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PARTIAL ADDING OF SYNTHETIC SIZING AGENT TO RICE STARCH

By

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الأضافة الجزئية لمواد البوش الصناعية لنشا الأرز

فى هذا البحث تم دراسة خاصية اللزوجة لعدد من مواد النشا مثل نشا الأرز والنشا المؤكسد والأكريلات و ال P V A ومخاليطهم مع نشا الأرز بنسب مختلفة . و كذلك تم تبويش عدد من مطاوى السداء من هذه المواد لدراسة تأثير نوعية مواد النشاء و اللزوجة علىخواص خيوط السداء المبوشة وتم ايجاد معامل الأرتباط بين اللزوجة و خواص الخيوط. و قد وجد أنة بجانب الخواص المتميزةلقوة الشد و مقاومة التاكل لمواد النشا الصناعية فأن اللزوجة تعتبر عامل مهم للوصول الى درجة تغليف مناسبة و درجة تغلغل محدودة

ABSTRACT:

In this article, the viscosity characteristics of rice starch, and synthetic size such as acrylate, P V A, and their mix in different ratios is investigated. The properties of warp beam yarns sized with different sizing agents were studied to find out the relationship between yarn properties and sizing agent viscosity. It was found that the yarn properties are highly correlated to viscosity and sizing material used. Beside the superior strength properties and resistance to abrasion of the synthetic sizing agent, the viscosity is an important factor to achieve suitable encapsulation and limited penetration.

INTRODUCTION:

The main target of warp sizing is to increase the weavability " weaving performance". Sizing should bind fluffs, increase yarn strength and maintain yarn elongation. Secondary aim of sizing is to give softness to yarn and provide anti static measures and increase the cohesion of fibers.

The yarn during weaving process suffer from repeated and compound stresses. these may be listed as follows:

- Rubbing of warp yarns against the mechanical parts of the loom,
- Rubbing of warp yarns against each other inside the same reed,
- Dynamic stresses and tension caused by up and down of healds.

Good sizing agent should give high and even stretch, even tension, slight hairiness and no crossing in thread run. The following are the major requirements should be realized in sizing agent:

- Penetrate to a certain extend,
- Form an elastic film around the yarn,
- be easily removed,
- Be non polluting and harmless, and
- Absorb sufficient moisture to act as anti static agent during weaving.

Starch is the most popular sizing agent for cotton yarns. However, high relative humidity (80% and above) is required for efficient weaving process, to reduce brittleness of starch film warp breakage / 1 /. The cost of warp sizing is clearly an important consideration in the economics of woven fabric production, and a major factor in this respect is the cost of sizing material itself.

With the advent of synthetic size products, an important advance in sizing efficiency was made / 2 /. In most access the level of size fiber adhesion was increased, the toughness and abrasion resistance of the size film was enhanced, and the hairiness after sizing was reduced. A s an additional benefit, synthetic size is usually water soluble and easy to remove in desizing process. Almost thirty years after the introduction of synthetic sizing agent into staple yarn sector, starch is still the most widely used material for textile warp sizing / 3 /. Different sizing agents are used in warp sizing such as rice starch, oxidized starch, acrylate and polyvinyl alcohol.

The following agents and applicable fibers are given in the following table.

Table (1)

Polarity	Sizing agent	Applicable fiber
Hydroxyl group	Starch, PVA, CMC	Cotton, rayon, Acetate
Ester group	Acrylic Ester group	Polyester, Acetate
Amido group	Acrylic Amido (PAM)	Nylon, silk, wool
Hydrogen bond	Starch, PVA, CMC, PAM	Cotton, Acetate, Rayon and nylon

Blumenstien /4/, discussed the sizing with PVA, and found that, beside the superior strength and abrasion resistance of PVA, a low add on, lower humidity and lower viscosity is achieved. Cacho /5/, found that the viscosity of CMC starch decreases gradually, while held constant at 80 °C, and no decrease in mechanical properties of the size was observed.

Adding a minor proportion of synthetic size to a starch based formulation, become quite common to use in industry. This improves starch characteristics and hence wrap sized yarn and leads to improving weaving performance.

The present paper study the effect of partial replacement of PVA, Acrylate and Oxidized starch in different ratios. The viscosity characteristic of sizing agent is correlated to wrap sized yarn properties.

EXPERIMENTAL WORK:

The experimental work is deviled in two parts. The first part, deals with a laboratory study of viscosity of different sizing agents. The second part is directed towards the investigation of effect of different sizing agents on the properties of wrap sized yarn.

Material and method:

A 10% of starch was used for preparing the liquor, by adding 50g of the starch to 500 cm of water in the cup of the **Viscograph** apparatus. The starting temperature was 80 °C, heating for 45 minutes, the viscosity in Brabender units versus time is registered on chart recorder attached to the apparatus. Synthetic size such as " PVA, Acrylate and Oxidized starch " was added to rice starch at different ratios from 0% to 100%.

Six wrap beams were sized on " **Sucker & Mueller** " sizing machine type W.L. 1982. Table (1) gives the constitution of sizing material used. The sizing machine was adapted to normal industrial running conditions. The number of cotton wrap threads was 3263, the yarn count was Ne. 20/1 and the twist multiplier 3.7 . The speed of the machine was adjusted to 80 m/min. The machine setting was kept constant through the course of experiment. Samples of these yarns were taken and tested against the different tests of yarn properties and encapsulation and penetration of sizing agent in the yarn.

Table (2)

Code	Sizing material
1	100% Normal starch
2	95 % Normal starch + 5 % Acrylate
3	90 % Normal starch + 10% Acrylate
4	95 % Normal starch + 5 % P V A
5	90 % Normal starch +10 % P V A
6	95 % Normal starch + 5 % oxidized starch

YARN TESTING:

Tensile properties:

Breaking load and breaking extension of sized yarn were obtained using the Universal tensile testing Machine " Lloyd PLC ", gauge length 50 cm and cross head speed 50 mm/min.

Frictional properties:

The electronic friction meter of "**Rotschild model F-meter R1182**" was used to find the coefficient of friction of sized yarn against Ceramic. The output tension due to yarn to yarn friction is also measured.

Yarn abrasion:

The yarn abrasion tester type **FY-20** from **Metrempex** was used to find the number of cycles until yarn breaks. Running speed was adjusted to 1000 cycle/min.

Size add on:

The size add on is obtained by weighing 10 m of yarn before and after sizing.

Size penetration and encapsulation:

Microscopic investigation was provided to determine the encapsulation and penetration of sizing agent. Specimens of yarn cross section were dyed by a "coloring agent" composed of iodine 0.2%, boric acid 0.5% and sodium iodate 0.5%. The sizing agent changes its color, while the yarn fibers are not affected. 10 photographs for each yarn was taken. A micro processor controlled camera attached to the microscope type " **Reichard, photostar Automatic** Camera **System** " was used. The encapsulation was calculated as the angle in degrees of the circumference of covered yarn with sizing agent. The penetration is taken as the percentage increase of radius across the yarn cross section as shown in fig.(1). This method was applied according to **Seydel Co.** / 6 /.

RESULTS AND DISCUSSION:

VISCOSITY CHARACTERISTICS OF SIZING AGENTS:

It is known that the synthetic size such as acrylate and PVA have very high tensile properties. As expected by adding synthetic sizing agent to rice starch, the strength of the sizing agent becomes more harder and leads to better strength characteristics of sizing yarn, due to the covering effect of the size.

To get the benefits of the synthetic size, the encapsulation and penetration of the starch must be correctly established. This will be achieved through the viscosity characteristics of the starch. Thus the viscosity or the fluidity of the starch is very important physical factor which affect strongly the whole sizing process.

Fig. (2a-f), show the original charts get from the viscograph for the different sizing agents. The maximum and the so-called linear viscosity for different sizing liqueur are plotted in figures (3 - 5). It is seen very clear that by adding acrylate or PVA to rice starch, the viscosity decreases very quickly, and then becomes somehow constant. This is because the grains of rice starch swells a little in the presence of synthetic starch. This cause solving a part of it in water, and the maximum viscosity and hence the linear viscosity decreases.

In case of oxidized starch, where the oxidizing agent is mostly sodium hypoclorate or potassium permanganate is used, the polymerization degree and the carboxyl groups decrease. This phenomenon is known as " The retrogradation process ".

From fig. (6), it seem that, the viscosity of the liqueur of 10% acrylate is the smallest one followed by PVA, and oxidized starch. Photographs fig. (7), are good proof for limited penetration and suitable encapsulation for liqueurs mixed with Acrylate and PVA.

EFFECT OF ADDING SYNTHETIC SIZE ON YARN PROPERTIES:

Correlation coefficient between yarn properties and viscosity of the sizing agents are given in Tab. (3). Most coefficient of correlation are significantly high, this means that there is a functional relationship between viscosity and yarn properties.

Table (3)

Correlation matrix of viscosity and yarn properties							
	B.L.	B.L.	B.E.	Abr.	Y.O.T.	Friction	Pick up
Vis. C.L.	1 100	-.879 97.9	-.863 97.2	-.956 99.8	.952 99.7	.916 98.9	.937 99.4
B.L. C.L.		1 100	.837 96.2	.903 98.6	-.804 94.6	-.732 90.2	-.742 90.8
B.E. C.L.			1 100	.868 97.5	-.773 92.8	-.763 92.2	-.771 92.7
Abr. C.L.				1 100	-.949 99.6	-.936 99.4	-.798 94.3
Y.O.T. C.L.					1 100	.908 98.8	.870 98.6
Friction C.L.						1 100	.776 93.0
Pick up C.L.							1 100

Vis. = Viscosity B.L. = Breaking load B.E. = Breaking Extension Abr. = Yarn Abrasion
Y.O.Y = Yarn out put tension. C.L. = Confidence limit %

The viscosity is negatively correlated to yarn breaking load and extension, i.e. as the viscosity decreases, the tensile properties of the yarn increases. this is because of good penetration and encapsulation of the size due to high fluidity or in other words the viscosity. The size pick up is positively correlated to viscosity, where the higher viscous liqueur adhere more to yarn circumference, this does not mean that the size encapsulate probably the yarn. The coefficient of friction and yarn output tension are higher as the viscosity of the size increases. This is because the viscous size contain coarser grains and this produce rough yarn surface. It can be also observed that abrasion resistance correlates negatively with friction , i.e. as the yarn friction is low, the yarn abrasion resistance becomes higher, and this is a result of penetration of size in yarn due to lower viscosity.

Fig. (8), represents the yarn properties sized by different sizing agents. It is seen that only limited differences in yarn tensile properties. A slight higher strength is given to yarn sized by acrylate and PVA of 10% added to the rice starch. This is because the normal bonds which are h-bonds, Van der Wall and the electro static bonds are activated in the presence of synthetic size, resulting in a higher adhesive power between the synthetic polymer and the yarn.

The size take up is the highest for rice starch and the lowest for yarns sized with a mix of 10% of acrylate. The coefficient of friction of yarns sized with synthetic size is substantially lower than of those sized with rice starch. The output tension obtained from yarn to yarn friction have completely the behavior. This is because, the synthetic polymer is soft and the degree of polymerization is relatively high, compared with rice starch. This leads to rearranging the polymer molecules, and result in a compact, fine and even surface.

Higher abrasion resistance is due to 10% of acrylate mix, and the lowest value is related to 100% rice starch. This is because the rice starch is brittle and wear easily due to abrasion.

The technical economical analysis and profit cost are very important factors in introducing new materials in sizing technology. This analysis must be based on long run period. Material cost, energy cost, water are the major cost factors, the benefits which are presented in higher weaving efficiency, must be balanced with the cost. The percentage of adding synthetic size must be optimized to the count and type of fiber used. Due to the introducing high speed weaving looms in to industry, synthetic size become more essential for stable weaving process. the scope of this research was limited to the evaluation of yarn properties sized with the most well known sizing agents and their mix . Preliminary exploration of the effect of these sizing agents, shows that the overall weaving efficiency was increased by about 2% due to using a mix of 10% of acrylate or PVC, and 1 to 1.5 % due to the use of oxidized starch.

CONCLUSIONS:

- Viscosity is very important physical property for sizing agent and a necessary factor for good and stable sizing process.
- Viscosity is highly correlated to sized yarn properties. It is negatively correlated to frictional properties and abrasion resistance.
- Encapsulation and limited penetration are important controlling condition for the sizing process.
- Adding 10% of acrylate or PVA to rice starch leads to substantial improvement in sized yarn properties.
- Mixing oxidized starch by 10% with rice starch shows limited improvement in yarn properties.

ACKNOWLEDGMENT:

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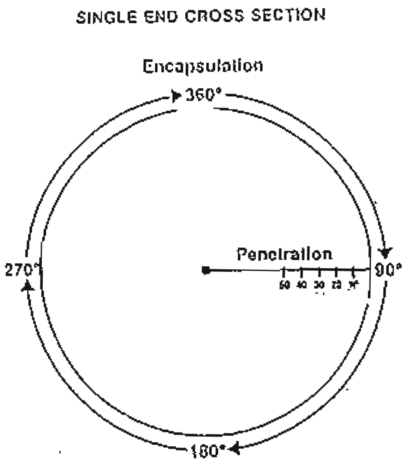
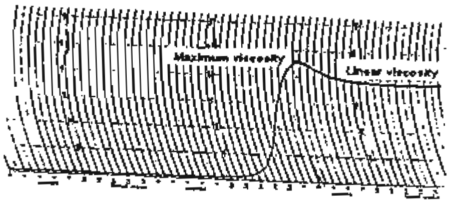
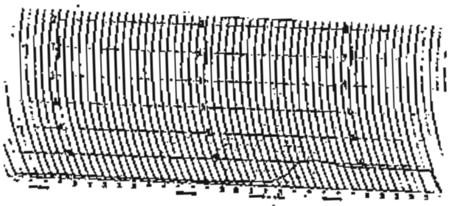


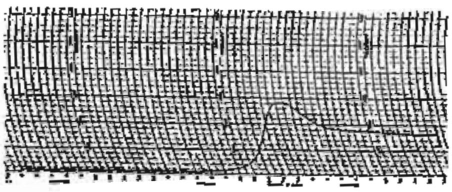
Fig. (1), The principle of evaluating the encapsulation and the penetration



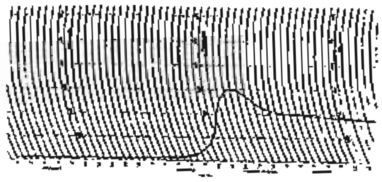
(2-a), Rice starch



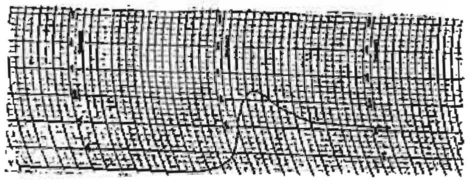
(2-b), Rice starch + 10% Acrylate.



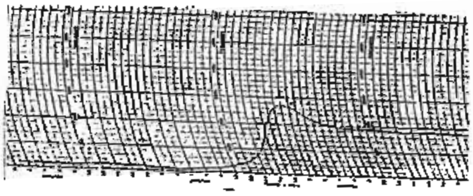
(2-c), Rice starch + 5% Acrylate.



(2-d), Rice starch + 10% PVA



(2-e), Rice starch + 5% PVA



(2-f), Rice starch + 5% Oxidized starch

Fig. (2), Chart diagram of viscosity for different sizing agents.

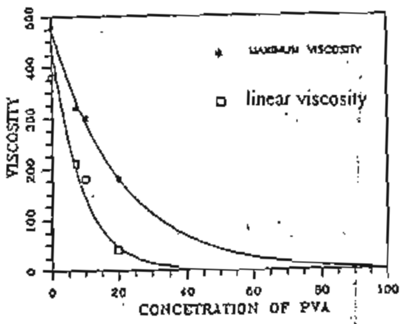


FIG (3) EFFECT OF ADDING PVA TO RICE STARCH ON VISCOSITY

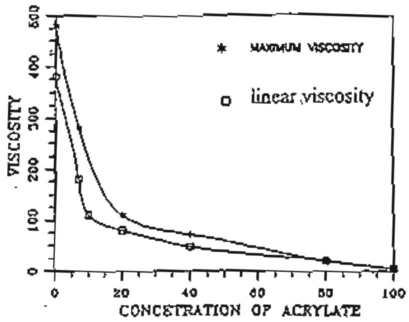


FIG (4) EFFECT OF ADDING ACRYLATE TO RICE STARCH ON VISCOSITY

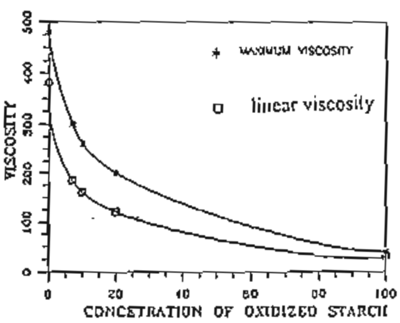


FIG (5) EFFECT OF ADDING OXIDIZED STARCH TO RICE STARCH ON VISCOSITY

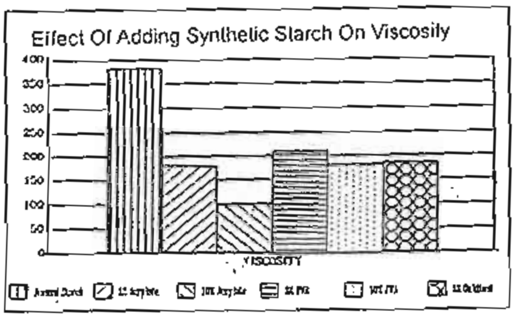
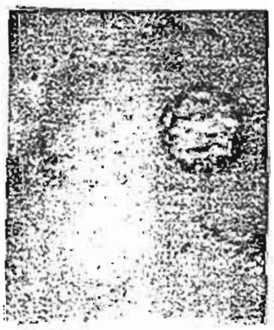


Fig. (6)

Oxidized starch

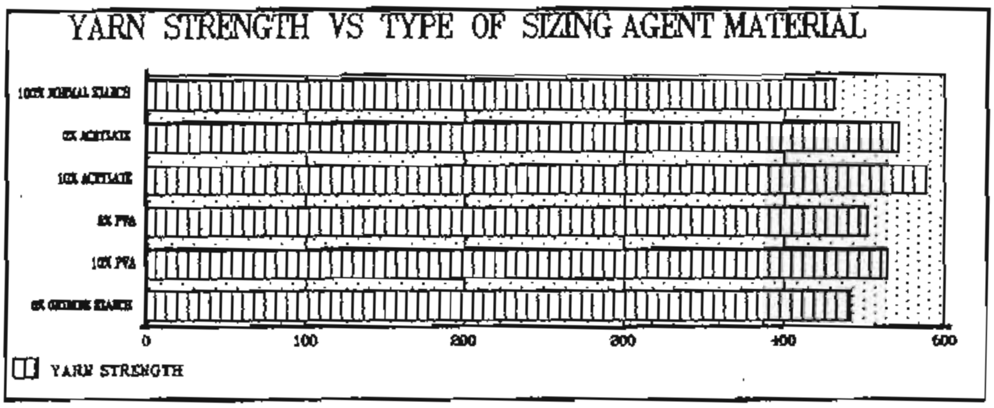
Rice starch



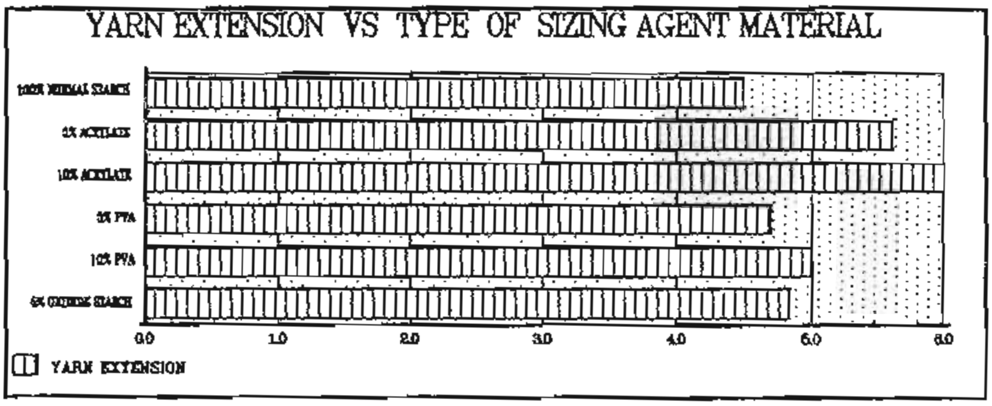
Acrylate 10%

PVA 10%

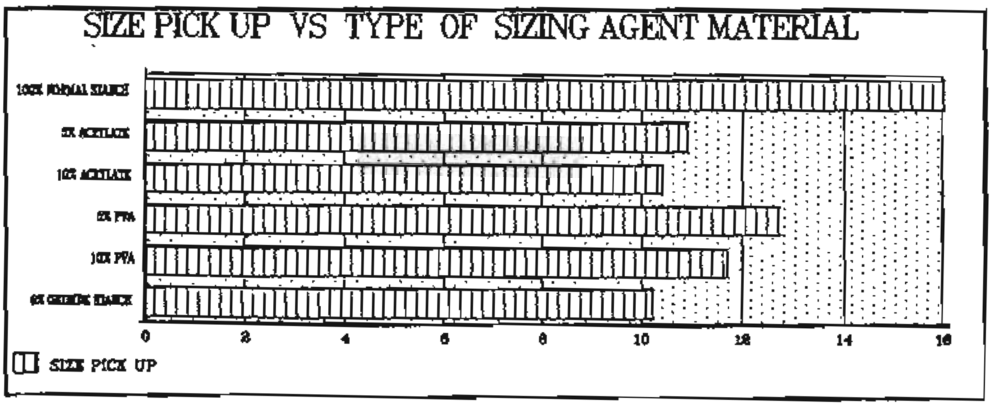
Fig. (7) Typical photographs for different sizing agents.


YARN STRENGTH VS TYPE OF SIZING AGENT MATERIAL
100% NORMAL STARCH
5% ACRYLATE
10% ACRYLATE
5% PVA
10% PVA
0
100
200
300
400
500
YARN STRENGTH

(A)

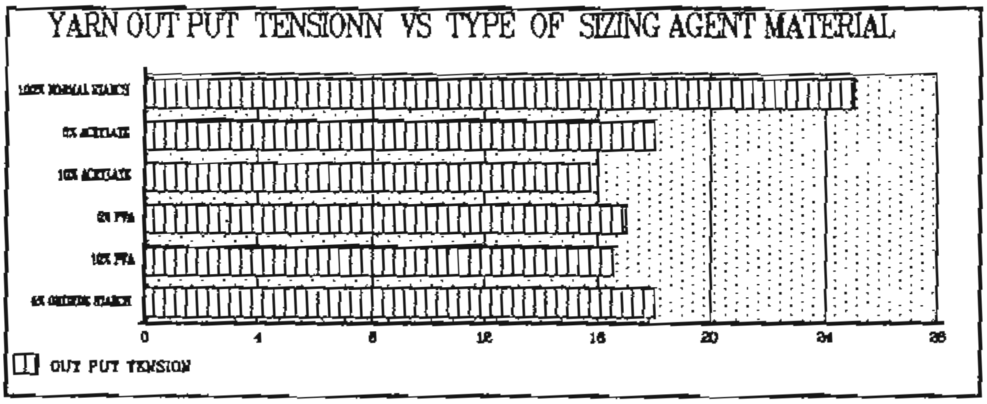

YARN EXTENSION VS TYPE OF SIZING AGENT MATERIAL
100% NORMAL STARCH
5% ACRYLATE
10% ACRYLATE
5% PVA
10% PVA
0.0
1.0
2.0
3.0
4.0
5.0
6.0
YARN EXTENSION

(B)

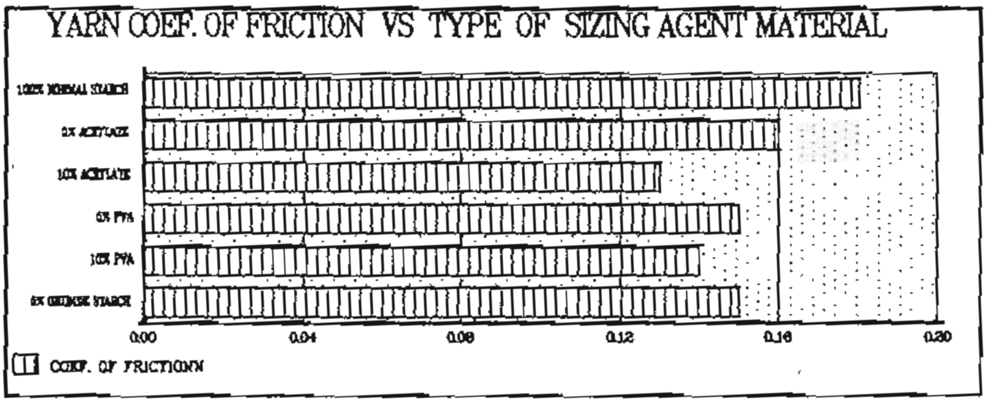

SIZE PICK UP VS TYPE OF SIZING AGENT MATERIAL
100% NORMAL STARCH
5% ACRYLATE
10% ACRYLATE
5% PVA
10% PVA
0
2
4
6
8
10
12
14
16
SIZE PICK UP

(C)

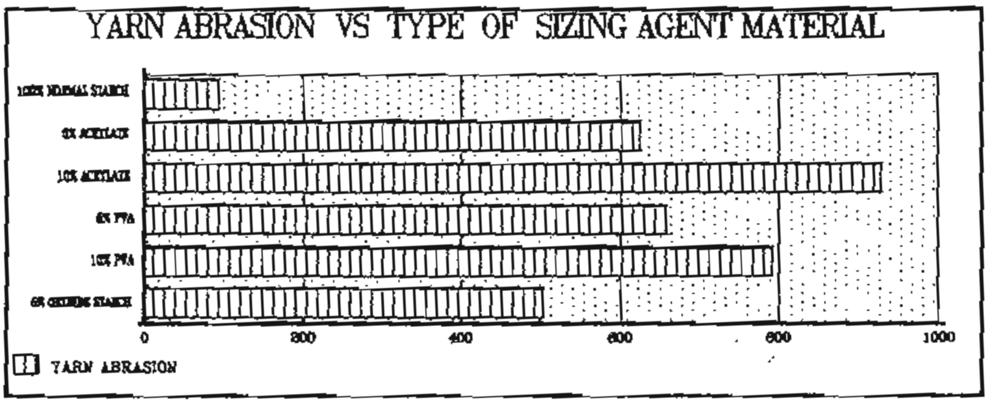
Fig.(8)


YARN OUT PUT TENSIONN VS TYPE OF SIZING AGENT MATERIAL
0
4
8
12
16
20
24
28
OUT PUT TENSION

(D)


YARN COEF. OF FRICTION VS TYPE OF SIZING AGENT MATERIAL
0.00
0.04
0.08
0.12
0.16
0.20
COEF. OF FRICTIONN

(E)


YARN ABRASION VS TYPE OF SIZING AGENT MATERIAL
0
200
400
600
800
1000
YARN ABRASION

(F)

Fig. (8)