KEY **ACCUMULATION AND LINE EFFICIENCY** EQUATIONS

Throughput is the key metric in determining the speeds of the conveyors transporting product. If the belt speed equals the throughput, product will be transported back-to-back with no gaps, or 100% steady state density. If the belt speed is less than the throughput, the machine producing the product will have constant stoppages. The units are measures of length over time (e.g., feet per minute, meters per second, etc.).

$$\text{THROUGHPUT} = \text{Product Length} \times \text{Product Rate}$$

Steady state pitch refers to the length of the product plus the length of the gap between one product and the next when the line is running in a consistent flow at the typical operating speed of the production machines and conveyors without stoppages (i.e. “steady state operations”). Assuming products produced are identical lengths, pitch can be determined as a ratio of the belt speed and the production rate. The units are measures of length (e.g., feet, inches, meters, etc.).

$$\text{STEADY STATE PITCH} = \frac{\text{Belt Speed}}{\text{Product Rate}}$$

Steady state gap refers to the gap between one product and the next when the line is running in a consistent flow at the typical operating speed of the production machines and conveyors without stoppages. The gap between products is a function of the difference between the belt speed and the throughput. The units are measures of length (e.g., feet, inches, meters, etc.).

$$\text{STEADY STATE GAP} = \frac{\text{Belt Speed}}{\text{Product Rate}} - \text{Product Length}$$

Steady state density compares the size of the gaps between products to the product lengths themselves. This indicates how much space is available to collect more product in the event of downstream stoppage. The lower the percent density, the more time available until accumulation is full. The unit is measured as a percentage.

$$\text{STEADY STATE DENSITY} = \frac{\text{Product Length x Product Rate}}{\text{Belt Speed}}$$

Time to close steady state (SS) gap refers to the time it takes to close the gaps between each product. This formula, along with the length of the accumulation conveyor, can determine the amount of time before the conveyor is full. Additionally, it, and the amount of downtime expected due to the downstream stoppage, can determine the length of conveyor needed to prevent accumulation from becoming full and stopping upstream operations.

$$\text{TIME TO CLOSE SS GAP} = \frac{\text{Steady State Gap}}{\text{Belt Speed}}$$

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