



UNC CHARLOTTE

The WILLIAM STATES LEE COLLEGE of ENGINEERING

Senior Design Project Description

<u>Company Name</u>	The Polymers Center of Excellence, Inc.	<u>Date Submitted</u>	March 21st, 2018
<u>Project Title</u>	Automation of Cooling System for Analytical Instruments (PCE_COOL)	<u>Planned Starting Semester</u>	Fall, 2018

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project. 250 hours are expected per person.

Complete the following table if this information is known, otherwise the Senior Design Committee will develop based on the project scope:

Discipline	Number	Discipline	Number
Mechanical	3	Electrical	2
Computer	0	Systems	
Other ()			

Company and Project Overview:

The Polymer Center was founded in 1972 when the State of North Carolina funded plastics specialists in the Industrial Extension Service program at UNCC. The center, located at that time on the UNCC campus, expanded in 1994 when a joint venture was entered into with NCSU to form PEP (Polymers Extension Program). By 1999, PEP moved off of the UNCC campus and became today's Polymers Center of Excellence (PCE). In 2012, Polymers Technology Center (PTC) was added for small scale production for plastic injection molding and compounding plastics. Since then, the Polymers Center has continued to impact economic development through education, research and development, and trial production.

The laboratory at the Polymers Center specializes in the testing of plastics. No other organization in the country has the testing and analysis capabilities offered by PCE. Although certain tests are available at other organizations, only at the Polymers Center can processors compound, mold and test all in one location.

PCE offer a variety of mechanical and chemical analysis testing, including:

- Material composition identification and analysis
- Mechanical properties determination
- Third party verification of materials properties
- Failure analysis
- Quality assurance testing
- Finished part performance evaluation



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The scope of this project is associated with two of the tests that the Polymers Center provides, which are TGA and DSC tests. Briefly described the tests are as follows:

Differential Scanning Calorimetry, or DSC, is a thermal analysis technique that tracks the heat capacity of a material by an increase in temperature. A sample of known mass is heated or cooled and the changes in its heat capacity are tracked as changes in the heat flow. This allows the detection of transitions such as melts, glass transitions, phase changes, and curing. Because of this flexibility and since most materials exhibit some sort of transitions, DSC is used in many industries, including pharmaceuticals, polymers, food, paper, printing, manufacturing, agriculture, semiconductors, and electronics.

Thermogravimetric Analysis or TGA is a technique in which the mass of a substance is monitored as a function of temperature or time as the sample specimen is subjected to a controlled temperature program in a controlled atmosphere. These instruments can quantify loss of water, loss of solvent, loss of plasticizer, decarboxylation, pyrolysis, oxidation, decomposition, weight % filler, amount of metallic catalytic residue remaining on carbon nanotubes, and weight % ash.

Both of those instruments require cooling water--sometimes cold and other times room temperature. At this time the respective cooling systems are ad-hoc and manual. The entire system requires analysis and an engineered solution such that both instruments can access cooling water at the correct flow rates and temperatures.

Project Requirements:

Presently we have in mind to analyze the problem, design a single cooling solution that accommodates the needs of both instruments and fits in the space presently occupied by the existing solution.

The two tests share a bench top that is approximately 12 feet long by 4 feet wide. The analytical instruments are in the front of the bench and the cooling water equipment is behind the instruments. There are two different cooling water supplies, but the equipment is very un-organized and manual. The scope of this project will be to remove both of the existing water cooling apparatus' and replace with a single integrated unit that will supply both instruments and be configurable in terms of temperature and flow rates. The desired solution will take up less table space and offer a cleaner and more organized set-up. A user interface will be provided to allow easy control and status of the equipment.

The student team will first understand the requirements of the DSC and TGA test instruments. This will include flow rates, temperatures, timing, etc. The equipment supplied in the design will include tanks, pumps, heat exchangers, solenoids and PLC. Due to the benchtop scale, it is believed that this can be accomplished within the project budget. The programming, construction and installation will require some creativity in that the space provided is limited. Electrical schematics, PLC program, P&ID, statement of conformance to safety standards, and mechanical drawings will be required.

Expected Deliverables/Results:



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- Replacement cooling water system
- Bill of material for all parts
- User's manual

Disposition of Deliverables at the End of the Project:

The system will be tested and verified at PCE. If practical, the system should be shown at Expo and Post Expo, delivered and re-installed at PCE.

List here any specific skills, requirements, knowledge needed or suggested (If none please state none):

- Programming including a P&ID to determine the subassemblies
- Heat exchange calculations
- Electrical engineering for the pumps, solenoids, and thermocouples
- Mechanical construction of the system
- Analysis of the safety requirements for lab operation
- Design reviews are planned to be done at PCE, 8900 Research Dr, Charlotte