MVFRI RESEARCH SUMMARY
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Research in Automotive Fire Suppression

Based on contracts with:
University of Maryland
National Institute of Standards and Technology (NIST)

The data analysis conducted for MVFRI shows that underhood fire constitutes a significant portion of the major fires in NASS/CDS [Digges 2008; Kildare 2006; Bahouth 2005]. These fires pose a risk to occupants who are trapped or unable to exit the vehicle rapidly due to injury or physical impairment. This project considered the possibility of implementing fire protection measures that would mitigate the effect of underhood fires. These measures aim at delaying or preventing fire spread from the engine compartment to the passenger compartment. The goal was to suppress fire sources originating immediately after the crash until the first responders arrive on the scene. This time is estimated to be in the order of 20-30 minutes [Bahouth 2004].

DEVELOPMENT AND TEST OF AN UNDERHOOD FOAM FIRE SUPPRESSION SYSTEM

One method of retarding underhood fires is by establishing and maintaining an inert atmosphere in the engine compartment. Foam products in conjunction with an inert gas provide the desired combination to inert the space and to maintain the inert gas in place for the required time. MVFRI contracted with The University of Maryland to fabricate and test a system to inject high expansion water-based foam with entrapped nitrogen into the engine compartment [Gunderson 2004; Gunderson, 2005].

The primary scope of the project included the development and test of a simple foam generator suitable for installation in a vehicle. The associated supply and delivery system were not optimized for use in a vehicle. However, the weight and cost of an optimized system were estimated.

MVFRI also contracted with the National Institute of Standards and Technology (NIST) for the consulting services of Dr. Anthony Hamins to assist in developing test procedures and evaluating the test results. The main scenario examined in testing was that after a collision, in which the hood loosely covers the engine compartment, a fire originates at the battery position in the engine compartment. The ignition fire power for the tests was 80 kW, based on recommendations from Dr. Hamins.

In a baseline test, a fire at the battery position in the engine compartment was ignited, the hood is closed and the car was allowed to burn uninhibited. The fire increased in strength rapidly, engulfing the front of the car within 100 seconds. All available combustibles within the engine compartment contributed to the fire a few minutes after ignition. Based on this test, it was concluded that the system must be able to fill the engine compartment with foam within the first sixty seconds after activation to be successful. If the foam is not deployed within this time, a fire large enough to overcome the foam could develop.

Two suppression tests demonstrated the ability of the Nitrogen foam system to extinguish an 80 kW gasoline pool fire in the engine compartment originating at the battery location. The fire source was gasoline in a 9 by 14 inch baking sheet, filled to a depth of 14 mm. The foam was initiated immediately after fire ignition. The engine compartment was completely filled with foam within 60 seconds.

The foam surrounded the fuel pan, reducing ventilation from inside the engine compartment. The foam fill rate eventually overcame the vaporization rate and the foam front was able to move across the fuel pan and extinguish the fire. The foam formed a seal over the top of the remaining fuel, thus preventing re-ignition.

It is also noted that after sitting undisturbed for 10 minutes within the engine compartment there was only 20 percent breakdown of the foam. By 30 minutes, the foam breakdown was almost total.

Another test was performed with a vehicle on its roof to determine the ability of the Nitrogen foam system to extinguish a fire in a possible rollover scenario. The fire was located on the inside of the hood directly underneath the engine. The foam spread across the inside of the hood and was able to extinguish the fire. The foam did not fill the engine compartment and a large amount of the foam exited from the sides of the hood and spilled onto the ground. While the system was successful in this situation it may be ineffective against a fire that originates above the foam within the engine compartment.

The Nitrogen foam system, for a medium size car, has a mass estimated at about 7 kilograms and a volume of the order of 5 Liters. The system can be positioned between the engine compartment and the passenger cabin. This location will commonly be protected from collision damage.

RESEARCH IN FIRE SUPPRESSION

MVFRI contracted with NIST for the services of Dr. Anthony Hamins to assist in evaluating fire suppression systems. As part of his study he assessed the state-of-the-art in fire protection and discussed the challenges in providing fire suppression for pool fires as well as under-hood fires [Hamins 2006].

The report by Hamins documents in detail the test procedure used by Ford to assess the performance of the suppression system for pool fires that was introduced as an option in 2006 for the Crown Victoria used by police. It also summarizes the results of a SAE panel discussion of fire experts on the requirements for fire suppression systems.

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