

## **InnovationDistillation Collaboration with Outside Sources:**

### **Professor Meng Wang** – *University of Notre Dame*

InnovationDistillation representative Daniel Driscoll met with Prof. Wang 9/1/06 to discuss the preliminary feasibility of the use a heat pump to recycle energy from the condenser to the boiler. No calculations had been performed prior to the meeting. No conclusive results were reached, but InnovationDistillation was referenced to Dr. Sen for his work with campus air conditioning systems and extensive doctoral research in heat transfer. Chapters 10 and 11 of Fundamentals of Heat and Mass Transfer, containing information on heat exchangers and condensers, were also mentioned.

### **Dr. Mihir Sen** – *University of Notre Dame*

After performing some crude calculations for the energy required to heat and boil water, and the resulting volumetric flow rate of the steam, InnovationDistillation met with Dr. Sen 9/5/06 to further discuss the feasibility of using a vapor-compression heat pump to recycle energy. Although he was not able to discuss in detail the use of a vapor-compression cycle as a heat pump, Dr. Sen mentioned the possible implementation of a thermoelectric unit. This unit would greatly reduce the complexity of the entire system, as well as increase the durability of the system. A vapor-compression cycle has the potential for failure by leaks and may eventually lose its charge through normal operation. He also referenced InnovationDistillation to Professor Liu, whose husband works at Whirlpool.

### **Professor Eric Jumper** – *University of Notre Dame*

InnovationDistillation representative Daniel Driscoll contacted Prof. Jumper through email, in an effort to better understand the vapor-compression heat pump. Prof. Jumper failed to respond in a timely manner.

### **Professor Katherine Liu** – *University of Notre Dame*

InnovationDistillation representative Daniel Driscoll met with Katherine Liu 9/11/06 to discuss the application of a vapor-compression cycle to a water distillation device. She coined the term “energy harvesting,” which helped to better describe the sought process. Although no technical knowledge was gained from this meeting, Prof. Liu said she would have her husband, who works with Whirlpool, come to meet with the group to discuss the availability of pre-made units for purchase.

### **Dr. Stephen Silliman** – *University of Notre Dame*

InnovationDistillation representative Daniel Driscoll contacted Dr. Silliman through email, in an effort to better understand the target market and eventually develop more concise design requirements. A meeting was set for 9/20/06.

### **Red Cross**

InnovationDistillation representative Kevin Hederman sent emails to both the national marketing office and local St. Joseph county office. Neither groups have responded.

### **James Hudson** – *Sullivan Products*

InnovationDistillation representative Kevin Hederman corresponded with James through email about the use of electric motors for generating electricity from mechanical input. The requested motor was to have maximum power output, with maximum efficiency. James mentioned that although a unit exists with roughly 99% efficiency of mechanical to electrical energy conversion, such a motor would cost upwards of \$4,000. Other, more economical motors, would cost around \$100, but would only be roughly 80% to 90% efficient.

**Comment [d1]:** This needs to be checked with Kevin. I can't remember exact numbers anymore, and I never recorded them.

### **Mr. Liu** – *Whirlpool*

InnovationDistillation representative Daniel Driscoll met with Mr. Liu and his wife Prof. Liu 9/15 to explore the use of a vapor-compression cycle as a heat pump for harvesting and recycling energy. Mr. Liu mentioned that in order to achieve the  $T_H$  temperature of 120° C required for operation, CO<sub>2</sub> must be used

as the refrigerant. He also discussed the implementation of using both external and internal heat pump cycles, using a sequential system connected to a single compressor. Using a heat pump to draw energy from the air could have a greater COP than using electrical resistance in a heating element to initially boil the water. By sequentially switching the flow of refrigerant from the steam condenser to a network extracting heat from the air, the overall COP of the system could be further enhanced. Mr. Liu also referenced InnovationDistillation to the companies Copeland, Tecumseh, and Embraco as possible suppliers for the heat pump system.

**Comment [d2]:** I couldn't think of any more contacts we had, but please add any more you can think of.