Indian Journal of Fibre & Textile Research
Vol. 41, March 2016, pp. 89-92

Short Communications

Stabilised blending delay time in blowroom multimixer

Abhijit Majumdar[a]

Department of Textile Technology, Indian Institute of Technology, New Delhi 110 016, India

Received 13 August 2014; accepted 1 September 2014

Blending delay time of a multimixer represents its potential to mix fibres arriving from different bales. A generalized expression for stabilized blending delay time for multimixer has been derived here. It is found that blending delay time of a multimixer varies at the initial cycles of operation and thereafter it stabilizes. The stabilized blending time is higher for multimixers with more number of chambers.

Keywords: Blending, Blowroom, Multimixer, Spinning, Stabilised blending delay time

In a blowroom line, mixers are generally placed after the coarse cleaner[1]. The primary objective of the mixer is to mix the fibres as homogeneously as possible. Unimix and multimixer by Rieter and Truetzschler, respectively, are the two commonly used mixers in the spinning lines. The working principles of these two mixers are different. However, both of them try to mix fibre flocks which have differences in arrival times through the overhead ducts of blowroom. If it is assumed that n flocks are being mixed together by a multimixer and they have arrival times t_1, t_2, t_3, …, t_n, such that $t_n>t_{n-1}$, …, $t_3>t_2$ and $t_2>t_1$, then blending delay time is t_n-t_1. Therefore, blending delay time is the largest difference in arrival times of two flocks which are being mixed together[2]. If blending delay time is zero then all the fibre flocks are coming from the same bale and thus the possibility of averaging out the differences in fibre properties between bales is the minimum. In contrast, if the blending delay time is very high then there are chances that fibre flocks coming from a large number of bales will be mixed together and thus the differences in fibre properties between bales will be averaged out.

Multimixers are available in different sizes, i.e. different number of vertical chambers. For example MPM 4, MPM 6, MPM 8 and MPM 10 models have 4, 6, 8 and 10 chambers, respectively[3]. The height of these chambers can be up to 5 m. Before the start of multimixer, the fibres are filled in a stair like pattern. If the multimixer has six columns, it can be divided into six horizontal rows creating a matrix of 6×6. The first column is filled up to 1/6th of its height and the second column is filled up to 2/6th of its height and so on. The sixth column, the last one, is filled completely as shown in Fig. 1. The values in the box represent the completion times for the feeding of fibres, assuming that a small box of the matrix takes 5 unit time to be filled up. The time required for this filling operation of multimixer is 105 units. Once the machine is started, it has to run in equilibrium. Therefore, the input and output of materials per unit time has to be the same. The fibres of first row will be delivered on the conveyer belt in 30 unit time and during this period the 1st column will be filled up completely (Fig. 2). So, the stair like pattern will be maintained though there is relative change in positions of the columns. The blending delay time for the 1st and 2nd cycle of operations is 75 and 95 units, respectively. For the 1st cycle, the earliest and latest arrival times of two fibre flocks are 5 and 80, leading to a blending delay time of 75 units (Fig. 1). Similarly, for the 2nd cycle, the earliest and latest arrival times of two fibre flocks are 15 and 110, leading to a blending delay time of 95 units (Fig. 2). The blending delay time for 3rd, 4th, 5th and 6th cycles will be (140-30), (170-50), (200-75) and (230-105) i.e. 110, 120, 125 and 125 units, respectively. Therefore, it is observed that in the initial cycles, blending delay time increases with the number of cycles but at a decreasing rate. The value stabilizes at the 5th cycle for a 6 chamber multimixer i.e. at the $(n-1)^{th}$ cycle for n chamber multimixer.

The generalized situation of operation of multimixer having n chambers is depicted in Figs 3-5. It is assumed that the time required to fill one chamber is nx units. Therefore, the time required to fill one small box of the matrix is x unit. From Figure 3, the completion time to fill $(n-1)^{th}$ chamber up to $(n-1)/n$ fraction of total height can be expressed by following equation:

$$x+2x+3x+...+(n-1)x=\frac{n(n-1)}{2}x \qquad \dots (1)$$

[a]E-mail: majumdar@textile.iitd.ac.in

	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Row 6						105
Row 5					75	100
Row 4				50	70	95
Row 3			30	45	65	90
Row 2		15	25	40	60	85
Row 1	5	10	20	35	55	80

Fig. 1- First cycle of operation in multimixer

	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Row 6	135					
Row 5	130					105
Row 4	125				75	100
Row 3	120			50	70	95
Row 2	115		30	45	65	90
Row 1	110	15	25	40	60	85

Fig. 2— Second cycle of operation in multimixer

So, completion time to fill the lowest box of n^{th} column is given in following equation:

$$\frac{n(n-1)}{2}x + x \qquad \ldots (2)$$

Thus, the blending delay time for 1st cycle can be expressed by following equation:

$$\left[\frac{n(n-1)}{2}\right]x + x - x = \left[\frac{n(n-1)}{2}\right]x \qquad \ldots (3)$$

The completion time to completely fill the n^{th} chamber is expressed by following equation:

$$x + 2x + 3x + \ldots + nx = \frac{n(n+1)}{2}x \qquad \ldots (4)$$

For 2nd cycle (Fig. 4), the completion time to fill the 1st box of column 1 is as follows:

	Column 1	Column 2	Column 3	…	Column n-1	Column n
Row n						$\left[\frac{n(n+1)}{2}\right]x$
Row n-1					$\left[\frac{n(n-1)}{2}\right]x$	…
…					…	…
Row 3			$6x$	…	$\left[\frac{(n-2)(n-1)}{2}\right]x+3x$	$\left[\frac{n(n-1)}{2}\right]x+3x$
Row 2		$3x$	$5x$	…	$\left[\frac{(n-2)(n-1)}{2}\right]x+2x$	$\left[\frac{n(n-1)}{2}\right]x+2x$
Row 1	x	$2x$	$4x$	…	$\left[\frac{(n-2)(n-1)}{2}\right]x+x$	$\left[\frac{n(n-1)}{2}\right]x+x$

Fig. 3— Generalized representation of first cycle

	Column 1	Column 2	Column 3	…	Column n-1	Column n
Row n	$\left[\frac{n(n+1)}{2}\right]x+nx$					
Row n-1	…					$\left[\frac{n(n+1)}{2}\right]x$
…	…				$\left[\frac{n(n-1)}{2}\right]x$	…
Row 3	$\left[\frac{n(n+1)}{2}\right]x+3x$			…	…	…
Row 2	$\left[\frac{n(n+1)}{2}\right]x+2x$		$6x$	…	$\left[\frac{(n-2)(n-1)}{2}\right]x+3x$	$\left[\frac{n(n-1)}{2}\right]x+3x$
Row 1	$\left[\frac{n(n+1)}{2}\right]x+x$	$3x$	$5x$	…	$\left[\frac{(n-2)(n-1)}{2}\right]x+2x$	$\left[\frac{n(n-1)}{2}\right]x+2x$

Fig. 4— Generalized representation of second cycle

Row n		$\left[\frac{n(n+1)}{2}\right]x+2nx$				
Row n-1	$\left[\frac{n(n+1)}{2}\right]x+nx$	…				
…	…	…				$\left[\frac{n(n+1)}{2}\right]x$
Row 3	$\left[\frac{n(n+1)}{2}\right]x+4x$	$\left[\frac{n(n+1)}{2}\right]x+nx+3x$			$\left[\frac{n(n-1)}{2}\right]x$	…
Row 2	$\left[\frac{n(n+1)}{2}\right]x+3x$	$\left[\frac{n(n+1)}{2}\right]x+nx+2x$		…	…	…
Row 1	$\left[\frac{n(n+1)}{2}\right]x+2x$	$\left[\frac{n(n+1)}{2}\right]x+nx+x$	$6x$	…	$\left[\frac{(n-2)(n-1)}{2}\right]x+3x$	$\left[\frac{n(n-1)}{2}\right]x+3x$

Fig. 5— Generalized representation of third cycle

$$\frac{n(n+1)}{2}x+x \quad \ldots (5)$$

Therefore, the blending delay time for 2^{nd} cycle is

$$\left[\frac{n(n+1)}{2}\right]x+x-3x \quad \ldots (6)$$

Using Fig. 5 and extending the same analogy, the following expressions can be formulated:

Blending delay time (3^{rd} cycle)=

$$=\left[\frac{n(n+1)}{2}\right]x+nx+x-6x \quad \ldots (7)$$

Blending delay time (4^{th} cycle)=

$$\left[\frac{n(n+1)}{2}\right]x+2nx+x-10x \quad \ldots (8)$$

Blending delay time (5^{th} cycle) =

$$\left[\frac{n(n+1)}{2}\right]x+3nx+x-15x \quad \ldots (9)$$

Blending delay time (6^{th} cycle)=

$$\left[\frac{n(n+1)}{2}\right]x+4nx+x-21x \quad \ldots (10)$$

Equations (7)-(10) have four terms and two of them, namely $\left[\frac{n(n+1)}{2}\right]x$ and x are omnipresent. The other two terms, in different cycles, are in series where one increases and other decreases with the increase in the number of cycles. Blending delay time will be stabilised when the increase and decrease of these two terms will compensate each other. The value of the first series (*nx*, *2nx*, *3nx*, …), increases by *nx* in every cycle. The value of the second series (*6x*, *10x*, *15x*, *21x*, …for 3^{rd}, 4^{th}, 5^{th} and 6^{th} cycles, respectively) can be generalized as $\left[\frac{k(k+1)}{2}\right]x$, where k is the number of cycle. So, the decrease in this term at k^{th} cycle = k^{th} term of the series- $(k-1)^{th}$ term of the series. This can be expressed as follows:

$$\left[\frac{k(k+1)}{2}\right]x-\left[\frac{k(k-1)}{2}\right]x=kx \quad \ldots (11)$$

Thus, when the increase and decrease of the two terms in Eqs (7)-(10) compensates each other, $nx=kx$. So, $n=k$. This implies that blending delay time increases till $(n\text{-}1)^{th}$ cycle of operation and then it stabilizes. Thus, the blending delay time has to be identical for $(n\text{-}1)^{th}$ and n^{th} cycles.

So, the series *nx*, *2nx* and *3nx* for the 3^{rd}, 4^{th} and 5^{th} cycles respectively, will yield the terms (n-3)nx and (n-2)nx in the $(n\text{-}1)^{th}$ and n^{th} cycles, respectively. The series *6x*, *10x* and *15x* for the 3^{rd}, 4^{th} and 5^{th} cycles, respectively, can be generalized as $\left[\frac{k(k+1)}{2}\right]x$. For the $(n\text{-}1)^{th}$ and n^{th} cycles, the terms will be $\left[\frac{n(n-1)}{2}\right]x$ and $\left[\frac{n(n+1)}{2}\right]x$ respectively.

So, the generalized expression of blending delay time for the $(n\text{-}1)^{th}$ cycle is given in following equation:

$$\left[\frac{n(n+1)}{2}\right]x+\left[n-3\right]nx+x-\left[\frac{n(n-1)}{2}\right]x=x\left[n-1\right]^2 \quad \ldots (12)$$

The generalized expression for blending delay time for the n^{th} cycle is given in following equation:

$$\left[\frac{n(n+1)}{2}\right]x+\left[n-2\right]nx+x-\left[\frac{n(n+1)}{2}\right]x=$$
$$x\left[n^2-2n+1\right]=x\left[n-1\right]^2 \quad \ldots (13)$$

Equations (12) and (13) imply that blending delay time stabilizes after the $(n\text{-}1)^{th}$ cycle as same term nx is added and subtracted from the expression of blending delay time. Therefore, a 10 chamber multimixer (MPM 10) will have higher blending delay time than 6 chamber multimixer (MPM 6) and thus the former provides better mixing of fibres.

References

1 Klein W, *The Technology of Short Staple Spinning*, Vol. 2 (Textile Institute), 1987.

2 Chattopadhyay R & Salhotra K R, *Indian J Fibre Text Res*, 11 (1986) 73.

3 Technical literature of Truetzschler blowroom. http://www.truetzschler-spinning.com/en/products/blow-room (accessed on 12th August 2014).