IPRO 348: Design a System to Recycle Condensate from Residential Air Conditioners

Summer 2009

PROJECT PLAN

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Abstract

The goal of IPRO 348 is to first find a use for the condensate produced by air conditioners, and then to create a product that will recycle the condensate for said use. The first task for IPRO 348 is to collect information on how condensate is formed, its purity, and the amount that is produced by a central air conditioning system. The end goal of the IPRO is to have a marketable system that will collect and store the condensate produced by the air conditioning units and will then proceed to use the condensate in the form of cleaning water, irrigation water, and possibly various plumbing purposes such as flushing toilets. After creating a viable product, the IPRO team is determined to make the product scalable, expanding its market from residential to commercial industries. To fulfill this goal, the IPRO team has been broken down into subgroups which are each responsible for a different objective. The first subgroup is responsible for the creation of a device that will allow for the condensate to be collected and stored. The second subgroup is responsible for analyzing the collected sample's composition and checking for bacterial growth. The third subgroup is responsible for setting the parameters and methods for condensate collection. The fourth subgroup is responsible for obtaining the condensate samples from various sites, as well as collecting environmental data. The fifth subgroup is responsible for beginning the marketing aspects of the project. As a whole, the IPRO team will determine how the project should progress.

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I. BACKGROUND

Condensation is the process by which water vapor becomes a liquid (condensate). Condensate is a naturally occurring substance on surfaces cooler than the ambient temperature, such as an air conditioning (A/C) unit. To date, there is no known product that collects condensate from A/C units. Moreover, condensate is not even considered a valuable resource due to the cheap price of water in Illinois. However, A/C condensate is a wasted resource that has many uses in a residential setting, many of which can be scaled up for commercial use. Recently, condensate has been used for irrigation purposes. In Texas, condensate has been used for landscaping, gathering as much as 60,000 gallons a day for usage. At Arizona State University, a bio-design institute has gathered 6,000 gallons of condensate per day and has used it for irrigation. It is not clear if there are any purification procedures in place at these two facilities, however, it has been found that condensate may have impurities such as lead and bacteria. A/C condensate is a resource that should not be wasted, but many consumers and companies, such as the Air Conditioning Contractors of America have no intention of harnessing this resource at the current time. Since condensate is an overlooked resource, this IPRO is designed to look more in depth at, and create a system for, recycling the condensate for everyday uses in residential and eventually commercial situations.

II. OBJECTIVES

A. Design Oriented Objectives

The overarching objective of IPRO 348 is to design and create a system to capture and reuse the condensate that forms on home A/C units. The team has come up with a more specific set of desired qualities for the end product in that it should be:

1. Marketable to a large consumer group.
2. Scalable both upwards and downwards so that similar designs may be applied to both window units in apartments and large split A/C systems.
3. Inexpensive to manufacture and thus inexpensive to purchase.
4. Easy to install and operate.

B. General Project Objectives

For the project in general, the team set these goals:

1. Visit at least 3 different sites to collect condensate and determine the rate of condensation with respect to various atmospheric conditions.
2. Test various samples of condensate to determine the chemical makeup and if any bacteria are present and, thus, determine if any filtration is necessary.
3. Keep a comprehensive and well organized record of all research conducted, collected results, and valuable sources of information for future IPROs.

III. METHODOLOGY

A. The Problem

Air conditioner condensate is a wasted resource, since it is drained out through plumbing in most buildings. Yet, despite the recent attempts by society to "go green", there has been only minimal research conducted regarding the reuse of A/C condensate and no attempt to create a system to recycle condensate for residential or commercial use. Thus, this IPRO is determined to design a system to capture and reuse the condensate for non-drinking applications, such as irrigation or toilet water.

B. Plan of Action

1. We will begin the semester by conducting initial research on several topics related to A/C systems, condensate, and prior research completed by other institutions and companies. We will then analyze the results of this initial research and brainstorm to identify a list of tasks/goals that need to be accomplished during the first half of the semester.
    - The team will be grouped into sub-teams each charged with a specific task, based on their skills and academic interests.

2. Initial field research will then be conducted at several testing sites (compiled by another sub-team).
    - A collection/ measuring device created by one sub-team will allow us to measure the amount of condensate produced under standardized conditions (set by a sub-team).
    - 500 ml samples of condensate will be collected from each site.

3. Laboratory testing will then be carried out by one sub-team using the samples collected from the test sites and will include:
    - Biological testing for the presence of microbial growth.
    - Chemical testing to determine the chemical constituents of the condensate, other than water.
    - Comparison to tap water and distilled water.

4. During the second half of the semester, we will analyze the results of the field and laboratory tests to determine potential and practical uses for recycled condensate.
    - This includes a discussion of the method of filtration needed, if any.

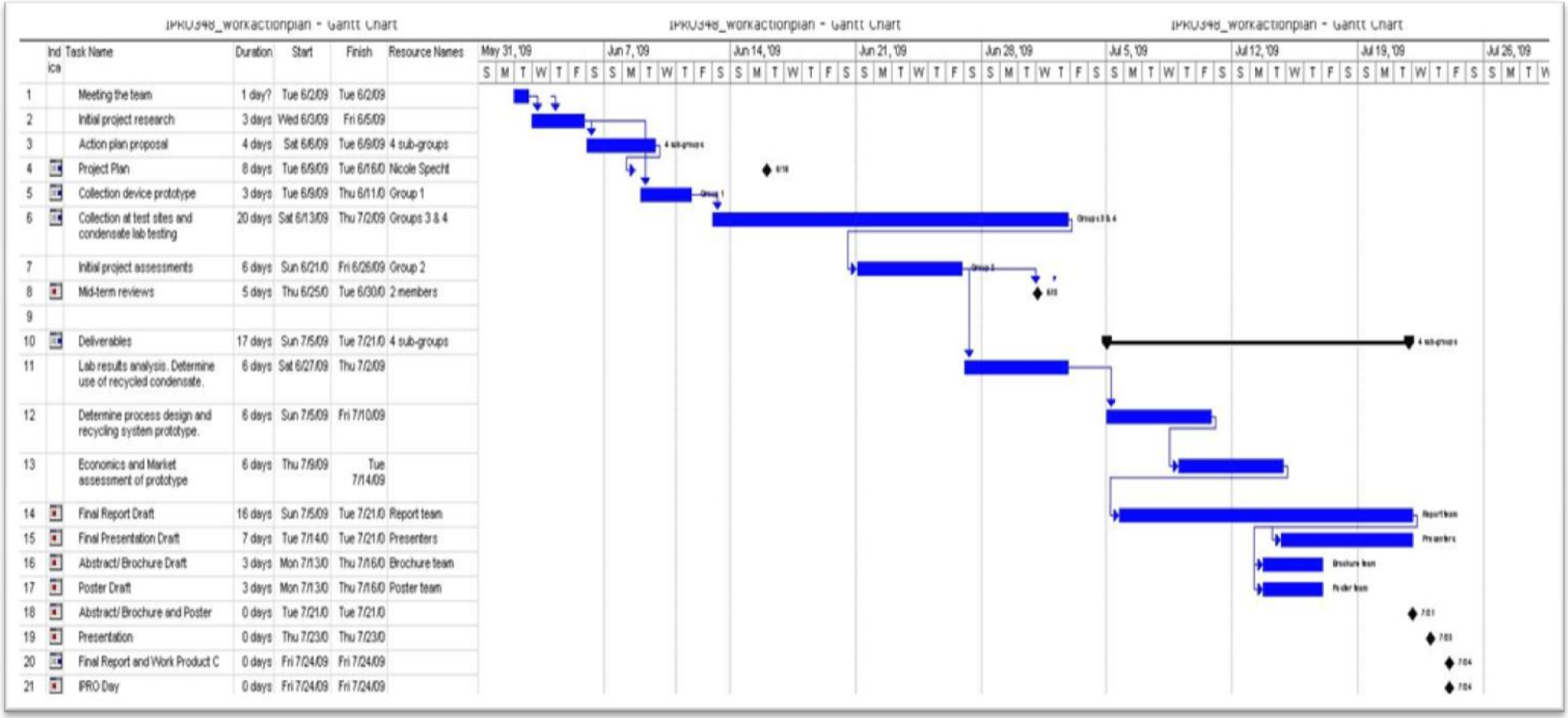
- Also includes research of codes and regulations that we need to meet in order to use the condensate for our desired purpose(s).

5. Once we determine the potential uses, we can begin to design a system prototype, as well as establish the potential market and calculate a cost/benefit analysis.
    - In order to complete these tasks, the team will regroup into sub-teams, each charged with one of these tasks.

C. Documentation

During the course of our research, all data acquired from field tests as well as laboratory testing will be recorded in a standard log book. This log book will also contain a compilation of all external documents related to all research conducted, including pictures, drawings, and surveys. Moreover, since this is a new IPRO, it will include detailed accounts of the team's methodology, analyses, and conclusions reached throughout the semester so that future semesters have a more solid foundation.

D. Working Schedule



	Indicator	Task Name	Duration	Start	Finish	Resource Names
1		Meeting the team	1 day?	Tue 6/2/09	Tue 6/2/09	
2		Initial project research	3 days	Wed 6/3/09	Fri 6/5/09	
3		Action plan proposal	4 days	Sat 6/6/09	Tue 6/9/09	4 sub-groups
4		Project Plan	8 days	Tue 6/9/09	Tue 6/16/0	Nicole Specht
5		Collection device prototype	3 days	Tue 6/9/09	Thu 6/11/0	Group 1
6		Collection at test sites and condensate lab testing	20 days	Sat 6/13/09	Thu 7/2/09	Groups 3 & 4
7		Initial project assessments	6 days	Sun 6/21/0	Fri 6/26/09	Group 2
8		Mid-term reviews	5 days	Thu 6/25/0	Tue 6/30/0	2 members
9						
10		Deliverables	17 days	Sun 7/5/09	Tue 7/21/0	4 sub-groups
11		Lab results analysis. Determine use of recycled condensate.	6 days	Sat 6/27/09	Thu 7/2/09	
12		Determine process design and recycling system prototype.	6 days	Sun 7/5/09	Fri 7/10/09	
13		Economics and Market assessment of prototype	6 days	Thu 7/9/09	Tue 7/14/09	
14		Final Report Draft	16 days	Sun 7/5/09	Tue 7/21/0	Report team
15		Final Presentation Draft	7 days	Tue 7/14/0	Tue 7/21/0	Presenters
16		Abstract/ Brochure Draft	3 days	Mon 7/13/0	Thu 7/16/0	Brochure team
17		Poster Draft	3 days	Mon 7/13/0	Thu 7/16/0	Poster team
18		Abstract/ Brochure and Poster	0 days	Tue 7/21/0	Tue 7/21/0	
19		Presentation	0 days	Thu 7/23/0	Thu 7/23/0	
20		Final Report and Work Product C	0 days	Fri 7/24/09	Fri 7/24/09	
21		IPRO Day	0 days	Fri 7/24/09	Fri 7/24/09	

IV. BUDGET

Item	Estimated Cost ($)
Travel/Transportation	$270
Printing for prototypes	$20
Prototyping Materials	$400
Miscellaneous	$50
Total	$740

V. TEAM STRUCTURE

A. Team Information

Team Name: The Drip Drops
Team Motto: "Every drop counts"
Team Logo:

B. Team Structure Chart

Name	Major / Year	Skills / Strengths	Experience
Anam Abro	Architectural Engineering/ 3rd	MS Word, Excel, Power point, AutoCAD, Problem solving	Internship at AF Fergusons
Nicole Specht	Biology / 3rd	MS Office, Strong organizational and writing skills	Lab experience
Erich Ruszczak	Applied Math/ 4th	Proficient in MS Word, Excel, Powerpoint, Java, MATLAB, Skilled in mathematics and problem solving	Tutoring skills
Malisa Ismail	Chemical Engineering/4th	Proficient with Aspen Hysis, Instron, Oracle, Matlab, AutoCAD, MS Word, Excel, PowerPoint, Access, Project, Outlook, Lab experience, Report writing and editing	Lab technician at Dow Automotive. Medical Receptionist/ Radiography technician, Production Planning Assistant
Jessica Martinez	Biology/ 4th	MS Word, Excel, Access, Powerpoint, Excellent research skills	REU summer intern at IIT, office assistant in provost and BME office, laboratory research

Cari Hesser	Aerospace Engineering/3rd	Microsoft Word, Excel, Powerpoint, AutoCAD, Lab view, Prompt and clear communication, Excellent research and documentation skills	Work in Fluid Dynamics Research Center
Siddhartha Raghuvanshi	Mechanical Engineering/4th	Microsoft Word, Excel, Powerpoint, Problem solving skills	Interned for company administrator
Niravkumar Hazariwala	Mechanical Engineering/4th	Thermodynamics-heat and mass transfer and thermal designs, Computer hardware and software: MATLAB, SolidWorks, ProE	Work for Geek Squad, Internship at Bipico Tools, Research in thermodynamics
Matt Claxton	Mechanical Engineering/4th	Very good design skills, CAD, Solidworks	Employed by Apple
Syeda Ahmed	Molecular Biochem and Biophysics/4th	MS Office, Writing and organizational skills, Excellent research skills	Biochemistry lab work, office work experience
Rachel Yanover	Architecture/4th	MS Office, Photoshop, Illustrator, AutoCAD, AutoDesk, Revit, Hand and power tool skills.	Experience in Crown Hall shop

C. Team Tasks

The team will be divided into subgroups and each subgroup will be assigned a task related to the subject. Information will be collected by each subgroup and will be shared with the rest of the class.

Current Sub teams:

GROUP 1
Niravkumar Hazariwala
Siddhartha Raghuvanshi
Matt Claxton
Task: Design a measuring and collecting device for the condensate.

GROUP 2
Syeda Ahmed
Nicole Specht
Anam Abro
Task: Find the necessary resources to analyze various samples of condensate and carry out biological and chemical lab tests to analyze the samples.

GROUP 3
Malisa Ismail
Erich Ruszczak
Task: Set standards and methodology for collecting condensate.

GROUP 4
Cari Hesser
Jessica Martinez
Rachel Yanover
Task: Research common types of A/C units and their specifications. Attain samples of condensate when possible.

GROUP 5
Malisa Ismail
Erich Ruszczak
Anam Abro
Niravkumar Hazariwala
Siddhartha Raghuvanshi
Task: Begin initial market study activities.

TEAM LEADER
TBA

MINUTE TAKER
Cari Hesser

Additionally, the team has set the following protocol for the term:

1. Every member will contribute equally to team efforts.
2. Every member will attend all class sessions, emergencies notwithstanding.
3. Every member will keep a log of the hours spent on the project through the iGroups website.
4. The team will always cite outside sources of information.

D. Schedule of Availability