FIELD TESTS OF A SYSTEM TO PREVENT IGNITION OF ORGANIC DUSTS ON COMBINE HARVESTERS

Daniel Humburg, Kevin Dalsted
Michael Sukalski, Zhengrong Gu

South Dakota State University
Brookings, SD 57007

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Outline...

- Review of Laboratory Studies
- Review of Machine Concept
- Prototype Field Experience
  - 2012 Experiment
  - 2013 Experiments
- Next Steps
Late November 2013
Near Presho, SD
Laboratory Results

- Sunflower residue ignites at lower temps than other residue
  - Tests point to the pith in the stem that forms “white dust” under dry crop stem conditions
  - The fine dust has very high porosity and surface area
  - Sunflower dust begins to volatilize (smell) at temps as low as 428° F
- We have not been able to ignite dust on a surface with a static spark
# Ag. Dust Comparison

<table>
<thead>
<tr>
<th>Mesh #</th>
<th>Particle Size (μm)</th>
<th>Ignition Temp. (Deg. F)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Corn Stover</td>
<td>Sunflower</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>710-300</td>
<td>608</td>
<td>554</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>300-150</td>
<td>590</td>
<td>536</td>
<td></td>
</tr>
<tr>
<td>230</td>
<td>150-63</td>
<td>590</td>
<td></td>
<td>536</td>
</tr>
<tr>
<td>500</td>
<td>63-25</td>
<td>572</td>
<td></td>
<td>500</td>
</tr>
<tr>
<td>500 Mesh Samples</td>
<td></td>
<td>482</td>
<td></td>
<td>428</td>
</tr>
<tr>
<td>Volatilization Temper</td>
<td></td>
<td>67.85 (J/g)</td>
<td>75.11 (J/g)</td>
<td></td>
</tr>
<tr>
<td>Total Combustion Energy</td>
<td></td>
<td>12.48 (kJ/g)</td>
<td>13.77 (kJ/g)</td>
<td></td>
</tr>
</tbody>
</table>
Prototype Concept

- Enclose the exhaust manifold, turbocharger, and exhaust pipe
- Draw air through a filter to remove organic dusts
- Pump clean air into the enclosure around the exhaust system
- Provide means to control the exit of air from the enclosure to manage heat transfer
2012 Prototype and Field Test

- Prototype developed to fit Case IH 8120
- System installed on a cooperator’s 8120 and operated throughout the fall 2012 season
2013 Installations

- Case IH 8120
- John Deere 9770
- Case IH 8230 Tier IV A
  - Twin City Fan mated to Donaldson air filter with Donaldson Spin Top to minimize filter load (no scavenging available)
- John Deere S680 (collect temps only)
Case IH 8120 Manifold Cover
View from Radiator Side
Case IH 8120 Fan & Filter
Deere 9770 Fan & Filter
Instrumentation

2014 Project

• Logging Temperature Data
• Logging CANBus Data
  • Temperatures and Engine Data
Producers’ Experience

- One fire on Deere 9770 (bearing failure)
- Shaft seal failure (drain required...) on 8120
- No fires with fan/filter operating
- Able to load the machine as the crop allowed
- Crop and field conditions were wet and cold with few fires across the region. Not a good test of the systems this year
Next Step Research - 2014

• Computational Fluid Dynamics
  • Model
  • Simulation
  • Optimization

• Model may suggest smaller fan/filter setups on Machines
Next Step Research - 2014

- Leave existing installations in place
- Add one or more systems with reduced fan and filter size to JD 9770 or other model
- Complete CFD model documentation
- Complete lab apparatus to test airborne ignition temps of sunflower dust
Next Steps

- SDSU has filed a patent application on the system to allow for commercialization if possible.
- Challenge to retrofit enclosures to multiple brands and models of the existing fleet.
- Note that JD has implemented a system that filters air and pumps it to an enclosure around the Diesel Particulate Filter.
- So far they are not protecting the turbo.
Questions?