

Operating Equipment Efficiency

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OVERVIEW

Operating Equipment Efficiency (OEE) has become a focus for companies in the discrete and repetitive manufacturing industries. These manufacturers are being challenged by their management to produce more goods out of existing facilities and reduce costs. This is to meet the management and its stockholders focus on improving the return on fixed assets of the company. To meet this challenge, production management is striving to operate the equipment at its highest efficiency. This enables the company to meet current demand without expensive expansion projects.

BUSINESS CHALLENGES

The specific business problems facing the production management are related to the output of the facility and its ability to meet required delivery dates. These problems challenge management to:

Maximize production from existing lines (output)

The production manager must find ways to improve efficiencies to increase production. This may be accomplished by increasing the speed of current lines, reducing downtime, or upgrading individual machines to improve performance. Management would like to focus on existing equipment and optimize its production. If management cannot increase production from existing equipment, they have to add additional production shifts or new production lines, although these are typically much more costly options.

Meet required cycle times/delivery dates for each product

Individual production runs may take longer than planned, because of inefficiencies on the production line. This has an impact on the supply chain and the company's ability to meet customer demand. Companies are implementing

supply chain software to meet the expectations of the customer. If the plant cannot produce the right product at the right time, the supply chain and ultimately the customer relationship are affected. Management will increase inventory levels to insure that the needs of the customers are met when production cannot meet the schedule.

Reduce costs

To improve profitability, the production manager is looking for ways to reduce operating costs. They can do this by understanding how each machine operates depending on the product being produced. Alternatives can then be tested to find lower cost materials for production or more efficient ways to run the machines.

UNLOCKING THE HIDDEN FACTORY

There is a hidden factory in each manufacturing facility to help the managers solve their business problems; it is the additional output that can be achieved by improving their OEE. The improvement can be accomplished by increasing equipment performance and reducing equipment downtime, both planned and unplanned. Leading manufacturers will have an OEE of between 85 to 90%. Many manufacturers operate with an OEE of only 65%. Each percentage increase in OEE will increase the total output of the plant by an equal amount without increasing fixed costs.

There are several types of data that must be collected and analyzed to develop an effective program to improve OEE. The data are used to develop metrics for identifying what is happening on the line and the opportunities for improvement. They are:



Planned Availability of Equipment

The number of hours of planned operation of the equipment is the basis for determining how well the manufacturing operation is performing. This is calculated from the number of hours scheduled for production (i.e. if a plant is scheduled for two 8 hour shifts each day, the Planned Availability (PA) is 16 hours a day or 960 minutes per day).

Efficiency Losses

Planned Downtime – During each production shift, production management will schedule downtime to complete certain operations. These are planned and controlled by management, but no production occurs while these activities are being performed. They include planned maintenance, calibration of instruments, testing of equipment. In addition, management may plan downtime for employee breaks, meals, and meetings.

Changeover – Before each production run, the equipment needs to be set-up to run the particular product. This may include changing tooling or other equipment, adjustment of machines, changing raw material (new labels, bottles, etc.). This step also includes any required cleaning of the equipment. In all cases, there will be a standard developed for how long this operation should take.

Downtime – Downtime is the unplanned shutdown of the equipment resulting from a mechanical failure or operator intervention. Many times this will be a jam or

misalignment where the machine will shut itself down. Downtime also occurs when the machine is switched to idle mode for an adjustment or to add more raw materials (i.e. bottles, labels, etc.). The other cause of downtime is when a downstream machine is down and the line is blocked, so the machine must be shut down.

Speed – Each operator will typically adjust the speed of the machine on every shift. Many times this is based on their feel of the best operating conditions. Downtime can be reduced in many cases by running the machine at a lower speed. Each machine has a standard speed for each product. When the machine is running less than the standard, production capacity is lost.

Quality – If the machine is operating correctly, but generating significant amounts of below standard quality, efficiency will be lost. There is a relationship between machine adjustment, machine speed, and output quality that must be analyzed in order to attain optimal production conditions.

Maintenance – The most expensive type of maintenance is when you are fixing machines that are broken. It is far cheaper to perform routine preventative maintenance instead of waiting for equipment to break. Production and maintenance management wants to understand the relationship between preventative maintenance and machine downtime. They also need a system that helps them quickly identify the actual cause of a breakdown.

Typically, OEE would be defined as:

$$\text{OEE} = \frac{(\text{Planned Availability} - \text{Planned Downtime} - \text{Changeover} - \text{Downtime})}{\text{Planned Availability}}$$

If the system had the following performance (on a daily basis):

Planned Availability (PA) = 1440 minutes

Planned Downtime (PDT) = 120 minutes

Changeover (CO) = 100 minutes

Downtime (DT) = 300 minutes

$$\text{OEE} = (\text{PA} - \text{PDT} - \text{CO} - \text{DT})/\text{PA} = (1440 - 120 - 100 - 300)/1440 = 64 \%$$

By decreasing Downtime by 5 minutes an hour or 120 minutes a day you get the following:

$$\text{OEE} = (1440 - 120 - 100 - 180)/1440 = 72 \%$$

ROCKWELL AUTOMATION APPROACH

Rockwell Automation provides services and products to implement an OEE system that will help companies improve operations and increase efficiency.

The steps that are followed in a typical project are:

Identify Business Drivers

Identify the key business drivers for implementing an OEE system. This includes looking at the major problems of meeting demand/delivery dates and controlling operating costs. Determine how to use data from the factory floor to measure efficiency. The data is then used to analyze operations and determine methods to improve operations. Some companies are interested in a simple view of the production lines, while others are interested in a complete view of all activities. This determination needs to be driven by business reasons and not available technology.

Design and Implement an automatic data collection system

The system installed must be designed from the top down, with the flexibility to answer business problems. This may be accomplished by calculations in a PLC with display on a Panel Display. It may require the development of an information-enabled architecture to collect the data in a central repository for reporting and analysis. The installation of a data collection system allows a company to review past operations and determine trends in efficiency. Another approach is to have a consultant spend a couple of days observing operations and recording data, although this approach only provides a snapshot of operations and not the complete picture of the system over time.

Baseline Development

After installation of the system, information is collected from the production line to prepare a baseline for measuring progress. This allows the company to see its progress and be able to understand the value received from the system.

Analysis of Data

The collected data is then analyzed to give the company an understanding of what is happening on their lines. The different items analyzed are:

Downtime Analysis – The first step is to look at unplanned downtime on each machine. Identify the equipment with the greatest amount of downtime and the reasons or faults that caused the downtime. These can be corrected by improving maintenance, changing operation, adjustment of the equipment, or replacement. If the downtime is great enough, you can justify the purchase of a new piece of equipment.

Changeover – The actual time spent on changeover can be analyzed. This can be done by looking at the differences between lines, products, and shift personnel. Many times the changeover can be improved by further training of operators. However, in order to provide focused training, you need to know where the problems exist.

Product effects – Many times the efficiency can be affected by the type of product being run on the line. You must analyze the data to see if the loss is constant across all products or related to an individual product type. If certain products cause it, procedures can be changed to improve efficiency during those product runs.

Production run effects – The efficiency can also be affected by the length of the production run. For example, some equipment or shifts will operate best during a long production run on one product, but have bad results when there are multiple small runs.

Speed effects – Each piece of equipment has a recommended speed for operation. You may find that by reducing the speed, downtime decreases, but you do not produce as much product. The relationship between optimal speed or equipment settings, downtime, and output must be studied and optimized.

Corrections and Review – After the major causes for efficiency loss are determined, the company can implement procedures to improve the problems. They must always continue to analyze the data to insure that they are seeing improvement. They can accomplish this by comparing results to the baseline that has been created.

SUCCESSSES

Rockwell Automation and its partners have implemented many of these systems to improve OEE for its customers. By using the information contained in the system, the companies have been able to implement changes that provided improvement in their operations. Companies will usually see a 5 to 15% improvement in efficiency after they implement an OEE solution. Examples of these implementations are:

Monitor the downtime of production machines

By analyzing the data the company was able to identify the major causes of downtime on their machines. They used this information to improve operations and reduce downtime on their machines. The result was a 15% increase in output from the same production equipment, which allowed them to reduce the number of weekend production runs.

Analyze the operating conditions on the line

The company used the data to determine the operating settings of the equipment during successful production runs. This allowed them to develop new standards for operating the equipment. They could then review runs and insure that the new settings were used by all of the shifts. This generated a 5% increase in output.

Improve the safety of operations

The company analyzed the machine faults to determine the major causes of jams that required operators to reach into the equipment. Those faults that increased the risk to the operators were prioritized for being fixed. This improved the working conditions for the employees. The number of safety related faults have decreased by 15%.

Utilization of maintenance resources

Several companies are using the OEE systems to assist maintenance operations. The automatic collection of the machine fault data allows the maintenance and engineering staff to analyze the data and determine the root cause of the problem. The maintenance activity is then focused on actual problems and time for repair decreased. One company saw the percentage of maintenance time used for repair decrease by 15% because of this data. The additional time saved was then used for preventative maintenance. TM

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