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Quality Improvement through First Pass Yield using Statistical Process Control Approach

[1]R. Raj Mohan, [1]K. Thiruppathi, [2]R. Venkatraman and [1]S. Raghuraman
[1]School of Mechanical Engineering, SASTRA University, Thanjavur, 613401, India
[2]Director, Shanmuga Precision Forging, Thanjavur, 613401, India

Abstract: The objective of this study was to improve First Pass Yield (FPY) and reduce the defect rate of a product. Nowadays, the competitive manufacturing background illustrates that the customers always demanding higher quality in product. Therefore, suppliers strive to satisfy the customer needs beside they are trying to reduce the operating cost and to stay profitable. To survive in a spirited market, improving quality of product is must for any company. In this study, data regarding quantity output of good parts and defective parts has been collected from daily check sheet, critical issues related to defective parts were identified using Pareto analysis chart and its root causes were identified using fishbone diagram. Finally, improvement action plan for critical issues were suggested for quality improvement. After the accomplishment of the action plan, the existing first pass yield is compared with the preliminary first pass yield and substantial improvement in first pass yield attained indicates that defect rate decline with improvement in quality.

Key words: First pass yield, Pareto analysis, fishbone diagram, improvement action plan

INTRODUCTION

To meet up the high shifting market demands along with high quality at similar prices, one shall have to recognize quickly the root causes of quality related problems by reviewing an occurrence, with the goals of determining what happened, why it happened and what can be prepared to reduce the possibility of recurrence. The increase in the rejection means more time to be depleted on rework and an increase in the total man-hours and cycle time and inventory carrying cost. Hence, it is necessary to find out the reason for the rejection of the components and also the remedy to reduce the same.

Statistical quality control tools: Traditionally, the term Statistical Process Control (SPC) was used to address the use of control charts (Wadsworth *et al*., 1986; Grant and Leavensworth, 1988). Other authors (Montgomery, 1996), use the term SPC to address a set of tools known as the seven tools (Histogram, check sheet, Pareto chart, cause and effect diagram, defect concentration diagram, scatter diagram and control Charts), that includes control charts but also non-statistical tools. Montgomery uses the term Statistical Quality Control (SQC) to address various other statistical tools directed at quality, including SPC, acceptance sampling and design of experiments. Some authors (Wetherill and Brown, 1991) also include these techniques in the definition of SPC. Others, such as Vasilash (1993) use an even broader definition of SPC that equals Total Quality Management (TQM), thus referring to a concept that includes a wide range of tools. When an out of control situation occurs, it is not always directly clear what the special cause of this out of control situation is and how the process should be adjusted. Therefore, the black box of the process has to be opened to look for disturbing process factors such as machines, materials, tools and so on. For this purpose, SPC techniques were extended with problem solving tools such as Pareto analyses and fishbone diagrams. Although not all of these tools are of a statistical nature, they are often seen as part of the SPC toolkit. Another improvement towards prevention was to learn from errors in the past. This means that an out of control situation should not only lead to solving this specific occurrence of the problem, but also to more structural improvements that can prevent this kind of problem in the future (Schippers, 2000). Statistical tools like cause and effect diagram and Pareto diagram are hereby used for problem solving and quality improvement (Chandna and Chandra, 2009).

Pareto analysis: Pareto chart shows the significance of various factors in declining order in columns along with cumulative significance in a line. Pareto charts are frequently used in quality control to exhibit most common causes for failure, customer objections or product defects.

Corresponding Author: R. Raj Mohan, School of Mechanical Engineering, SASTRA University, Thanjavur, 613401, India

The principle behind Pareto charts is called as Pareto 80-20 principle. The Pareto principle states that, for many events, roughly 80% of the most significant effects come from 20% of the reasons (Rohani and Teng, 2001).

Cause and effect diagram: To identify the potential or actual causes for a performance problem. Fishbone diagrams provide structure for a group's discussion around the potential causes of the problem. It is constructed to identify and organize the possible causes for a particular single effect (Mahto and Kumar, 2008).

FIRST PASS YIELD

The FPY is defined as the number of products coming out of a process divided by the number of products going into that process over a specified phase of time. Only good units with no rework are counted as coming out of an individual process. FPY, also known as Throughput Yield (TPY).

The calculation of FPY, first pass yield, shows how good the overall set of processes is at producing good overall output without having to rework units. Let 'X' be the total number of new components produced and 'Y' be the total number of new components rejected (Vijaykumar and Mantha, 2007).

$$FPY = \frac{X - Y}{X} \times 100$$

PRELIMINARY FIRST PASS YIELD

Data regarding quantity output of good parts and defective parts has been collected from daily check sheet. Total No. of aluminium, brass and copper products produced and rejected for the month of March, April, May and June 2011 as follows in Fig. 1-3.

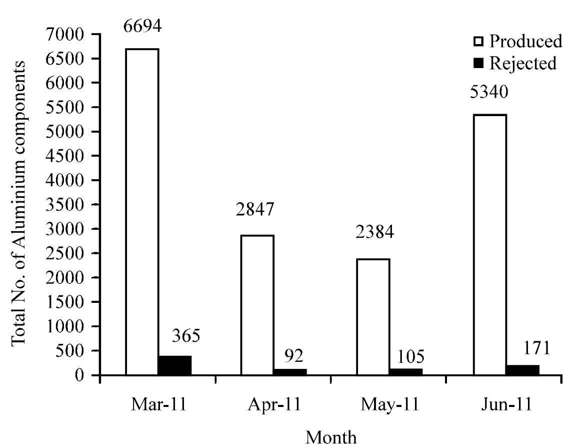

Fig. 1: Chart for aluminium components

FPY is calculated based on the values provided in the charts above for aluminium, brass and copper components. The calculated FPY for the month of March, April, May and June 2011 as shown below in consolidated format Fig. 4.

PARETO CHARTS

A Pareto chart or Pareto graph shows the significance of various factors in lessening order in columns along with cumulative significance in a line.

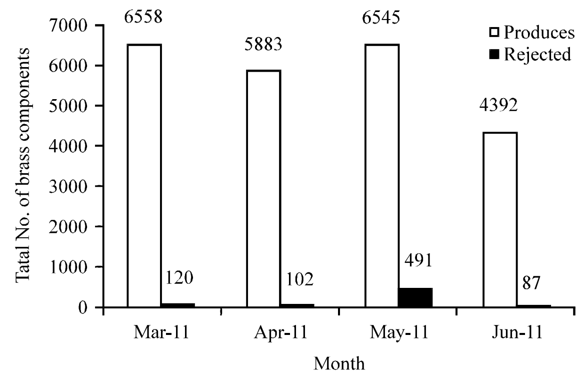

Fig. 2: Chart for brass components

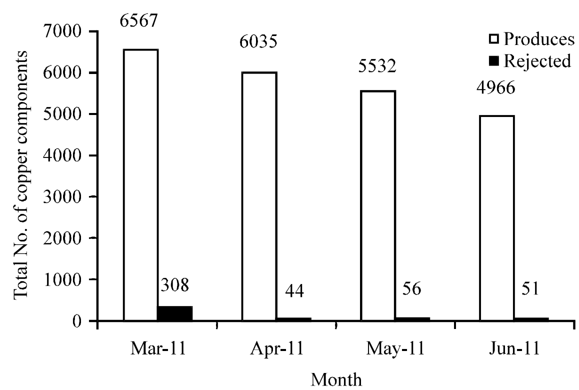

Fig. 3: Chart for copper components

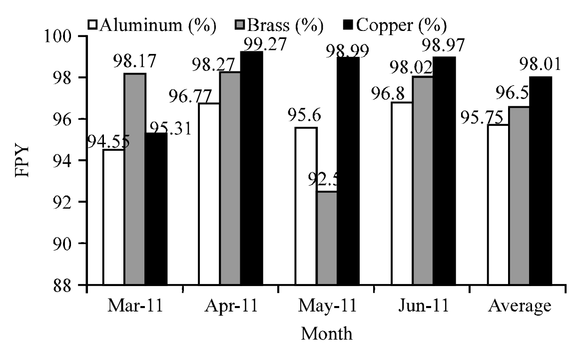

Fig. 4: Consolidated chart for preliminary first pass yield

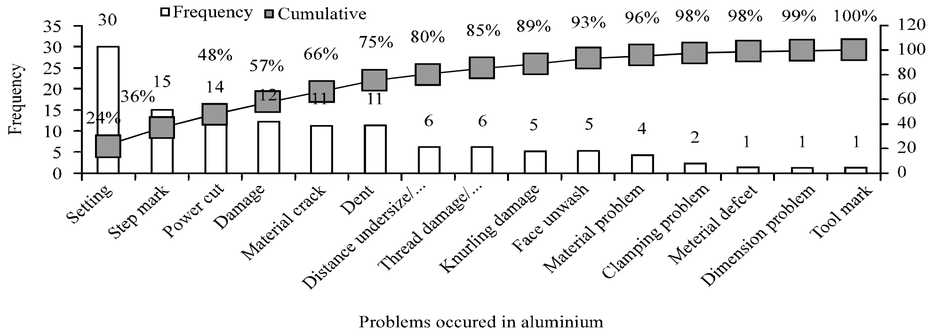

Fig. 5: Pareto chart for aluminium components

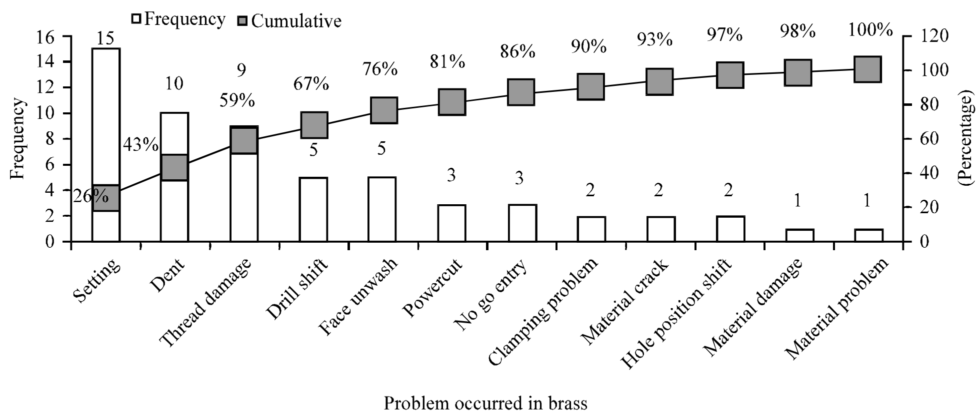

Fig. 6: Pareto chart for brass components

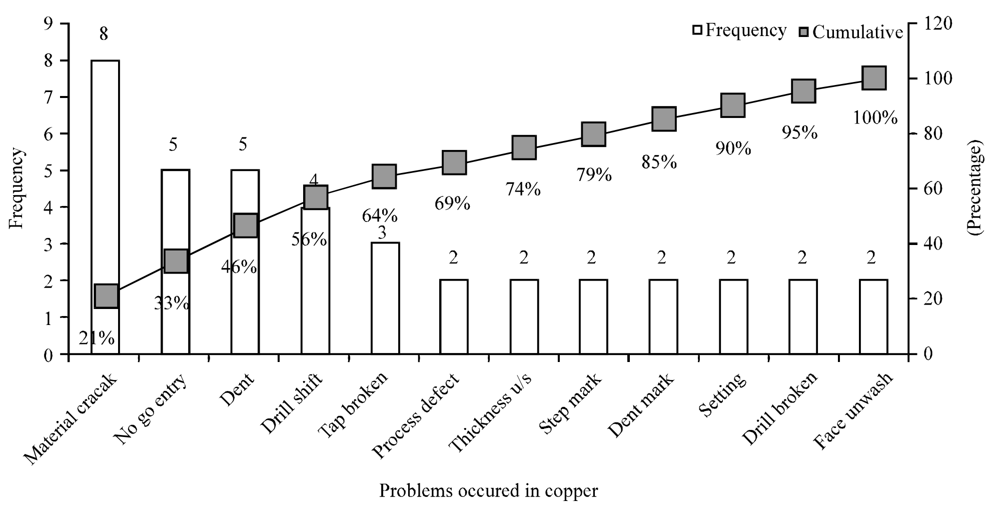

Fig. 7: Pareto chart for copper components

Pareto charts are frequently used in quality control to exhibit most common causes for failure, customer grievances or product faults. Pareto charts can be used when you want to focus your resources on few important items from a large list of possible.

The Pareto principle states that, for many events, roughly 80% of the significant effects come from 20% of the sources.

The critical issues related to defective part for aluminium, brass and copper components were identified using Pareto analysis chart.

Pareto chart for Aluminium, brass and copper components and its corresponding critical issues with cumulative percentage of its contribution from overall defects are mentioned in Fig. 5-7.

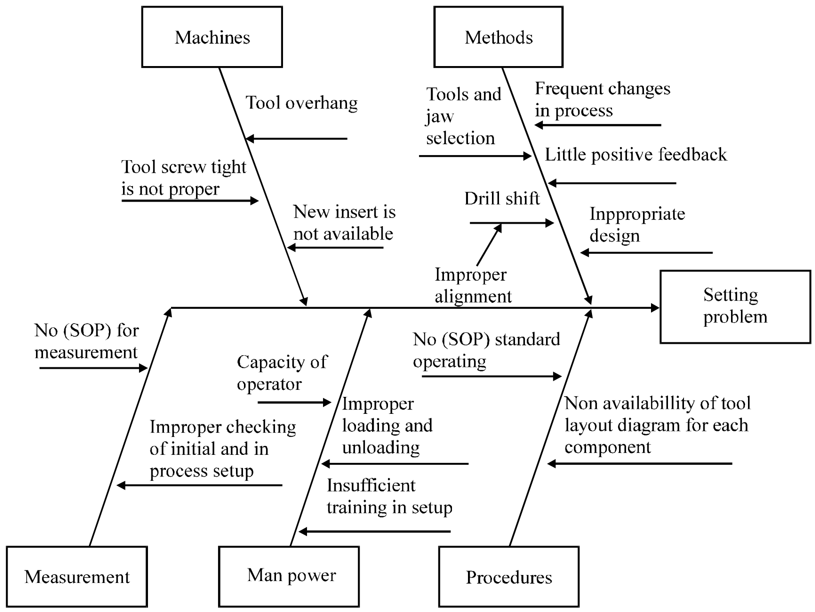

Fig. 8: Fishbone diagram for setting problem

CAUSE AND EFFECT DIAGRAM

This diagram, also called Ishikawa or fishbone diagram, is used to associate multiple possible causes with a single effect. The diagram is constructed to identify and organize the possible causes for a particular single effect. Causes in cause and effect diagram are frequently arranged in four major categories. For manufacturing cases it is manpower, methods, materials and machinery. For administration and service sectors, it is equipment, policies, procedures and people. To identify root reasons or input drivers contributing to some consequence or measurable result.

Used in these conduct, the fishbone diagram will assist to create ideas about the possible causes of problems and identify the components in the practice that are accountable for the existing troubles. It can also be used to plan new processes to meet quality expansion proposal or new business opportunities.

Here, fishbone diagram is generated for major general critical problems associated with defect rate arising from aluminium, brass and copper components. The critical problems are setting, no-go entry, damage/dent problems that can be identified through Pareto chart analysis.

For setting problem, causes are categorized by machines, methods, measurement, manpower and procedure. The fishbone diagram for setting problem is shown below in Fig. 8. For no-go entry problem also the causes are categorized by same procedure adopted in setting problem. The fishbone diagram for no-go problem is shown below in Fig. 9. Similarly, for damage/ dent entry problem causes are categorized and analysed. The fishbone diagram for damage/dent problem is shown below in Fig. 10.

ACTION PLAN FOR QUALITY IMPROVEMENT

Another improvement towards prevention was to learn from errors in the past. This means that an out of control situation should not only lead to solving this specific occurrence of the problem, but also to more structural improvements that can prevents this kind of problem in the future. Especially when certain out of control situation that occur frequently, one has to search for root causes and take actions to prevent this situation in the future.

After finding the causes for critical issues through Pareto chart and fishbone diagram, suggestions are provided for avoidance of these major issues of setting problem, no-go entry and damage/dent.

RESULTS AND DISCUSSION

The consolidated data regarding quantity output of good parts and defective parts has been collected from daily check sheets for the total No. of aluminium, brass, copper products produced and rejected for the

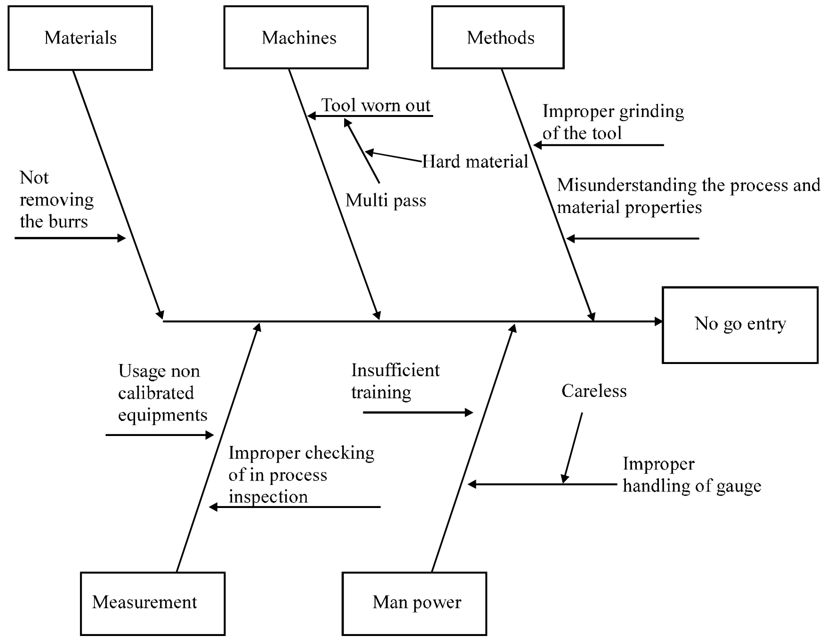

Fig. 9: Fishbone diagram for no-go entry problem

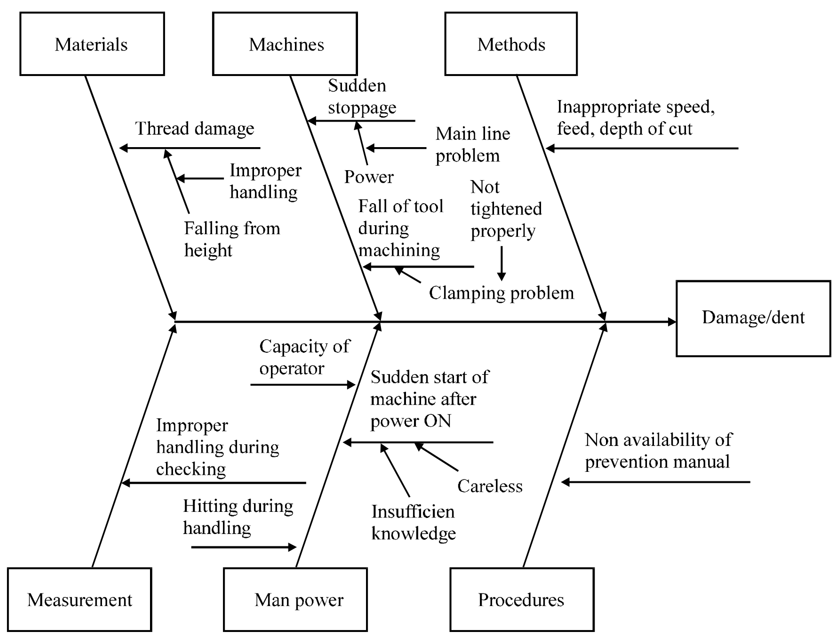

Fig. 10: Fishbone diagram for damage/dent problem

period of three months are considered for validating the first pass yield. After the implementation of action Plan, the first pass yield is calculated and compared with preliminary first pass yield and the results are shown through bar chart in Fig. 11-13. Consolidated existing first pass yield is charted below in Fig. 14.

For aluminium components, first pass yield is increased from 95.75-95.99% after the implementation of action plan is mentioned in Fig. 15.

For brass components, first pass yield is increased from 96.58-97.19% after the implementation of action plan is mentioned in Fig. 16.

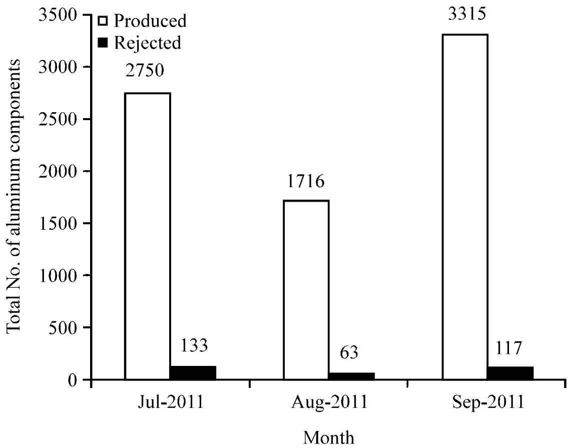

Fig. 11: Chart for existing total number of aluminium components

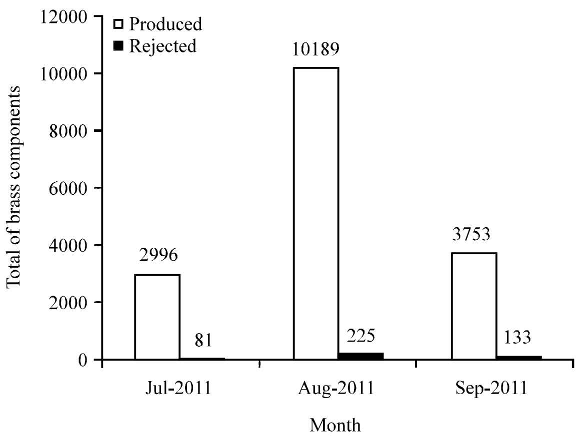

Fig. 12: Chart for existing total number of brass components

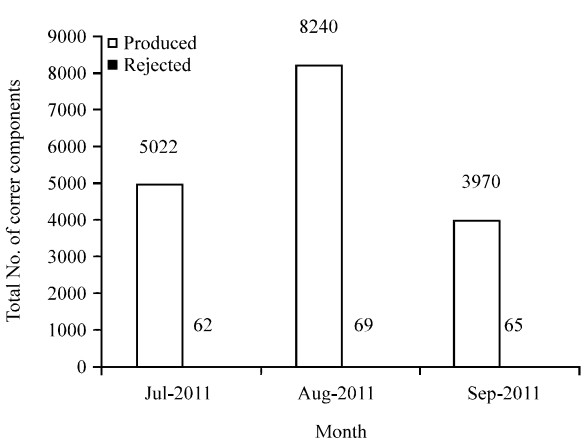

Fig. 13: Chart for existing total number of copper components

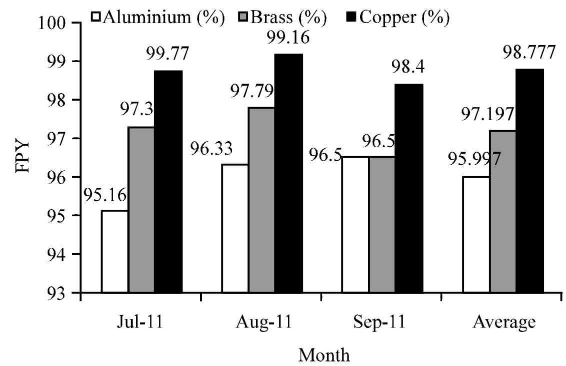

Fig. 14: Consolidated existing first pass yield

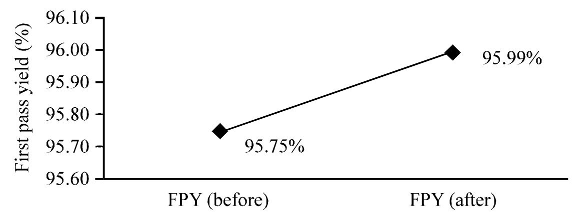

Fig. 15: Comparison of existing and preliminary FPY for aluminium

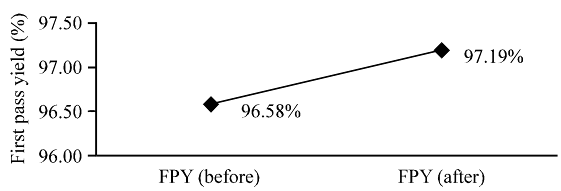

Fig. 16: Comparison of existing and preliminary FPY for brass

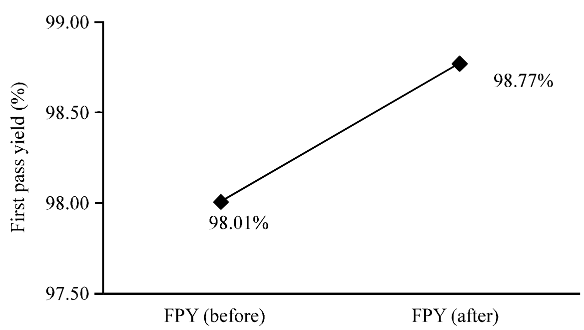

Fig. 17: Comparison of existing and preliminary FPY for brass

For Copper components, first pass yield is increased from 98.01 to 98.77% after the implementation of action plan is mentioned in Fig. 17.

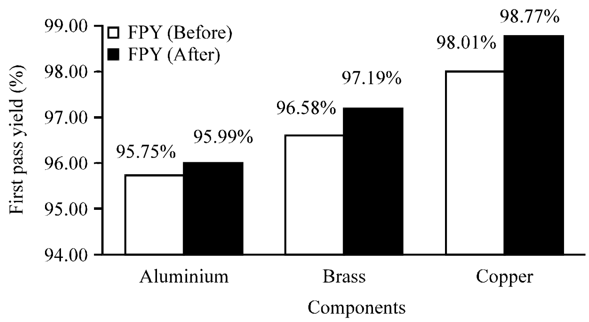

Fig. 18: Consolidated comparison chart for existing and preliminary FPY

CONCLUSION

Finally, it is concluded that statistical process control approach is an effective means for controlling and improving the process quality and noted that simple QC tools can make substantial improvement in first pass yield is mentioned in Fig. 18.

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