June 25, 2012

TC 8.3 RESEARCH SUBCOMMITTEE
MINUTES OF MEETING IN SAN ANTONIO, TX

TC 8.3 Research Subcommittee met on June 25, 2012, in San Antonio, Texas. A list of minute recipients and attendees is attached. (Attachment 1)

1. Review of Minutes from January 23, 2011, meeting in Chicago, IL.

The minutes were reviewed and no changes were requested by the subcommittee members.

2. Bidder Selection 1462 TRP *"Active Mechanisms for Enhancing Heat and Mass Transfer in Sorption Applications".*

Three proposals were received. The proposal evaluation subcommittee met earlier and reported as follows:

Ebrahim failed to submit his score. The decision for vote was postponed until all evaluation results are available. A letter vote by the committee members is expected.

3. RTAR 1638 *"Absorption Refrigeration Cycle Training Simulator for Sustainable Resource Use".* (Attachment 2)

There was some confusion within ASHRAE regarding the RTAR and suspicion that it got lost. David Yashar, RAC liaison, was to investigate. Vikas Patnaik and Ebrahim AL-Hajvi agreed to review ASHRAE comments and make adjustments in January, 2011, and did do so.
ASHRAE was to respond, (see Minutes from June 27, 2011). It appears no response was received from ASHRAE.
Vikas agreed to follow up with ASHRAE regarding its feedback.

4. RTAR 1662 *"Absorption Cycle Computer Simulator".* (Attachment 3) (Changed from RTAR 1641 to RTAR 1662)

Paul Sarkisian and Jay Kohler are the authors of this RTAR. The subject was not addressed at the last subcommittee meeting due to the confusion between RTARS (1638 & 1641). Paul Sarkisian agreed to contact ASHRAE to explore the status.

5. Other Business

Application Guide for Absorption Cooling/Refrigeration of Recovered Heat.

Piyush Patel expects to report his review findings at the next meeting.

Attachment 1

ATTENDANCE LIST

Hank	Bagheri	Handbook Liason	hbagheri@aol.com
Ebrahim	Al-Hajri	Petroleum Institute	ealhajri@pi.ac.ae
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~~Ken~~	~~Schultz~~	~~Webmaster~~	~~kschultz@trane.com~~
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David	Yashar	Research Liason	dyashar@nist.gov

Attachment 2

Unique Tracking Number Assigned by MORTS _____

RESEARCH TOPIC ACCEPTANCE REQUEST (RTAR) FORM

(Generally 2 to 6 pages, with 10 pt Times New Roman font)

Sponsoring TC/TG/SSPC: _____8.3_____

Title:
Absorption Refrigeration Cycle Training Simulator for Sustainable Resource Use

Applicability to ASHRAE Research Strategic Plan:
The absorption refrigeration cycle training simulator would meet Goal 7 (Support development of tools, procedures and methods suitable for designing low energy buildings) of the 2010-2015 ASHRAE Research Strategic Plan. The training tool would enable users with a better understanding of the absorption refrigeration cycle, which is deemed by industry experts to be a sustainable technology using zero-ODP, zero-GWP refrigerants and improving overall energy utilization rates. Further education and understanding of this technology would lead to further development and deployment of the absorption cycle, replacing systems using harmful ozone depleting substances and higher grades of energy. In addition, with further development, refrigeration / air-conditioning could be introduced to areas of the world where availability of this higher grade of energy (electric power) is limited.

Research Classification:
Technology Transfer

TC/TG/SSPC Vote:
6-0-0-6

Reasons for Negative Votes and Abstentions:
N/A

Estimated Cost:
$75,000

Estimated Duration:
15 months

RTAR Lead Author
Vikas Patnaik, vpatnaik@trane.com

Expected Work Statement Lead Author
Ebrahim Al-Hajri, ealhajri@pi.ac.ae

Co-sponsoring TC/TG/SSPCs and votes:
N/A

Possible Co-funding Organizations:
N/A

Application of Results:
Software program available for purchase from ASHRAE, ASHRAE Green Guide, Handbook chapters 1 and 41.

State-of-the-Art (Background):
A few absorption cycle simulation programs have been developed and released in the past, the most notable of which is ABSIM (2002), from Oak Ridge National Laboratory. Others are not as publicly available and/or have not been actively maintained. Any active programs tend to be proprietary and serve as design tools for companies producing absorption equipment. ABSIM is a modular computer code for simulation of absorption systems, based on unit subroutines containing the governing equations for the system's components and on property subroutines containing the thermodynamic properties of the working fluids. However, ABSIM was developed in Windows 95 and is not currently funded or supported. As a result, it has not performed consistently stably in newer Windows environments.

Advancement to the State-of-the-Art:
For the purposes of training/educating the general HVAC&R practitioner, a tool is needed that uses state-of-the-art software technology and is not as complex as ABSIM or other previous similar tools. These have been more equipment-focused, rather than application- or solution-oriented. The proposed tool is more intended to show the functioning of the absorption cycle in its various configurations, and how these respond to changing operating conditions – heat source temperatures, ambient conditions, cooling load etc.

The underlying component models of the configurations will be based on the fundamental principles of thermodynamics, mixture equilibrium and heat & mass transfer. This approach is deemed sufficient to illustrate the benefits/applicability of absorption technology for a variety of application scenarios or envelope conditions.

Validation of such models is typically not necessary, especially when they do not comprise a design tool. As a result, model validation will not be part of the scope of this work.

Having said this, the proposed tool will build on the capabilities of ABSIM and other similar tools to be a more user-friendly program that could find widespread use in the HVAC&R industry beyond the advanced design engineer. It would give flexibility to the user to link components/fluids which are not available with the current version of ABSIM.

Justification and Value to ASHRAE:
Ultimately, the deployment of the tool will result in a better understanding and awareness of how absorption systems can reduce overall energy utilization via integrated energy systems that avail of renewable sources of energy such as waste heat and solar. The commercial, industrial and retail HVAC&R consulting/contracting communities looking to reduce overall energy consumption rates will thus benefit from the proposed work. This directly supports the sustainability goals ASHRAE has set forth for itself. Last but not least, this work will result in increased revenues for ASHRAE through the sale of the simulator tool.

Objectives:

1. Survey the open literature for simulation efforts on absorption technology to build upon.
2. Develop simulator that includes a library of energy sources and their characteristics, including renewables, a library of proven (in-practice) working fluids and their characteristics, and finally a library of proven (in-practice) sub-systems (components) and systems and their characteristics. Energy sources would include direct exhaust, indirect waste-heat (hot-water or steam), solar etc.. Working fluids would include water-lithium bromide and ammonia-water. Components would include the generator, absorber, condenser, evaporator, solution heat exchangers, pumps, expansion valves, interconnecting piping, and so on.
3. Allow for plug-&-play simulation with components (dynamically linked libraries) from other sources.
4. Use state-of-the-art software platforms such as Windows 7 and the .NET framework while preserving backward compatibility with older systems.
5. Test tool for reasonableness (accuracy), robustness (crash-worthiness) and usability (speed, GUI).

Key References:

Grossman, Gershon, and Zaltash, Abdi, 2001, "ABSIM — modular simulation of advanced absorption systems," *International Journal of Refrigeration*, Volume 24, Issue 6, pp. 531-543.

McLinden, M. O., and Klein, S. A., 1985, "Steady State Modeling of Absorption Heat Pumps with a Comparison to Experiments," *ASHRAE Transactions*, Vol. 91, Part 2b, pp. 1793–1807.

Phillips, B. A., 1988, "Development of a Gas-Fired Heat Pump with an Improved Absorption Cycle," *Proceedings of the 1988 ASME Winter Annual Meeting, Chicago, Illinois, November 27–December 2*; Analysis and Applications of Heat Pumps, Vol. AES-8/SED-6, pp. 97–102.

Attachment 3

2.3 Research Topic Acceptance Requests (RTARs)

Unique Tracking Number Assigned by MORTS ___ 1641-RTAR _____

RESEARCH TOPIC ACCEPTANCE REQUEST (RTAR) FORM

(Sponsoring TC/TG/SSPC: TC 8.3

Title: **Absorption Cycle Computer Simulator**

Applicability to ASHRAE Research Strategic Plan:

The absorption cycle computer simulator would meet the ASHRAE research strategic plan. Specifically, it would apply to Goal 1 of the 2010 – 2015 Strategic Plan, to maximize the actual operating energy performance of buildings and facilities in that it would enhance the understanding of equipment operators and technicians to the operation of absorption chillers, making them more capable of operating chillers to maximize efficiency and avoid chiller failure. It would also comply with item 10 of the Needed Research under Goal 1 in that it would allow the identification of "best practice" sequences of operations to improve the quality of controls implementation for the absorption chiller, or chillers, in a building. The model would allow equipment operators and technicians to understand the impact of chilled and cooling water flow rates and firing rates on absorption chiller cooling capacity and COP. It would also allow understanding of the impact on of these on important system characteristics such as proximity to fluid crystallization. This knowledge would likely allow the operators and technicians to evaluate and develop a better appreciation for optimal operational performance of these chillers in a building environment. The model would also be of sufficient sophistication to allow modeling of different type of single and double effect chillers by engineering students in an educational environment.

The proposed Absorption Cycle Computer Simulator would be useful as a technician or operator training tool or for the education of HVAC engineering students. The Simulator would become a standalone product for sale at the ASHRAE Bookstore.

Research Classification: Basic/Applied

TC/TG/SSPC Vote:

7-0-0

Reasons for Negative Votes and Abstentions:

No Negative Votes

Estimated Cost:

$150,000

Estimated Duration:

18 months

RTAR Lead Author
Paul Sarkisian

Expected Work Statement Lead Author
Paul Sarkisian

Co-sponsoring TC/TG/SSPCs and votes:

None to date

Possible Co-funding Organizations:

None to date

Application of Results:

CD for Purchase at ASHRAE Bookstore. If desired, the Simulator could also be used as an online ASHRAE software resource.

State-of-the-Art (Background):

The present state-of-the-art modeling software is suitable for absorption simulation is ABSIM. While a good tool for detailed analysis of a wide variety of absorption and absorption/vapor compression cycles, the program requires considerable training time to use and lacks the type of user friendly graphical user interface that would be suitable for use as an educational or training tool.

Advancement to the State-of-the-Art:

Efforts under this project would result in an educational and training tool for students, technicians and operators interested in LiBr-H_2O absorption technology. No such tool presently exists.

Justification and Value to ASHRAE:

The proposed Absorption Cycle Computer Simulator would have an impact on absorption chiller technicians, operators and students studying absorption cycle thermodynamics. Lack of ability to simulate absorption cycles is cited as an impediment to the understanding of such systems. . When powered by waste heat, absorption equipment can significantly reduce energy consumption in HVAC systems, and this simulation capability could help improve the understanding of this type of CHP system.. ASHRAE could provide the Simulator as a separate CD to be purchased at the bookstore, and its revenue would likely support the cost for its development and provide additional long term sales for the Society. The software would be exclusively owned by ASHRAE and subject to its requirements for distribution.

Objectives:

The objective of the Absorption Cycle Computer Simulator project is to develop an educational tool that would allow a user interactive analysis of a variety of LiBr-H_2O absorption thermodynamic cycles. The simulator would have a graphical user interface (GUI) for simple interaction by the user. Included in the simulator would be the capability of modeling single and double effect chillers fired by hot water, steam, natural gas combustion or waste heat.

The GUI interface would allow components such as the generator, absorber, evaporator, condenser, solution heat

exchanger and solution and pump to be input into the model by the user. Different solution circuiting possibilities would be possible, such as those used in various types of double effect chiller cycles. The model will allow heat exchanger and pump parameters to be input by the user and would also allow the possibility of water or air cooling of the absorber and condenser. Default parameters would be set so that novice users could obtain useful results.

Operating condition parametric studies would be possible using the model. Entering source and sink fluid flows and temperatures along with variation of these parameters would be allowed using a simple GUI interface. Variation of heat exchanger UA values or effectiveness would also be allowed. Solution flow rate parameters could be input as relative pumping rates or mass flow rates and flow splits and mixing capabilities would also be possible. Both full and part load performance would be modeled.

Outputs from the model, which would be viewable using the GUI, would include all thermodynamic state points, including their temperature, concentration, enthalpy, entropy in tabular form as well as a Duhring plot representation of the cycle. The Duhring plot would include the crystallization line and would allow multiple cycles to be plotted at the same time for parametric studies. In addition, the output would allow plots of capacity, COP, or other state point information to be plotted as a function of an input parameter for the parametric study.

The model would include simplified baseline absorption cycle models for single effect (steam and hot water fired) and double effect cycles (steam and direct fired) that are representative of generic commercial products. These baseline cycles would be useful in the training of absorption technicians and operators to further their understanding of the effects of such variables as cooling tower water inlet temperature and flow rate, chilled water inlet and flow rate, hot water temperature and flow rate, steam pressure and firing rate on chiller capacity and COP.

The approach to this effort would be to develop the models based on basic absorption cycle thermodynamic, heat transfer and LiBr-H_2O fluid principles. The mathematical modeling would allow modular subroutine type flexibility, with a user friendly GUI that is suitable for a product offering.

The software would be available for sales as a standalone CD by ASHRAE

Key References:

1. Grossman, G., Zaltash, A., "ABSIM : Modular Simulation of Advanced Absorption Systems," International Journal of Refrigeration 24, 531-543 2001
2. G. C. Vliet, M. B. Lawson and R. A. Lithgow. "Water-Lithium Bromide Double Effect Absorption Cooling Cycle Analysis." *ASHRAE Transactions,* 88, Part 1, pp. 811–23 (1982).

3. M. O. McLinden and S. A. Klein. "Steady State Modeling of Absorption Heat Pumps with a Comparison to Experiments." *ASHRAE Transactions,* 91, Part 2b, pp. 1793–1807 (1985).
4. G. Grossman and E. Michelson. "A Modular Computer Simulation of Absorption
5. Systems." *ASHRAE Transactions,* 91, Part 2b, pp. 1808–27 (1985). Also ORNL/Sub/83-43337/2, Oak Ridge National Laboratory (1986).
6. G. Grossman, K. Gommed and D. Gadoth. "A Computer Model for Simulation of
7. Absorption Systems in Flexible and Modular Form." *ASHRAE Transactions,* 93, Part 2, pp. 2389–2428 (1987). Also ORNL/Sub/90-89673, Oak Ridge National Laboratory (1990).

1) There needs to be a better establishment of the need for the research. Be more specific about the connection to the Research Strategic Plan. List the specific parts of the plan under "Needed Research" in goals 1 and 7. Your literature search has references to models but not education. You need to show that the tool, when developed, will be used for education purposes by citing references to existing training in absorption technologies. Give some examples of classes and institutions that conduct this training.

2) I think you will need to seek co-funding. The research backlog is pretty full right now and projects that come with co-funding get priority.

3) You would help your cause if you listed a goal to develop an algorithm specifically for existing energy use simulation engines such as Energy Plus.

4) The RTAR gives some reasonable goals for the tool but says little or nothing about the approach to develop it. Even though this is not a work statement, some discussion of the approach is needed for this work to get any serious consideration by RAC.

Finally, you saw the email stream with our Publication and Education leadership and can see that in order for this work to be useful for ASHRAE in a business sense it must stand on its own and not be simply put in with the Handbook.

I suspect that there will be some on RAC that will wonder if any project regarding Absorbers has a broad market potential. You need to address that prejudice up front to head it off.