Alex. Eng. J., Alex. Univ., Volume 28 No. 2, pp. 261 - 276 (1989)

EVALUATION OF THE PERFORMANCE OF A SIZE MIX IN A MODERN SIZING SHED

R.I. Mashaly

Textile Engineering Department

Faculty of Engineering, Alexandria University

Alexandria, Egypt

Abstract

Partial replacement of polyvinyl alcohol with local starch "rice strach" to form a suitable size mix is investigated. Optimum mixing ratio, measured by size film mechanical properties, as well as measurements of adhesion and interaction between size film and fibres is determined. Field experiments to judge the measures suggested for the yarn performance in both sizing stage and in the weaving shed were made and results are interpretted.

Introduction

In the last decade weaving technology has presented a real challange for production rates and quality of pre weaving processes whether spinning or preparation stages. The introduction of Sulzer projectile weaving m/c associated with a weft insertion rate of more than 1000 meter per minute, air jet looms now reach supersonic speeds and multiphase loom is expected to reach an equivalent of 2000 meter per minute [1].

Such rates of yarn speeds necessitates the usage of super quality sized yarns.

Experimentation on sizing machines under field conditions means dealing with several thousands of yarn ends and considerable amount of waste and production loss to judge the quality of sized warps under various operating parameters whether relating to the type of mix, and or sizing machine parameters.

Concerning size mix,partial replacement of native starches by polymers with better adhesion and mechanical properties is now a known trend in the modern sizing sheds [2,3].

The use of polyvinyl alcohol in particular gives much better film properties [4] for the sizing material whether on its own or as partial replacement of the starch.

It is established beyond any doubt that viscosity and surface tension of a sizing solution play an important role in adhesion of two solid surfaces [5], in sizing, this means between fibres constituting the

yarn body. Film properties as well as the compatability of the type of strach used with the polyvinyl alcohol affects the performance and properties of the sized yarns.

In the current investigation a technique for judging the quality of a size mix, which was initially considered by Faasen and Harten [6] is developped and used for the evaluation of size mix formulae, using combinations of native starchs, polyirnyl alcohal, and Carboxy Methyl chloride (C.M.C).

Firstly the properties of a film produced from certain mix was tested for breaking load, extension, and bending rigidity. Secondly, tests of single end sizing under laboratory conditions "low pressure and free air drying" were carried out. Thirdly surface tension of different size mix as an estimate for the degree of spreading, and hence the adhesion, passibility of the film to the yarn surface, and also viscosity of a size as it affects size add on to the yarn have been investigated.

Fourthly some field experiments on some favourable blends of starch - P. V.A. and C.M.C sizing materials were made and yarn properties were tested.

Fifthly, a field measurements of the performance of sized yarn in weaving shed are carried out.

Experimental Work

1. Measurements of surface tension and viscosity of defferent size. Yeager's apparatus was used for measurement of surface tension.

The principle of measurement is that when an air bubble is formed under a liquid surface the relation between the pressure difference "p" inside and outside the bubble and the surface tension "T" for the liquid is P = 2T/R where "R" is the bubble raduis. The viscosity of size solution is estimated by measuring of the time required for a solution of given concentration to flow through an orifice.

2. Study of the film properties made from different size mix. solutions of 100 cm^3 each of water + P.V.A. + starch, with different ratios of P.V.A. to starch are prepared. For each blending ratio, three different percentages of lubricant are added namely 0.5, 1, 2% producing three different samples. A total of 10 % of adhesive in size solution is added, this is quite arbitrary as water will be evapourated. A total of 10 grams of a adhesive are used in each experiment e.g. 1 gram starch + 9 P.V.A., or 2 grams starch + 8 P.V.A.,..., etc. After preparing the solutions, the formation of a thin film is achieved by pouring the constant weight of the solution in a clean non stick Tefal plates, followed by drying these plates at 60° C for 24 hours in a controlled oven. on the evapouration of water, a layer of constant weight per unit area is left, from which samples can be cut and tested. Tensile properties of the produced films are determined on the Instron. Samples of 3 cm length and 1 cm width are tested with a cross-head speed of 50 cm/min. The breaking loads and elongations are determined for five samples of each mix.

The film's Bending rigidity is determined using Peirces heart loop test [7], and bending modulus is worked out .

3. Tests on Single end Sizing

The object is to find a measure for yarn-adhesive interaction, as measured by yarn mechanical properties when tested after being soaked for 10 munites in different size liquors and then squeezed under relatively constant low pressure and dried in the open conditioned atmosphere for 48 hours. Thus all machine parameters such as drying temp-speed-Squcezing pressure are avoided. Only the interaction between fibres and size liquor is considered - size pick-up is determined and the relation between yarn properties and different percentages of P.V.A. & starch is determined at different lubricant percentages - for different yarn counts.

4. Experiments on Sized Yarns

The three size mixtures used are as follows:

mix a -	24	kg	P.V.A.	6.65 %
	24	kg	Rice starch	6.85 %
	2	kg	of Hamadol lubricant.	
	350		liters of water	
	count Ne 40			
Mix b -	50	kg	Rice starch	140 %
	4	kg	P.V.A.	1.1%
	½	kg	C.M.C	0.14 %
	1	kg	Hamadol	
	count Ne 40			
Mix c -	50	kg	Rice starch	
	350		litre water	
	Ne = 26			

Yarn properties were tested before and after sizing. Viscosity and concentration of size solution are estimated in each case.

5. **Experiments on yarn performance on loom:**

Ends down rate of Sulzer loom "Warp breaks/hr" were estimated.

a) The first mix 50% P.V.A. - 50 % starch with a total add on of 6.85 P.V.A. & 6.85 starch.

Loom picks per minute = 255

Pick per inch = 48

Ct 40/1

b) The second mix, P.V.A., C.M.C, and starch

Picks/ min. = 255 Picks/inch = 48

Ne = 40/1

c) The third mix

starch 100 % Ne = 26

Picks/min. = 160

Picks/inch = 42

The loom beam specification were as follows;

N^{o} of ends/inch 60

Ne = 40/1

Total number of ends 2400

3 widthes per m/c, plain weave

The size pick-up in each case is determined.

Results and Discussion

1. Measurements of surface tension and viscosity of sizing solution.

Figure (1) shows the relation between surface tension in N/M of size solution and the starch P.V.A. ratio. It is clear that the

value of surface tension of size solution increeaces with the

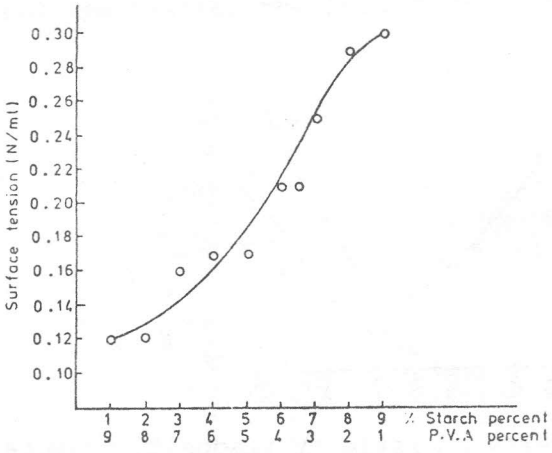

Fig. (1) Effect of P.V.A - Starch ratio on the surface tension of sizing solution "1% lubricant"

increase of starch % in the mix-while this is an advantage in adhesion,low surface tension is required for spreading of size solution along the fibre's surface - A mix of 40 - 60 or 50 - 50 starch P.V.A. seems to be a reasonable choice for a reasonable value of surface tension.

Figure (2) shows the effect of P.V.A. starch ratio on viscosity measure "Lubricant added is 1 % of the solids in sizing solution". It is clear that the higher the P.V.A. starch ratio the higher the viscosity of the size solution. Higher values of viscosity increases pick-up and bonding of fibres-but gives less penetration through the yarn body [8].

2. Study of the Film Properties

The effect of starch - P.V.A. ratio in the size mix on the breaking

load of the film made from this mix at different lubricant

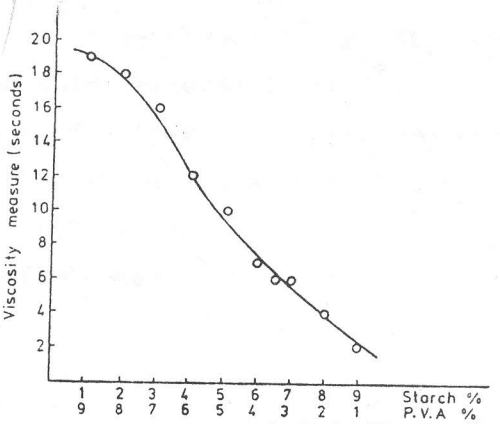

Fig. (2) Effect of P.V.A-starch ratio on viscosity measure "at 1 % lubricant".

percentages has been investigated. It is clear from "fig. 3" that the higher the P.V.A. percent, the higher the film strength - which is quite expected as a film made from 100 % starch is quite weaker than an equivalent film made P.V.A. [ ].

From Fig. (3), it is also clean that the effect of lubricant % plays an important role on film strength with higher per centages of P.V.A. while this trend is not quite noticable with higher startch %.

The best results for film strength is generally obtained with 1 % lubricant :
Generally the addition of 1% lubricant gives the best results as for as the yarn breaking extension is concerned.

Figure (5) shows the effect of blending ratio of P.V.A. to starch

on the bending modulus of the film-Apparently the more the starch percent the stiffer the film.

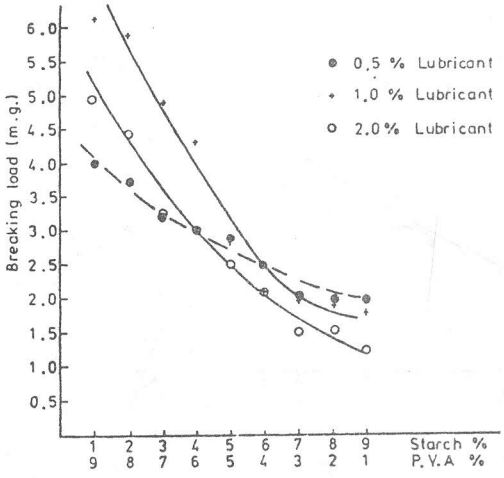

Fig. (3) Effect of starch-P.V.A. blending ratio on the adhesive film breaking load at different lubricant percentages

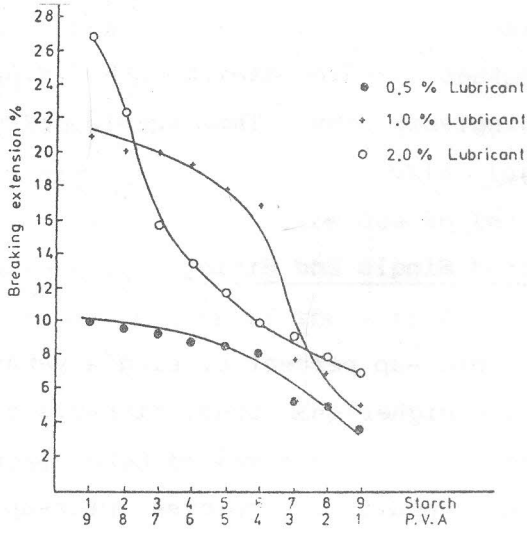

Fig. (4) Effect of starch-P.V.A blending ratio on film breaking extension at different luricant % age

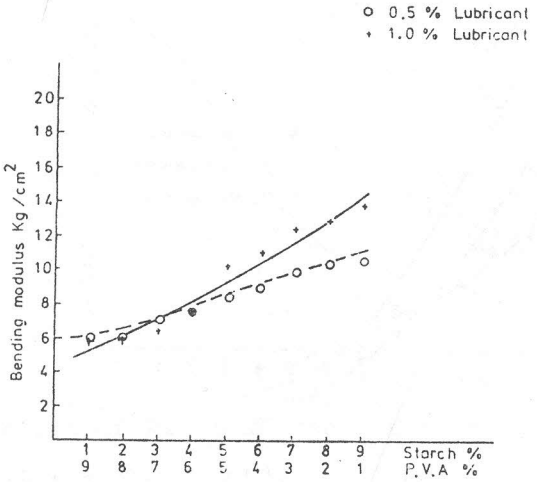

Fig. (5) Effect of starch-P.V.A blending ratio on the adhesive film bending modulus.

This indicates that blending starch with P.V.A. produces a mixture of less bending rigidity. This should decrease sheddings later during weaving.

3. Results of Testing Single End Sizing

Measurement of pick-up percent of single yarns under low pressure produces , a higher than usual pick-ups as shown figure (7).

Higher lubricant addition improves pick-up and the increase of P.V.A. in the mix increases the pick-up. At 60 % - 40 % P.V.A. size and 50 - 50 mix about 19 % pick-up is recorded. Under normal

squiezing pressure in sizing m/cs , this value should be normally about 10 %.

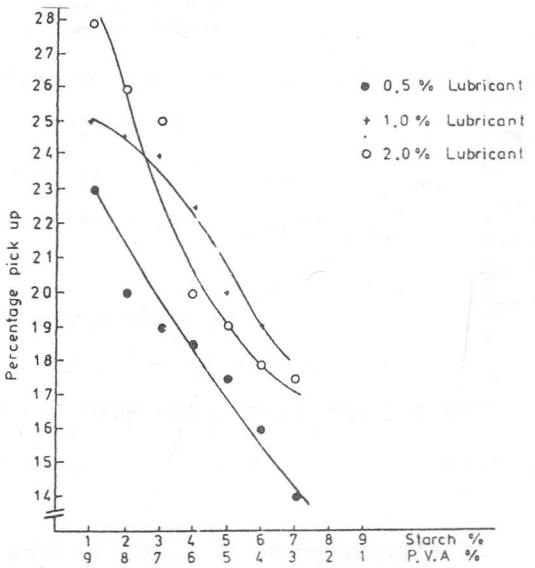

Fig. (6) Effect of blend ratio of strach-P.V.A on percentage size pick up with different lubricant 1 % age.

Tests on yarn breaking load and extension give a similler trend as that found when testing the size film itself (Fig. (7) & Fig. (8)). Increasing P.V.A. percentage does increase the yarn breaking load and extension. However the breaking extension of the composite structure "the yarn" is half that of the size film itself, or even less. This may be due to the hetrogenity of the composite structure compared to the film and also due to the fact that the lack of penetration of the size film associated with too low pressure.

This is of course added to the fact that fibres have low breaking extension.

Fig. (8) shows also that too much pick-up reduces extension at

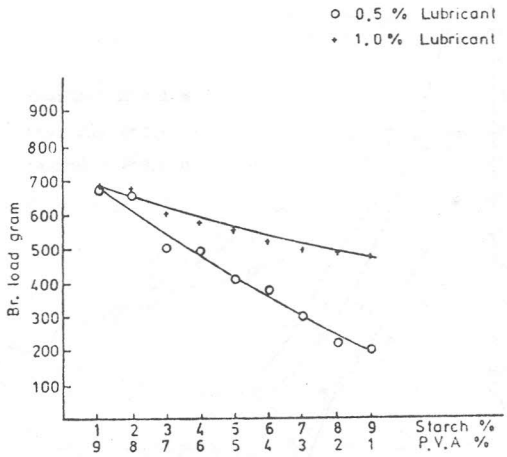

Fig. (7) Effect of starch -P.V.A. % on the breaking load of a single sized yarn-(N_e=14) cotton yarn.

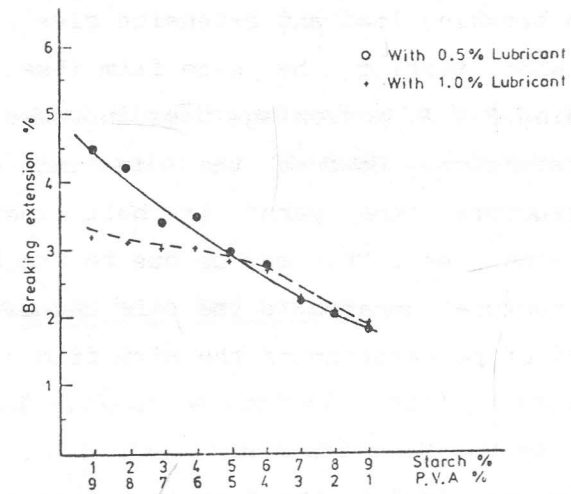

Fig. (8) Effect of starch-P.V.A blending ratio on the breaking extension of a single sized yarn (N_e 14 cotton)

break even if hot stretch does not take place

Fig. (7) also shows that 1% lubricant improves the breaking load emmensley compared to the case when only 0.5% lubricant is used. It seams that compared the higher lubricant percent tends to make the fibres and the film more compatable by reducing the beding rigidity of the size film.

4. Testing of sized warp threads

The following table gives the details of three yarns from actual daily production of a mill. Using the three mixtures of adhesive, denoted as mix a,b, and c in the experimental work.

It can be seen that there is an increase of the tenacity of about 60 % for mix a and 40 % for mix b - and 16 % of mix c - Starch was used with a relatively coarse count (Ne 26) as - its usage with fine counts gives a relatively bad results.

A 50 - 50 P.V.A. starch mix with about 0.6 lubricant and of about 9 % pick-up gives better results than when using only 10 % P.V.A. 90 % starch and with 1 % C.M.C. as in mix b.

However both blends give better results compared to 100 % starch.

5. Tests on weaving shed

Loom effeciency and warp breaks in the weaving shed was determined for the three formulae. The results are shown in table (2).

Table (1)

Size mix.	Breaking before sizing	Breaking after sizing	Count before sizing	Count after sizing	Tenacity before sizing	Tenacity after sizing	C.V. % before sizing	C.V. % after sizing	Pick up
Mix. (a) P.V.A.+st.	208	318	3.6	3	39	36	13.8	18	10.6	8	9.2
Mix (b) Starch + P.V.A. + CMC	208	288	3.6	2.9	39	35	13.8	17	10.6	9.5	13
Starch	350	400	4.5	3.9	26	22	15.4	15.9	12	11.7	18

Effect of sizing on sized yarn properties

mix	Starch + P.V.A.	Starch + P.V.A; + C.M.C.	Starch
Ends/inch	60	60	40
Pick/inch	48	48	42
Pick/m	255	255	160
Warp stopes per m	1	8	13
loom affeciency (Actual)	80	60	55

Further field experiments are needed for other types of yarns size mix and different working conditions. However it can be concluded that a fifty - fifty - starch - P.V.A. mix with about 0.6 % lubricant - gaves an acceptable results.

Conclusions

1. Study of the film properties gave a quick and inexpensive technique for gudjing the quality of a size mix on its own and to some extent as part of the sized yarn.
2. Measurements of viscosity and surface tension of the size liquor gives another important parameter which is reflected on both size pick-up and on sized yarn properties.
3. Choice of size formula and lubricant added proved to be of a prime importance in determining the extension at break of the sized yarn-even when avoiding hot strenching and high squeezing which

are associated with modern sizing processes. This has been proved through the experiments on single end sizing under low pressure.

4. A fifty - fifty P.V.A. starch with a total of about 9 % solids & 0.6 lubricant, gives good sized yarn properties this is quite near to the results made on the size film.
5. Actual field experiments proved that a size pick-up of about 9% of P.V.A. Starch, 50-50, blends is much better than a size pick up of 13% of P.V.A; starch C.M.C. of 9, 90, and percent respectively.
6. An economic study for the ccst with the different size formulae seems to be necessary.

References

[1] R.M. Dawson, Shuttleless and Multi-Phase weaving Machine Principles and Developments. Textile Institute and Industry July 1979 P. 236.
[2] Partial replacement for P.V.A. in Warp sizing, Testile Industeries, March 1975 P. 79
[3] J.T. Modi, REcent advances in low cast sizing, Textile Industeries, April 1983, P 38.
[4] K. Tsunemitsu, and H. Kshimptp, in Polyvinyl Alcohol, edited by C.A. Finch; London, Wiley, 1973.
[5] W.A. Zisman, Industerial and Engineering Chemistry, Vol. 55 No. 10, 1963.
[6] N.J. Faasen and K. Von Harten. The effect of sizing on weavability of cotton yarns, J.T.I. 57, T 269 - T 285 (1966).
[7] F.T. Peirce, J.T.I., 28, T 45 1937.
[8] P.V. Seydel, and J.R. Hunt, "Textile warp sizing "Long and Clapton Inc., Atlanta, 1972.