



TPM Case Study on Bus Bar Bending Machine

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TPM approach is one of the most effective ways to attain maximum efficiency and produce premium quality. To get the most of the TPM approach, the approach is further divided into eight basic pillars. These are mainly three of the important pillars which are going to be addressed. Among the main aims in TPM approach are the continuous improvement and the factors relying on to get the best of quality. This helps in the overall performance in a drastic manner with tackling many major issues of any asset. In the particular paper a detailed TPM approach was carried on bus bar bending machine. An approach of 5s was carried out, which was followed by a detailed focused improvement step. For a better understanding of machines, the planned and autonomous maintenance was studied and analyzed accordingly. To sum up the exact efficiency of the products produced, OEE calculation was carried out of the machine and the why-why analysis was formulated. A detailed analysis was assessed of the bus bar bending machine and the improvements were carried out with the help of TPM approach.

Keywords: TPM, 5s, OEE, Why-Why Analysis, Bus Bar Bending Machine

Introduction

The bus bar bending machine is located in the asset which is sited in locality of wadi kabir industrial zone, Muscat Oman. This asset selected was established in 1983 which leads in production of steel and services like sandwich panel manufacturing, switch gear, civil contracting, MEP contracting. This particular asset selected is one of the major industrial contractors and their main claim relies on giving the best solution to the clients.

The bus bar bending machine is one of the most important machines in the asset. It plays a vital role in the proper functioning of the asset. The bus bar bending machine helps in the making of the sandwich panel. The three steps involved in the bus bar bending machine are cutting, punching and bending process. It is performed on a daily basis and depends on the orders which have been issued (Figure 1).



Figure 1: Bus bar bending machine.

Methodology

Implementation of 5s/CANDO

For the proper functioning of the bus bar bending machine in the asset the first foremost step is implementation of 5S. Through following certain protocols in an organized manner, the staff can achieve better functioning of the equipment as well as improve the overall performance of the asset. Further with these following steps the work can be completed much faster and efficiently.

The 5s are as follows:

- a. **Seiri/Arrange:** In this particular step, the items related to the machine are sorted in a methodological manner. To keep the focus on the job of the equipment the most important items are kept, and the unwanted items are removed from the working place. This involves grouping similar items related to the machine. Clear demarcation is created between the items for the staff to apprehend the job.
- b. **Seiton/Neatness:** The next step is almost similar to its predecessor step. This involves labelling the main items related to equipment. Every item related to the job is assigned, maintained and defined for better maintenance. This helps the staff to have a clear perception of the job. The main aim of this step is to properly put away the items related to the equipment to its appropriate designation, which can reduce the time to get the items when needed.
- c. **Seiso/Clean:** This step involves the cleaning process of the equipment. For less hassle and maintenance, the cleaning process of the particular machine should be kept as priority. This includes the responsibility of the cleaning process and to clearly understand the duties of cleaning with certain standards to be maintained for the better operation of the equipment. The method to dispose all the unwanted waste should be kept as

priority at all means.

This step includes group work and should be considered a moral duty of each member of staff when it comes to cleaning the equipment and its related surroundings.

d. **Seiketsu/Order:** This is considered the heart of the 5s, in this step the equipment is refined and set to certain standards for proper operations of the equipment. Proper indication and markings, especially visual, are installed for the easy understanding of the equipment. This can help to predict any future errors and reduce human errors to the minimum. For example, in the bus bending machine the indicators would be the directions of the machines, highlighting the main areas of cleaning, a proper schedule on the inspection checks with numbering etc. An innovative strategy of single point lessons is introduced for operators and staff.

e. **Shitsuke/Discipline:** This step has to majorly deal with disciplinary actions. This step makes sure all the other previous steps are regularly followed with particular standards. A check among the assets should be performed like audits (monthly) to make sure all the steps are followed with priority. Action should be taken for not meeting the standards.

Focused Improvement

In this particular case the focused improvement was applied to the bus bar bending machine. The main aim was to eliminate all kinds of losses and focus on performance. This can reduce the failures of the machine. A detailed study was done on the machine and the loopholes were studied which could help overcome the failures. The bottlenecks related to bus bar bending machine were formulated. Then the machine was studied on the failures and the losses which were associated with it. The small minor losses were dealt with accordingly. Through this process an analysis was made of where we could start. The goal was to attain the basic condition

of bus bar bending machine. With this the most important step was to articulate a plan for improvement. Where all the protons were assessed, and all the important points related to improvement were brainstormed. Then the next step was implementation of the plan. This had all the test phase, and the instruction was laid out for the operating methods and improvement of the bus bar bending machine. Then the results were evaluated and seen if the targets were met on the performance.

If the targets were not satisfactory the plan was restudied and a better plan was made. The whole results were set according to standards and made as manuals for further reference. The information was documented for the betterment of the bus bar bending machine. So, the staff could make the maximum efficiency and achieve the best quality.

Autonomous and Planned Maintenance

Among the TPM pillars, the two most important pillars are the planned maintenance and autonomous maintenance.

Autonomous maintenance

In this technique the maintenance is done in a more logical manner. The bus bar bending machine maintenance schedule is studied and then the approach of autonomous maintenance is applied. In this particular approach the bus bar bending machine operation is checked daily for the right function of the machine. This can avoid deterioration of the machine and with proper management the ideal state of the machine can be restored. The condition for the machine is set up for the proper maintenance of the bus bar bending machine. The staff and operators are taught innovative techniques and given advanced training in the equipment. So, the operators are the experts in handling the equipment. Standards are set up for the whole staff members and are made sure that are strictly followed to avoid downtime of the equipment and maintain the performance quality at all times. This activity can bring about so many positive changes in the bus bar bending machine. The productivity of the bus bar bending machine can be almost double with reduction of further drastic maintenance. Cleanliness plays an important role in this technique and is made sure certain protocols have been followed regarding the cleaning schedule of bus bar bending machine.

Planned maintenance

The maintenance which is happening in the asset on monthly basis for the bus bending is the check of oil for the better performance on the bending and cutting operations. The oil is checked in the hydraulic pump. The second most important thing which the operator has to check is the PLC control panel. If the PLC panel is not overheating and the right amount of voltage is attained to drive the bus bar bending machine. The operator has a checklist which he performs in the morning for the right functioning of the bus bar bending machine.

To achieve more efficiency in the maintenance schedule a planned maintenance is applied. This can help in achieving zero breakdown goals. It's more of a lengthy process and requires more effort from the asset staff members. But if planned maintenance is applied in its exact steps the equipment can achieve less break-

downs and improve in the losses. Further the planned maintenance which is carried out on the bus bar bending machine is kept at cost minimum giving maximum efficiency. The next important step which is introduced into the asset is categorizing the schedule mostly by the priority which ranges to extremely critical to low critical issues. A job plan is created accordingly for the equipment which ranges activities like checklist, introducing effective CMMS system, maintenance on the condition of the machine, setting standards etc. Lastly the most important step is to sum up all these steps and have a budget to cover all the job plans. A team should be prepared to make all this procedure cost efficient and make the most of these techniques in the consideration of the asset expenditures [1-5].

Results & Discussions

OEE Calculation

The data collected of bus bar bending machine is on daily when there are back-to-back orders for the asset and production is kept on an ideal rate.

Working hours per day: 8 hours (8x60) = 480 mins

Planned downtime: 2 hours (2x60) = 120 mins, Unplanned Downtime: 45 mins

Output Avg/day: 185 units, Defective Components: 4 units.

Ideal Cycle time 1mins/Item

OEE Calculations

Total available time: 480-120 = 360 mins

Actual working time: 360-45 = 315 mins

Availability: $360-45/360 = 0.875$ or 87.5 %

Performance: $1 \times 185/315 = 0.587$ or 58.7%

Quality Rate: $185-4/185 = 0.978$ or 97.8%

OEE Availability: Availability x Performance x Quality Rate

$= 0.875 \times 0.587 \times 0.978 \times 100\%$

$= 50.69\%$

Analysis and Recommendation on OEE

After calculating the OEE, the results were obvious that OEE is very low and not meeting the standards which are ideally 85%. This has to majorly deal with the performance, which is indeed very low as compared today. This can be due to minor stoppages and the speed of production. According to the calculation the availability meets the standards but there is always space for improvement. The quality rate is exceptional. The asset's main concern should be on the performance and should be given high priority in this matter. If they increase production in the time available and make the ideal cycle time at least 1.5/min. The performance will reach almost 88%, which is well above the standards. Lastly all the factors mentioned will help in increasing the overall efficiency of the equipment.

Why-Why Analysis

Why-Why analysis method was applied to the equipment to

identify different problems and the cause concerning the problem. The aim was to find the root cause of the problem in the bus bar bending machine. Simple questioning of why was outlaid until the

main reason was discovered. This was a chain process leading to the main problem (Table 1).

Table 1: Why-Why analysis table (Production Related).

S. No.	Question	Answer	Action
1	Why there is less production	Equipment is not efficiently used	The stoppage time should be reduced/ More units should be produced
2	Why Equipment is not efficiently used	There is less manpower operating the equipment	The manpower should be addressed by the asset
3	Why there is less manpower operating the equipment	Due to insufficient knowledge of the equipment	Training and proper skills should be developed by the operators/ Seminars should be given to the staff for better operations of the equipment
4	Why there is insufficient knowledge of the equipment	Due to less training and the awareness of the machine	
5	Why there is less training and the awareness of machine	Because of complexity of the machine	

Conclusion

In conclusion TPM approach was applied to the bus bar bending machine and the different pillars were applied to increase the overall efficiency of the equipment. Further a detailed analysis on OEE and why-why analysis were discussed. The equipment OEE which was calculated and discussed can help in the production sector as the equipment is developing a high-rate quality but not meeting the performance standards. By the analysis given the performance percentage can be increased from 58.7% to 88%. This will overall help in production and availability of the equipment. By applying the TPM approach the maintenance sector was drastically affected. There is always further scope of applying all the pillars of TPM approach to have the best standards when it comes to the operations of bus bar bending machines.

Acknowledgement

None.

Conflict of Interest

No conflict of interest.

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