Research Proposal:

Modeling Heat Generation and Overpressure in Haul Truck Tire

Problem:

Large pneumatic tires may be subject to explosive over-pressure under certain conditions. The conditions in which a runaway overpressure event can occur are not well understood. An example is recorded in a video of a welding torch held to a truck wheel rim, showing pressure slowly climbing before spiking just before the tire explodes.

Potential Solution and Benefit:

Improved understanding of the mechanism of failure for truck tires, especially when subjected to heat near the bead of the rim, would allow for measures to be taken to reduce risk to personnel and equipment when such events are likely to occur.
An investigation is proposed to create a computer simulation of the failure event, to understand the underlying failure mechanism.

Research Objective:

Modeling of damage mechanism and verification testing (but not under pressure).

Proposed Methodology:

Model the heat transfer mechanisms of a tire rim and tire, and to assess the effects of temperature on friction coefficient at the bead, structural strength of rubber, and potential chemical reactions or off-gassing that could lead to pressure spikes.
An attempt will be made to verify the model with respect to the archival video, as well as to measurements on a smaller-scale, unpressurized tire under laboratory conditions.

Resources Required:

People: 1 graduate student
Budget: $25 k for salary x 1.5 years, $10k for software and consumables
Equipment: new workstation, numerical modeling software (ANSYS, ABAQUS, or COMSOL), use of existing mechanical testing machine, existing tire loading apparatus, heating elements, thermocouples, data acquisition system, existing cameras, existing digital image correlation software to estimate strains on (heated and stretched rubber)
Facilities: lab in MECE 1-38
Schedule: 1.5 years (includes grad student course work for eight months, during which literature review and preliminary model development will be done)

Deliverables:

Report on analysis and simulation results, with interpretation and applicability to large-scale tires (through simulation only).

Funding Sources:

SMART member companies.

M.G.Lipsett, T.G. Joseph, May 2, 2012