Canadian National Railway Cold Weather Defect Detection

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In order to maintain rail integrity and safety, railways constantly test for and repair internal rail defects. Modern railways use ultrasonic trucks to locate these defects for removal. Once the defect has been removed, Canadian National (CN) Railway goes one step further to insure that the entire defect was removed with the use of dye penetrant on the cross sections at the ends of the rail. Unfortunately, this process has its limitations due to adverse weather. This project looks at other detection options and ways to make improvements to the current one.

Introduction

This report summarizes the Canadian National Railway study conducted by Advanced Metalworks Enterprise (AME) at Michigan Technological University for Canadian National Railway entitled Canadian National Railway Cold Weather Defect Detection.

In the rail industry profit comes down to a train's average car velocity. Defects can cause this velocity to be reduced, with slow orders or as a train is stopped, waiting for a repair. The goal of this project was to create a process that could be completed reliably, in all weather, in a shorter period of time.

CN's current process is to use a SpotCheck® dye penetrant to further test each rail cross section. The current process can be adversely affected by weather. Cold and wet conditions can cause SpotCheck® tests to fail.

Background

A liquid dye penetrant relies largely on the penetrant's wettability, shown below as Figure 1, on the tested surface. There are many factors that can affect wettability, but a material's wettability is strongly dependent upon its surface tension. Unfortunately, the surface tension of a liquid increases with a reduction of temperature, thus lowering the materials wettability.

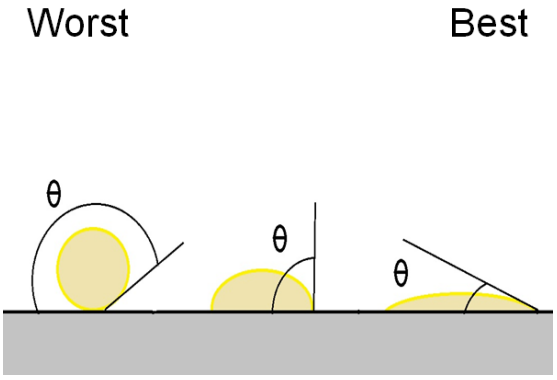

Figure 1: Demonstration of how wettability is determined in a liquid

Magnetic particle inspection relies on the flux created by field lines being forced to bend around a defect in a magnetized piece of material. The magnetic viewing film uses this same flux to manipulate a nickel flake inside of the film, as shown in Figure 2. The flake (purple line in the below image) will reflect light at certain orientations and will display defects as a white line on green film.

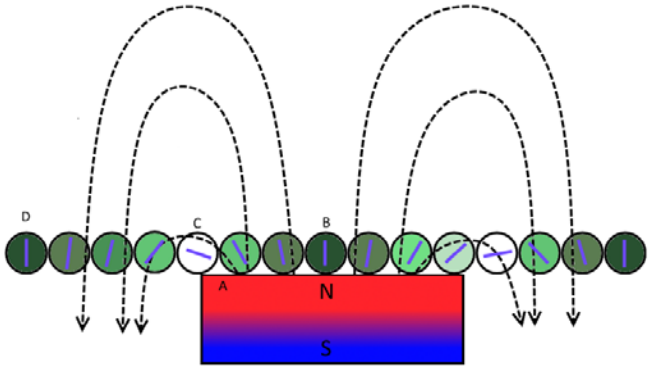

Figure 2: Demonstration of how a magnetic field effects the magnetic viewing film

Hypothesis

Two hypothesis were generated to guide the analysis. They are summarized here:

1. Substituting an alcohol based penetrant for SpotCheck® will allow for colder operating conditions as the lower freezing point of alcohol allows for better wettability at low temperatures.
2. Substituting the entire process for one using a magnetic film inspection will allow for a faster and more reliable test at lower temperatures, as the magnetic field should experience no negative affects based on cold temperatures.

Methods

In order to test both hypothesis, 11 samples containing defects were tested at temperatures ranging between -30°F and 40°F as well as at room temperature. The total time and temperature was recorded for all testing and the dwell time was noted for all penetrant tests.

Conclusion

Hypothesis 1 was rejected, while hypothesis 2 was accepted.

1. There is no perceived increase in reliability of the alcohol based penetrant at reduced temperatures. It also has issues caused by it 'running' off of the cross section.
2. Magnetic viewing film inspection offers a fast and reliable alternative to liquid dye penetrants

In conclusion, this project has successfully created a proof of concept for magnetic viewing film in the detection of defects in rail cross sections. It is suggested that the process and product be further refined before implementation.

Recommendations

- SpotCheck® penetrant is reliable and sufficiently fast at temperatures above 40°F
- A magnetic particle/viewing film inspection can produce reliable tests down to -30°F
    - Further testing is suggested for the magnetic viewing film before implementation

Costs

Figure 3 estimates the cost of implementing a magnetic film process over 3, 5, and 8 years compared to the cost of continued SpotCheck® usage. It can be seen that, even with the high startup cost, over time (4-6 years) magnetic film usage will become lower than continued use of liquid penetrant.

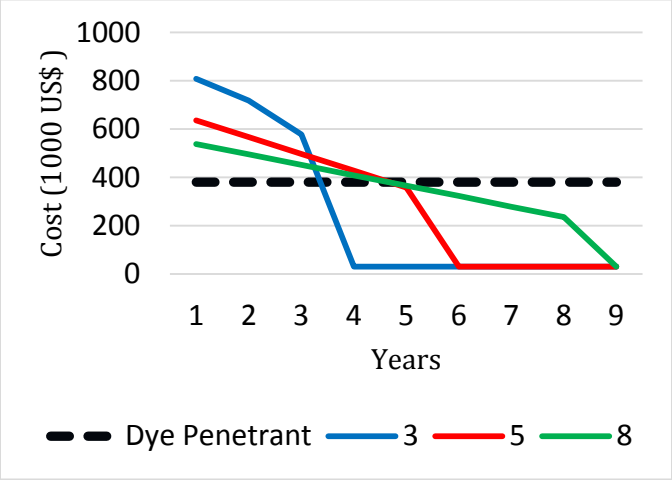

Figure 3: Cost estimate of integrating the magnetic film over time

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