Productivity Improvement of Filter Drier Manufacturing Using Time Study

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Abstract. Productivity improvement is critical for any business because it has an effect on output and profits. The purpose of this paper is to examine the implementation of industrial engineering tools in a company that manufactures filter driers. This study begins by reading standard operating procedures and analysing the process flow in order to gain a comprehensive understanding of how to filter driers. Simultaneously, observations were made on the production line to ascertain the existence of any problems. The primary issue addressed in this study was a deviation in working hours from the standard. As a result, the manufacturing company's productivity decreased. This research examined and sought out potential solutions and alternatives aimed at achieving the objective through the use of motion and time-related tools. In aggregate, the suggested alternatives resulted in an expected increase in production capacity of 174.8 %.

Keywords: Productivity, Method Study and Time Study.

1 Introduction

Motion and time analysis requires an understanding of how an operation is carried out when a new product is created or an existing process is improved. Approaching any problem logically and methodically involves the following steps: Problem definition and analysis; search for potential solution; evaluation and discussion of alternative solutions; and recommendation for action are all included in this process. Repetitive production tasks, which can be monotonous, boring, exhausting, and demoralising, have a high priority for management in terms of employee satisfaction and productivity (Shikdar and Das, 2003).

Throughout history, there has been an accumulation of knowledge that has been geared toward enhancing the productivity of an organization and its employees. Goals in motion and time study are to eliminate redundant work and develop methods and procedures that are most effective, require the least effort, and are best suited to the user (Barnes, 1980; Meyers and Stewart, 2002).

The goal of this research was to determine how well a filter drier manufacturing company's work flow performed and how to make it run more efficiently.

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2 Background And Review

Productivity may be defined as follows:
Productivity = Output/Input

It's possible for this definition to apply to an individual company, a specific industry, or the entire economy. When a system can extract a specific output from an input, the term "productivity" is used (Kanawaty, 1992). To put it another way, productivity can be thought of as the ratio of output to resources expended in order to generate that output.
Production resources, including raw materials and supplies, personnel, land, buildings, machines and equipment as well as energy are all factors that contribute to operational efficiency. Manufacturing, as we all know, relies on a variety of other resources in addition to labour. Gross domestic product (GDP) increases as a result of both an increase in the quantity of production factors (inputs) and an increase in productivity when discussing economic growth. As a result, productivity is seen as an important factor in economic growth (Galarneau and Dumas, 1993).
Working on streamlining or modifying a process in order to reduce the amount of time spent on completing a task, as well as the waste of resources, is the goal of a work study. As a result, it's obvious that productivity and work studies go hand in hand. If rearranging or simplifying the method of operation results in a 20 percent reduction in the time required to complete a specific task, then productivity increases by the same amount, or 20 percent. Methodological studies and work measurement studies are two types of work studies. It's a tool for systematically examining and improving human work practises by taking into account all of the variables that have an impact on productivity and working conditions. A time study can be conducted by recording all relevant information about the job, decomposing the job into elements, examining those elements and establishing the sample size, timing each element with a stopwatch, determining the worker's speed, converting the observed time to basic time, establishing allowances, and establishing the standard time after establishing a sample size and determining the sample size (Pisuchpen and Chansangar, 2014).

3 Manufacturing Process For Filter Drier

FILTER DRIER

The filter drier is a component used for the moisture adsorption of the refrigerants used in the cooling systems. Hence, as the application for the particular component is important in the cooling systems, the quality of the component is at most important. Similarly, to meet the customer requirement with the required quality the productivity of the company plays the major role in the market. The productivity of the filter drier component of the company should meet the customer requirements. Filter drier is mainly divided into two types. DML core type and DCL core type. DML cores 100 % Molecular Sieve, DCL cores 70% Molecular Sieve + 30% actuated alumina, DCL more resistant. Similarly the end connectors also vary for each component type requirement as mentioned by the customer. Four types of connector as Solder connector, Flare connector, Face seal connector, Cu - plated connector.

PROCESS FLOW OF FILTER DRIER MANUFACTURING

Filter drier manufacturing consists of three set of different activities. 1) Washing and brazing, 2) Assembly and welding, 3) Packing. Before packing the required types of filter driers are given to third party painting and then final packing happens in the company.

WASHING AND BRAZING

Washing and brazing operation consists of the following activities. The below mentioned activities are done on the basic component, filter cup.

1. Washing
2. Rinsing
3. Drying
4. Inspection
5. Connector ring fitting
6. Connector insertion
7. Dummy ring placement in the furnace
8. Brazing in the furnace
9. Inspection

FILTER DRIER ASSEMBLY PROCESS

After the brazing process is completed, the main assembly of the filter cups along with the other sub-components are done. TIG and plasma welding is done on the filter cup assembly for leak free final component.

1. Filter cup part 1assembly
2. Felt mat insertion
3. Perforated sheet insertion
4. Core punching
5. Filter cup part 2 assembly
6. Inspection

WELDING AND LEAK TEST

The assembled sub-assembly is now ready for welding and leak test. The following processes are done on the filter drier sub-assembly.

1. TIG welding
2. Inspection
3. Plasma welding
4. Inspection
5. Leak test
6. Inspection

PACKING OPERATION

Once the filter drier assembly is finished, it is sent to third party painting according the respective batches. After the painting process is done and received from the third party painting company, final packing process happens in the following flow.

1. Flare and connector cap fixing
2. Packing in separate boxes
3. Sticker pasting and silica gel insertion
4. Packing in industrial boxes

5 Outcome Of Literature Review

A "Work Study" is a term that encompasses both methodological investigation and the measurement of labour. Gilberth's action study and Taylor's time study formed the basis of what would become the most important industrial engineering method ever devised. In order to boost output, lower costs, and improve the company's competitiveness, the most obvious characteristic is that less or no investment is required. As part of this, the company's operating methods are improved, work quotas are set at reasonable levels, and its resources are fully utilised. The study of methods and the quantification of work is known as a "work study." Working time quotas for each operating system are determined by the work measurement study, which focuses on determining the most efficient working method (Lan, et al., 2009). Work Study is a methodical approach to accomplishing a variety of distinct but related tasks, such as enhancing resource efficiency and establishing performance and quality standards for the activities to be performed. Method studies (Motion studies) and time studies (Work measurement) are the two main types of work studies (Kulkarni, et al., 2014). The primary goal of methodology is to find better ways of doing things. By eliminating inefficient processes, avoidable delays, and other waste, it adds value and improves efficiency.

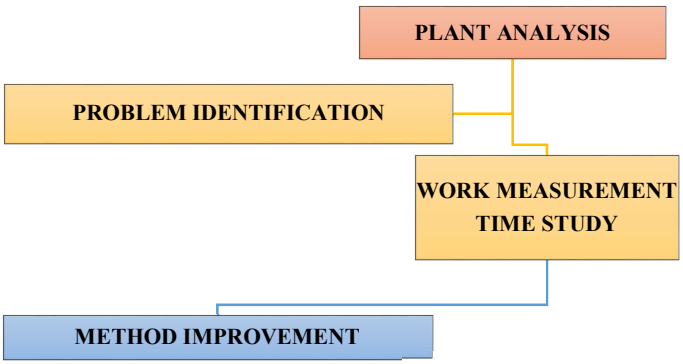
6 Objectives Of Research

Observational data collection is used in this study. On a "preliminary study form," the times observed for specific work cycles and work elements are recorded alongside the expected times for each process element. Results are analysed; times measured are specified, and times measured multiplied by ratings to determine "base periods" after the timing process is complete. Base periods are used to calculate "representative period," and "standard time" is calculated by multiplying the shares by this base period. In-depth interviews with the plant manager and shift supervisor determine which employees will be included in the research. Participants in the timing study are chosen based on suggestions made by their managers and shift engineers for experienced workers who work at a balanced and average pace.

1. To increase the productivity of the filter drier according to the sales plan department requirement.
2. To improve the production plan by considering the before painting and after painting of filter drier
3. To reduce the inventory of the filter drier sub-components due to improper planning of the production order sequence.

7 Methodology

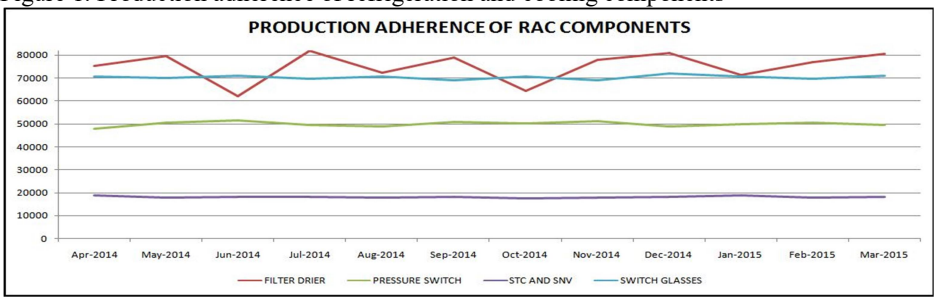
The following methodology is followed for the improvement of productivity in the filter drier manufacturing operation.



PROBLEM INDENTIFICATION

The plant analysis is done for the initial process and the main problem in the manufacturing company has been found out based on the following production data.

Figure 1. Production adherence of refrigeration and cooling components



From the graph, it is evident that the productivity of the filter drier component in the refrigeration and cooling section is fluctuating when compared to the other components.

8 Experimenation

The purpose of the time study is to ascertain whether the manufacturing processes for filter driers adhere to efficiency principles. As such, our objective is to compare standard times obtained through "Time study" to actual process times in order to identify avoidable insufficient periods and to state preventative measures.

Assumptions In Time Study

The following assumptions are considered while conducting the study and assessing the results:

1. The number of observations determined represents the universe.
2. The rating is accurate and valid.

3. The times measured with electronic stop watch are accurate and valid.
4. The time study's objective is to determine whether the manufacturing processes for filter driers follow efficiency principles. As such, our objective is to compare standard times obtained through "Time study" to actual process times in order to identify avoidable insufficient periods and to recommend corrective actions.

Research Limitations

Ratings are used to calculate the base period, which is a crucial step in achieving standard time values. Instantaneous evaluation of an object is possible when it is being observed. The most difficult part of the course is rating. "The difficulty in determining immediately which work pace is normal" is the most significant limitation of this study. Another problem is that when employees know they are being watched, they tend to work more slowly.

Time Study

Time study for the various activities in the manufacturing of filter driers have been conducted based on the following work hours in the filter drier manufacturing company norms.

Table 1. Work hours time table

	5:00 AM	**6:00 AM**	**7:00 AM**	**7:45 AM**	**8:00 AM**	**8:00 AM**	**9:00 AM**		**10:00 AM**	**11:00 AM**	**12:00 PM**	**12:45 PM**	**1:00 PM**	**1:00 PM**	**2:00 PM**
1ST Shift	**WORK HOURS**			**BREAK**		**WORK HOURS**		**BREAK FAST**	**WORK HOURS**			**BREAK**		**WORK HOURS**	

	2:00 PM	**3:00 PM**	**4:00 PM**	**4:45 PM**	**5:00 PM**	**5:00 PM**	**6:00 PM**		**7:00 PM**	**8:00 PM**	**9:00 PM**	**9:45 PM**	**10:00 PM**	**10:00 PM**	**11:00 PM**
2ND Shift	**WORK HOURS**			**BREAK**		**WORK HOURS**		**DINNER**	**WORK HOURS**			**BREAK**		**WORK HOURS**	

Table 2. First shift time study time table

S.No	**Activities**	**30-01-2017**	**31-01-2017**
1	Washing Machine feeding (Pallet to conveyor)	5:00 AM to 6:00 AM	5:00 AM to 6:00 AM
2	Connector ring fitting and connector insertion on the cup	6:00 AM to 7:00 AM	6:00 AM to 7:00 AM
3	Dummy Ring Placement	7:00 AM to 7:06 AM	7:00 AM to 7:06 AM
4	Cups removal from the furance and placement in pallets	8:00 AM to 9:00 AM	8:00 AM to 9:00 AM
5	Filter cups from pallet to fixture	7:10 AM to 7:45 AM	7:10 AM to 7:45 AM
6	Wire mesh + Felt mat insertion		
7	Perforated Sheet placement		
8	Plate spring setting		
9	Core pressing		
10	Station to fixture for filter cup part 2 assembly		
11	TIG Welding & Inspection	10:00 AM to 11:00 AM	
12	TIG welding fixture to plasma welding placement	11:30 AM to 11:30 AM	
13	Plasma welding & Inspection	11:30 AM to 12:30 PM	
14	Plasma welding fixture to leak test machine station	12:30 PM to 12:45 PM	

15	Leak testing & Inspection	1:00 PM to 2:00 PM	
16	Leak testing station to pallet arrangement		10:00 AM to 10:30 AM
17	Cap fitting		10:30 AM to 11:30 AM
18	Filter cup from pallet to fixture		11:30 AM to 12:30 AM
19	Flare and connector cap fixing		
20	Sticker and silica gel insertion		12:30 PM to 12:45 PM
21	Packaging in separate boxes		
22	Industrial Packaging		1:00 PM to 2:00 PM

Table 3. Second shift time study time table

S.No	Activities	06-02-2017	07-02-2017
1	Washing Machine feeding (Pallet to conveyor)	2:00 PM to 3:00 PM	2:00 PM to 3:00 PM
2	Connector ring fitting and connector insertion on the cup	3:00 PM to 4:00 PM	3:00 PM to 4:00 PM
3	Dummy Ring Placement	4:00 AM to 4:08 AM	4:00 AM to 4:08 AM
4	Cups removal from the furance and placement in pallets	5:00 PM to 6:00 PM	5:00 PM to 6:00 PM
5	Filter cups from pallet to fixture	4:10 PM to 4:45 PM	4:10 PM to 4:45 PM
6	Wire mesh + Felt mat insertion		
7	Perforated Sheet placement		
8	Plate spring setting		
9	Core pressing		
10	Station to fixture for filter cup part 2 assembly		
11	TIG Welding & Inspection	7:00 PM to 8:00 PM	
12	TIG welding fixture to plasma welding placement	8:00 PM to 8:30 PM	
13	Plasma welding & Inspection	8:30 PM to 9:30 PM	
14	Plasma welding fixture to leak test machine station	9:30 PM to 9:45 PM	
15	Leak testing & Inspection	10:00 PM to 11:00 PM	
16	Leak testing station to pallet arrangement		7:00 PM to 7:30 PM
17	Cap fitting		7:30 PM to 8:30 AM
18	Filter cup from pallet to fixture		8:30 PM to 9:30 PM
19	Flare and connector cap fixing		
20	Sticker and silica gel insertion		9:30 PM to 9:45 PM
21	Packaging in separate boxes		
22	Industrial Packaging		10:00 PM to 11:00 PM

Table 4. First shift time study data

S.No	Activities	30-01-2017	31-01-2017	01-02-2017	02-02-2017	03-02-2017
1	Washing Machine feeding (Pallet to conveyor)	4.0404	4.0584	4.5163	4.1671	4.4894
2	Connector ring fitting and connector insertion on the cup	3.0134	3.0284	2.9865	3.0083	3.0142
3	Dummy Ring Placement	366.0000	376.0000	350.0000	390.0000	358.0000
4	Cups removal from the furance and placement in	4.5044	4.5118	4.4712	4.4699	4.4791

	pallets					
5	Filter cups from pallet to fixture	14.9286	14.9571	14.9231	14.8043	15.5956
6	Wire mesh + Felt mat insertion					
7	Perforated Sheet placement					
8	Plate spring setting					
9	Core pressing					
10	Station to fixture for filter cup part 2 assembly					
11	TIG Welding & Inspection	5.0381		4.9986		5.0420
12	TIG welding fixture to plasma welding placement	3.4795		3.3155		3.3083
13	Plasma welding & Inspection	14.8750		14.5415		15.1787
14	Plasma welding fixture to leak test machine station	4.0362		3.6816		3.8291
15	Leak testing & Inspection	14.8410		15.1581		14.8984
16	Leak testing station to pallet arrangement		3.4932		3.4343	
17	Cap fitting		3.4496		3.4119	
18	Filter cup from pallet to fixture		7.9514		8.0767	
19	Flare and connector cap fixing					
20	Sticker and silica gel insertion		4.4724		4.5187	
21	Packaging in separate boxes					
22	Industrial Packaging		4.5000		4.8333	

Table 5. Second shift time study data

S.No	**Activities**	**06-02-2017**	**07-02-2017**	**08-02-2017**	**09-02-2017**	**10-02-2017**
1	Washing Machine feeding (Pallet to conveyor)	4.0202	4.0854	4.0564	4.0608	4.0745
2	Connector ring fitting and connector insertion on the cup	3.0261	3.0266	3.0067	3.1239	3.0492
3	Dummy Ring Placement	454.0000	467.0000	488.0000	356.0000	389.0000
4	Cups removal from the furance and placement in pallets	4.4975	4.4724	4.4845	4.5263	4.5239
5	Filter cups from pallet to fixture	15.2500	14.8099	15.4265	14.5862	14.5694
6	Wire mesh + Felt mat insertion					
7	Perforated Sheet placement					
8	Plate spring setting					
9	Core pressing					
10	Station to fixture for filter cup part 2 assembly					
11	TIG Welding & Inspection	5.0506		4.9944		5.1605
12	TIG welding fixture to plasma welding placement	3.5067		3.4824		3.7004
13	Plasma welding & Inspection	15.2627		14.9664		15.2917
14	Plasma welding fixture to leak test machine station	3.8067		4.1193		4.0917
15	Leak testing & Inspection	15.0936		14.7243		16.5094
16	Leak testing station to pallet arrangement		3.4731		3.4685	

17	Cap fitting		3.6545		3.5603	
18	Filter cup from pallet to fixture		8.1016		7.8652	
19	Flare and connector cap fixing					
20	Sticker and silica gel insertion		4.4776		4.6667	
21	Packaging in separate boxes					
22	Industrial Packaging		4.3333		4.8333	

Table 6. Consolidated time study data

S.No	Activities	First Shift (S)	Sec Shift (S)	Cons Time (S)
1	Washing Machine feeding (Pallet to conveyor)	4.25	4.06	4.16
2	Connector ring fitting and connector insertion on the cup	3.01	3.05	3.03
3	Dummy Ring Placement	368.00	430.80	399.40
4	Cups removal from the furance and placement in pallets	4.49	4.50	4.49
5	Filter cups from pallet to fixture	15.04	14.93	14.99
6	Wire mesh + Felt mat insertion			
7	Perforated Sheet placement			
8	Plate spring setting			
9	Core pressing			
10	Station to fixture for filter cup part 2 assembly			
11	TIG Welding & Inspection	5.03	5.07	5.05
12	TIG welding fixture to plasma welding placement	3.37	3.56	3.47
13	Plasma welding & Inspection	14.87	15.17	15.02
14	Plasma welding fixture to leak test machine station	3.85	4.01	3.93
15	Leak testing & Inspection	14.97	15.44	15.20
16	Leak testing station to pallet arrangement	3.46	3.47	3.47
17	Cap fitting	3.43	3.61	3.52
18	Filter cup from pallet to fixture	8.01	7.98	8.00
19	Flare and connector cap fixing			
20	Sticker and silica gel insertion	4.50	4.57	4.53
21	Packaging in separate boxes			
22	Industrial Packaging	4.67	4.58	4.63

Table 7. Time study comparison with company standards

S.No	Activities	Std Time (S)	Time Study (S)
1	Washing Machine feeding (Pallet to conveyor)	3	4.16
2	Connector ring fitting and connector insertion on the cup	2	3.03
3	Dummy Ring Placement	300	399.40
4	Cups removal from the furance and placement in pallets	4	4.49
5	Filter cups from pallet to fixture	12	14.99

6	Wire mesh + Felt mat insertion		
7	Perforated Sheet placement		
8	Plate spring setting		
9	Core pressing		
10	Station to fixture for filter cup part 2 assembly		
11	TIG Welding & Inspection	5	5.05
12	TIG welding fixture to plasma welding placement	2	3.47
13	Plasma welding & Inspection	12	15.02
14	Plasma welding fixture to leak test machine station	3	3.93
15	Leak testing & Inspection	12	15.20
16	Leak testing station to pallet arrangement	2	3.47
17	Cap fitting	2	3.52
18	Filter cup from pallet to fixture	5	8.00
19	Flare and connector cap fixing		
20	Sticker and silica gel insertion	3	4.53
21	Packaging in separate boxes		
22	Industrial Packaging	5	4.63

9 Conclusions

The process flow required for the filter drier manufacturing has been found out according to the production sequence. The set of activities for the different assembly process are laid out for the time study calculation. Assumptions and ground rules have been according to the basic time study calculations for the filter drier manufacturing process. Time study has been done using standard time chart and electronic stop watch with 4% allowance. From the final time study analysis, it is found that the importand operations such as 1.) Dummy ring placement in the furnace 2.) Filter cup assembly 3.) Plasma welding and inspection 4.) Leak testing and inspection

1.) Filter cup to pallet fixture and 6.) Flare connector cap fixing have not been performed on the Standard time chart as fixed by the company norms. The annual requirement for the filter drier production is 80,000. Monthly requirement is 6668 with 26 days working day. Considering this, per day requirement is 256 according to the production standards maintained by the company.

From time study, we have found that there are major devtations with standard time in dummy ring placement, filter drier assembly, plasma welding, leak testing and filter package section. Due to this practice, the production per day has reduced to 228. We have found the major setbacks in the productivity using the time study, once the standard time is followed in the respective workstations; we can achieve the actual requirement of 256 filter driers per day.

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