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Numerical Study of Sub-Nozzle Flows for the Weft Transmission in an Air Jet Loom

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Abstract

The air jet loom is widely applied in the textile industry due to its high productivity, convenient controllability, high filling insertion rate, low noise and low vibration levels. High-Speed air jet weaves the weft yarn, and transports it through the weft passage. In the present study, a computational fluid dynamics method is applied to solve the incompressible Navier–Stokes equations with one-equation Spalart-Allmaras turbulence model. Which is used to solve the flow filed in a weft passage. The aim of this analysis is to determine the distribution of the flow velocity along the weft passage. Results revealed the strong relationship between air jet velocity and forces on the weft.).

Keywords: Air Jet Weft Insertion, Main Nozzle, Sub Nozzle, Air Jet Loom, Profile Reed

Nomenclature

dF_f	fiction force [N]
c_f	drag coefficient for the surface [-]
τ	shearing stress [$N \cdot m^{-2}$]
D	nozzle diameter [mm]
ρ	density [$k \cdot g \cdot m^{-3}$]
u	air jet velocity [$m \cdot s^{-1}$]

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v	weft velocity [$m \cdot s^{-1}$]
X	weft length [mm]

1. Introduction

According to the set intermittent operation of the air jet loom weaving machine, the structure is designed based on the characteristics of the weft insertion of the weaving machine. Air-jet weft insertion systems are currently used in all kinds of fibres and yarns. The weft is moved by the friction created by the high speed flow of the air jet loom. The air jet force is required to move and accelerate the weft yarn.

These forces should be higher than the inertia and resistance. It is defined in consideration with the characteristics and physical properties of the air flow, and resistance properties. The actual air speed depends on the properties such as turbulent air flow or laminar flow, a constant thread diameter, linear density and elasticity. The complex relationship between the air flow speed and productivity of weft in important [1,2]. It is controlled so as to change the count and twist factor at all times. If the twist coefficient increases, and the speed of the weft is reduced the average speed is a goes up [3].

The first commercial system introduced by Max Paabo Maxbo air jet loom that is 80cm in width cloth surface to 350Hz display in Sweden in 1951. It was charged with developing the main nozzle insert, shaped cross-sectional profile of the sub nozzles and U- lead system by a German company in 1969 in Te Strake. The role of the flow guide channel with recessed groove portion of the lead body in profile was also modified. When using a profile reed it is not necessary for separation of the guide rings, and to solve the problem in which it passes through a ring of air flow guide system slope method.

The combination of low manufacturing requirements and high performance of air-jet loom has many advantages, such as inserting a very high speed, high productivity and low initial expenditure, a simple operation of moving parts, reduced risk, low noise and vibration levels. The changes depending on the development status of air-jet looms, which focuses on the interaction between the guidance system to increase of the speed of the yarn is mainly on air speed.

Driving force with the velocity of the air jet was obtained by performing a numerical analysis for the sub nozzles in this study. Improving speed due to the change in the radius of the air-jet nozzle and the width of the next sub and drive were focused on.

2. Theoretical Analysis

Fig. 1. The setup of air jet loom equipment.

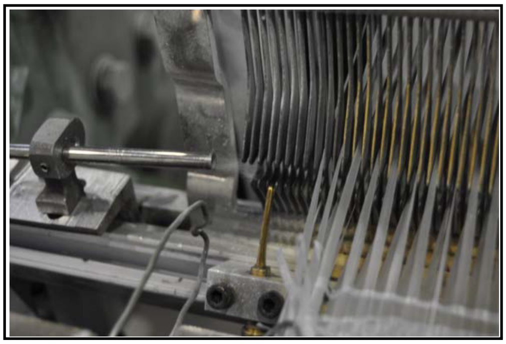

Fig. 2 Positions of the main nozzle and the sub nozzle.