ABSTRACT

An attempt has been made through this research work for developing single air jet nozzles and the production of single jet yarns using newly developed single head single jet yarn spinning unit. The fibre losses and end breakages during the production of sliver fed and roving fed 40s Ne cotton, 50s Ne viscose and 60s Ne polyester single jet yarns were observed in designed 21 nozzles. Regular ring yarns, Suessen regular compact yarns and newly introduced Suessen D-slot compact yarns, Murata air jet yarn and Murata air vortex yarns were produced and compared with single jet yarns.

The design and development of single jet nozzle was carried out in three phases in this research work. The developed nozzles consist of air inlet chamber, wrapper fibre chamber, false twist chamber and fasciated yarn chamber. In the first phase, 1-11 Nozzles were developed with different dimensions. In the second phase 12-16 nozzles were developed with Inner flanged type wrapper fibre chambers in various air feed angle such as 45°, 50°, 55°, 60° and 65°. In third phase 17-21 nozzles were developed with rectangular shape type wrapper fibre chambers in various air feed angle such as 45°, 50°, 55°, 60° and 65°. Using experiment and slip-up principle, trails were conducted using above 21 developed nozzles.

Single head single jet spinning unit has been designed and developed. It consists of drafting zone, air jet nozzle zone and winding zone. With the help of servo motor arrangements and 4/4 drafting system, it was designed to provide the draft range of 10-250 and to run the unit up to 150 m/min.
Developed nozzles were critically analyzed and significance of sliver feeding over roving feeding using 40s Ne cotton, 50s Ne viscose and 60s Ne polyester yarns were analyzed. Through the various developed nozzles, design parameters such as two different wrapper fibre chambers, five different air feed angle and five air pressures totally 300 samples were produced.

In these trials in 40s Ne cotton, 50s Ne viscose and 60s Ne polyester yarns with both sliver and roving feed the nozzle number 16 and 21 which are having air feed angle of 65° and the nozzle numbers 11 to 14 and 16 to 20 with air pressure of 3.0 kg/cm² is observed with higher fibre loss of 2.1% to 38.5% and end breakage rate of 5.6% to 48.8%. In the above conditions it is observed that the air turbulence at yarn forming zone in the nozzles collapses the fiber alignment and also disturbing the yarn forming process. Hence it is unable to spin the yarn and also found high end breakage rate.

In the above trials in 40s Ne cotton, 50s Ne viscose and 60s Ne polyester yarns with both sliver and roving feed the nozzle numbers from 12 to 15 and 17 to 20 with air pressure from 1.0 kg/cm² to 2.5 kg/cm² is observed that the fiber loss s 0.5% to 1% and end breakage rate is 0.65% to 0.98%.

Using Scanning Electron Microscope (SEM) and Leico microscope the single jet yarn structure were critically analyzed. From the observation of the images, single jet yarn structure consists of parallel core fibre and regularly twisted wrapper fibers. The core fibers of single jet yarn appears in the yarn central axis, and the arrangement of wrapper fibers is wrapped
spirally around the core fiber to prevent the movement and also to hold the position firmly.

While analyzing the images of single jet yarn structures, it is observed that there are three major types. Type-I structure has crimped core fibres which are tightly wrapped by a ribbon of wrapper fibres. This Type-I structure consists of about 75%-80% core fibres and about 20%-25% wrapper fibres with wrapping angle of $45^0$ to $50^0$. Type-II structure has long regular wrappings around the crimped core fibers. This Type –II structure consists of about 65%-70% core fibres and about 30%-35% wrapper fibres with wrapping angle of $50^0$ to $60^0$. Type-III structures have only crimped core fibers without any wrapped fibres. The crimped core fibres are having higher crimp than the earlier two types of structures.

By using nozzle number 12 to 15 and 17 to 20 with air pressure of 1.0 kg/cm$^2$ to 2.5 kg/cm$^2$, 192 single jet yarn samples were produced and the design parameters of the nozzle and type of feeds were optimized. Trends and significance of the results was analyzed using statistical tool of multi - variant ANOVA. All samples of the sliver fed yarns were significantly superior than the samples of roving fed yarns. The optimized nozzle parameters for cotton yarn are rectangular wrapper fibre chamber with $55^0$ air feed angle. Whereas inner flanged wrapper fibre chamber with $50^0$ air feed angle gives optimum yarn characteristics for the viscose and polyester. The optimum air pressure for cotton and viscose are 2.5 kg/cm$^2$ air pressure and for polyester it is 1.0 kg/cm$^2$ air pressure.

40s Ne cotton regular ring yarns, Suessen regular compact yarns and newly introduced Suessen D-slot compact yarns were produced and
compared with single jet yarns produced from the nozzle number 19. The unevenness of 40s Ne cotton single jet yarn has no significant difference when compared with ring yarns. Tenacity of 40s cotton single jet yarn is weaker by 35% when compared to ring yarn. The hairiness test results of 1mm, 2mm and S3 hairs are lower by the 40 - 80% when compared to the ring yarns. 40s Ne cotton single jet yarn has higher wickability than the ring yarn and compact yarns. Mean fibre Position of 40s cotton single jet yarns has 13% lower than ring yarns. The RMS deviation and migration intensity of single jet 40s cotton yarn has no significance difference when compared to ring yarns.

The U% of 50s Ne Viscose single jet yarn produced from the nozzle number 13 is 36% and 6% less when compared to that of ring yarn and Murata vortex yarns respectively. The count variation of single jet yarn is 6% and 14% higher when compared with ring yarn and Murata vortex yarns respectively. The studies of single jet yarns hairiness 1mm and 2mm are increased by the 21%, 40% when compared with the Murata vortex yarns respectively. In the Tenacity Rkm values, the 50s Ne viscose single jet yarn has significant increase of 7% when compared to Murata vortex yarns. The ‘yarn to metal friction” of 50s Ne viscose single jet yarn is increased by 33% on comparison with Murata vortex yarns’.

In 60s Ne polyester, there was no significant change in the tenacity Rkm values between the single jet yarn produced from the nozzle number 13 and Murata air jet yarns. The studies of single jet yarn shows that the hairiness 2mm and S3 hairs are increased by the 14%, 37% when compared to Murata air jet yarns respectively but in 1 mm hairiness is reduced by 110%.