Senior Design Project Definition

1. Project Title: Magnetically Coupled Mixer/Pump System for Cryogenic Propellant Tank Destratification

2. Submitting Organization and Company: National Aeronautics and Space Administration (NASA) – Marshall Space Flight Center (MSFC).

3. Liaison Engineer Information :

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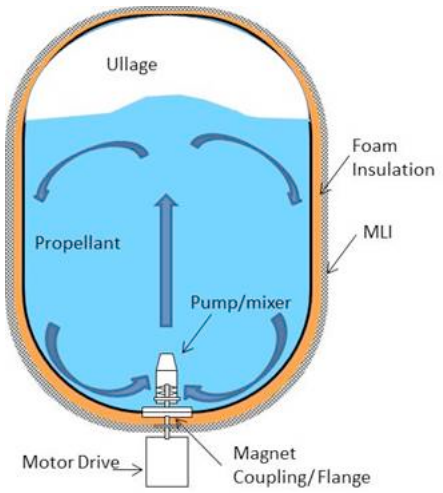
4. Project Background:

Long term storage of cryogenic propellants such as liquid hydrogen and oxygen present technology issues related to pressure control and destratification. Typically these propellants are stored at low pressure (15 to 25 psia) to minimize tankage weight and maintain very cold saturated condition necessary. Incoming heat leak from the environment causes the propellants to boil which generates pressure rise and increase in fluid saturation temperature if the tank is locked up. Foam and multilayer insulation (MLI) are used to reduce environmental heat leak in ground/atmospheric and space/vacuum conditions, respectively. To help alleviate the rapid pressure rise issue, the stored propellants can be mixed to create a more homogenous temperature condition within the fluid and vapor (ullage) portion of the tank. By reducing temperature stratification, especially in the ullage, the pressure of the tank can be lowered to the bulk saturated state; buying time before venting is required. Venting is difficult in low gravity environments since vapor position is not always know and can result in a performance/propellant loss (typically low gravity venting operations are conducted using a thermodynamic vent system). Traditionally the mixing has been performed using various AC single and 3-phase motor systems which are directly coupled to a pump and place within a propellant tank or mounted to flange with the motor operating in a submerged condition. This creates a range of issues some of which including, 1) dumping waste heat from the motor into the propellant increasing fluid heating, 2) introduces feedthroughts /connectors for power which creates leak paths and potential for failure, and 3) requires expensive specialize development of motors to operate in cryogenic conditions



Tank Mixer System General Layout

5. Most Important Project Objectives:

A potential technology which might allow placement of the motor outside of the cryogenic fluid is to use a magnetic coupling to transmit rotational motion from a motor across the tank wall to a pump/mixer device located on the inside. The pump/mixer portion would be designed for operation in the cryogen receiving the magnetic rotational motion (from the motor) and imparting it to the fluid through impellers/etc. contained within a housing to produce flow (up to 15 gpm) and pressure rise (up to 5 psid). The challenge of this project is to design, fabricate and test an electric motor-pump unit that makes use of magnetic coupling technology to position the motor outside of the cryogenic tank while still providing sufficient pumping pressure/flow and incorporating insulation between the coupling and tank wall so as not to introduce additional heat leak. The unit should have minimum number of parts, be compact in arrangement and can be designed for operation on a flange allowing it to be installed more easily into a tank configuration. Testing should be performed with water and liquid nitrogen.

6. Design/Result Expectations:

Design, fabricate and test an electric motor-pump unit that makes use of magnetic coupling technology in both water and liquid nitrogen.

7. Prototype(if required) Expectations:

An electric motor-pump unit that makes use of magnetic coupling technology. Students will also have to fabricate the "tank" for the water and hydrogen.

8. Estimated Costs of Hardware, or Items Provided by Sponsor: Sponsor can provide raw materials (e.g. stainless steel, flanges, windows for tank, etc…), instrumentation (e.g. TC wire), and magnets provided the students identify the needs on or before November 10, 2014.

9. New Technology Requirements:

none

10. Special Information:

Suggested Majors: Mechanical/Aerospace Engineering, Electrical Engineering

FAMU-FSU College of Engineering
Department of Mechanical Engineering
Senior Design Project Sponsorship Agreement

Sponsor participation is essential to the success of this program and we will make every effort to accommodate potential sponsors who have projects that fit within the framework discussed in this brochure.

Our general request is that each sponsor provide a contribution of $4,000/year or more to cover basic program costs, which include hardware purchase/fabrication, machine shop expenses, supplies, presentation materials, software, media, photocopying, short distance transportation, etc. Different financial sponsorship could also be arranged upon discussion.

Each sponsored team will be allocated to a maximum of $2,000 or half of the funding level for the project. Certain projects will require additional funds and/or materials and services provided by the sponsor. The nature of the project will dictate supplementary costs and students requiring additional funds will be required to present justification to the sponsor for those costs.

The best method of sponsorship is through a donation to the Department of Mechanical Engineering account at the Florida State University Foundation. Checks should be made payable to FSU Foundation/Mechanical Engineering and sent directly to the Department.

If a sponsor is unable to provide funding through such a donation, research grant or contract funding vehicles can be arranged. The Department will be happy to provide further information on request.

To remit contributions or discuss alternative funding arrangements, please contact:

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