

Measuring overall effectiveness of processing equipment

This report by Dr. Tanveer Hussain, Department of Textile Processing, National Textile University, Faisalabad explains the major aspects to monitor, measure and improve the overall effectiveness of processing equipment. The aim of any textile manufacturing company is to deliver a consistent quality product to its customers on time and every time. This is only possible if the manufacturing equipment in operation is effective, efficient, reliable and consistent in producing desired quality products at the desired rate.

Overall Equipment Effectiveness (OEE) is a "Best Practice" way to monitor and improve the effectiveness and efficiency of your processing equipment. It can help you minimize downtime, speed and quality losses.

Downtime losses

- (i) Machine break downs, e.g. equipment failure, unplanned maintenance, etc.
- (ii) Machine set up and adjustments, e.g. batch changeover, adjustments, warm up, etc.

Speed losses

- (i) Small machine stops, e.g. jams, misfeeds, etc.
- (ii) Reduced machine speed.

Quality Losses

- (i) Machine start up rejects, e.g. scrap, rework, in-process fabric damage, etc.
- (ii) Production rejects, e.g. scrap, rework, in-process fabric damage, etc.

Overall Equipment Effectiveness (OEE) can be calculated as follows:

$$OEE (\%) = \text{Availability} (\%) \times \text{Efficiency} (\%) \times \text{Quality} (\%)$$

Where, Availability (%) describes the amount of equipment "uptime" and can be calculated as follows:

$$\text{Availability} (\%) = (\text{Gross Equip. Operating Time} / \text{Planned Production Time}).$$

Where as,

$$\text{Planned Production Time} = \text{Plant Operating Time} - \text{Planned Shutdown Time}$$

Gross equipment operating time is that time for which the equipment is working and producing output. It excludes all unplanned downtime i.e. time elapsed during any event that stops planned production for an appreciable length of time (e.g. equipment failure, unscheduled maintenance, and batch changeover time, etc.).

Planned shutdown time is the time for which you have no intention of running the equipment (e.g. lunch breaks, scheduled maintenance, or periods when there is nothing to produce).

Plant operating time is the amount of time your plant is open and available for equipment operation. See figure given as under.

Figure: OEE Factors

Plant Operating Time				
Planned Production Time			Planned Shut down	
Operating Time		Downtime	Planned Shut down	
Net Operating Time		Speed Loss	Downtime	Planned Shut down
Fully Productive Time	Quality Loss	Speed Loss	Downtime	Planned Shut down

Efficiency or Performance (%) describes the actual performance of equipment relative to its ideal performance. It can be calculated as follows:

Efficiency (%)

$$= (\text{Net Equip. Operating Time} / \text{Gross Equip. Operating Time})$$

$$= (\text{Actual Production Rate} / \text{Max. Design Production Rate})$$

$$= [(\text{Total Prod. output} / \text{Equipment Operating Time}) / \text{Max. Design Prod. Rate}]$$

Efficiency measurement takes into account speed losses due to any factors that cause the equipment to operate at less than the maximum design speed (e.g. due to material mis-feeds, and/or operator inefficiency, etc.). A 100 % performance means that the equipment has been consistently running at its maximum design speed.

Quality or Yield (%) describes the Right First Time production, i.e. the amount of production output that meets the customer specifications without any re-work. It can be calculated as follows:

Quality (%)

$$= (\text{Fully Productive Time} / \text{Net Equip. Operating Time})$$

$$= (\text{Right First Time Production} / \text{Total Production})$$

A 100% quality means that there have been no rejects or rework. An example data for the calculation of OEE is given in the following table.

Table: Example data for calculation of OEE

Item	Data
Shift Length	8Hour = 480 minutes
Short Breaks	2@15 min = 30 minutes
Meal Break	1 @ 30 min, = 30 minutes
Downtime	47 minutes
Max Design Run Rate	60 meters per minute
Total fabric meters processed	19,271 meters
Rejected meters	423 meters

On the basis of this data, OEE can be calculated as follows:

$$\text{Planned Production Time} = (\text{Shift Length} - \text{Breaks})$$

$$= (480 - 60) = 420 \text{ minutes}$$

$$\text{Operating Time} = (\text{Planned Production Time} - \text{Downtime})$$

$$= (420 - 47) = 373 \text{ minutes}$$

$$\text{Right 1}^{\text{st}} \text{ Time Production} = (\text{Total Production} - \text{Rejected})$$

$$= (19,271 - 423) = 18,848 \text{ meters}$$

$$\text{Availability} (\%) = \text{operating Time} / \text{Planned Production Time}$$

$$= 373/420 = 0.89 = 89\%$$

$$\text{Efficiency} (\%) = (\text{Total Production} / \text{Operating Time}) / \text{Max. Design Run Rate}$$

$$= (19,271/373)/60 = 0.86 = 86\%$$

$$\text{Quality} (\%) = \text{Right First Time Production} / \text{Total Production}$$

$$= 18,848/19,271 = 0.98 = 98\%$$

$$\text{OEE} (\%) = \text{Availability} \times \text{Efficiency} \times \text{Quality}$$

$$= 0.89 \times 0.86 \times 0.98 = 0.75 = 75\%$$

An average manufacturing plant works on an OEE of around 60% while a world-class plant has an OEE of 85%, with minimum 90% availability, 95% efficiency and 99.9% quality. The companies in Pakistan are advised to measure OEE of their processing equipment and compare it with world-class OEE. If there is a gap, implement Total Productive Maintenance (TPM) for making improvements. ♦