Scope

**EML 4551C – Senior Design – Fall 2011 Deliverable**

Team # 16

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Needs Assessment:

The National High Magnetic Field Laboratory in Tallahassee Florida routinely does extensive tests in superconductivity research. However, because of the nature of superconductivity, very low temperatures close to three and four Kelvin must be achieved. This is accomplished by using both liquid nitrogen and liquid helium due to their naturally low temperatures.

Justification/Back ground:

Magnets are used in everyday life from the mundane common place cell phone to the lifesaving NMR and MRI scanning machines. More cost effective and more powerful and efficient magnets are being searched for constantly to improve devices like these. One area of research falls into the field of superconductors and magnets made from superconductors.

Superconducting magnets are designed around the critical current measurement, or I.C. measurement. This is the maximum amount of current that can be passed through a superconducting material at a certain magnetic field before the superconductor loses its superconducting properties. Since superconducting properties can be disrupted by strong enough magnetic fields, even from the superconducting magnet itself, the need for I.C. measurements is great. This is why short samples of superconductors are placed inside a magnetic field during this test. It is the critical current at an applied field.

There is still a great amount of research in creating a better superconductor that can carry higher critical currents in higher fields. Some of this research takes place today at the N.H.M.F.L at FSU. New processes and designs of superconductors happen weekly to attain goals of better superconducting magnets. For this research much testing of the critical current is need, which is why a multi-sample probe is in demand. A multi-sample probe allows for eight samples at the maximum to be tested per I.C. measurement. Testing multiple samples at once allows for processes of making superconductors to be compared at a faster rate helping to find better superconductors in less time.

In order to preform I.C. measurements liquid helium is needed. Liquid helium is needed to cool down the magnet that the short samples are placed into and to cool down the superconductors to the superconducting state. Both the magnet and the short samples must stay at the liquid helium temperature throughout the whole of the I.C. measurement. Since the I.C measurement can take a few hours to complete much liquid helium is needed and being 5.00 dollars a liter this is not a cheap process. Minimizing the loss of liquid helium through the redesign of the multi-sample probe is the goal of this project.

Modifying the existing probe is not possible because of the demand for its use is too high and would slow down important research needing to take place. This is why a whole new probe needs to be designed and implemented. A new probe will allow for research to continue on I.C measurements while a more helium efficient probe is designed. The new probe will save helium which in turn with save money and allow for more efficient test to be carried out for I.C. measurements.

Methodology

 Fully understanding the way the existing probes work is the first step to successfully meeting the customer’s needs. Research about cooling using liquid helium to cool superconductors is essential to coming up with a design for a more efficient probe. Also, understanding the customer’s needs for the finished product will be a crucial step. Background research on the subject will be fully conducted after a meeting with the customer to determine their expectations.

 Once the research is conducted and the customer’s expectations are documented, materials which can sustain cryogenic conditions for an extended amount of time without significant deformation will need to be identified. The material for the probe body, leads, and other miscellaneous objects on the probe will need to be selected. A tentative probe design will be used for reference when choosing the material. The budget will need to be taken into account when selecting the material for the improved probe. Once the final materials are selected, the design will begin to be finalized. Several designs that meet the customer’s needs will be submitted by group members. With the help of the sponsor as well as the assigned faculty advisor, the team will select the most efficient design. Once this design is chosen, the probe must be built. After construction, the probe will need to be tested. Several parameters will be tested to ensure effectiveness. This probe does not only need to do what prior probes have accomplished, it also needs to reduce the consumption of helium as well as provide a mount to test a spiral sample. Identifying sources of heat leaks in the system will be the most productive and effective way to reduce helium consumption. The tests can be made at the National High Magnetic Field Laboratory in the dewar which is currently used for testing sample properties. The chosen design will be constructed in a timely manner to assure adequate testing time.

Constraints

There are several constraints on the design of a suitable probe. This particular probe must be able to test 6-8 samples as well as at least one spiral sample. This project is limited to the Fall and Spring semesters and must be completed by April. The development of this design must cost less than $4000. The samples need to be placed in the middle of the magnet. Therefore, the probe length must be designed for a certain dewar. The diameter of the probe must also be compatible with the dewar.

Expected Results

Upon completion of this project, the customer’s needs will be met sufficiently. The amount of helium used per test will be reduced dramatically by fixing the heat leaks which are in the current system. Also, a successful testing of a spiral sample will be achieved.

A well-designed working probe that reduces the consumption of helium and can test at least 6 samples as well as a spiral sample will be produced.