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Ammunition Production Equipment Diagnosis

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Outline

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- High Speed Video
- Metallurgical Analysis
- FEA Analysis
- Conclusions

Introduction

In a high production rate manufacturing environment, dilemmas frequently arise that require diagnosis of equipment, tooling issues and implementation of corrective actions. The degree of difficulty trouble-shooting varies depending on the issue being investigated. In some circumstances unique methods of troubleshooting are used to diagnose a problem.

This presentation will show examples of how the following more advanced trouble-shooting methods have been used at the Lake City Army Ammunition Plant:

- High Speed Video
- Metallurgical Analysis
- Finite Element Analysis

High Speed Video Missing Cannelure Cut

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Problem encountered:
- Bullets were being found with missing cannelures.
- A missing cannelure can result in low bullet pull of the completed cartridges.

Challenges with troubleshooting:
- Machine runs at approximately 80 parts per minute in a small enclosure.

From this video, it was determined that:
- Cut part got stuck in the collet and ejected late
- Due to late ejection, the uncut part was pushed out the back side of the transfer unit.
- Uncut part was pushed into good material catch pan and cut part fell into scrap.

Corrective action:
- Underlying cause of failure to eject part was component wear. Implemented a new preventative maintenance program on the worn components.

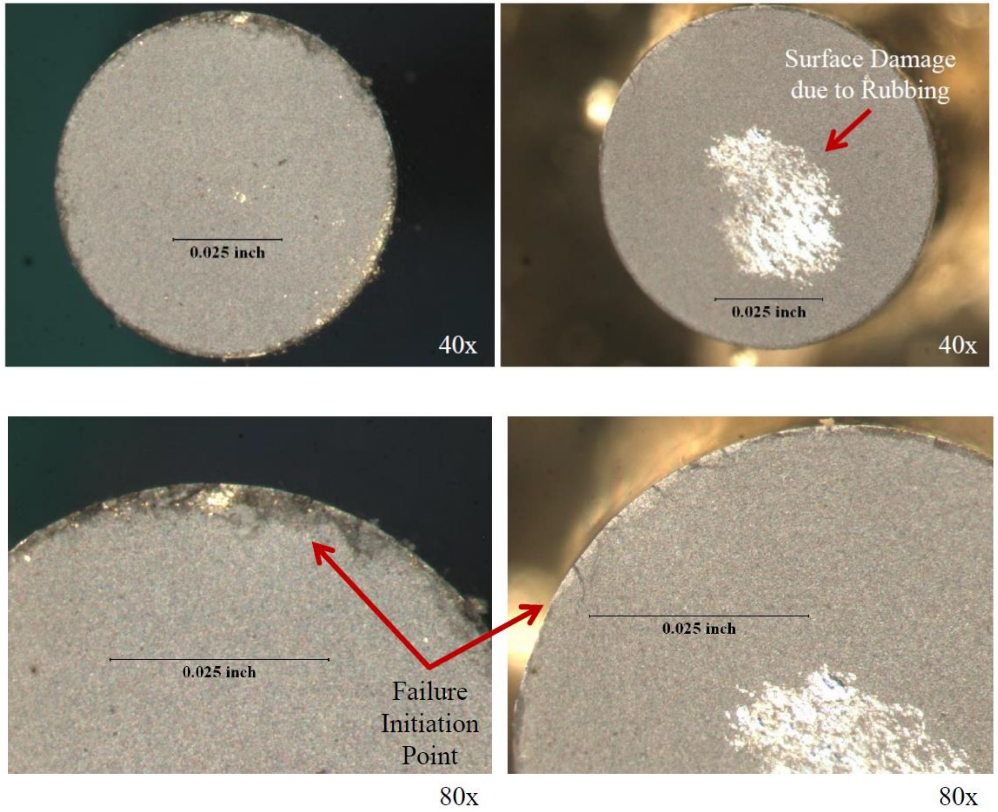
When diagnosing equipment that runs at a high rate of speed, high speed videography is a very effective way to slow the process down to see what is causing the failure.

Metallurgical Analysis Broken Vent Punch

Problem encountered:
- High usage of vent punch tooling due to tool breakage
- High usage of vent punch tooling results in increased tooling cost, increased downtime and an increased risk in no vent cartridge failures.

Challenges with Troubleshooting:
- Machine runs 300 parts per minute. Impossible to see what is occurring during normal operation

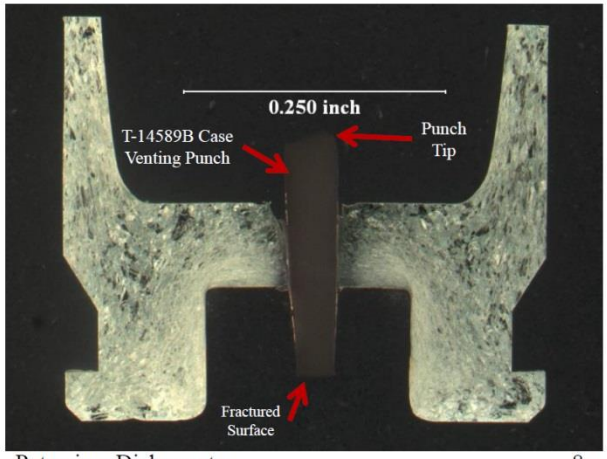
Conclusions from this analysis were:
- The material and hardness were correct per the drawing
- Failure initiation points were identified
- A brittle fracture occurred
- Rubbing on the broken surface of the punch suggests crack propagation over multiple punch hits

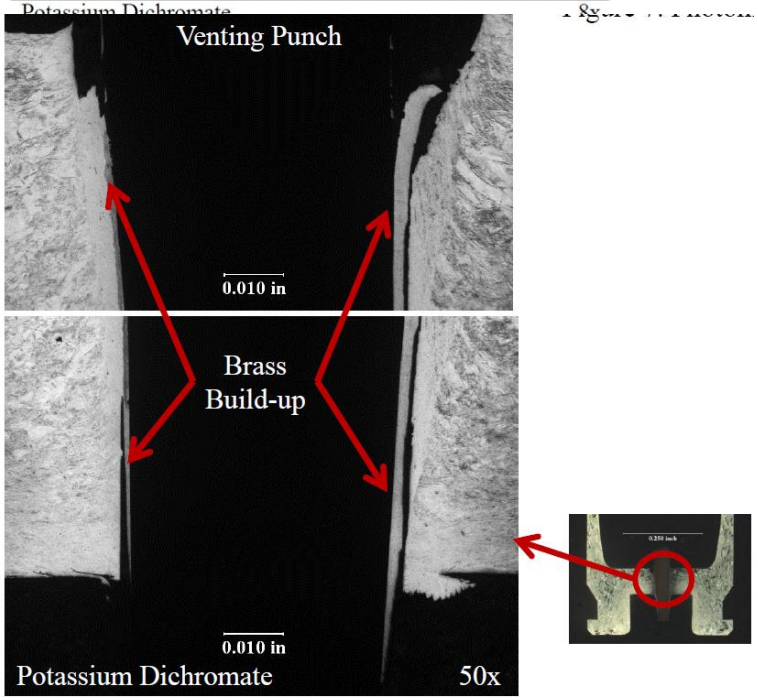


Metallurgical Analysis Broken Vent Punch- continued

Conclusions continued:

- The microstructure of the case that caused the broken punch was not atypical
- Excess buildup on the punch was asymmetric- adding bending stress to the punch





When troubleshooting tooling issues, metallurgical analysis is very useful in diagnosis. Knowing the material properties and type of failure help guide the troubleshooting process in the proper direction.

Finite Element Analysis (FEA) Broken Vent Punch

Problem encountered:

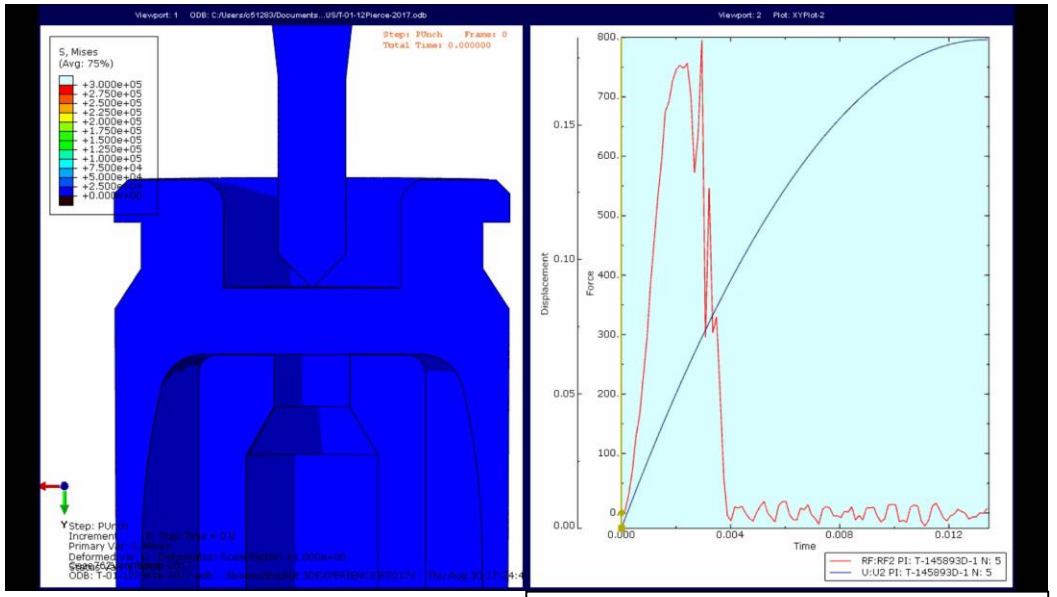
- High usage of vent punch tooling due to tool breakage
- High usage of vent punch tooling results in increased tooling cost, increased downtime and an increased risk in no vent cartridge failures.

Challenges with Troubleshooting:

- Machine runs 300 parts per minute. Impossible to see what is occurring during normal operation

How FEA has been utilized to troubleshoot:

- Current punch design was modeled to identify improvement opportunities.
- Additional scenarios that are seen in production are being modeled to identify likely failure modes
- The results of this FEA model look very similar to the actual broken punches seen in process



Actual broken punches seen in production

How FEA is being used to fix the problem:

- Design concepts are being analyzed using FEA before being prototyped. This allows us to assess improvement of a new design before spending excessive amounts of money to make and test prototype parts.

From diagnosing issues to prototyping solutions, FEA simulations are a great start to finish tool when diagnosing equipment and tooling issues.

Conclusion

Running a high rate production facility involves troubleshooting equipment that is difficult to diagnose due to machinery speed and complex modes of failure. Innovative troubleshooting and diagnostic tools are needed.

High speed video, metallurgical analysis and finite element analysis are great tools to utilize to determine root cause and corrective actions of more complex equipment and tooling diagnosis challenges.

Thank you!

Questions?