Group 24

Magnetically Coupled Pump System for Cryogenic Propellant Tank Destratification

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Agenda

- Background Information
- The Project
  - Objectives
  - Specifications
- Provided Materials
- Design
- Budget
- Prototype Testing
- Project Timeline
  - Future Work
- Summary

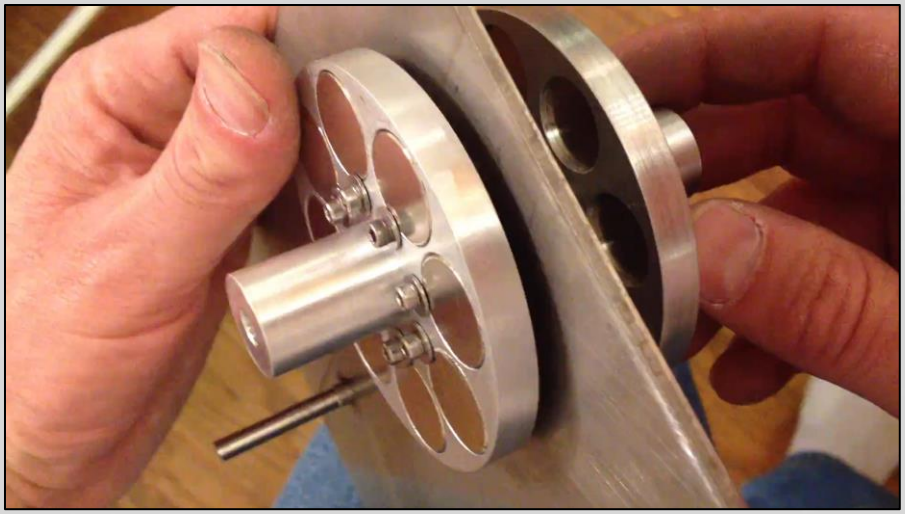
Background

- Long term storage of cryogenic propellants present technology issues
  - Pressure control
  - Destratification
- Insulation
  - Prevent environmental and space/vacuum heat leak
- Mixing the propellants
  - More time before venting

Figure 1: Foam and multilayer insulation (MLI)

The Project

- Current Design
  - Foam and insulation
  - Motor couple to a pump operating in submerged conditions
- Problem
  - Waste heat from motor into fluid
  - Connectors
  - Expensive specialized development of motors
- Proposed Solution
  - Magnetic coupling technology
  - Motor must be on outside of tank



Goal Statement

Need Statement

"Due to the motor used inside cryogenic tanks there is too much heat addition when mixing the fluids"

Goal Statement

"Design a better way of mixing cryogenic fluids"

Objectives

- Minimize heat addition
- Must produce volumetric flow rate of 5-15 gpm
  - The pressure rise due to the pump must reach 5psid
- Magnetically couple motor shaft to pump shaft
- Minimum number of parts and be compact in design
- Must attach to current tanks and be mobile

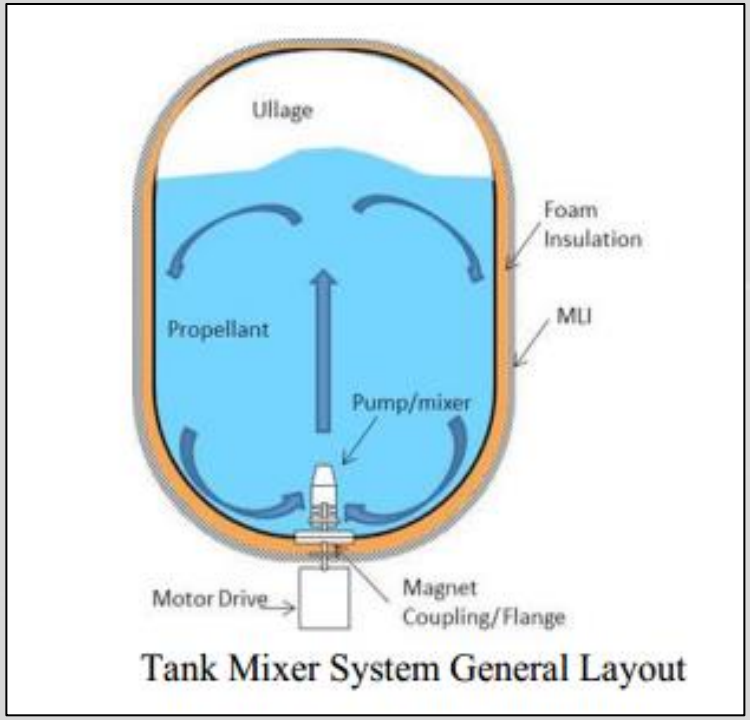


Figure 2: Tank Mixer System General Layout

Project Specifications

Requirement	Specification
Tank Size	• Height: 29 in • Outer Diameter: 16 in • Inner Diameter: 14 in • Gross Capacity: 60 Liters
Insulation	• 0.5 in of foam • >20 layers of multi-layer insulation (MLI)
Mounting	• Mounted to 6 in flange • Flange has 4 in port into tank
Pump Motor	• Variable Flow Rate : 5 - 15 gpm • Generates 5 psid rise in pressure • Mixer/Pump must reach 12 inches into tank
Additional Requirements	• Tank must be adiabatic to surroundings • Pump shaft must be magnetically coupled to the motor shaft • Friction must be held to a minimum • System must be compact • Materials used for the magnetic housing and flange must be non magnetic • Materials must withstand extremely cold temperatures between 63K - 77.2K

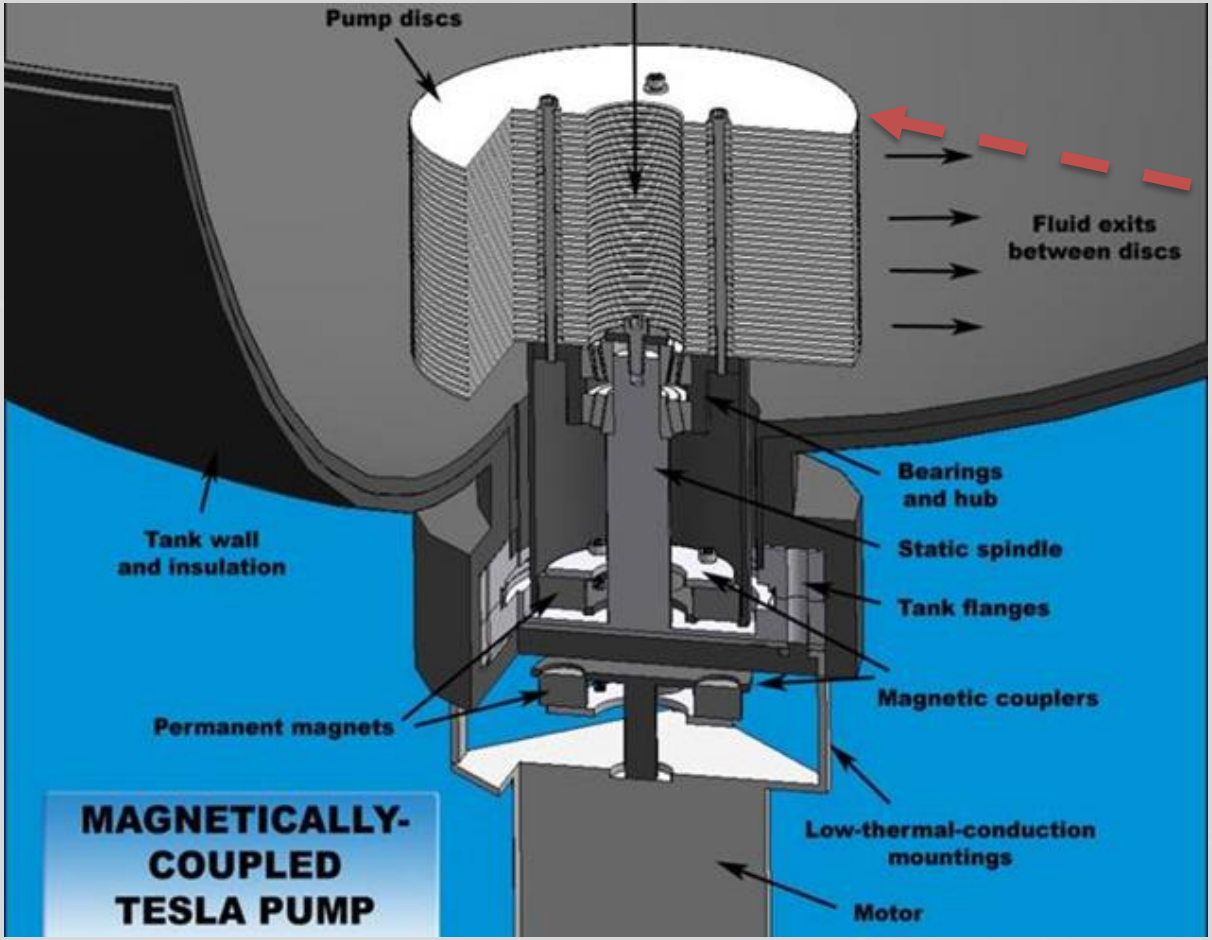
Provided Materials

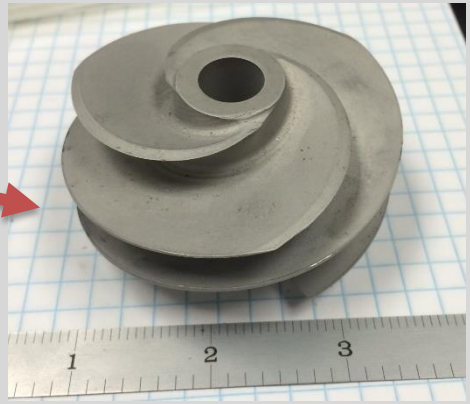
Cryofab CF 1424-F model that will be used in the project

Cryofab CF 1424-F head that flange will attached to

6 inch ConFlat flange made of stainless steel that the design will be attached to.

Proposed Designs





- Primary Design entails the use of a Tesla pump
- Secondary design would make use of 3-tooth inducer

Budget

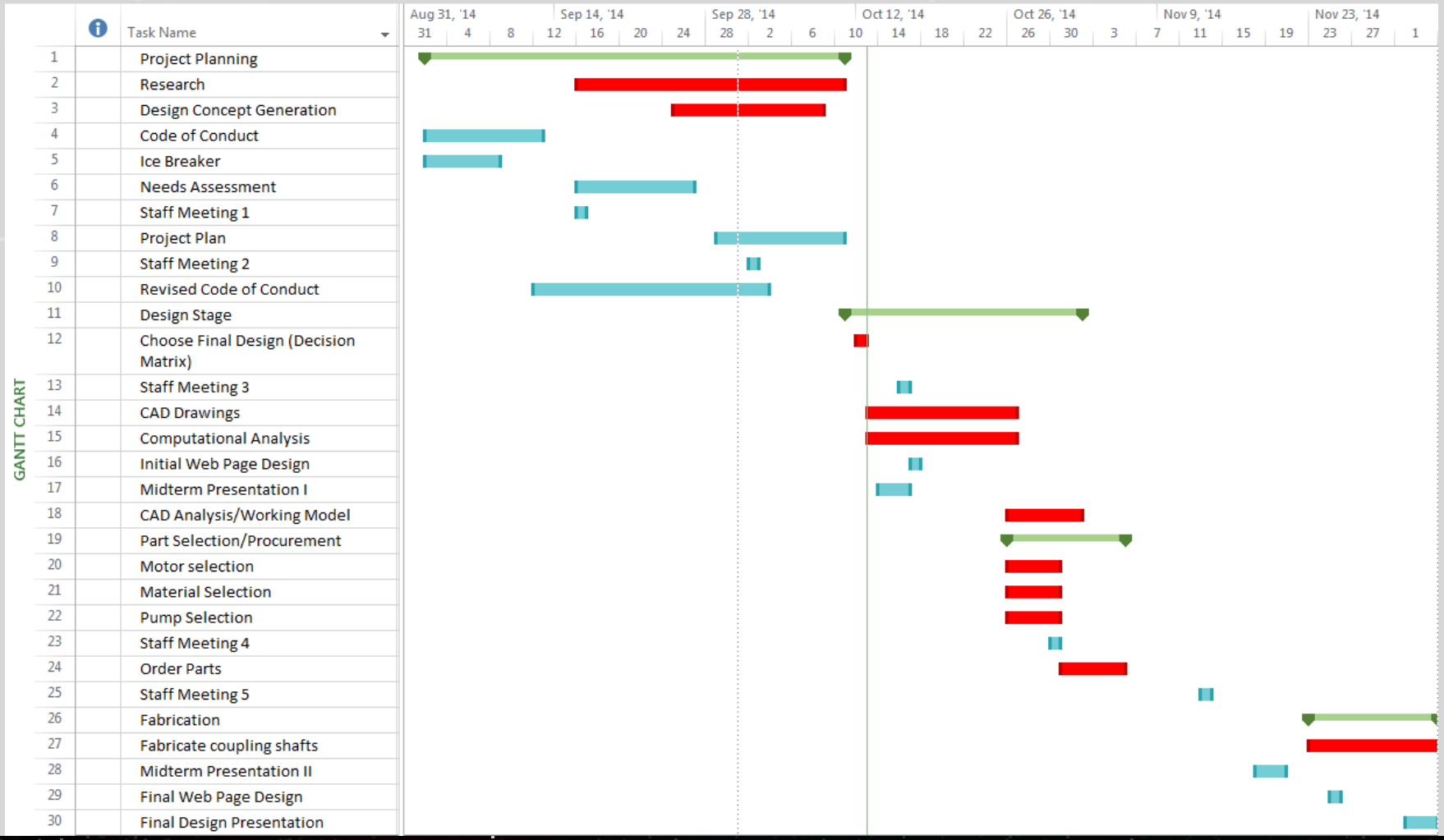
- $500 from Florida Space Grant
- Fabrication Materials
- Sealing
  - Indium wire
  - Copper seal gasket
- Magnets
  - 12-16 permanent magnets
- Motor
  - Produces required volumetric flow rate

Item	Percentage
Fabrication Materials	45%
Sealing	20%
Magnets	15%
Motor	20%
Total	100%

Prototype Testing

- Preliminary Magnet coupling test
  - Build a square tank for water tests
- Pressure tests
  - Fitted pressure gauge on the cryostat
- Flow rate
  - Fabricated square tank (Water)
  - Fluid transfer between two cryostats (Liquid Nitrogen)

Project Timeline



Future Work

- CAD Drawings
- Computational Analysis
  - Acquire motor specification
  - Flow rate
  - Pressure rise
- Material and Part Selection
  - Magnets
  - Motor
- Fabrication
  - Prototype
- Testing

Summary

- The Project
  - Reduce heat addition
  - Magnetic coupling technology
- Design proposal
  - Solves the issues of heat addition
  - Satisfies the objectives
- Constraints
  - Budget, materials, and size
- Future Plans
  - CAD drawings
  - Computational Analysis
  - Fabrication and Testing

References

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- [3] "Magnetic Couplings | Technology | Magnomatics." Magnetic Couplings | Technology | Magnomatics. N.p., n.d. Web. 25 Sept. 2014.
- [4] "HowStuffWorks "Parts of the Tesla Turbine"" *HowStuffWorks*. N.p., n.d. Web. 09 Oct. 2014.
- [5] Pump, Nikkiso Cryogenic. *NIKKISO CRYOGENIC PUMP* (n.d.): n. pag. Web.

Questions

For more information and updates:
http://eng.fsu.edu/me/senior_design/2015/team24/