Influence of Analytical Characteristics of Dissolving Sulphate Pulp on Viscose Rayon Making

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A large number of analytical tests are required to get a partial characterization of the dissolving grade pulp. Along with this, small scale tests of viscose making and filtrability tests give somewhat good information about the pulp. But the actual process conditions and therefore the actual processing of pulp to viscose is known only when it is actually processed in the mill.

Before discussing the analytical characteristics and quality of pulp it is essential to give a brief outline of how wood is processed to Rayon by Sulphate Process.

The debarked wood is chipped into acceptable size and is fed to the digesters. There it is subjected to a prehydrolysis and then it is cooked with sulphate liquor to the desired viscosity and permanganate number. This is then washed and bleached by usually a six stage bleaching system to the desired brightness and viscosity.

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This pulp is further processed in the Rayon Mill. The first step is making alkali cellulose. This can be accomplished in two ways. One is the conventional sheet steeping process in which the sheets kept vertically in press are flooded with 18% Caustic Soda. After about an hour it is hydraulically pressed to a predetermined ratio and is then shredded to fine crumps. In another process (slurry process) which is becoming more popular due to its easy operation, the pulp is made into a slurry (3% cy.) in 18% caustic soda solution, agitated and then pumped to a filtering press where the excess alkali is pressed out. It is then shredded to get alkali cellulose. The aim of both the processes is the same i.e. to get a uniform alkali cellulose. Then it is allowed to get matured at 24°C to 35°C which is known as ageing. When the cellulose reaches the desired DP it is allowed to react with about 30–40% carbon disulphide and the resulting xanthate is dissolved in diluted alkali to get viscose. The viscose is filtered, aged and deaerated before spinning and then the cellulose is regenerated in an acid bath by passing the viscose under pressure through spinneretts to get rayon fibre.

Wood Quality

There was a time when technologist presumed that only certain species of wood could be used for dissolving grade pulp. But it is ultimately proved that the chemical constituents of alpha cellulose is the same in all woods and only the lignin, hemi-cellulose, resins, fats, etc. differ from species to species. Although most of the species of wood can be used, the important factor is that the wood must be healthy. Decayed or rotten wood result in poor filterability and inferior fibre strength. Before chipping, the log must be thoroughly debarked since the bark will increase the mineral content of the pulp and give poor filterability. Care has to be taken to avoid extraneous dirt coming into the system.

Effect of Pulp Mill Operation

The cooking is the most important stage in dissolving grade pulp production. The alpha cellulose content and pentosans are controlled by the prehydrolysis stage. Under hydrolysis gives a product of low filterability and over hydrolysis results in poor yield. Slow steaming and strict temperature control are necessary to get a uniform product. The screened rejects will show the uniformity of the

pulp. In fact the rayon pulp mill should have only very less rejects if not nil.

For better whiteness and to have minimum impurities, six stage bleaching is required. Care has to be taken to bleach the fibres without over degrading the cellulose. The viscosity control and brightness are the main criteria in bleaching process. But the alkali solubility clearly will yield whatever degradation has taken place during bleaching and this will definitely affect the yield and filtrability of viscose.

Viscosity

The cellulose is a polymer built up of a chain of anhydroglucose molecules. The number of these units in a cellulose molecule is known as the degree of polymerisation or D.P. The viscosity shows nothing but the DP of the cellulose. The uniformity of the pulp is studied by the D.P. distribution. The viscosity specification of each rayon maker may vary but what is important is the uniformity in the viscosity. A pulp with uniform DP distribution will result in better yarn strength.

A number of cold and hot alkali extractions are required to find certain characters of the dissolving pulp. These tests are very important since it shows the rayon yield, gamma and beta cellulose and the degree of degradation of the pulp. A high S 10 shows how much the alpha cellulose is degraded during the pulping process. A higher 7.14% hot alkali solubility shows the severity in cooking and bleaching. It is advisable to keep all solubilities to the optimum. However the pulping process has its own effects on the alkali solubilities and the desirable range is given in the Table above. The beta cellulose is nothing but the degraded alpha cellulose. The prehydrolysis sulphate pulp always give Rayon yield above 96%.

Pentosans

The high amount of pentosans will give a high hemicellulose build up in the steep lye. More over high pentosans in the pulp consume more than its share of carbon disulphide during xanthation. There are also indications that high pentosans adversely affect the rayon strength. The sulphate dissolving pulp generally has pentosans below 2% and hence it will not much affect the rayon quality.

Alkali Solubility

Tests done	Optimum Range of Solubility	Objective
18% solubility 20°C	2–3%	Rayon Yield (95–98%)
17.5% ,, ,,		Gamma Cellulose (1–2%)
10% ,, ,,	4–8%	Alpha Cellulose (93–96)
7.14% ,, 100°C	3–6%	Beta Cellulose (S10–S18)
1.0% ,, ,,	1–2%	Degradation during the process.

Resins

High resin in the pulp is observed to give a poor rayon colour and spinning problems. With proper attention in the wood seasoning and by the use of certain chemicals in the alkaline extraction stage of bleaching, the resin contents are kept at a low level. As pulp with very low or no resin content are found to give filtration problems, a resin content of 0.2 to 0.4 is desirable.

Mineral Impurities

The high mineral impurities in the pulp always cause trouble in filtration and during spinning, it is not the big size dirt (for example, large size sand or rust pieces) that affectt the process. It is the sub-microscopic portion that creates trouble. Particles of 20 to 100 microns create trouble during filtration by plugging the filtering cloth. Particles below 20 microns pass readily through the filtering medium and often cause spinning trouble.

Effect of Silica

High silica can cause filtration and spinning problems. Generally it is safe to keep silica below 50 PPM. However for staple fibre production higher silica does not affect much.

Calcium

Main problems calcium can give

are (1) Precipitate hemicellulose in the recycled steep lye (2) reduce the viscose filterability (3) cause spinneretts incrustation. About 200 ppm of Ca is tolerable in rayon process. However the pre-hydrolysis sulphate pulp generally has much less calcium compared to sulphite pulp.

R_2O_3 (Other Minerals)

Metals like iron, aluminium, manganese etc. have specific action on fast ageing of alkali cellulose and therefore if uncontrolled, can upset the viscose process. Rayon Pulp mills are successfully controlling these feature so that viscose process is not hindered. Presence of copper has no effect on viscose processing but can give a lower colour for rayon. Copper is generally not found in the wood, but can be picked up from the Wet End and Drying machine of the pulp mill.

Copper Number

Copper number is a measure of the amount of carbonyl groups and varies according to the severity of the cooking and oxidative degradation that has taken place during bleaching. High copper number pulp has higher caustic solubility and leads to fast alkali cellulose maturing, lower rayon colour and poorer strength.

Brightness

Though brightness has not much effect on viscose making, it has good effect on final fibre product. A good brightness after steeping correlate with good fibre colour. So, it is desirable to keep a brightness above 90 GE.

The above mentioned characters are evaluated in all pulp mills and it is controlled to get a uniform pulp. But as mentioned in the begining of this article the most valuable evaluation comes from the actual run of the pulp in the rayon mill. So for actual quality control of pulp, feed back of datas from the viscose mill to the pulp producer is required. This points out to more close co-operation with the pulp producer and the Rayon maker.