TC 08.05 RESEARCH REPORT – JAN 2010 / ORLANDO

ACTIVE PROJECTS

1316-RP: Experimental Evaluation of the Heat Transfer Impacts of Tube Pitch on a Highly Enhanced Surface Tube Bundle. *PI: Steve Eckels, Kansas State Univ. PMS: Petur Thors (chair), Ben Dingel, Satheesh Kulankara, Axel Kriegsmann. Status: active (start date: Jan-2006. original target completion date: Jul-2008. extension #1 granted Salt Lake City mtg, Jun08: Jul-2009. extension #2 granted Louisville mtg, Jun09: Jul-2010. current projected completion date: Jul-2010.)*

Evraam Gorgy is the student working on this project as a PhD candidate. The seal elastomer/refrigerant compatibility problem has been solved. Turbo-BIIHP tubes were successfully installed and stable operation of the facility has been achieved. The amount of refrigerant in the rig is manipulated at each operating condition to reach a critically charged state. The PMS has approved the test matrix proposed by the PI on 07-Dec-2010. The first portion of the test matrix, P/D = 1.33 w/R134a, has been completed, although some testing continues to check repeatability.

Bundle average heat transfer coefficients were presented and general agreement was shown with the previous Robinson and Thome study. Analysis to determine local heat transfer coefficients is underway. Tests with R123 in the 1.33 bundle will be conducted next. Data collection is projected to be complete by the summer meeting. If additional time is needed to complete testing, analysis, and compilation of the final report, that request will be made in Albuquerque.

Two papers are being prepared: 1) "Pool Boiling of R-134a and R-123 on Smooth and Enhanced Tubes, Average Heat Transfer Coefficient Analysis" has been circulated to the PMS for comments and will be submitted to *HVAC&R Journal*. 2) "Local Heat Transfer Measurements in Water Heated Tubes Undergoing Pool Boiling" is in development.

The PI has proposed holding monthly meetings *via* electronic means to keep the PMS (and others as interested) updated on progress and results. The PI will initiate the meeting invitations.

1345-RP: Waterside Fouling Performance of Brazed-Plate Type Condensers in Cooling Tower Applications. *PI: Lorenzo Cremaschi & Jeffrey Spitler, Oklahoma State Univ. PMS: Jim Bogart (chair), Art Fovargue, Axel Kriegsmann, Ken Schultz, Xudong Wang (ARTI cofunding). Status: active (start date: May-2008. original target completion date: Oct-2010).*

The students performing this work are Ellisa Lim and Annamalai Ramesh. A better understanding of water quality with regard to precipitation fouling has been reached with the help of Bill Pearson (TC 3.6, Water Treatment). To create and maintain foulant concentrations at/above the saturation point (at the elevated wall surface temperature), a small cooling tower has been installed in the test loop. After the initial mixing of the reverse osmosis water and minerals, the cooling tower is operated without makeup water until the desired LSI is reached; pH is measured and adjusted twice daily. From here on, makeup water is added to maintain the target LSI.

Tests have been completed on the first BPHE – aspect ratio #1 w/60° ("soft") corrugation angle (measured from horizontal) at 105°F refrigerant saturation temperature. The fouling resistance steadily increased to a value of ~0.002 hr-ft²-°F/Btu at ~25 days. This value was sustained for another ~10 days with the cooling tower isolated from the water circuit. The pressure drop steadily increased over the course of exposure, reaching 50% higher at the end than the "clean" beginning value. Speculation is that localized buildup of precipitate is occurring near the exit ports. A visual inspection of the plate ports will be attempted (*via* a lighted dental mirror).

The rig is currently being run with the second BPHE – aspect ratio #1 w/30° ("hard") corrugation angle. In this case, the fouling resistance remained below 0.0001 …/Btu (with periods of increase followed by sudden decreases) for first 30 days. In the last week, the fouling resistance is tending upward more steadily, but is still just approaching 0.0001. Exposure will continue for another week or so; data will be shared with the PMS to decide when to stop the test.

Prior to adding chemicals to the water, UA_{clean} was determined as a function of water flow rate and refrigerant saturation temperature in the neighborhood of the target operating condition. The average fouling resistance for each day is then determined using the UA_{clean} for the average operating conditions of the day. This allows the effects of small deviations from the target operating conditions to be accounted for. This has proven to be especially important in the second case where the fouling resistance as remained quite small.

The remaining phases of the test matrix, two more geometries at 105°F saturation plus the first two geometries at 120°F, are now projected to run into April 2011. In addition, it is proposed to run a test of one enhanced tube geometry in an attempt to provide a means of comparing fouling between BPHE's and enhanced tubes in the same physical and chemical setup; this would take through July 2011. An extension will be considered at the summer meeting in Albuquerque.

1394-RP: Study of Carbon Dioxide Condensation in a Chevron Angle Plate Geometry Exchanger. *PI: Amir Jokar, (ex-)Washington State Univ - Vancouver. PMS: Zahid Ayub (chair), Joe Huber, Jim Bogart. Status: final report submitted (start date: Sep-2007. original target completion date: Aug-2009. extension granted Louisville mtg, Jun09: Jan-2010.)*

A draft final report has been submitted to the PMS. Comments are being incorporated and the final report is near completion. Due to illness of the chair, the PMS was not able to compile a recommendation for action at this meeting. Final disposition will be handled by email ballot when circumstances resolve.

The final results of the data analysis were presented. The relatively small regions of single-phase desuperheating and and liquid subcooling were accounted for, so the derived correlations are applicable to the fully two-phase condensation region. Appropriate non-dimensional parameters were identified for the correlations and generally result in fitting the data well within ±10%.

The PI proposed attempting to standardize the definitions are various geometric parameters related to corrugated plate exchangers. It was suggested that Chapter 38 in the HVAC Systems and Equipment volume of the Handbook would be a good place for this.[1] It was also encouraged that the correlations developed in this work be inserted into an appropriate Handbook chapter (Heat Transfer or Two-Phase Flow in Fundamentals, …?).

FUTURE RESEARCH TOPICS

1556-WS: Characterization of Liquid Refrigerant Flow Emerging from a Flooded Evaporator Tube Bundle. *author: Jon Hartfield*

This project is being led by TC 1.3, with TC 8.5 as a cosponsor. The work statement was approved by RAC at the Louisville meeting (Jun09) and therefore ready to go out for bid – when money is available; see below.

[1] Actually, some BPHE geometry parameters, including corrugation angle, are defined in Fig. 32 of Chapter 3 (Heat Transfer) in the 2005 Handbook of Fundamentals – β is measured from vertical here.

TC 3.6 (Water Treatment): How Mechanical Filtration of Cooling Loops Affects Efficiency of Equipment with Enhanced Tubes. *RTAR being drafted*

The research chair from TC 3.6, Scott Mayes (mayesscott@aol.com), visited the TC 8.5 meeting to see if there would be interest in cosponsoring and helping with this project. Ken will request a copy of the draft RTAR for circulation to TC 8.5 membership.

Research Project Ideas

- "Fouling of Tube-in-Tube Type Condensers" This would continue our line of projects attempting to quantify the impact of fouling on heat transfer performance in various types of exchangers. In the past, AHRI has indicated cofunding might be available for this project. Indications given at this meeting are that the 2010 budget has been set; it could be considered for 2011. HTRI has expressed interest in doing this project. Now that 1345-RP is showing positive results, ie, this type of experimental work is feasible, it might be time to start working on an RTAR.

- Resubmission of the fouling in enhanced tubes WS remains a possible project because 1205-RP was not successful. Again, with the positive progress made by 1345-RP, it could be time to pursue this. A new WS should account for the fact that low fouling potential water did not produce any measurable fouling effect. It has also been suggested that we consider adding a modeling aspect – how should fouling be described (ie, is "$\beta_2 \cdot FF$" the correct/best description)?

- "Enhancement of Internal Flow Heat Transfer Coefficient with Micro-Encapsulated Phase Change Material" Some question about the value of this (hasn't this been done before?), but also some support. There is still some question about best place for this topic: TC 8.5 or TC 1.3. A champion for this project has yet to step forward.

- "Characteristics of new low GWP refrigerants in heat transfer equipment" Samuel Yana Motta and Jon Hartfield again expressed interest to begin drafting an RTAR. This is becoming more timely as (at least perceived) pressure continues to build for alternatives to the current portfolio of refrigerants with high GWP's.

- "New Technologies for Reducing Refrigerant Charge" This topic was proposed by Samuel Yana Motta as a corollary to the project on low GWP refrigerants because of their main drawback (many of them are flammable or toxic to some degree).

- "CO_2 in Secondary Loops" This topic was raised by Omar Abdelaziz. The rationale is that the flammable and/or toxic nature of the natural and new low GWP refrigerants might require use of secondary loops to separate these fluids from occupied spaces.

- "Nanofluids for HVAC" This topic also being considered by TC 1.3. Ken Schultz and Petur Thors stated interest in taking a shot at this. Amir Jokar also expressed interest as this is the topic of his work as a New Investigator Awardee. The suggestion was made that the work should be focused on gaining a better understanding of fundamentals as opposed to "simple" empirical work of which there are many studies in the literature with inconsistent and conflicting results.

SUMMARY FROM RESEARCH CHAIR BREAKFAST

Service to ASHRAE Research Award was given to John Murphy of TC 5.9 (Enclosed Vehicular Facilities). (?)

Beginning with the Albuquerque meeting (Jun10), the ASHRAE Transactions will contain two types of papers:

- Conference Paper – meant to emphasize current information (similar to seminar preso). Subject to expedited single-person double-blind review. Work is still eligible for future publication in HVAC&R Journal (revised and expanded). This is being done in response to

complaints about the requirement to have seminar presentations recorded. The DVD is going away.

- Technical Paper – as today, describes applied research of shorter term value. Subject to three person double-blind review.

The HVAC&R Journal remains the place for archival material of a more fundamental nature and of longer term value.

The new research liaison for Section 8 is Rick Hermans. He is beginning a three year term.

RAC is consulting with the following organizations as it reviews, prioritizes, and selects research projects: AHRI, CIBSE, CEC (California Energy Commission), and USGBC.

The final draft of the new Research Strategic Plan for 2010-2015 has been posted to the ASHRAE Research web page, http://www.ashrae.org/technology/page/39. The Plan consists of 11 goal topics, each of which was compiled from TC member inputs. Comments are being accepted through 22-Feb-2010 *via* email, ashrae.rap@gmail.com. The objective is to incorporate comments as appropriate and submit a final document for approval at the Jun10 meeting.

The Plan is not meant to dictate spending of ASHRAE research funds nor to displace tactical research. The Plan is supposed to enable and encourage broader scope, multi-TC projects of a more strategic nature. It is meant to attract outside funding in order to enable larger projects. Handout is attached.

RTAR's don't need to explicitly fit into the RSP. They do need to describe how the project will benefit ASHRAE and society. "If it's good research, it will get funded."

Due to a cash flow problem, no WS's were released for bid last fall. About 15 projects were awarded at Louisville; these consumed a good share of the available funds. On top of this, the ASHRAE board voted to withhold the 2% of member dues that are normally allocated to research for other purposes; this hit the research fund for about $130K-$150K. RAC will prioritize the approved WS's (ranking criteria not known at this time, 1556-TRP is in this pool) in a teleconference this spring; the released as RFQ's will likely be limited. Contributions to the research fund will be a factor; it they pick up, more RFP's could be released in the fall.

25-Jan-2010
Orlando

New Strategic Plan for ASHRAE Research

Being developed by RAP and RAC at direction of BOD
Seeking member input:

- Draft plan available for review at http://www.ashrae.org/technology/page/39
- February 22, 2010 last day to submit comments to RAP via ashrae.rap@gmail.com
- Final plan scheduled for submission June 2010

What It's NOT:

- It's not a plan for spending all ASHRAE research funds.
- It's not a plan for preventing tactical research.
- It's not a plan for eliminating the research aspect of specific TCs.

What it IS:

- A plan to enable and encourage strategic, broader-scope, multi-TC research projects.
- A plan to provide guidance and motivation for TCs.
- A plan to help RAC prioritize.
- A plan to encourage outside co-funding in order to enable larger $ projects
- A plan that recognizes that ASHRAE research is initiated and managed by TCs.

11 Goals – summarized on 2 pages each

1. Maximize the actual operational energy performance of buildings & facilities
2. Progress toward Advanced Energy Design Guide (AEDG) and cost-effective net-zero energy (NZE) buildings
3. To reduce significantly the energy consumption for HVAC & R, water heating and lighting in existing homes
4. Significantly advance our understanding of the impact of indoor environmental quality (IEQ) on work performance, health symptoms, and perceived environmental quality in offices, providing a basis for improvements in ASHRAE standards, guidelines, HVAC designs, and operation practices
5. Support the development of ASHRAE Energy Standards and reduce effort required to demonstrate compliance
6. Building Information Modeling of energy efficient, high performing buildings
7. Support development of tools, procedures, and methods suitable for designing low energy buildings.
8. Facilitate use of natural and low global warming potential (GWP) refrigerants Natural/Low GWP Refrigerants and develop methods to reduce refrigerant charge
9. Support the development of improved heating, ventilating, air conditioning, and refrigeration components ranging from residential thru commercial to provide improved system efficiency, affordability, and reliability – include safety.
10. Significantly increase the understanding of energy-efficiency, environmental quality, and the design of buildings in engineering and architectural education
11. Understand influences of HVAC on airborne pathogen transmission in public spaces and develop effective control strategies

TC 8.5 provided input

2010-2015 Research Strategic Plan Draft[1]

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11. Understand influences of HVAC on airborne pathogen transmission in public spaces and develop effective control strategies.

The full plan, 26 pages in length, is available online at:
http://www.ashrae.org/technology/page/39

Comments are requested by February 22, 2010. Please click on the link at the above URL or send them to ashrae.rap@gmail.com.

[1] From the January 4, 2010 public review draft.