Slosh Damping Using Magneto- Active Propellant Management Device

Nikita Amberkar
Embry Riddle Aeronautical University

Issues

Figure1. Tanker Accidents due to uncontrolled moment

Figure2. A trajectory deviation of the rocket (Falcon, 2007)

Figure3. Internal cracks in the Volvo bus fuel tank

Liquid Slosh

Movement of free surface of a liquid within a container or a propellant tank.

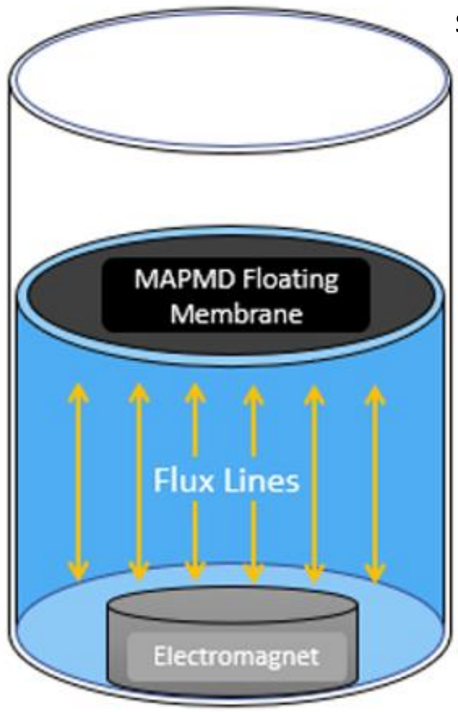
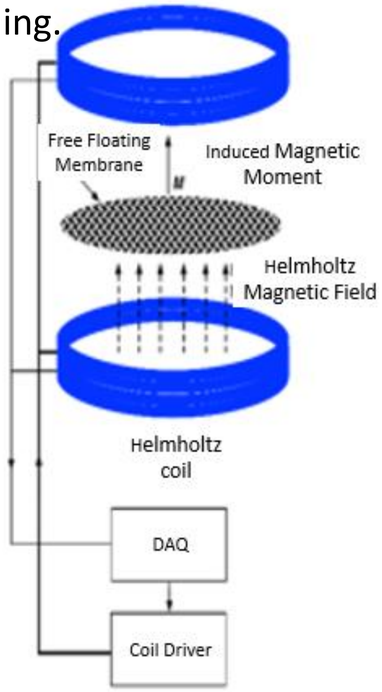
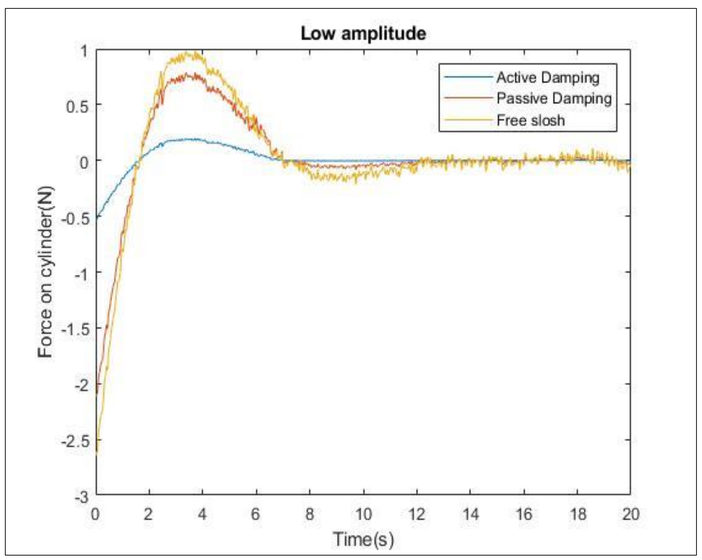


Figure4. For MAPMD active condition, no visible deviation and synchronous peaks in the plot is seen. This can be attributed to the fact that slosh wave amplitudes are low in this condition and damping can be attained at 6s. For inactive and free slosh condition, deviations in the curve can be seen even after 20s.

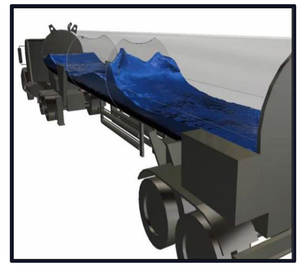
Working Principle

Sloshing in the propellant tank is controlled by electromagnetic membrane which creates a downward force to reduce sloshing.



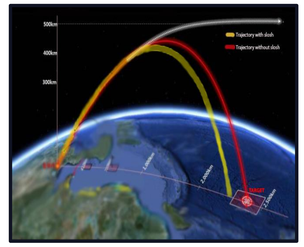


Applications

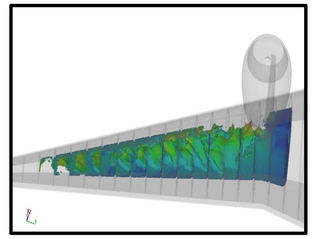


Tanker

Oil train



Missile Trajectory



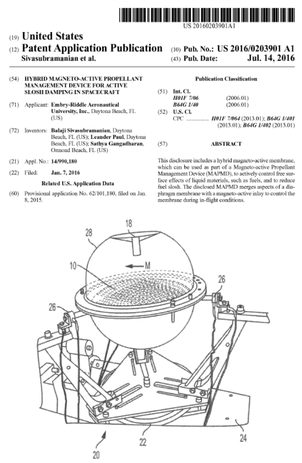
Aircraft Fuel tank

Space Mission

Marine

Patented Technology

US 2016/0203901 A1



(19) United States
(12) Patent Application Publication
Sivasubramanian et al.
(10) Pub. No.: US 2016/0203901 A1
(43) Pub. Date: Jul. 14, 2016

(54) HYBRID MAGNETO-ACTIVE PROPELLANT MANAGEMENT DEVICE FOR ACTIVE SLOSH DAMPING IN SPACECRAFT

(71) Applicant: Embry-Riddle Aeronautical University, Inc., Daytona Beach, FL (US)

(72) Inventors: Balaji Sivasubramanian, Daytona Beach, FL (US); Leander Paul, Daytona Beach, FL (US); Sathya Gangadharan, Ormond Beach, FL (US)

(21) Appl. No.: 14/990,180

(22) Filed: Jan. 7, 2016

Related U.S. Application Data

(60) Provisional application No. 62/101,180, filed on Jan. 8, 2015.

Publication Classification

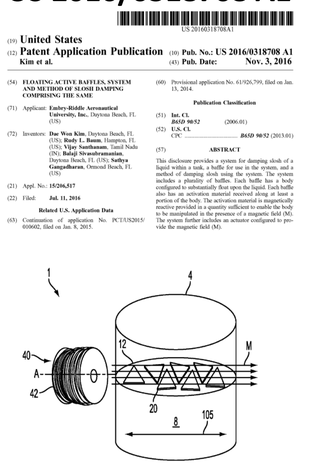
(51) Int. Cl.
H01F 7/06 (2006.01)
B64G 1/40 (2006.01)

(52) U.S. Cl.
CPC H01F 7/064 (2013.01); B64G 1/401 (2013.01); B64G 1/402 (2013.01)

(57) ABSTRACT

This disclosure includes a hybrid magneto-active membrane, which can be used as part of a Magneto-active Propellant Management Device (MAPMD), to actively control free surface effects of liquid materials, such as fuels, and to reduce fuel slosh. The disclosed MAPMD merges aspects of a diaphragm membrane with a magneto-active inlay to control the membrane during in-flight conditions.

US 2016/0318708 A1



(19) United States
(12) Patent Application Publication
Kim et al.
(10) Pub. No.: US 2016/0318708 A1
(43) Pub. Date: Nov. 3, 2016

(54) FLOATING ACTIVE BAFFLES, SYSTEM AND METHOD OF SLOSH DAMPING COMPRISING THE SAME

(71) Applicant: Embry-Riddle Aeronautical University, Inc., Daytona Beach, FL (US)

(72) Inventors: Dae Won Kim, Daytona Beach, FL (US); Rudy L. Bunn, Hampton, FL (US); Leander Paul, Daytona Beach, FL (US); Balaji Sivasubramanian, Daytona Beach, FL (US); Sathya Gangadharan, Ormond Beach, FL (US)

(21) Appl. No.: 15/206,517

(22) Filed: Jul. 11, 2016

Related U.S. Application Data

(63) Continuation of application No. PCT/US2015/000602, filed on Jan. 8, 2015.

(60) Provisional application No. 61/926,799, filed on Jan. 13, 2014.

Publication Classification

(51) Int. Cl.
B65D 90/52 (2006.01)

(52) U.S. Cl.
CPC B65D 90/52 (2013.01)

(57) ABSTRACT

This disclosure provides a system for damping slosh of a liquid within a tank, a baffle for use in the system, and a method of damping slosh using the system. The system includes a plurality of baffles. Each baffle has a body configured to substantially float upon the liquid. Each baffle also has an activation material received along at least a portion of the body. The activation material is magnetically reactive provided in a quantity sufficient to enable the body to be manipulated in the presence of a magnetic field (M). The system further includes an actuator configured to provide the magnetic field (M).