can be increased by use of modified starches and other chemicals, the tear factor is difficult to improve, as it is dependent of the intrinsic fiber strength, d.p. cellulose chains etc. These being basic characteristic of fibers, are difficult to alter.

Fibers with good intrinsic fiber strength contribute to various properties like good tear index, CMT/RCT, which are desired by all papermakers. When most of the furnish consist of short fibers which are poor in strength, one of the most common ways to improve strength properties is addition of some long fibers either natural or synthetic. However, these options are expensive and most of the times economically unviable.

Our research was concentrating around rejuvenating weak fibers in the furnish chemically, so that the cellulose chains have higher degree of polymerization and give stronger fibers. This has been achieved by cross-linking by formation of covalent bonds between the cellulose chains. Covalent bonds are permanent wowing to their high bond energy compared to very low bond energies of hydrogen bonds. The article also discusses about new chemical and actual results.

INTRODUCTION

Almost 1/3rd of the paper production in the country comes from mills using recycled fibers. These mills have to compete with mills with forest-based raw materials in the market and are, therefore, continuously looking forward to improve their quality. These quality improvement techniques have to be essnentially economic as the mills using recycled fibers are generally smaller in size, which is an inherent drawback in their economy of production.

There has been numerous research and publications in the field of strength development in papers by various means. While most of the strength properties directly associated by hydrogen bonding between the fibers can be improved by a number of

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alternatives available, it is difficult to improve the strength properties, which are directly linked with the strength of fibers.

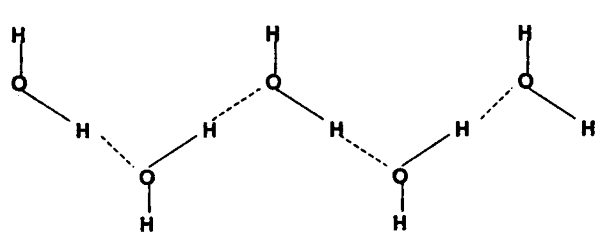
The chemical being duscussed in this paper "HITEAR FR-10" has been developed to specifically increase the tearing strength and other properties, which are directly linked with the individual fiber strength.

Use of this chemical is also very economic and a dose of just 1% or even less is able to give a very substantial rise in the tear factor. With the price of the chemical being very low, it has great economics in its use. The cost involved may be just 1/4th of the means currnetly available with the papermakers.

HOW THE CHEMICAL WORKS

In order to understand how the chemical works, it would be of help to review a few commonly used terms in organic chemistry, which are as below :

a. Hydrogen Bonds : When a hydrogen atom is lined with a very strongly electronegative atom (as with O in water), it forms positive end of the dipole. There is strong evidence that hydrogen, though univalent, behaves as a bivalent element under certain conditions. It is noticed that certain molecules which contain O-H and some other bonds, have a great tendency to link up to form larger molecules as shown below :



As indicated above, the hydrogen atom seems to form a linkage between two oxygen atoms i.e. hydrogen bridges them. This mode of linking is called hydrogen Bonding.

Hydrogen bonds are weak but are wide spread and have a very significant effect on the physical properties of organic compounds.

Hydrogen bond energies lie in the range of 2 to 8 kcal/mole comared to O-H bond energy of 110 Kcal/mole.

b. Covalent Bonds : This type of linkage binds two atoms, both of which are short of electrons. The two atoms contribute one electron each and then share the resulting pair of electrons. In covalent bond, two half-filled orbitals belonging to different atoms overlap in space and merge to form a new bigger orbital which is known as molecular orbital.

c. Bond Energy : It is the energy needed to break that bond in any compound in which it exists.

HITEAR FR-10 does not form hydrogen bonds between cellulose chains as is mostly the case with other chemicals used for developing strength. It forms covalent bonds, between the cellulose chains both sideways and partially in length.

As explained above, covalent bonds have very high bond energy and are permanent. Hydrogen bonds are very weak and are easily broken by various means. Therefore, HITEAR FR - 10 actually makes the cellulose chain longer and much stronger. This gives a better intrinsic strength to the fiber. A better fiber strength then leads to improvement in various sheet properties like tear etc.

ABOUT THE NEW CHEMICAL

The chemical "HITEAR FR - 10" has following basic properties :

Appearance	:	Smooth, homogeneous liquid, white to creamish in colour.
Nature	:	Non-ionic
pH (2% in distilled water)	:	Neutral
Miscibility	:	Fully miscible in water
Compatibility	:	Compatible with non-ionic, anionic and Cationic products

		and in mild acids and alkalies.
Stability	:	Excellent
Shelf life	:	Over 6 months when stored properly.

RECOMMENDED DOSE AND METHOD OF USAGE

The chemical is supplied in ready to use form. A dose of 1% (10 kg./T) is generally recommended and is sufficient. Higher dosage do not yield any better results. It should be added at a point where it gets few minutes time to be in contact with the pulp. It can be added in thick or thin stock but a through mixing with pulp is recommended to get the best results. It is recommended to be dosed continuously at the inlet of fan pump or screen or a measured quantity can be added in the stock chest as well. Chemical is effective when added in pulp of consistencies upto 4%.

LABORATORY TRIAL AND RESULTS

Hand-sheets were made and tested as per TAPPI standards. Tests were carried out for two different basis weights. Results are as under :

PLANT TRIAL RESULTS

Results of plant trial are as under :

RUN 1:

Type of Pulp : 100% Indigenous recycled fibers

		Blank	**Results with 1% HITEAR**
Basis weight (gsm)	:	152	146
Tear (MD/CD)	:	68/76	80.8/88.2
Burst Factor	:	11.5	12.5

RUN 2:

Type of Pulp : 100% Indigenous recycled fibers

		Blank	**Results with 1% HITEAR**
Basis weight (gsm)	:	143	148

Test 1 :

Type of pulp : 100% Indigenous recycled fibres.

		Blank Results	**Result with 1% HITEAR**
Basis weight (gsm)	:	174	175
Avg. Tear (Factor)	:	49.2	63.5
Avg. Burst Factor	:	12.6	13.3

Test 2 :

Type of pulp : 100% Indigenous recycled fibres.

		Blank Results	**Results with 1% HITEAR**
Basis weight (gsm)		78	80
Avg. Tear Factor	:	17.2	22.3
Avg. Burst Factor	:	8.6	10.6

Tear (MD/CD) :	66/74.5	82.5/93.5
Burst Factor	10.7	12.7

SAVING POTENTIAL

The improvements that could be achieved are shown in above results. Getting the most out of these benefits vary form mill to mill and it is only they who know the areas where there can be best savings in their mill. At times it may be the philosophy of an individual mill to just give a better quality at marginally higher cost of production and retain/get a premium sector of the market. The calculation part is, therefore, not included. However, some of the areas where the mills can consider saving can be:

a. Saving in the cost of expensive long fibers - natural/synthetic.

b. Increasing fillers in paper.

c. Achieve a better runnability and productivity on machine.

d. Producing special grades of paper for premium market where relization is higher.

e. Produce some grades of paper like lower gsm. which were so far difficult to produce due to poor strength.

f. Any combination of above.

CONCLUSIONS

There is now a technology available to rejuvenate the recycled fibers. Thus the recycled fibers will have a better strength and will be able to produce stronger paper. This is achieved by means of forming covalent bonds between the cellulose chains in the fibers. The chemical employed to achieve this is very inexpensive and therefore has a good saving potential for the papermakers who employ expensive means to improve the difficult-to-improve strength properties like Tear etc.

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