Some Salient Features of Regenerated Cellulose Film and Comparision with Viscose Rayon

S.B. Rajvanshi
B. Biswas

Some salient features regarding the production of regenerated cellulose film, popularly known as cellophane and its characteristic properties, have been discussed. The importance of moisture-proofing and lacquering of the film for increasing the utility of the product has been pointed out. The difference in the ripening index (R.I.) and viscosity of viscose for the regenerated cellulose film and viscose rayon have been indicated.

Regenerated cellulose film, popularly known as "cellophane" owes its name to Du Pont, who secured a licence and started production in 1924 under the name and design "La cellophane", the regenerated cellulose film by a process developed in 1910 by Brandenberger[1]. Although originally a trade name of regenerated cellulose film produce by Du Pont, cellophone has now become synonymous with regenerated cellulose film by viscose process and the name is now freely used in text books and literature. Many production units of this commodity are coining names of their products by suitably prefixing a few letters with "phane".

Without moisture and plasticizer, the generated cellulose film is brittle and therefore of little industrial use. The process of moistureproofing of the film, which was developed later, has increased the versatility of the product[2], and a variety of use for the moistureproof and plasticized film has been developed *(ibid)*.

On an average the regenerated cellulose film contains 5 to 10 parts of moisture and 8 to 25 parts of softeners. The commonly used softners are glycerol, ethylene glycol and urea. The properties of regenerated cellulose film which is plasticized (or softener treated) but uncoated are governed by the atmospheric humidity. If the moisture content of the surrounding air is less than that in the uncoated plasticized cellulose film, moisture will escape from the film. If the surrounding atmosphere contains more moisture than the uncoated film, moisture absorption by the film will take place. It is, therefore, customory to apply a suitable coating on the moisture and plasticized treated cellulose film, to arrest the moisture loss or gain of the film.

Depending on the customer's requirement the regenerated cellulose film is either coated on one side or both. The coating makes the film moistureproof, resistant to water, heat sealing and highly transparent. The thickness of the coating is normally one micron, on each side of film. Nitrocellulose based formulations are most extensively used in lacquering (or coating) medium. By changing the composition of the coating medium a variety of properties can be manifested in the cellulose film[3]. Cellulose film, plasticized and coated, and thus rendered moistureproof, are suitable for packing even wet products.

A new quality of coated cellulose film has been developed by using copolymers instead of lacquers based on nitrocellulose formulation. A product known as SARAN-coated, though superior to one coated with nitrocellulose formulation, is expensive. Saran resin-coated product is superior in appearance and has very good

S.B. Rajvanshi, Ex-Chief Chemist, Kesho Ram Rayons, Naya Sarai, West Bengal.
Present Address :
Nehrunagar, Ghaziabad (U.P.)
B. Biswas, Retd. Officer Govt. of U.P.
Present Address :
Nawabgunj, Kanpur, (U.P.)

barrier properties for moisture and gas and possesses very good resistance to folding, creasing and abrasion. Venyl copolymers have also been used for coating regenerated cellulose film and the product obtained is intermediate in properties between nitrocellulose coated and saran coated products[4]. Polyethylene coated products are also manufactured for special uses. Regenerated cellulose film suitably moistureproofed by plasticizing and coating, contributes beneficial properties like stiffness and thermal stability, moisture barrier and good machineability and also good printability on both surfaces. Moistureproofing makes the product resistant to water, heat sealable and highly transparent.

Regenerated cellulose film was the first to be used as flexible, transparent, wrapping and packaging medium. The plastic film came in the packaging field later. Unlike cellulose film which has moisture as an essential component, the plastic films are free from moisture. Because of the ability of cellulose film to be worked with more certainty and speed, on automatic and semi-automatic packaging machines, than many other synthetic fibre products, the demand of the regenerated cellulose film has not diminished.

Cellulose film has a low tear resistance, once the tear started. This is because of high interfibre bonding in cellulose film[5]. Tearing resistance increases with fibre length but decreases with increase in interfibre bonding, after a minimum amount of bonding has taken place *(loc.cit)*. The high degree of bonding in regenerated cellulose film is due to the crystallites being more paralled in it than in paper.

The Process

Upto the formation of viscose solution, from the dissolving pulp, the method for viscose rayon and cellulose film is similar, except for the differences in the Ripening Index (R.I.) and viscosity of the viscose solutions. While in the case of viscose rayon, the Ripening Index (R.I.) of the viscose solution is normally maintained between 9.5 to 10.5, that used for cellulose film production is almost half of above, and maintained between 5.0 to 6.0. In terms of ball fall, the viscosity of the viscose solution for rayon should be from 40 to 50 seconds, whereas for film production, the viscosity of the solution should be from 30 to 40 seconds.

After filtration and deaeration, the viscose is extruded through the lips of casting head, immersed in a bath consisting of dilute sulphuric acid and sodium sulphate. However, the acid bath does not contain zinc sulphate or any other additives. For rayon fibre production, the coagulation bath must also contain zinc sulphate, beside dilute sulphuric acid and sodium sulphate (and often other additives). The casting heads are mono block, normally vertical, with spindles to adjust the opening of the lips. The opening of the lips adjusts the gauge (or thickness, that is, the weight per square meter) of the regenerated cellulose film.

Through the lips of the casting heads, the viscose solution is made to extrude at an uniform rate, to produce regenerated cellulose film of uniform gauge. On coming in contact with the spin bath solution, the viscose solution, (which is sodium cellulose xanthate in dilute sodium hydroxide solution), undergoes a chemical reaction forming a number of products, which *inter alia* include the formation of sodium sulphate and the regenerated cellulose in the form of thin transparent film. The spin bath is maintained at an optimum temperature of 45°C and contains 160 g pf sulphuric acid 200 g of sodium sulphate per litre.

The process of regeration of the film is not complete in this bath (known as the first bath). It is, therefore, necessary to pass the film through a second bath containing 100 g/litre of sulphuric acid to complete the process of regeneration. The film is then passed through a series of tanks each containing different solutions, in the following order. The first tank contains wash water. The second tank contains desulphurising wash solution prepared by dissolving about 6 to 8 g of sulphide per litre of water. The temperature is maintained at 60°. The third tank contains wash water. The fourth tank bleach

wash, containing 1.0 to 1.5 g. available chlorine (usually sodium hypochlorite solution is used). This is followed by a tank containing wash water and then by a softner bath containing glycerol or glycols and antiblocking agent such as silica disperson. This bath is maintained at a temperature of 50 to 60°C.

The film is next passed through a drum drier and finally made into rolls. The rolls are kept in conditioning rooms, so as to enable the film rolls to regain 9 to 10% moisture. The rolls are eut into smaller rolls or in sheets of desired size. For moistureproofing, the film is passed on to the moistureproofing plant, where a coating of a nitrocellulose lacquor (or alternatively, saran, venyl copolymers, etc ,) is applied on the surface, as per customer's requirement.

The moistureproof products are also tested for water vapour permeability, heat sealing and oilproofness.

Differences in the requirements of regenerated cellulose film and viscose rayon fibre.

	Viscose Solution	Regenerated Film	Rayon Fibre
1.	Ripening Index (R.I.)	5.0–6.0	9.5–10.5
2.	**Spin bath composition**		
	Sulphuric acid	160 g/l	140 g/l
	Sodium Sulphate	200	270
	Zinc Sulphate	nil	14

Remark— (a) No difference in pulp composition.

(b) No special need of additives for viscose for film production or for its spin bath.

(c) The film is usually made of the following gauges :
300 g/sq. m
400 g/sq. m and
600 g/sq. m

(d) The width of the regenerated film from the casting head is normally 1480 mm. After drying it becomes 1295 mm. Thus a shrinkage of about 12.5% in width of the film has taken place due to drying.

Some Important Properties of Regenerated Cellulose Film

Substance, gsm	Tensile Strength, lbs	Elongation, %
	(Machine direction)	
300	4 0	13
400	5.5	13
600	8.0	13
	(Transverse direction)	
300	2.0	25
400	2.5	25
600	3.0	25
	Bursting strength lb/sq. in	
300	30	
400	35	
600	50	

The film should not block under a weight of about 1.1 g/sq. cm at 68°F ± 3°F at 65% R.H. ± 2% R.H.

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