Cellophane From Cotton Linter Pulp—A New Dimension in Cellulose Technology in India

P. R. Ramaswamy

Cellophane or Cellulose Film, as it is called, is essentially regenerated cellulose. The history of regenerated cellulose may be considered to start with the discovery in 1892 by Cross, Bevan & Beadle that cellulose could be converted into a dispersible form by treatment with Caustic Soda followed by CS_2, known as xanthation. A method of coagulation and regeneration cellulose in the form of a film or foil was subsequently patented by Stearn in 1898. The Swiss scientist Bradenberger was, however, largely responsible for the initial work on producing regenerated cellulose foil in continuous sheets and his first patents for continuous casting machines were issued in 1911. Bradenberger is also credited with the coining of the familiar trade name Cellophane which is derived from the first syllable of cellulose and the last syllable of the French word 'Diaphane' meaning transparent. The first plant for the production of Cellophane was erected in France by La Cellophane followed shortly afterwards by Great Britain and the United States using the core Bradenberger process but with fast developing improvements. The subsequent development in 1927 of methods of obtaining Moistureproof Cellophane gave a boost to the technical applications and the demand for this product for an ever widening variety of uses has been increasing day by day. The higher strength properties and the comparatively cheaper price of cellophane are bound to sustain this product in competing with several other products like Polyethylene, PVC etc. of more recent origin.

Cellophane, because of its remarkable characteristics, is the most popular and versatile medium in the field of flexible packaging for reasons of its sparkling transparency and clarity, its superior properties of protecting against moisture, odour and gas, its smooth surface which imparts excellent printing characteristics, its high speed performance on packaging machines, its capacity to be tailored economically to meet a variety of packaging requirements and its ability to combine with other packaging media both by extrusion coating and by lamination. In other words, cellophane is the only packaging material that "shows what it protects and protects what it shows" and gives the buyer a feeling of reassurance that he is able to see what he buys and that the product packed is genuine and fresh. As more than 100 different types of Cellophane can be made suited to specified applications, no wonder that the position of Cellophane as a packaging medium is acclaimed as universal.

It is a matter of pride that the manufacture of Cellophane and Rayon was pioneered in India by Travancore Rayons in 1950, in the post-independence years of fast industrialisation of the country. From the initial 2–3 tons per day production, we have been growing and expanding in stages and now we have four cellophane plants with a capacity of 15–16 tons per day. Corrspondingly, there are three coating machines now, incorporating the latest technology in the field and we are now in a unique position to produce as many as 33–40 different types of cellophane to meet any designation or specification required by the customer. Quantitatively, we are equipped to produce about 4–5 thousand tonnes per year of cellophane, thus saving about 4–5 crores of foreign exchange. Along with

P. R. Ramaswamy
Superintendent
The Travancore Rayons Limited

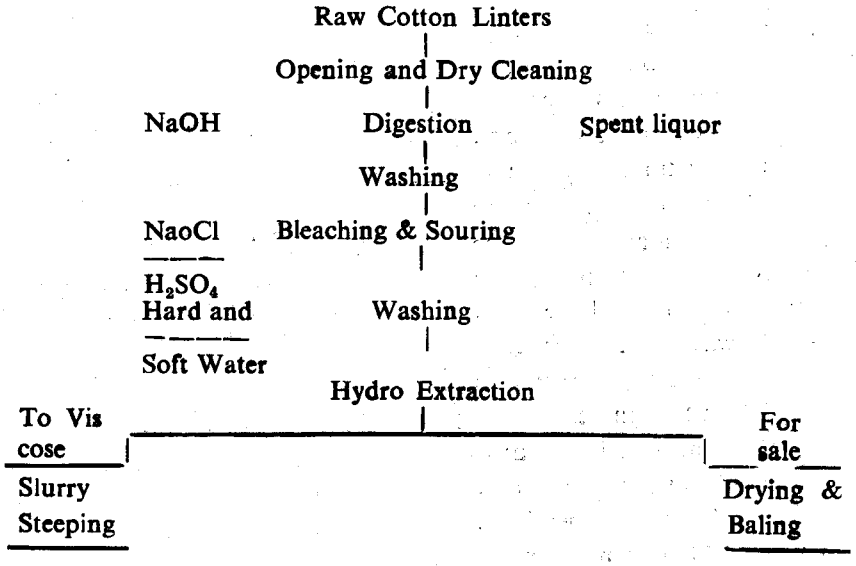
this, we engage in regular supplies of cellophane for Defence requirements and exports in sizable measure and contribute substantially to the national cause.

Pioneering as in the achievement of Cellophane production, Travancore Rayons has been the first in India to establish the successful use of cotton linters for viscose grade (dissolving grade) pulp. December 8, 1962, marked the historic commissioning of the 10 ton Cotton Linter Pulp Plant in the Travancore Rayons. Wood pulp (formerly imported and subsequently from indigenous sources) which was used as raw material for Cellophane manufacture gradually has been replaced over the years with Cotton Linter Pulp. For some years, Wood pulp was mixed with Cotton Linter Pulp in varying proportions and now we have been able to emerge out into a happy situation in which our entire Cellophane production is on Cotton Linter Pulp. The years preceding this were indeed trying periods for us not only in stabilising the rated production of cotton Linter Pulp but also in dovetailing the characteristics of this new material into the viscose processing to achieve the quality and quantity of our Cellophane production. Trials are now under way to utilise cotton linter pulp for our Rayon production also and it is hoped that tangible results will be achieved in this direction as well.

It may be apt to give a brief description of the process of Cellophane from Cotton Linters.

1. Cotton Linter Pulp:

Cotton Linters are generally of different grades—lst cuts, 2nd cuts, mill runs, and defibrated. An optimum blend of these grades is used. The process of converting the linters into pure cellulose pulp is done in batches.



The pressed bales of cotton linters are unwrapped and fed into the opening and cleaning machines where the physical impurities are cleaned and the linters are rendered into a uniformly loose and fluffly state for pneumatic transport to the Digesters through a Mixing Mill where the linters are mixed thoroughly with alkali containing some detergent also. The requisite batch weight of linters is thus charged into the Rotary Digester, after which steam is admitted into the Digester. When all the air has been displaced, the pressure is raised to between 5–8 Kg. The contents are thus "cooked" for a period of 2–6 hours depending on the viscosity to be attained in the product, the characteristics of which are determined by the concentration of the alkali and by the time and temperature of the digestion. Thorough mixing of the linters and alkaline liquor throughout the cooking period is essential to the uniformity of the product.

When digestion is completed, the contents of the digester vessel are discharged or 'blown off' under steam pressure through a valve at the bottom of the digester. The linters and spent liquor fall into a steel wash tank where the liquor is drained off and the linters (which at this stage will be brownish) are thoroughly washed to ensure complete removal of the alkali and the soluble degradation

products of the original impurities. Continuous washing of the brown stock is done on Dorr Washers which consist of a rotary pan with spray jets and a vacuum pump to withdraw the wash waters.

After washing, the brown stock is pumped to Hollander chests for bleaching. Sodium Hypochlorite is the usual bleaching agent and souring is done with dilute Sulphuric Acid. It is important during bleaching which is an oxidative process to control such factors as slurry consistency, time, temperature, pH and active Cl_2 concentration, to avoid degradation and at the same time to produce a cellulose having the desired colour. Thorough washing follows each stage of the bleaching process and special attention has to be paid to the quality of water used in reducing iron content, ash, silica etc. After final washing, the purified linters now termed as 'finished pulp' are pumped into large blending tanks which ensures uniformity of chemical and physical properties of the pulp through large consignments. The pulp is next hydro extracted in screw presses to a moisture content of approx. 50 – 55% and the material is pneumatically transported to the viscose station for viscose manufacture.

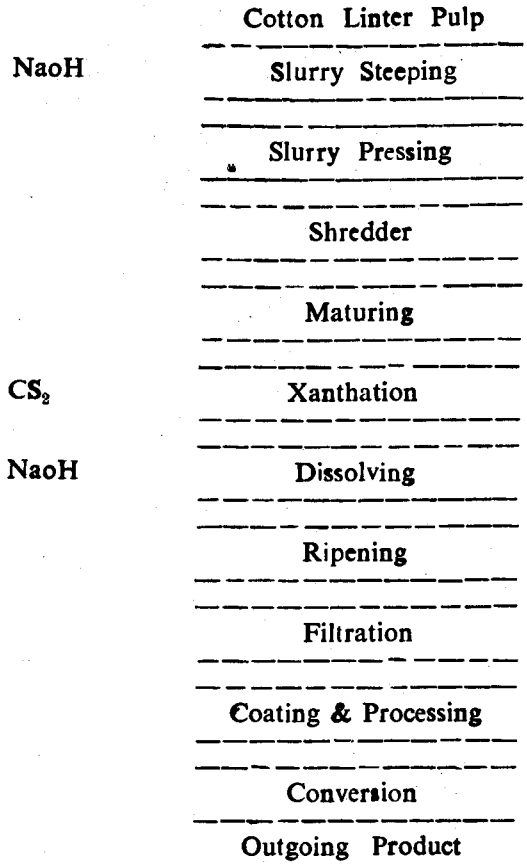
When drying is required, the hydroextracted pulp is conveyed through a tunnel drier where, under carefully controlled temperature and circulation of hot air, the pulp gets dry to a moisture of 5–7% and is compressed and delivered in bales of average weight approx. 100–150 Kg. to the consumers.

The following table gives a comparison of the typical analysis of our Cotton Linter Pulp as against IS 3518 specification for chemical cotton for viscose Type 1 and also against a Buckey's sample.

The first step is the preparation of alkali cellulose. Cellulose in the form of Cotton Linter Pulp shreddings is steeped in 17–20% Soda Lye in Slurry Mixers. The pulp absorbs NaOH, swells up considerably and the cellulose gets converted to alkali cellulose which is then pressed to remove excess liquids. The alkali cellulose is next shredded i.e. disintegrated

	Our typical sample	IS 3518 Type 1	Buckeye Sample
1	2	3	4
(i) Moisture percent Max.	4.20	7.5	
(ii) Alpha Cellulose Min.	98.2	98	96.90
(iii) Solubility in 7.14% NaoH Max.	2—4	2.0	3.60
(iv) Ether Soluble matter percent	0.07–0.15	0.1	0.10
(v) Ash Content percent max.	0.1–0.2	0.1	0.15
(vi) Acid insoluble ash ppm Max.	—	75	
(vii) Iron as Fe ppm max.	30–100	50	56
(viii) Calcium as Cao ppm	80–150	120	—
(ix) Manganese as Mn ppm	0.20	0.20	—
(x) Copper No.	0.3– 0.6	—	0.28
(xi) Fluidity/Viscosity Rhes (0.5 gm in 100 ml)	15–17	16.5—18.0	Vis. 8.6 c.p. (0.5% CED)

2. **Cellophane :**



into a fluffy powder form and fed into a large giant drum, rotating at a slow speed and fitted with a cooling jacket. Here, during the retention period of the alkali cellulose in the drum, "maturing" involving a certain controlled depolymerisation of the cellulose molecules, occurs. The matured alkali cellulose is then treated with CS_2 in specially proteeted vessels and gets converted to an orange coloured mass called cellulose xanthate. This mass is further dissolved under vigorous agitation in dilute NaOH under controlled temperature to give a thick honey like liquid termed 'viscose'. The next step is the ripening of the viscose. The viscose is kept for specified periods under low temperature. This is to bring it to a suitable coagulating point and viscosity for casting as Cellophane. During this period, viscose is filtered 2–3 times to remove all suspended impurities and subjected to a high vacuum to remove all trapped air bubbles. After proper ripening, the viscose is pumped by special pumps to a casting head. The lower part of the head consists of 2 lips made of special alloy, finely polished, fitted at an angle and having a very narrow adjustable slit all along its width. The head is mounted on lead lined acid tanks in such a way that the tips of the lids are immersed in a solution of 10–15% Sulphuric Acid and 14—20% Sodium Sulphate at a temp. 35—45°C. In this bath, the viscose is coagulated and regenerated back as a film of Cellophane. After this, the film in continuous sheet form passes over rollers through a series of baths for completion of the hydrolysis, expelling, CS_2 and H_2S, washing out of the acid, desulphurisation, bleaching, softening and plasticising, sizing, dyeing etc. and finally the important changes of drying, humidification. The continuous film is wound on large rollers.

The Cellophane so produced is plain and transparent. To import special properties of moisture proofness, heat sealability etc., the film is given further coating treatment. This essentially consists of a nitrocellulose coating plasticized together with resins, waxes, dissolved in a solvent mixture composed of ethers and toluene. The plain film is passed through the coating bath then dried in a current of hot air and the released solvents are recovered.

Apart from Nitrocellulose lacquers, other agents are also used in formulating the surface coating. The most common among them are 'Saran' (Vinyledene Chloride Acronitrile Copolymer) and Vinyl Chloride Acronitrile Copolymers By adopting suitable surface coating

compositions, cellulose films with varying properties best suited for each type of packaging have been developed by us.

The packing and storage of cellophane is also important, the main factors to be taken care of being air humidity, temperature handling, film wrap, protection from dust, foreign particles etc.

The various type of cellophane are identified by a rotation of letters and a few of the common symbols used with their meaning are as follows :

T : Transparent
M : Moisture Proof
P : Plain
S : Heatsealing

XX : Polymer Coated

Eg: A designation MSAT means that the film is moisture proof, heatsealing, anchored and transparent.

A : Anchored
C : Coloured
O : Opaque
U : Unsized, low surface slippage
W : Wrap Twist

From each of the above types, Cellophane is produced in different gauges, the common gauges being 300, 400, 600 which indicate the wt. in gms. of 10 Sq. Metres of the film.

I.S. 5012 : 1968 gives the Indian Standard Specifications for Cellulose Film. It is heartening that "Trayophane" (which is the trade name of Travancore Rayons Cellophane) not only complies with these specifications but excels them in respect of certain characteristics like tensile strength, elongation, burst strength etc. which can be attributed to the use of pure high alpha Cotton Linter Pulp as raw material.

Reference:

Cellulosic Plastics : V.E. Yarsley & W. Flarell Cellulosic Films in Packaging I.I.P.