Improving First Piece Yield (FPY) in Forging Units Using IATF 16949 Quality Tools.

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Abstract

First Piece Yield (FPY) is a key performance indicator in manufacturing, particularly in the forging industry where high-temperature operations and heavy-duty equipment increase the risk of defects. This study explores how tools prescribed by the IATF 16949:2016 standard can be applied to improve FPY in forging processes. The paper demonstrates how implementing structured quality planning methods, statistical tools, and systematic problem-solving approaches significantly enhances first-time-right production. A case study from a forging plant is also presented to validate the impact of APQP, Control Plans, PFMEA, and SPC in reducing first-piece defects and achieving sustainable quality improvements.

1. Introduction

Forging is a widely used metal forming process in the automotive and heavy engineering industries. However, due to the complexity of process parameters such as die wear, billet heating, and material deformation, it is prone to quality issues, especially during initial setups. A low First Piece Yield leads to rework downtime, and increased production costs.

IATF 16949:2016, a global automotive quality standard, integrates the principles of ISO 9001 with industry-specific requirements to ensure process consistency and defect prevention. This paper investigates how the application of IATF tools can systematically enhance FPY in forging operations.

Keywords : First Piece Yield (FPY), IATF – 16949 , APQP , FMEA ,Forging Quality, Flange Forging , QMS.

2. Problem Statement

In a XYZ forging plant producing SS flanges of 4” WNRF ASME B16.5, Class 300, Schedule 40S,.The major non-conformities observed were:

- Outer Diameter Mismatch
- Internal Diameter Eccentric (ID),
- Burr Found on Face .

3. Objectives

- This study aims to enhance FPY using IATF 16949 quality tools.
- To analyze the root causes behind low First Piece Yield in forging.
- To apply IATF 16949 tools for process improvement.
- To evaluate the effectiveness of implemented solutions via FPY metrics.

4 . Methodology

- Process Flow
- In Line Inspection
- Visual Inspection
- Why – Why Analysis.
- APQP
- PFMEA

5. Data Collection & Analysis

From the XYZ industry Collecting the data of "4" WNRF 300 S40s " flange of ASTM 304L or EN/ DIN 1.4306 grade of 200 Pieces.

Out of the 200 No's , 120 NO's are Ok , But remaining 80 NO's having,

Problem	Quantity
Outer Diameter Mismatch	24
Burr on Face	38
Internal diameter Eccentric	18

Table 5.1 – Data collection

6. IATF 16949 Quality Tools.

- **Advanced Product Quality Planning (APQP)**

APQP stands for Advanced Product Quality Planning. It's a structured process used primarily in the automotive industry, and manufacturing sectors, to ensure product quality and customer satisfaction throughout the product development and manufacturing lifecycle. APQP provides a framework for planning, executing, and controlling quality assurance activities from the initial design phase to production. For reduction In – House rejection.

Table 6.1 – Phases of APQP

1. Plan

Minimize or Outer Diameter Mismatch , Burr on Face , Internal Diameter Eccentric.

2. Product Design and Development

1. Control of OD Mismatch: Review Die Alignment.
2. ID Eccentricity Control: Check the Position of job in Trimming Die, Make a Fixture for ID Measure.
3. OD Burr Reduction: Review the Size of Trimming Ring.

3. Process Design and Development

1. Process Flow Chart: Includes heating, pre-forging, forging, trimming, and inspection.
2. PFMEA Highlights: High RPN for die misalignment and improper trimming
3. Control Plan: Visual Checklist , In- Process Inspection Reports.

4. Product and Process Validation

1. First Piece Inspection Report (FPIR) for each batch.
2. Petrol Inspection in Every half hour.
3. Check Die Condition Every half hour

5. Feedback, Assessment, and Corrective Action

1. Root Cause Analysis (RCA): Wrong Die Alignment, Trimming Ring Undersized , Piercing Tool improper positioning , Less Skilled Forger and Press Operator.

2. 2. Corrective Actions: SOP updates , Tool life management , Fixture upgrades for alignment , Operator training.

- **Process Failure Mode Effect Analysis (PFMEA)**

PFMEA is a methodical approach used for identifying risks on process changes. Risk is the substitute for failure on new processes. It is a good practice to identify risks for each process step as early as possible. The main goal is to identify risk prior to tooling acquisition.

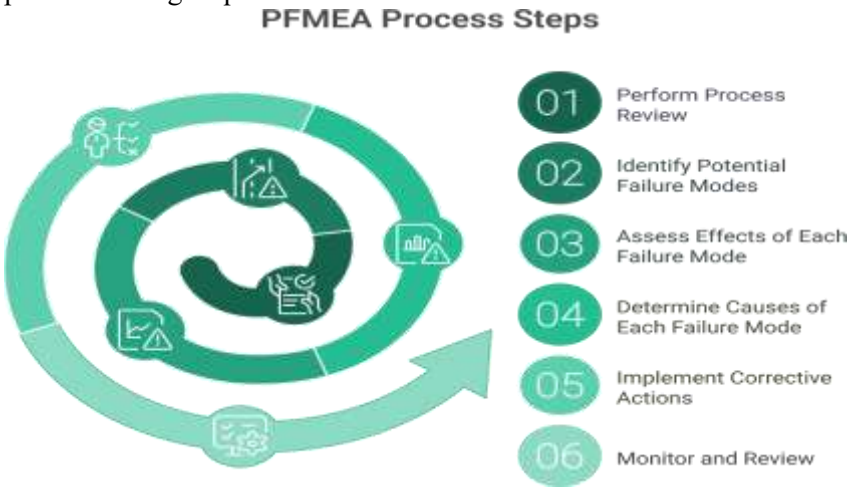

Table 6.2 – Steps Of PFMEA

- **Process failure Mode Effect Analysis :**

Process Function	Potential Failure Mode	Effect of Failure	Severity (S)	Potential Cause	Occurrenc e (O)	Current Control	Detect (D)	RPN
Forging	Outer Diameter Mismatch	Assembly not possible	6	Improper die alignment	5	Visual inspection	4	120

Trimming	Burr on Face	poor finish	6	Die wear	4	Manual du burring, visual	3	72
Piercing	ID Eccentricity	Misalignment of Piercing tool	5	Off- center piercing tool	5	Jig fixture, final inspection	3	75

Table 6.3 – Process failure Mode Effect Analysis (PFMEA)

- **Outcome of PFMEA**

1. Use of concentric die locators.
2. Poke-yoke fixtures in die setting.
3. Scheduled die inspection and regrinding.
4. Operator training + visual aid SOPs.

7. Conclusion

The above study shows that , all the above issue happens due to,

- Wrong positioning of Billet on Die
- Wrong size Trimming Ring used for Trimming purpose
- Wrong positioning of Forged components in Trimming Tool
- Less skilled operator

For the Overcome of these issue we have to implement IATF – 16949 tools for finding the Roots causes of the defects that will helps to minimise the rework and rejection at the shop floor. The minimise the defect we have to implement these technique as follows,

- Insure the Size of Trimming ring before the production start by both Quality and Production Supervisor.
- After the die setting Mud Die Alignment test must be take for Confirm the die position.
- Inspect the Forged job after every half hour.
- Adjust the proper position of Piercing tool to avoiding the ID eccentric cutting.

Implementing IATF 16949 tools in forging operations leads to significant improvement in First Piece Yield by addressing process variability and setup-related issues. The structured approach not only improves product quality but also minimize the rework cost and time.

8. References

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