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The Effect of Variables on the Penetration of Starch Applied at the Size Press

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Mr. Janes

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The Effect of Variables on the Penetration of Starch Applied at the Size Press:

The literature from 1928 until the present was searched as it relates to the above topic. It was organized into three areas. The first relates the reasons for surface sizing a sheet and how penetration affects them. The second topic states the beliefs as to which variables affect penetrtion and how they are believed to affect it. The last area concerns the work that has been done in this field. This work has been lacking due to a lack of good procedure. Some work has been done on starch coating adhesives and this was searched for useable technique.

John. Good. Correct way to cite reference.

Reasons for Surface Sizing:

To determine why a sheet is surface sized it is, first of all, important to define size. It has been defined by A.C. Dreshfield as, (1) " any chemical, other than bleach, fillers, pigments, and dyes which are added to the papermaking furnish or subsequently applied after the web is formed which alter those characteristics of the sheet that relate to its resistance to the transsudation or absorption of liquids which come in contact with the web." As this definition states there are two basic types of sizing: internal sizing and surface sizing. In this case the latter is to be discussed.

Surface sizing can be stated as a method of altering the surface characteristics of a sheet. It is applied to(2) increase smoothness, lay the fuzz, improve scuff-resistants, increase resistance to liquid penetration, (3)control evenness of ink penetration, and increase surface strength, notably surface pick and printability. It is usually stated that to have these actions accomplished the size should remain on the surface and not penetrate the sheet. In most cases,(4) the forming of a continuous film of size is the ideal.

When the sizing agent is considered starch offers some advantages. Starch has been found (2) to have higher strength, lower acidity, and greater weight when used in the sheet in place of rosin. Starch has been found to do a good job in meeting the needs of a surface sizing agent. Starch improves the physical properties of the

sheet. It improves (1) the burst and reduces surface fuzz to a large degree. It aids the following properties to a lesser degree: tear, fold, rattle, scuff resistance, erasability, smoothness, and feel. It (4) also keeps printing inks on the sheet surface.

There are several types of starch available. The type of base starch determines to a large degree the future uses. The initial viscosity, per cent solubility, and degree of water retention must be taken into consideration when making the choice of starch. Then there are several methods by which the starch can be degraded(3) to make it useable at the size press.

The starch choice is indicated by machine and sheet variables. The machine speed and type of size press are the machine variables(3). The furnish of the sheet affects the ease with which a sheet may be sized and hence the starch choice. The amount of internal sizing can affect this choice. Because of the water solvent of the size solution the moisture of the web at the point the size is applied is vital. The size particle that can be used and its retention is influenced by the smoothness of the basic sheet.

The method of modification of the base starch that is used the most is (5) oxidation. This is because, there is a lesser tendency of jelling than with other types of conversion, little or no stratification and exceedingly good film, and little or no tendency to foam."

Beliefs of Penetration:

There have been many ideas concerning penetration. They concern two basic ideas. If penetration is good or bad, by which is meant how does it affect the future use of the sheet and what are the economics. The second is, how to change the degree of penetration of the size. The theories in this respect can be divided into three groups. These are the machine, sheet, and size solution variables.

The most general equation found of penetration of a liquid in a sheet was by R.M. Cobb(6). - is this term originally!!

$$l^2 = \frac{r \sigma \cos \theta \, t}{2 \mu}$$

l = depth of penetration in cm

r = pore radius in cm

σ = surface tension liquid in dyne/cm

θ = contact angle

t = time in sec

μ = coefficient of viscosity in poises

This equation deals with variables relating to all three groups.

Of the variables of the size solution it seems the most important is the viscosity. Other variables appear to be important only as they affect the viscosity. The penetration, as can be seen from the Cobb equation, is inversely proportional to the square root of the viscosity.

To increase penetration (4) to improve strength the solution

should be kept as hot as practical (170-190°). Depolymerized starch products insure thin solution and increase penetration. The short chain modified corn starch was suggested as one good material. The solids content of sizing is important as to its effect on viscosity.

In the sheet, as in the sizing solution, there are primary and secondary variables which affect the penetration. The capillary pressure(7) on the surface of the sheet will pull the solution into the sheet more if it is high. This is determined by the depth and radius of the capillaries in the sheet. These in turn are a result of the (8) density or bulk, (1) porosity, and manner of refining. The smoothness of the sheet will affect the capillary pressure and(8) also the contact angle between the sheet and the solution. The type of pulp being used affects the ability of a sheet to be sized and probably(3) affects the penetration. The amount of internal sizing that has been done and the migration of the size in the sheet will affect the penetration, the more the internal size the less penetration can be expected. The moisture content of the sheet at the time the sheet comes in contact with the sizing solution seems to be of major importance. The range of moisture content is optimum between five and twelve per cent (9) with the penetration increasing with the moisture content in this range.

The most important machine variable in surface sizing is the method of application; size tub or size press. The tub offers maximum penetration and also greater size pick-up. The size press(10) pick-up is twenty-five per cent less than the size tub pick-up.

The size press itself offers many variables to size penetration. The nip pressure of the press will either (8) force the size into the sheet if the solution viscosity is low or will squeeze a high viscosity solution off the sheet. The rolls (9) should be of different hardnesses. Generally, the softer the roll the more pick-up of size due to wider nip line, The hardness of the top roll (10) of the press must be fitted to the moisture content of the sheet as it enters the press. As the moisture of the sheet gets higher the roll should get softer. The diameters of the rolls (9) have a direct relationship to the amount of roll loading required. The result of more loading on the press is less pick-up of size. The dwell time(10) both in the size solution and probably in the nip of the press affects the penetration. The longer the dwell time the more penetration. If the drive speed of the press (9) is faster than the machine speed a larger of amount of size is picked up. The condition (8) of the press must be considered as a variable.

The The machine has secondary variables which do not directly affect the penetration but alter the direct variables. The machine speed (1) will affect the dwell time and may affect the moisture content and sheet formation. The previous pressing(7) of the sheet will affect the surface of the sheet and also the moisture content. The previous drying will also affect the moisture content.

What has been done

The amount of information that has been gathered in the area of size penetration is very small. The lack of technique has been the biggest drawback. A microscopic observation by H. N. Lee of

beater and surface applied starches(11) seem to be the only work in this area. Other work on the penetration of coating adhesives with rather exotic procedures has been done. This was looked into for useable technique.

Lee's work showed that surface applied starches do not form the continuous layer as would be hoped for in an ideal surface application. He studied internal sizing and found that, "the fact that starch can be seen only near the surface and not in the interior of the sheet is not positive evidence that the paper has been only surface treated." This shows that migration on the dryers is very great. He found that the starch was on the surface of the fibers and filled the interstices between the fibers. None of the starch was seen in the fibers. The penetration was found to be strongly affected by the quantity of starch applied and also on the degree of previous sizing.

In the studies of starch coating adhesives Casey(12) found a relationship to sheet moisture. The wet sheet has, as was believed, greater penetration than the drier sheet.

condition	penetration in microns
air dry	62
no size	
wet	272

Dappen(13), in his study on clay coatings found that the sheet surface was made up of hills and valleys hence, it would be hard to say just where the surface of the sheet is for determining penetration distance. He also found some of the starch particles were possibly too large to get into the pores of the sheet and

therefore remained on the surface. His photocolorimetric determination of starch seems to be a good one. I believe it will be a good quantitative method for determination of starch in this project.

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