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Reduction in Setup time on Rubber Moulding Machine using SMED Technique

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***Abstract*— Due to growing competition in the industries and market there is gradual need for organization or industries to survive in the severe condition in the market. This cutthroat competition has made industries to work in a different way and efficient way. To keep themselves updated with tough market situations as well as fellow companions. Single Minute Exchange of Die (SMED) mainly focuses on recognition of online and offline operation.**

This paper discusses the implementation of above technique for moulding of rubber to metal phosphate components for production of anti vibratory mountings which requires frequent changeover. The main objective is to reduce setup time from two hours to 8 minutes with minimum investment resulting in excellent productivity the scope includes implementation of new scissor type stackers (two numbers), New standardized T-bolts , heat resistant roller bearing with spring cushioning, mould heating platen , shadow board, mould storage rack with rollers etc.

This application of SMED proved to be useful to reduce the setup time of rubber moulding machine which indirectly reduced the production losses occurring due to prolonged changeover process.

Keywords: - ***Single Minute Exchange of Dies, excellent productivity, setup process, recognition of online and offline operations.***

I. INTRODUCTION

In the past years it has been observed that there is increased need for product in right time and with appropriate quality. The other hand due to globalization and current scenario in the market the companies need to increase their production and increase product flexibility by manufacturing the product in small batches size. Due to manufacturing of products in small batches there is need for companies to increase the frequency of setup for such condition it is necessary to entertain quick changeover processes in order to reduce the production losses.

SMED (single minute exchange of die) is one of the lean manufacturing processes. [1] Here the phase "single minute" does not mean that the setup /changeover should take place in one minute but it states here that the changeover should take place within single digit of time in minutes that is within ten minutes.[2] SMED can also be called as quick changeover interchangeably.

II. HISTORY OF SMED

Ohno at Toyota developed SMED in 1950. Ohno`s idea was to develop a system that could exchange dies in a more speedy way. By late 1950`s Ohno was able to reduce the time that was required to change dies from a day to few minutes. [Shingo 1985] There are two types of setups: internal and external. Internal setup activities are those that can be carried out only while the machine is stopped, while external setup activities are those that can be done while the machine is running condition. [2]

The basic idea is to make as many activities as possible from internal to external. There has been lot of work done in detail for SMED methodology in various industries such as stamping industries, moulding industries etc.[3] In the implementation of SMED it is necessary that the following fundamentals requirements are playing vital role they are team work, performance measurement, kaizen and the environment of the production line.

With the help of SMED we can also conduct relationship between the changeover time and production as the batch size decreases, the cost of each part will increases since the changeover time will be of fewer parts. Which leads to high manufacturing cost when there are frequent setups. [4]

Shingo also states that "SMED can be applied in any factory to any machine". Work regarding the application of design changes according to the process [Shingo 1985].

III. LITERATURE REVIEW

Single Minute Exchange of Die (SMED) is the technique used for reducing the setup time of the equipment or machine. The main objective or the main motto of SMED technique is to complete the changeover within ten minute means within single digit of time.

Single Minute of Exchange of Dies which is equivalently known as quick changeover was developed by Shingo in 1985 who stated that it is scientific approach for the reduction of setup times. SMED is defined as the minimum amount of time taken to change the type of production activity taking into consideration the moment in which the last piece produced by subsequent lot [Shingo 1985]. (Ana Sofia Alves ET. Al 2009) concluded that the SMED methodology can be combined with other classic tools, providing very positive results for companies, such as chart analysis and statistical analysis allowed the identification and separation of different groups for analysis and added value of traditional SMED methodology.

(Antonio Carrizo Moreira 2011) also conducted that after implementing the SMED methodology it is possible to define that simple process based innovation as the separation of internal and external activities and conversion of internal activity (as many as possible) to external activity (Michel, 2007) applied the SMED methodology to the punch press changeover detailed in the study, the researcher concluded that SMED is improved tool to provide improved changeover methods resulting in reduction of overall time and labour.

(Shingo 1985) also showed that SMED consist of three conceptual stages namely separating internal and external setup, converting the internal setup to external setup, streamlining all the aspects of operation.

IV. PROBLEM DEFINITION

In case of Rubber moulding machine there is no fixed product moulded on the machine. Owing to the severe competition in the market, in order to increase flexibility of parts being manufactured on the machine, machine needs frequent changeover of mould due to variety of products, but the actual time required to have changeover on machine is two hours on an average considering the size of the mould, which comprised of lots of human effort, time consumption in heating of mould etc, which affected the productivity of machine, which would indirectly increase the cost of the product for which there was need to implement SMED technique.

V. METHODOLOGY

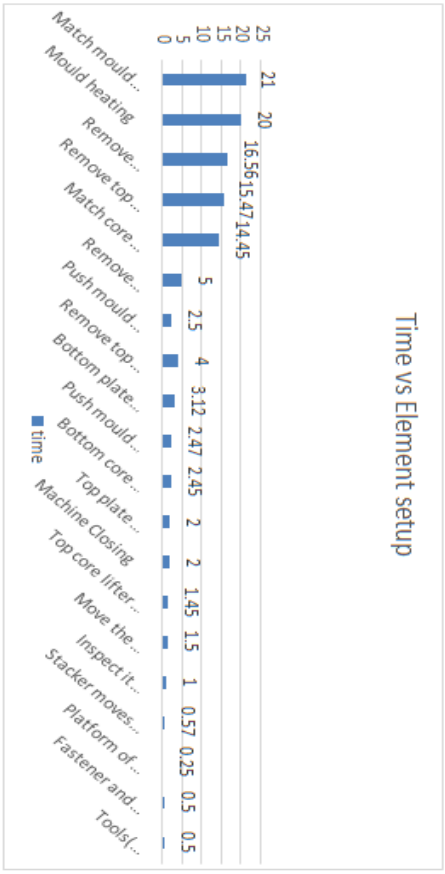
Reviewing literature about SMED and lean principle by referring books journals and manuals where we actually studied the definition and meaning of single minute exchange of die.

A. *Detailed study of operations*

- On the existing process of the change over the total number of employees involved mainly were two firstly.
- The removal of bolts was carried out after which the stacker was taken from mould storage area to the machine (without the mould) there after the mould was led on the stacker surface which was operated manually.
- The stacker was taken to mould storage rack after rack after which stacker was taken to the machine.
- Then from stacker the mould was transferred to the machine surface with an aid of lots of human efforts which made a tedious job for the changeover workers.
- After which the upper plate middle plate and lower plate needed to be fastened with the fasters sometimes it was observed that there was great shortage of bolts (availability of uneven bolts) and on the other hand due to the other hand due to lack of standardization there was problem of the bolts meshing with the t-slots of machine surface, which indeed was time consuming.
- There after the mould was heated on the machine itself at required temperature after which the machine was ready for further production of new rubber component.
- The format of process sheet is as shown in the figure below with noted time for each and every process.
  The figure shows the noted operations as well as the time taken for every process it was noted that the time taken for matching of mould and platen slot was more and of heating of mould was also more, there after the time required for fastening was more.
  Table 1:- Setup parameters and time required before implementation of SMED.

Sr. No	PARAMETERS OF SETUP	TIME REQURIE
1	Machine Closing	2mins
2	Tools(spanner) search	0.5mins
3	Remove top plate 4 nos. fastener	15.47mins
4	Remove bottom plate 4 nos. fastener	16.56mins
5	Remove top care lifter fastener 4 nos.	4mins
6	Remove bottom care lifter fastener 4 nos.	5mins
7	Move the stacker from mould storage area to machine (without mould).	1.5mins
8	Push mould from machine to stacker	2.47mins
9	Stacker moves from machine to mould storage area	0.57mins
10	Platform of stacker lifting from dead position to 3 feet	0.25mins
11	Push mould from stacker to machine	2.5mins
12	Match mould and platen slot	21mins
13	Match core lifter slot with mould slot	14.45mins
14	Fastener and washer search	0.5mins
15	Top plate fastener clamping	2mins
16	Bottom plate fastener clamping	3.12mins
17	Top core lifter fastener clamping	1.45mins
18	Bottom core lifter fastener clamping	2.45mins
19	Inspect it visually	1mins
20	Mould heating	20mins
Total time in minutes		116.34mins

The graph below shows relation of the same.



VI. Application of SMED Methodology

A. Separation of Internal and External activities

With an aid of implement this SMED technique the most important point to be considered is separation of internal and external activities. According to (Shiego Shingo 1989) there are two types of setup namely internal setup and external setup.

- Internal setup – setup operation that can be performed only when the machine is stopped such as mounting and removing of dies etc. the machine does not perform useful work.
- External setup – setup operation that can be completed while the machine is running such as transportation of dies collecting spanners, bolts etc.[5]

According to the improvements made the operations discussed above are classified as internal and external according to their sequence (The sequence may change according to characteristics of die). The following is shown in the table below.

Table 2: - Parameters of setup and the categorization of setup activity.

SR. NO	PARAMETERS OF SETUP	Internal / External
1	Machine Closing	Internal
2	Tools(spanner) search	External
3	Remove top plate 4 nos. fastener	Internal
4	Remove bottom plate 4 nos. fastener	Internal
5	Remove top core lifter fastener 4 nos.	Internal
6	Remove bottom care lifter fastener 4 nos.	Internal
7	Move the stacker from mould storage area to machine (without mould).	External
8	Push mould from machine to stacker	Internal
9	Stacker moves from machine to mould storage area	External
10	Platform of stacker lifting from dead position to 3 feet	External
11	Push mould from stacker to machine	Internal
12	Match mould and platen slot	Internal
13	Match core lifter slot with mould slot	Internal
14	Fastener and washer search	External
15	Top plate fastener clamping	Internal
16	Bottom plate fastener clamping	Internal
17	Top core lifter fastener clamping	Internal
18	Bottom core lifter fastener clamping	Internal
19	Inspect it visually	External
20	Mould heating	External

B. Converting Internal Activities to External

Here the main focus is directly on the task related to the heating of the mould , handling of the mould , adjustment of the bolts and matching of the platen , from table 2 we can see that though internal activities are more than external activities, we aimed to convert more internal activities to external as many as possible. One of the best examples is of externalization of heating mould.

C. Stremlining all aspects of the operation

In final stage all the improvement studies were done and the checklists were formed. The causes for the recursive activities were searched and the possible solutions were implemented to eliminate them. Finally the time delay was eliminated with proper records and well planning which would lead to proper customer satisfaction.

VII. IMPLEMENTATIONS

A. *External heating of Mould*

The most time required was with the heating of the platen or mould in order to overcome this difficulty the total operation which was earlier done on the machine itself was externalized with provision of heating station where if the temperature required was 150 the die or mould was heated up to 180℃ to 190℃ in ordered to compensate with losses occurring due to travel of new heated mould from heating station to the machine**.**

B. *Preparing with the tools like spanners bolts and coolant beforehand*

In order to prevent excess loss of time in setup procedure for searching bolts and spanners for fastening or removal of die prior preparation of collection of tools, bolts and spanners is done in order to prevent hustle and bustle of workers during changeover.

C. *Provision of Rollers*

In ordered to overcome difficulty with the human fatigue with moving of mould to the rack there was several changes that were made they are as follows

- Rollers on the machine surface
- Rollers on the stacker surface
- The stacker involved are two number's instead of one stackers
- Rollers on the mould rack

D. *Provision of two number of stackers/scissor type lift*

The two numbers of stackers are provided in order to reduce the time for handling of mould old as well as new mould simultaneously.

Referring to above processes the whole changeover was carried out taking into account the various processes and some of the activities were externalized as shown in the chart below and the standard process was followed for changeover (according to the sequence shown in chart).

VIII. RESULTS AND DISCUSSION

After implementing the changeover process the time was drastically reduced from two hours (on an average) to 8 minutes (average).the table below shows the actual time required for the changeover process.

As the ultimate aim of implementing SMED is to enhance productivity and reduce cost.

Table 3:-time required for setup after implementation of SMED

SR. NO	PARAMETERS OF SETUP	Time	Internal / External
1	Machine Closing	4 sec.	Internal
2	Tools(spanner) search	0	External
3	Remove top plate 4 nos. fastener	40 sec.	Internal
4	Remove bottom plate 4 nos. fastener	54 sec.	Internal
5	Remove top core lifter fastener 4 nos.	62 sec.	Internal
6	Remove bottom care lifter fastener 4 nos.	24 sec.	Internal
7	Move the stacker from mould storage area to machine (without mould).	0	External
8	Push mould from machine to stacker	5 sec.	Internal
9	Stacker moves from machine to mould storage area	0	External
10	Platform of stacker lifting from dead position to 3 feet	0	External
11	Push mould from stacker to machine	6 sec.	Internal
12	Match mould and platen slot	58 sec.	Internal
13	Match core lifter slot with mould slot	67 sec.	Internal
14	Fastener and washer search	0	External
15	Top plate fastener clamping	41 sec.	Internal
16	Bottom plate fastener clamping	22 sec.	Internal
17	Top core lifter fastener clamping	56 sec.	Internal
18	Bottom core lifter fastener clamping	26 sec.	Internal
19	Inspect it visually	18 sec.	External
20	Mould heating	0	External
Total time in minutes		8.05 mins.	

(Note*:- As the activity is externally and not done while the machine is on, so the time is considered as zero in the above table for changeover.)

IX. ANALYSIS

Time before implementation	Time after implementation	Cost before	Cost after	Percent Reduction in Cost
120 minutes	8 minutes	0.56 rupees/ unit	0.33 rupees/ unit	41%

X. CONCLUSION

The previous setup time for rubber moulding machine has been efficiently modified by using work study methods and lean tools. By deploying the required tools and techniques the setup time of rubber moulding machine, which was previously 2 hours has been reduced to 8 minutes/setup resulting in total 112 minutes of reduction, similarly before implementation of quick changeover the cost per unit was 0.56 rupees but after implementation the cost was reduced to 0.33 rupees per unit. Which means the percentage saving in cost was 41%.

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