Cooling Package Redesign
For Optimized Cleanout

Maxwell Leiser (Agricultural Engineering – Machine Systems) and Yijie Zhao (Agricultural Engineering – Machine Systems)

Introduction

Problem Statement:
- Current Caterpillar M3 series motor graders are not optimized for the cleanout process and do not easily allow the cooling cores to be blown out linearly.
- When operating in high dust and high debris environments, the radiator cores must be cleaned often to avoid cooling efficiency issues.

Background:
- Access panels located on either side of the machine
- Operator/ Mechanic must clean radiator cores with an air wand or pressurized water source
- Cooling fan swings open, allowing access to rear
- side of cooling cores
- Debris in radiator cores reduces cooling efficiency
- Must be cleaned often in high dust and high debris environments

Opportunity to Solve and Constraints

- Next line of motor graders to appear in the open market within the next few years
- Allow for increased access of air wand or pressurized water source to remove debris
- Increasing cleanout efficiency would decrease machine down time
- Operator and owner satisfaction is a key component to the continuation of the Caterpillar success in marketplace

Solution Generation

- Nine solutions generated based on criteria given by Caterpillar and given weights based on important decision making factors
- Top three solutions chosen for further analysis, design iterations, and determination of feasibility

Alternative Designs

<table>
<thead>
<tr>
<th>Vertical Orientation</th>
<th>Overhead Fuel Cooler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Production</td>
<td></td>
</tr>
</tbody>
</table>

Expected Results

- Increased space allows cores to be cleaned more efficiently.
- Cores can be locked in place in both cleaning and operating positions.
- Cooling performance impact is minimized because operating position has not changed from current design.

Final Design

- Cores slide forward to the engine baffle with minor clearance
- Utilization of original hardware simplifies manufacturing and design process
- Addition of a slider mechanism/latch to minor cores will securely fasten them in place

FEA analysis

Caterpillar uses a g-loading method as a test criteria for the fatigue strength of their models. The method involves applying multiple gravity loads to the model:

\[
\begin{align*}
\text{Ax} & : 5 & \text{Yx} & : 3 & \text{Zx} & : 2 \\
\text{Load} & : 49050 & \text{Load} & : 29430 & \text{Load} & : 19620
\end{align*}
\]

The weight of AC Condenser (4.6kg), Hydraulic Oil Cooler (26kg), and Fuel Cooler (4kg) is also added to the assembly as total of 339.4N.

Cost Analysis

The fatigue criteria is 40 MPa for welds and 140 MPa for parent materials, which was provided by Caterpillar.

Acknowledgements:
Scott Brand
Design Review Judges
Carol Weaver

Sponsors:
Brian Fehrenbacher – Caterpillar
Urmil Desai - Caterpillar

Technical Advisor:
Stanley Harlow

Instructor:
Robert Stwalley