IPRO 346

Design and Market Analysis of Condensate Recycling from Commercial HVAC Systems

PROJECT SPONSER: PENTAIR

FACULTY ADVISOR: PHILIP LEWIS

TEAM MEMBERS

ABHISHEK CHANDNANI

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MICHAEL REGACHO

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PHILIP TAM

AANCHAL TANEJA

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Abstract:

IPRO 346 is put together to work with and assist Pentair Water Company. The main task is to collect condensate from commercial HVAC systems in attempt to quantify it and test the chemical content of it. These tasks will be completed so that a feasible use or uses can be developed for the condensate water. The use or uses will be backed by not only the collected data but market and business analysis as well.

The uses for the collected condensate water and the data collected will be presented in a formal technical paper. This will include detailed information about the quantity and chemical content of the condensate. The uses proposed will be based on the amount of condensate produced and what Pentair products such as pumps and filters can be used to accomplish these uses. This will ultimately determine a 'green' solution for condensate harvesting and will incorporate Pentair's existing products.

The project plan is a report on the current work plan and the direction in which the IPRO is headed. This is subject to change as the summer semester progresses. It also includes a brief history and background about Pentair and condensate harvesting in general. Finally it includes a team breakdown which includes more specific tasks to be accomplished as well as a Gantt chart show the key deliverables and their deadlines.

Team Information:

The IPRO 346 roster, along with each individual's strengths, skills, and expectations, can be found in appendices A & B.

Team Purpose:

To propose a working, cost efficient system to recycle air conditioner condensate to reuse for productive non-drinking purposes based on the quantification and chemical data of samples.

Team Objectives:

The objectives set for the team include:

- Calculation of the amount of condensate water generated by air conditioning units
- Suggesting a plan for a system to collect the condensate water
- Testing the condensate for bacteria and other chemicals
- Finding a purpose for the generated condensate water
- Marketing the system to the consumer (if the water generated is a great amount and profitable).

Background:

History

In 1966 Pentair Industries, Inc. was founded by: Murray Harpole, Vern Stone, Vincent Follmer, Leroy Nelson, and Gary Ostrand, from where the company name is derived from the Greek root for five, penta-, for its five founders. The company charter which states that "the corporation has broad business purposes" was a base to the diversification that the company would later create success upon. By evolving with growing demands in 1968 Pentair first put their efforts into the paper business. By purchasing Peavey Paper Mills, the company achieved a profitable partnership with Proctor & Gamble. This would lead into purchases of other various paper companies. Throughout the 1970s the company looked into further diversifying and growing by investing in power tools. In 1981 Pentair acquired Porter-Cable a manufacturer of portable electronic power tools as their first non-paper business. The company expanded this business venture up until 2004 by

acquiring both Rockwell stationary tools, followed by Biesemeyer, and finally with Oldham Saw Co., Inc.
In 2004, with the acquisition of WICOR industries, building upon previous investments, and with keeping of the company charter, Pentair had improved and upgraded their company portfolio and is currently invested in the water industry. Their $2 billion water technology business serve commercial, industrial, municipal, and residential markets worldwide. Pentair continues to develop innovative solutions to the world's increasing water consumption needs. Pentair has head quarters in Asia and Europe, the main being in Minneapolis, Minnesota. Currently they are listed on the NYSE and in 2007 had sales of $3.4 Billion worldwide.

Current Issues

As certain resources dwindle and the world has become increasingly environmentally aware, many alternative methods, products, and processes have change in order to extend or be less reliant on these resources. Water of course is abundant in the world but fresh water is an increasing necessity in parts of the world, especially those in dry areas or less fortunate circumstances. Reducing waste water is an obvious solution. Pentair intends to use current HVAC systems' condensate water as a way to solve the ever growing water consumption issue.
In all HVAC systems, residential and commercial, as the refrigerant goes through the cooling pipes and as humid air passes over these same pipes, condensate forms and slowly drips into a collection pan; this water is then dumped and not used. While most just dump this condensate water into sewer systems, only few collect this condensate and reuse it. Many do not realize the amount of water that come off these HVAC systems and its potential as a source of clean water, with very little attempts at solving the problem.
Pentair is attempting to find a solution to the issue of increasing water consumption by using condensate as another source of water in dry and/or impoverish areas around the world in commercial applications. Commercial buildings generate thousands of gallons of condensate which can be used to potentially cut utility costs but also help become more "green" by reusing the typically dumped water for other applications.

Technology & Historical Considerations

Currently very few use condensate as a source of water. Most do not collect this condensate for later use, while only a few do collect it, usually those in dryer areas. Many do not employ any purification techniques which are important to consider since condensate from HVAC systems normally have impurities and bacteria despite that condensate can be just as clean as distilled water. Also state codes and

laws prevent the possible collected condensate to be pumped back into building for use or consumed due to these impurities. The only known use for condensate is for irrigating landscaping. Condensate is greatly overlooked as a potential source of water which many companies and cities can utilize and recycle.

Ethical Considerations

Two ethical issues that arise are reuse inside buildings and consumption. City codes and laws may prohibit the use of condensate back into buildings through existing plumbing. Whereas, uses for drinking water or irrigation of edible crops may be hazardous to the publics' health, both due to possible impurities and/or bacteria during collection of condensate.

Team Values Statement:

Desired Behaviors

- Punctuality and attendance is a must, a team is not a team if just one member is missing.
- Work efficiently by speaking what is on your mind and listening to every team member's ideas, this will help prevent a dictatorship team format.
- Take charge if needed, when something needs to get done volunteering is encouraged.
- When working with Pentair, be professional and treat all employees with respect, listen to what their needs are and work to meet and exceed those needs.
- Speak up in and out of class, if topics are unclear then ask questions, if ideas come up then share them with the entire team.
- Treat each team member with equal respect

Conflict Resolution

Conflicts of many sorts arise during the course of all team oriented project. Issues such as personal conflicts, conflicts of interest and team disagreement about the direction of the project will all be handled by communicating with one another in attempt to reach a reasonable resolution. The focus of the communication will be put on the problem itself rather than the individual who may have brought it up, this will allow us to avoid any personal disrespect in regards to any individual's problem. IPRO 346 will follow the method of conflict resolution shown below.

- Determine where the conflict arose and what mattes it contains
- Consider each team member's feelings concerning the conflict
- Figure out what is the best resolution to the conflict as a team
- Make sure each team member clearly understands the direction and desired outcome of the resolution
- Allow for open and mature understanding by each team member, this will help avoid any stubborn views on the direction of the project.

Work Breakdown Structure:

Team Structure
Overall Team Leader - Zachary Waas

Group 1: Survey / Business and Marketing

Members:
Sami Somo (Group Leader)
Zachary Waas
Michael Spytek
Christopher Najarian
Jinwoo Lee

Tasks:

- Choose various commercial locations such as museums, malls, grocery stores, etc.
- Create survey questions about how they are dealing with condensate and how much they are interested in reusing condensate as replacement for water
- Distribute surveys and collect data
- Based on the data, propose feasible uses for condensate and create a formal report of the results

Group 2: Testing

Members:
Philip Tam (Group Leader)
Sami Somo
Abhishek Chandnani
Aanchal Taneja

Tasks:

- Make an appointment to use labs and necessary materials such as vials and pipets
- Research on atomic absorption spectroscopy
- Acquire testing chemicals
- Test collected condensate and create a formal report of the results

Group 3: Research

Members:
Abhishek Chandnani (Group Leader)
Michael Regacho
Angad Singh
Jinwoo Lee

Tasks:

- Research laws and codes on current condensate use
- Research reasons for scarce uses of condensate
- Research current uses in commerce

Group 4: Collection and Quantification

Members:
Michael Spytek (Group Leader)
Angad Singh
Zachary Waas
Aanchal Taneja

Tasks:

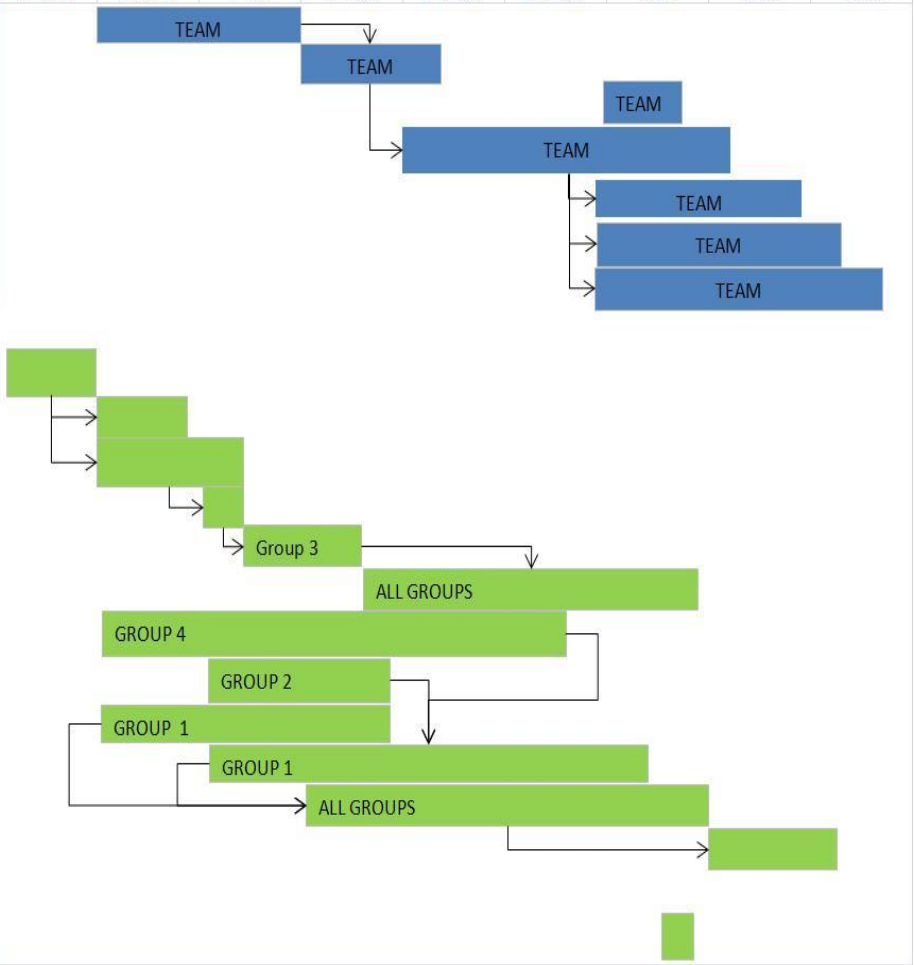
- Install Pentair pumps at commercial sites
- Collect condensate and quantify the amount collected on a daily basis
- Contact commercial buildings where there is a system that collects and uses condensate and ask if they can share the data

Problem Solving Process

1. Meet with Pentair Inc. to discuss the project plan
2. Take a tour of the factory and obtain two pumps that will be used in the project
3. Install one pump in Chicago area, and the other in a different area, in India for the project
4. Collect and obtain data on a daily basis
5. Meet with Clark, a maintenance engineer at MTCC, and take a tour of A/C unit.
6. Discuss with Clark about the project and obtain information about how condensate can be collected and used
7. Based on the collected data, test samples of condensate and record the results
8. Meet with Pentair Inc. again to present the progress and the result of the project
9. Discuss what can be improved and corrected for a better final result

GANTT CAHRT

Task No.	Task Name	Start	Finish
1	Project Plan	Thurs 5/27	Thurs 6/10
2	Midterm Review	Tues 6/8	Thurs 6/17
3	Ethics Bowl	Thurs 7/1	Thurs 7/1
4	Final Project Report (Draft)	Tues 6/22	Thurs 7/8
5	Abstrat, Brochure and Poster	Tues 6/29	Tues 7/13
6	IPRO Day Presentation	Tues 6/29	Thurs 7/15
7	Final Project Report	Tues 6/29	Sat 7/17
8			
9	IPRO Orientation	Tues 5/25	Tues 5/25
10	Introduce and Organize Team	Thurs 5/27	Thurs 6/3
11	Brain Strom Initial Ideas/Thoughts	Thurs 5/27	Tues 6/8
12	Visit Pentair (ALL TEAM MEMBERS)	Fri 6/4	Fri 6/4
13	Further Develop Ideas/Thoughts Based on Research	Tues 6/8	Thurs 6/17
14	Finalize Condensate Use/ Uses Based on Collect Data	Tues 6/15	Thurs 6/24
15	Quantify Condensate	Tues 6/1	Tues 6/29
16	Collect Samples For Chemical Testing	Tues 6/8	Tues 6/22
17	Condensate Market/Economic Research	Tues 6/1	Tues 6/22
18	Business Plan Development	Tues 6/8	Tues 7/6
19	Technical Paper (Draft)	Tues 6/15	Tues 7/13
20	Technical Paper (Final) -Quantified and Marketable Use	Tues 7/13	Thurs 7/15
21			
22	Second Visit to Pentair (ALL TEAM MEMBERS)	Thurs 7/8	Thurs 7/8



KEY	
	DEADLINES
	IPRO DELIVERABLE WORK PROCESS
	PENTAIR CONDENSATE USE WORK PROCESS

Expected Results:

IPRO 346, with help from the Pentair Water Company, is aimed mainly at collecting, quantifying, testing and making appropriate use of the condensate from commercial HVAC systems. In order to achieve our goals in an efficient and organized manner, four sub-teams were formed, who are working respectively on their assigned tasks. The "Survey" sub-team's goal will be to form and distribute questionnaires to collect people's views on collecting and making productive use of condensate. An identification of the possible contaminants of condensate will be possible through a series of biological and chemical tests performed on the samples by the "testing" sub-team. These samples for testing are collected from various environments in order to obtain accurate findings. The "Research" sub-team would help investigate and give us an idea about the laws and codes on current condensate use and to the reasons for the scarce usage of condensate. Finally, the combining and organization of all the data received from the various sub-teams would help us come up with an economical and feasible "green" product that makes productive usage of condensate.

Budget:

Activity	Cost	Description
Transportation	$720	2 Round trips to the company. 144 mile round trip at .50 cents/mile for 5 cars
Food	$70	Lunch at the company. 10 people at $7 a meal
Printing/Supplies	$70	Finishing cost for brochures/posters/supplies
Chemical Supplies	$100	Chemical supplies to test condensate collected
Shipment	$100	Shipment of pump to India
Counter	$90	Counter to determine amount of condensate at $30/pump for 3 pumps
PVC and Copper Piping Supplies	$250	Piping needed to attach pump to AC unit. Copper Piping for pre-cooling the air
Totals	$1,400	

Designation of Roles:

Minute Taker: Aanchal Taneja. She will be responsible for preparing the minutes from the weekly student meeting. Each sub team will also have a rotating minute taker to record the events of the weekly on-site meetings.

Agenda Maker: Mike Spytek. He will prepare the agenda for the weekly student meeting. The project group leaders will work to prepare the weekly agendas.

Time Keeper: Angad Singh. He will ensure the meeting go according to the planned agenda and will also work to avoid any distractions.

Igroups Moderator: Zach Waas. He will be responsible for ensuring that the IPRO deliverables are completed on time and properly uploaded to the iGroups website. Will be tasked to ensure that major milestones are added to the iGroups site and that necessary information is delivered to the team.

APPENDIX (A)

Team Roster:

Group Membersz	Major	Contact Info
Abhishek Chandnani	Mechanical Engineering	achandna@iit.edu
Jinwoo Lee	Architecture	jlee185@iit.edu
Christopher Najarian	Electrical Engineering	cnajari1@iit.edu
Michael Regacho	Mechanical Engineering	mregacho@iit.edu
Angad Singh	Mechanical Engineering	asingh63@iit.edu
Sami Somo	Biomedical Engineering	ssomo@iit.edu
Michael Spytek	Mechanical Engineering	mspytek@iit.edu
Philip Tam	Chemistry	ptam2@iit.edu
Aanchal Taneja	Electrical/ Computer Engineering	ataneja6@iit.edu
Zachary Waas	Mechanical Engineering	zwaas@iit.edu

APPENDIX (B)

Team Information:

Group Members	Strengths, Skills and Experience	Weakness	Knowledge/Skills to Develop	Expectations For project
Abhishek Chandnani	Good organization skills, Interpersonal Skills and networking capabilities, MS Word, MS Excel, MS PowerPoint, C++, AutoCAD, MATLAB	Marketing	Better understanding of HVAC systems and condensate use	Contribute towards a green environment
Jinwoo Lee	AutoCAD, 3dsmax, sketchup, Photoshop, Illustrator, Foreign Language: Korean	Communication skills, lack of knowledge of other fields	Better communication skills	greater knowledge of condensate and HVAC for use in architecture
Christopher Najarian	Math Skills, Creative thinking, Teamwork	Communication skills, lack of knowledge of other fields	Market research, learning about cost efficiency, communication among classmates	Learn as much as I can about condensate. Develop a real world application for the condensate
Michael Regacho	AutoCAD, ProEngineer, Paperwork/organization, MS Excel, MS Word, Skill Acquisition, Hands-on Work	coding and programming	HVAC systems	Gain more experience problem solving and working with a team, learn about HVAC systems, build new friendships, and apply current knowledge to solve a real world issue.
Angad Singh	Have Hands on Experience with the underfill, surface mounting, assembly and testing procedures. Pro-efficient in Word, Excel and PowerPoint.	Programming, spelling	How make HVAC systems more efficient	Contribute towards a green environment
Sami Somo	MS Word, MS Excel, MS Power Point and Matlab	Public speaking	exposure to project management skills	Team building and management
Michael Spytek	MS Office, Operation of Milling Machines, Fabrication of test equipment, Wood/Metal Working, Automotive Repair, Business Operations Including Suppliers/ Customers and Hiring Process, Working for a Department of Defense Research and Development Contractor	Organization, Spelling, Time Management	Better Organization, Better understanding of how HVAC systems work	To complete the project and find a useful application for condensate
Philip Tam	MS Work, MS Excel	Time management on projects	Learn how an engineer thinks and apply to Chemistry	Find out what impurities are in HVAC condensate and find a way to neutralize them
Aanchal Taneja	Team worker, Hard Working , Inquisitive and Explorative, Communicative, Coherent with the subject material as well as some of its real life implications	How mechanical thing work	Learn about HVAC	Find a way to use condensate to improve efficiency
Zachary Waas	excel, group work, hands on metal and wood work, AutoCAD, Solidworks, detailed dimensional drawings and 3-D renderings of various components	Programming, Time due to work schedule	Better understanding of HVAC systems and how to optimize their uses	To complete a successful project, learn more about the entire HVAC world, and build new friendships