STUDY SHAPE OF NOZZLE USED ON MULTI COLOR AIR JET WEFT INSERTION

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دراسة شكل الفوهة المستخدمة فى القذف المتعدد الالوان لخيط اللحمة بواسطة الهواء

الخلاصة :-

لقد تم بحث تاثير طول وزاوية انحناء ماسورة الهواء لفوهه هواء تشبه ذلك الموجودة على انوال الهواء متعددة الالوان، وذلك على سرعة الهواء وقذف خيط اللحمة. وقد وجد ان زاوية انحناء ماسورة الهواء تقلل من سرعة الهواء وقوة سحب الهواء للخيط. وبالتالى فان زمن قذف خيط اللحمة يزداد. وبزيادة طول ماسورة الهواء وجد ان ظروف قذف الخيط قد تحسنت. ووجد انه فى حالة القذف المتعدد الالوان لخيط اللحمة بواسطة الهواء ان وضع الفوهة بالنسبة لمدخل دليل الهواء له تاثير على قذف خيط اللحمة وهذا يستدعى ضبط ضغط الهواء عند كل فوهة حسب وضعها بالنسبة لمدخل دليل الهواء.

ABSTRACT:

The influence of the nozzle air tube length and bend angle , simulate that of multi color air jet loom , on air velocity and yarn insertion was investigated. The bend angle reduced the air velocity and air drag force on yarn. Cosequently, yarn insertion time was increased. An increase in air tube length improved yarn insertion. In case of multi color air jet weft insertion ,the position of nozzle axis with respect to the air guid system influenced yarn insertion. The matter which requries an adjustment to the supply air pressure at each nozzle according to its position in front of the air guide system.

1-INTRODUCTION:

The new developments of air jet weaving in both speed and flexibility ,as shown at the ITMA 91, put the air jet looms on the top of the list when loom selection is made by the textile industry. This is also influenced by the good performance which the air jet looms have shown in the weaving industry. Table(1) shows the exhibiters of air jet looms at ITMA 91, with the loom speed , width and rate of weft insertion. The two colors weft insertion system becomes an essential requirement on air jet loom to weave a single color weft fabrics. This is to overcome the problems arising from the variation in weft cones. Up to eight color weft insertion system was shown at ITMA 91. Each weft yarn is inserted from a seperate main nozzle. These nozzles are positioned in front of the profile reed such as , each nozzle exit occupies a certain area of the reed tunnel.

Table (1) Air jet looms shown at ITMA 91 Hannover

Loom maker	speed r.p.m.	weaving width cm	Rate of weft Insertion mt/min
Picanol	701-1249	312-155	2187-1936
Sulzer	650-960	228.5-183.9	1486-1765
Dornier	450-750	344-160	1548-1200
Tsudakoma	550-1500	255-170	1402.5-2550
Vamatex	630-1200	630-163	1830-1956
Nissan	736-1308	269-170	1980-2223
Grünne	430-700	150-360	---
Ishikawa	650-100	173-162	1124-1620
Somer	700-1200	268-153	1876-1836
Investa	500-1200	186-160	930-1920
Toyota	with Sulzer		

Due to the nozzle design and construction[1 and 3], the air tube is bent in a way to allow putting the nozzle housing of all nozzles together in one position on the sley . This results in curved air streamlines in the air tube and a pressure gradient along the radial direction of the curved portion is developed[6]. Thus, eddies are created which cause an air velocity loss in flow, consequently ;the air velocity at nozzle exit is reduced. When air is supplied at each nozzle and upon yarn release, insertion starts. The yarn movement during insertion is affected by the air drag force[2 and 3]. The air drag force (dF) on yarn element of length (dL) is giving by the following relationship:

$$dF = 0.5\,\pi\,\rho\,D\,C_d\,(V_a - V_y)^2\,dL$$

where,

V_a is the air velocity,
V_y is the yarn velocity,
C_d is air drag coefficient,
D is the yarn diameter, and
ρ is the air density.

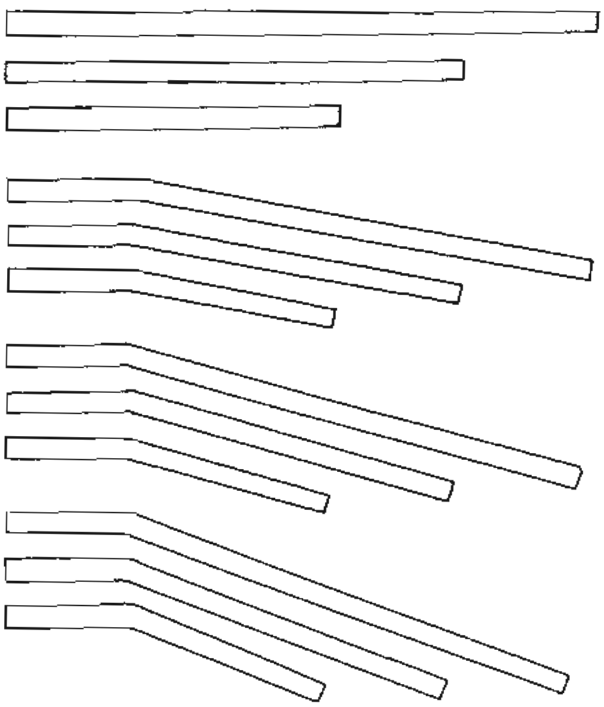
The yarn movement during insertion is influenced by the air velocity at nozzle exit[1 ,2 and 3], which in turn, is affected by the nozzle design and construction. The shape of the air tube will affect the air velocity at nozzle exit and the position of the air tube with respect to the air guide system is expected to have an influence on air velocity and yarn movement during insertion.

In this work , the shape of the nozzle air tube is going to studied in terms of its length and bend angle. the position of air tube axis with respect to air guide system will be also investigated.

2-EXPERIMENTAL

The test set up, shown in Figure(1),which was built earlier[5], was used in this course of experimental work. To study the shape of nozzle air tube, a glass tube (ID=7mm) was cut to pieces with different lengths . These pieces were bent to different angles , as shown in Table(2). The tube pieces are going to be called ,air tube extension. The tube inside diameter equals to the inside diameter of the Elitex air jet nozzle which was used in this expermintal work. An attachment piece was made to connect the tube extensions to the nozzle air tube to ensure the alignment. This was done to simulate the main nozzle used on multi color air jet loom.

Table (2) Length and bend angle of air tube extensions

Air Tube Extension	Length mm	Bend Angle degrees
	200	0
	150	0
	100	0
	200	10
	150	10
	100	10
	200	15
	150	15
	100	15
	200	20
	150	20
	100	20

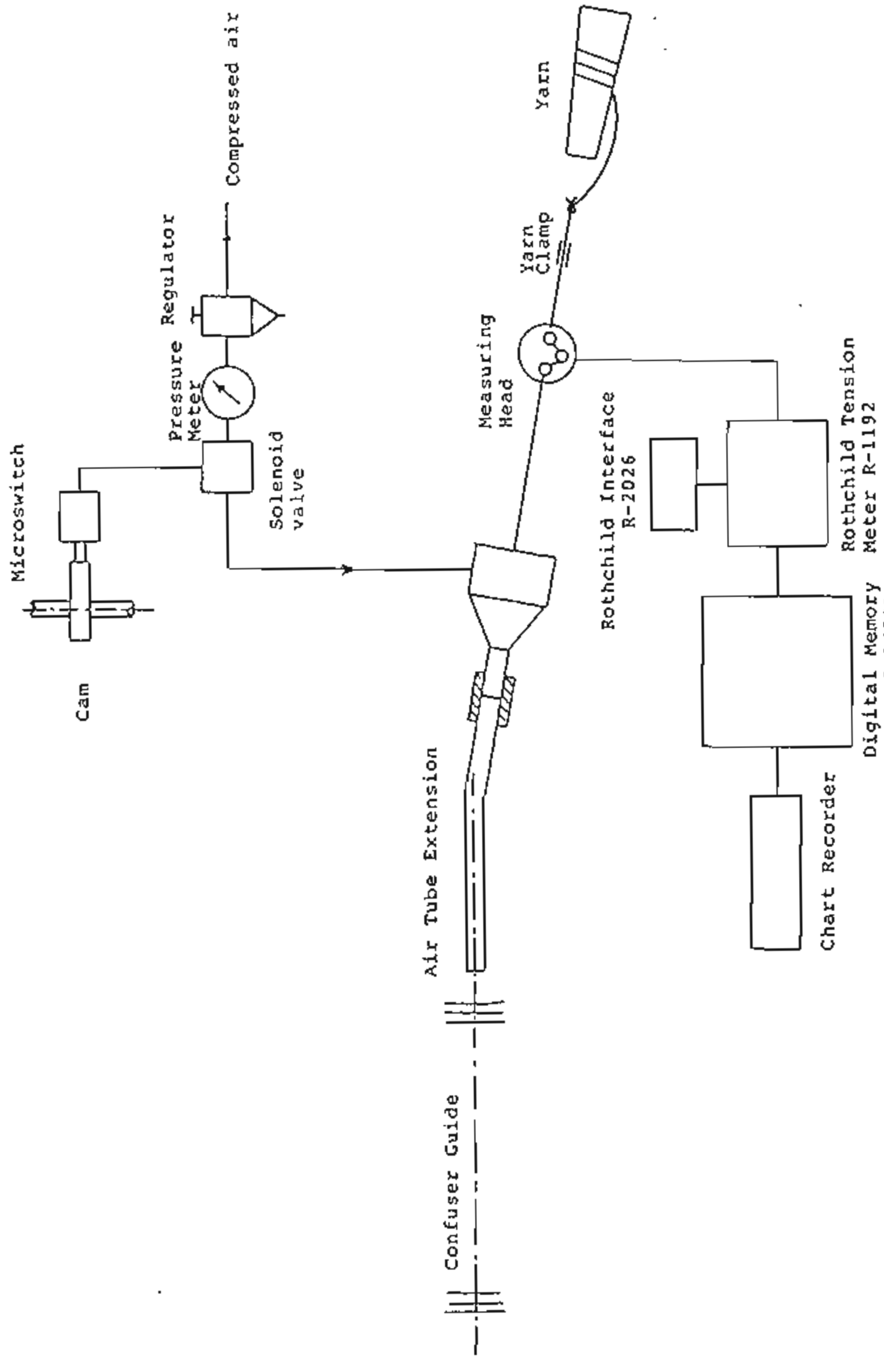


Figure (1) Schematic diagram of test set up and yarn tension measurement

2.1. Air velocity measurement

The air velocity at nozzle exit was measured by the hot wire anemometer system ,TSI model 1053B (constant tempreature). The prob was clibrated to measure an air velocity range of 0-200 mt/sec. To measure the turblence in air flow , the output signal was stord in the memory scope(MS1650B) ,and then was analized.

2.2. Air drag force measurement

The air drag force on yarn was measured by the Rothchield tension meter (1192R) with the 100 CN measuring head. A length of 143 cm of cotton yarn Ne 60/2, was stored behined the nozzle , as shown in Figure(1). Air was supplied to the nozzle at 4 bar pressure while the yarn was clamped. The air drag force was measured before and after the yarn was released until insertion was completed. The singnal of drag force measurement, as shown in Figure(2), was stored in the memory scop and later was analized to get the initial and final air drag , and insertion time.

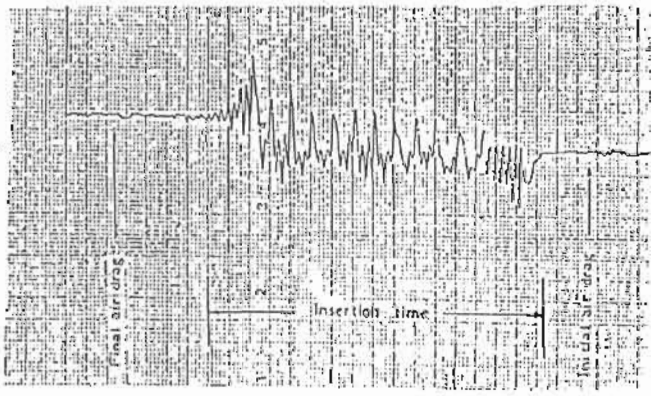


Figure (2) Signal of yarn insertion shown on chart recorder paper

3-DISCUSSION OF RESULTS:

3.1. Influence of air tube extension on air velocity

Figure(3) shows the influence of air tube extension on air velocity at nozzle exit. Generally , the air velocity decreased as the air tube extension was increased. At the same time , the air turblence in the flow at nozzle exit decreased, as shown in Figure(3). This is because the air flow inside the air tube was more developed as the length of tube extension was increased[3]. The air velocity at nozzle exit without extension was observed to be lower than that with extension. This is due to the high air tulblence which was found in the air flow at nozzle exit without tube extension[3]. The bend angle of the air tube extension affected , to a large extent, the air velocity at nozzle exit ,as shown in Figure(3). The air velocity decreased as the bend angle was increased. This is due to the curved streame lines, which developed a difference in pressure gradiant inside the tube and eddies were created[6]. The matter which resulted in a decrease in air velocity and increase in air turblence. The rate of decrease in air velocity depended on the air tube extension length. A decrease in air velocity of 11.7% was measured when a 100 mm tube extension was bent from 0° to 20°. In the case of 200 mm air tube extension, a decrease of 15.53% was measured.

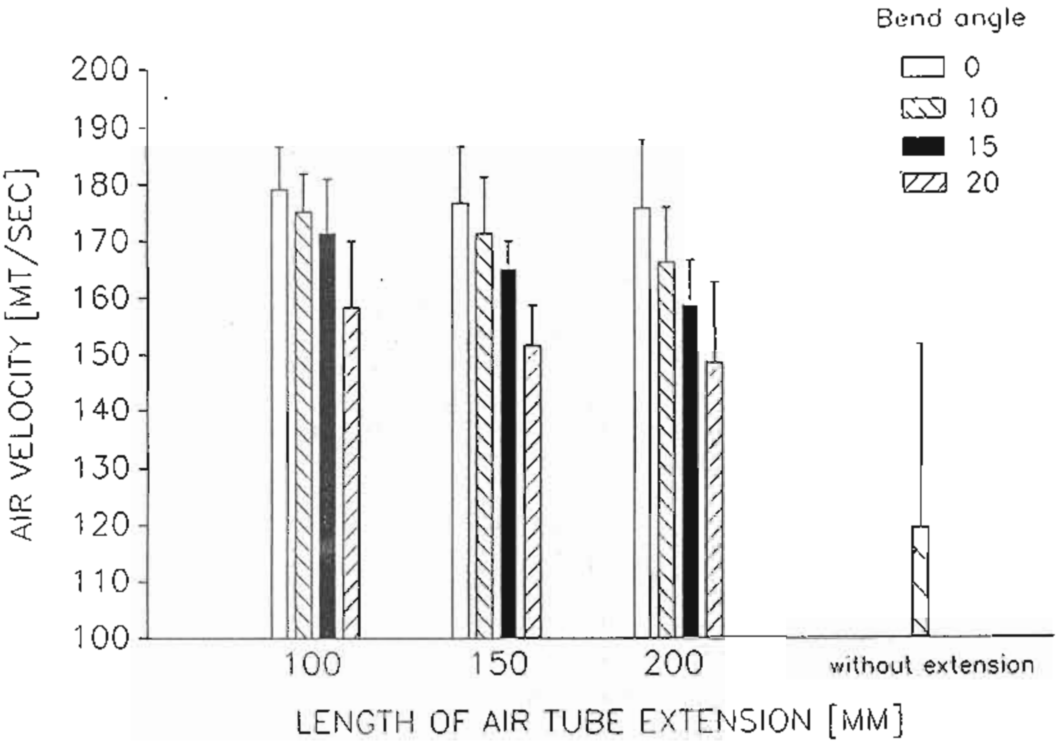


Figure (3) Influence of air tube length and bend angle on air velocity at nozzle

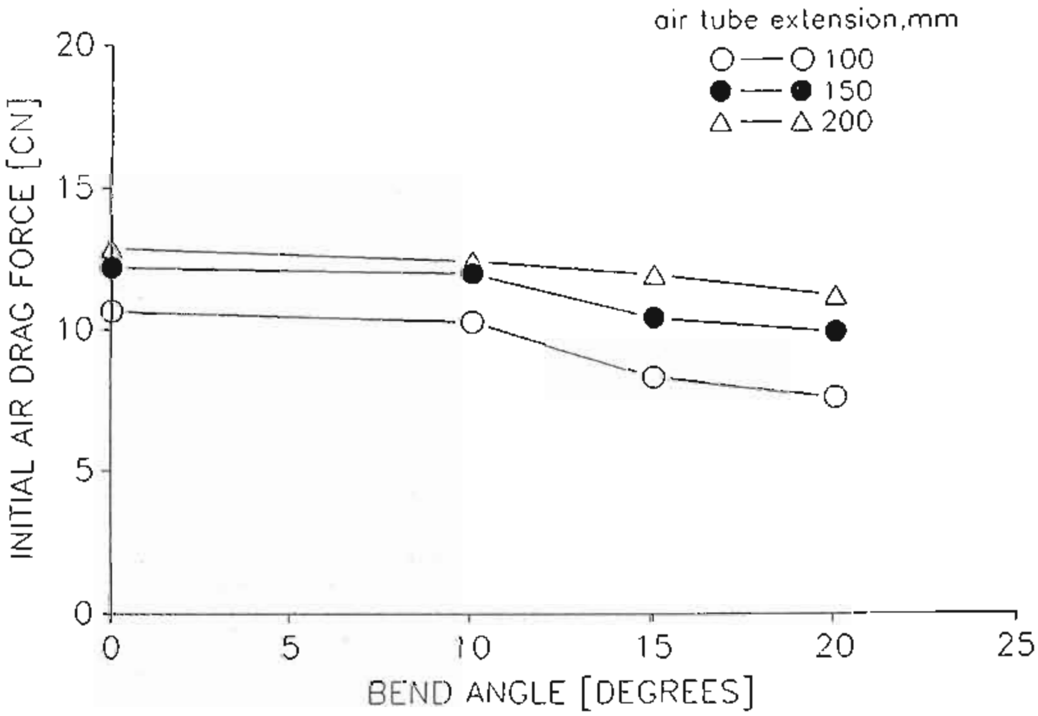


Figure (4) Influence of air tube bend angle on initial air drag force

3.2. Influence of air tube extension on yarn insertion

Figures(4,5 and 6) show the influence of air tube extension at different bend angles on the initial air drag , final air drag and insertion time, respectively. The increase in length of air tube extension increased both the initial and final air drage and reduced insertion time . This is due to the increase of yarn length existed in a high level of air velocity inside the air tube extension. The bend angle reduced the air drag force (initial and final), consequently, insertion time was increased. This is attributed to the reduction in air velocity at nozzle exit. A reduction in final air drag of 34.3% was measured when a 100 mm tube extension was bent to 20°. Cosequently, the insertion time went up by 149%.

Table(3) shows the influence air tube extension on the air velocity and yarn insertion. In this case , the air tube extension was investigated in terms of the raito of the straight part of the tube extension to the inclined part at different bend angles and lengths. In general,the air velocity decreased as this ratio was increased. This is because the flow was partialy developed over the straight part of the tube extension, then curved. The matter which resulted in energy loses due to the eddies in the flow over the curved part of the tube . With respect to yarn insertion, the total length of tube extension played an important role in determining the initial drag , final drag and yarn insertion. In the case of 100 mm and 150 mm tube extension, the high ratio of the straight part of tube extension to the inclined part showed a little improvement in yarn insertion. With 200 mm air tube extension, the low ratio showed a better yarn insertion than the high ratio. This is attributed to the development of the air flow after the curvature over the inclined part of the tube extension.

3.3. Position of nozzle axis with respect to air guide entrance

In order to study the influence of using more than one main nozzle on multi color air jet loom on yarn insertion. The nozzle air tube axis was positioned at different locations with respect to the entrance of i) complete tube with square cross section, and ii) confuser guide of Elitex loom. These positions are shown in Figure(7)

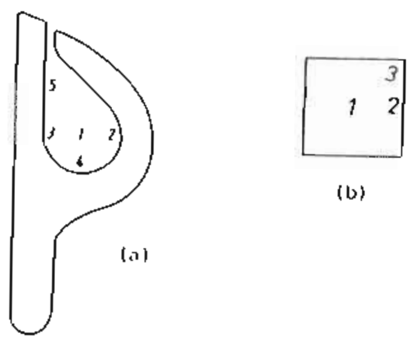


Figure (7) Positions of nozzle axis with respect to the entrance of: a) Confuser guide b) Square tube

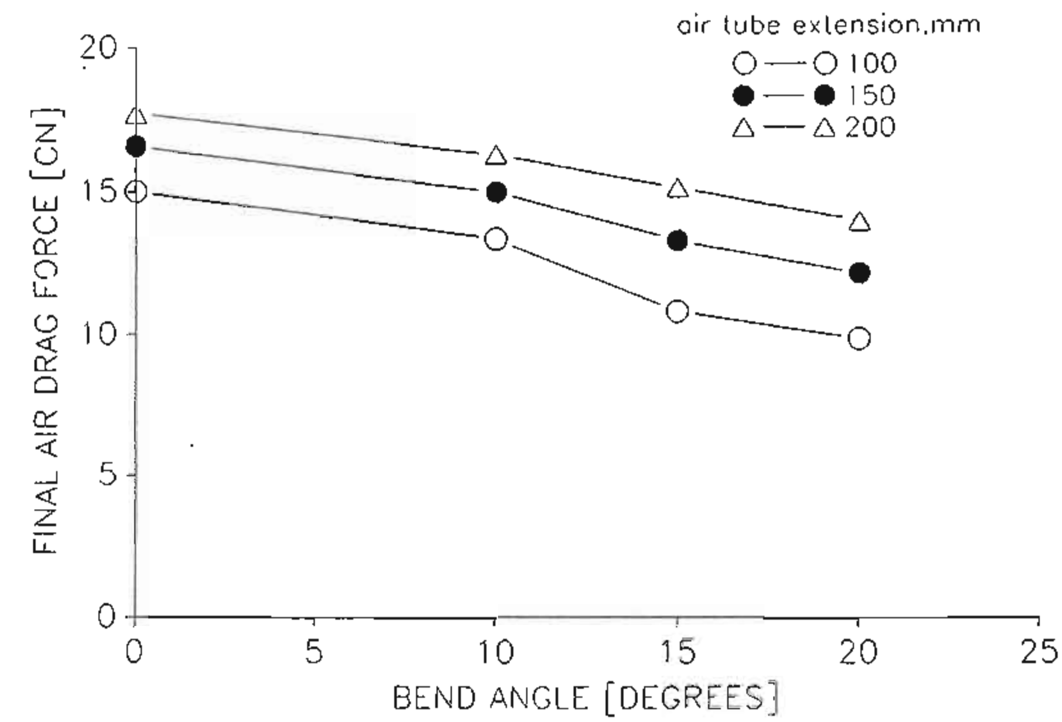


Figure (5) Influence of air tube bend angle on final air drag force

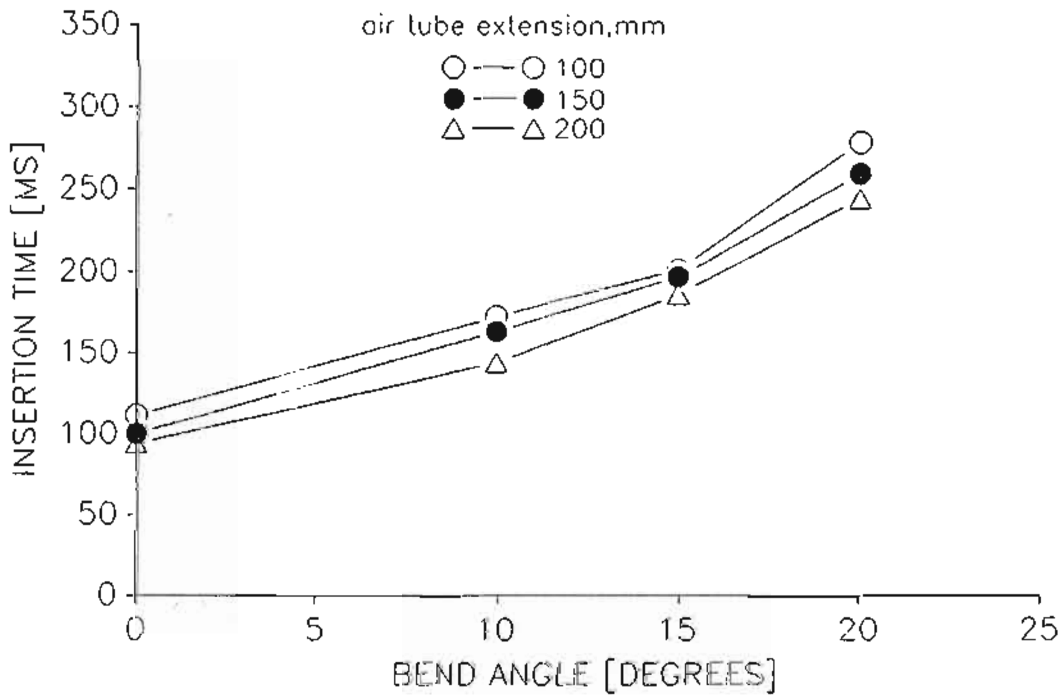
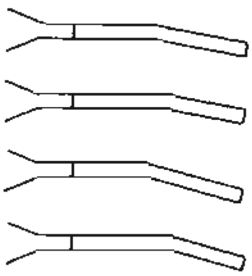
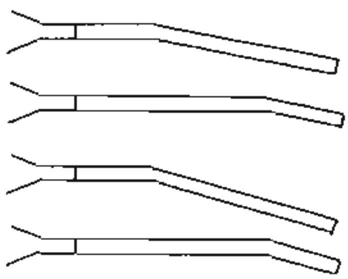
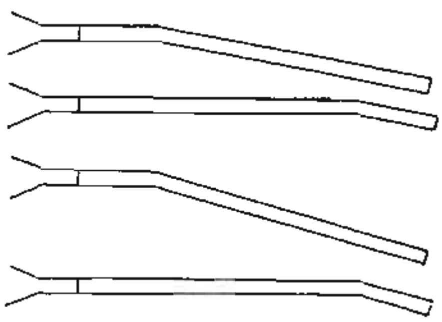


Figure (6) Influence of air tube bend angle on yarn insertion time

Table (3) Influence of air tube extension on air velocity and yarn insertion

Air Tube Extension 	Total Length mm	Bend Angle (Degra)	L_1/L_2	Air Velocity mt/sec	Initial air drag cN	Final air drag cN	Insertion Time msec
		10	0.8	175.2	10.28	13.39	172.8
	100	10	1.25	170.5	10.56	13.52	170.8
		15	0.8	171.4	8.32	10.85	201.6
		15	1.25	168.1	9.4	12.3	193.6
		10	0.4	171.4	11.99	15.02	163.6
	150	10	2.5	154.1	12.08	15.29	160.8
		15	0.4	165	10.92	13.32	197.2
		15	2.5	159.5	10.62	13.71	181.6
		10	0.26	166.2	11.44	16.34	144.4
	200	10	3.75	140.1	12.28	16.14	155.2
		15	0.26	158.5	11.95	15.18	186.9
		15	3.75	141.3	11.89	14.79	192.4

At each nozzle position, yarn insertion was investigated. Figures(8 and 9) show the initial air drag , final air drag and insertion time at different nozzle axis positions in case of square tube and confuser guide, respectively.
In the case of square tube , the difference between yarn insertion when the nozzle axis was put in positions 1 and 2 was not significant. at position 3 , the yarn insertion was influenced by the air velocity profil near the corner inside the tube(low air velocity field). Which resulted in a relatively large insertion time compared to positions 1 and 2 .
In the case of confuser guide , the position of nozzle axis with respect to the entrance of confuser showed a large influence on yarn insertion. Depending on the air velocity profil inside the confuser , which was affected by the exchange of air through the confuser lamella, yarn insertion was influenced . It was intersting to find that the yarn insertion time in position 3 was 6% higher than that at position 1 . At position 5 , which is near to the longitudenal slot of confuser, the insertion time was increased by 17.6% .

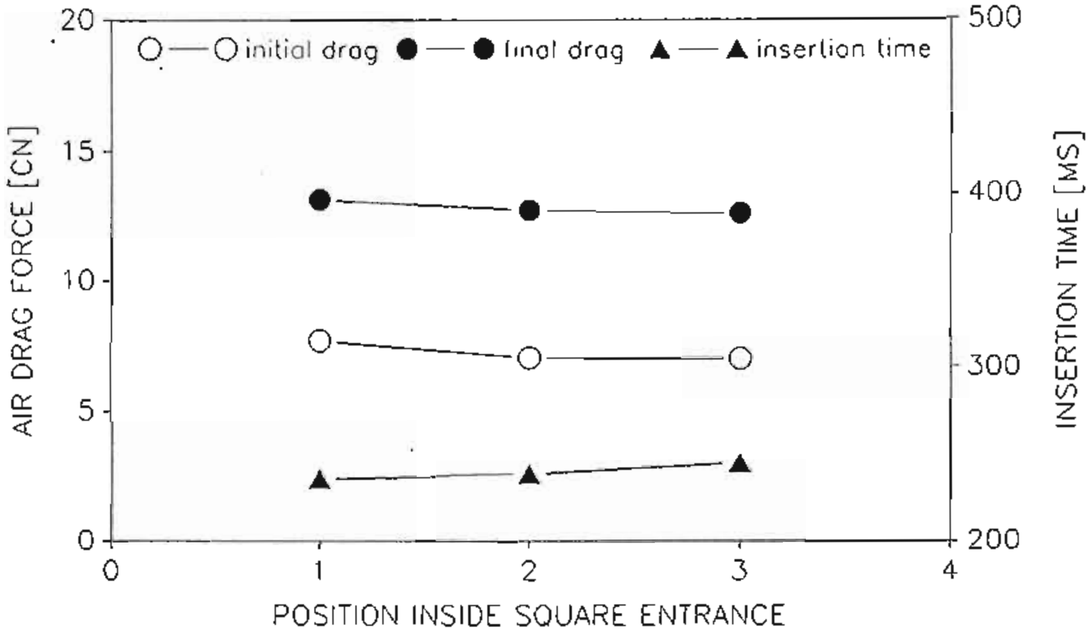


Figure (8) Effect of nozzle axis position inside square tube on yarn insertion

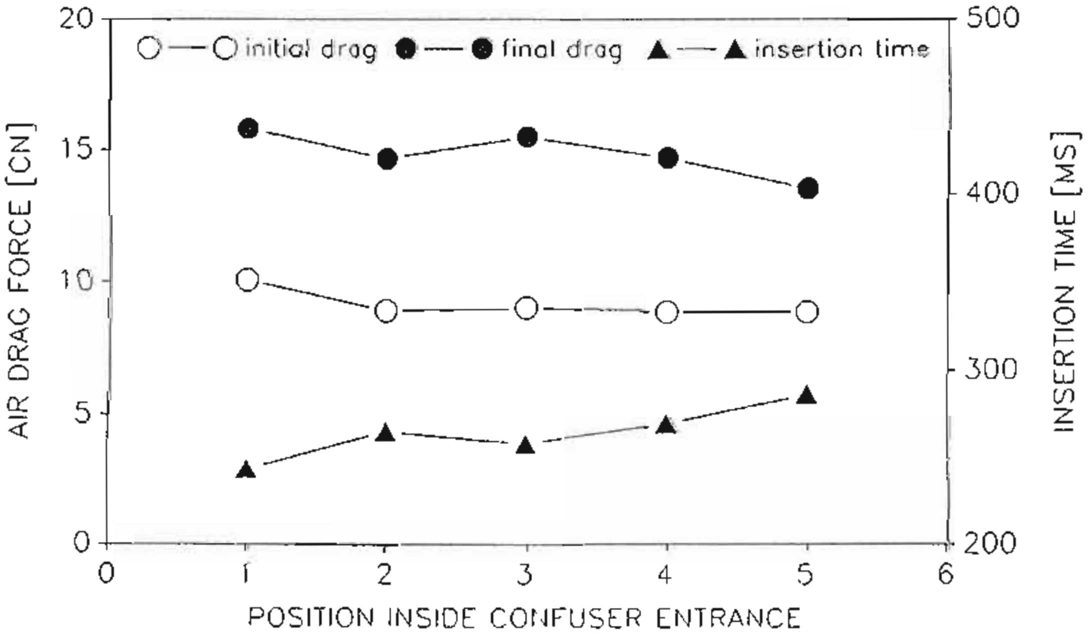


Figure (9) Effect of nozzle axis position inside confuser guide on yarn insertion

4.CONCLUSIONS:

The use of multi color weft insertion on air jet loom requries more than one main nozzle. This implies the bending of the nozzle air tube . Until four weft colors, the bend angle of each nozzle air tube expected to be the same. The experimental results and discussions showed that the bend angle of air tube reduced the drag force on yarn. To overcome this reduction , a long air tube must be used. The ratio of the straight part to the inclined part of nozzle air tube must be selected according to the total length of air tube. This is important to improve yarn insertion. The orientation of these main nozzles at the entrance of the giude system expected to have an influence on yarn insertion .The matter which requires a seperate adjustment to the supply air pressure at each nozzle.

5.REFERENCES:

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