AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC.
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TC/TG/TRG MINUTES COVER SHEET

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TC/TG/TRG NO TC 8.5 DATE April 1, 2010

TC/TG/TRG TITLE Liquid to Refrigerant Heat Exchangers

DATE OF MEETING Monday, January 25, 2010 LOCATION Orlando, FL

MEMBERS PRESENT	YEAR APPTD	MEMBERS ABSENT	YEAR APPTD	EX-OFFICIO MEMBERS AND ADDITIONAL ATTENDANCE
Amir Jokar	2008	Zahid Ayub	2008	Jon Hartfield
Petur Thors	2009	James Bryan	2008	Avinash Gholap
Joe Huber	2009	Jim Bogart	2008	Rupal Choksi
Ken Schultz	2008	*Corresponding Members:*		Evraam Gorgy
Satheesh Kulankara	2008	Michael Ohadi	2001	Augusto Zimmermann
John Thome	2008	Keith Starner	1993	Scott Wujek
Andreas Knoepfler	2008	Tom Ortiz	2008	Chad Bowers
		William McQuade	2002	Kurt Zoellick
		Ty Newell	2005	Omar Feliciano
Corresponding Members:		Josua Meyer	2005	
Axel Kreigsmann	2008	Parviz Payvar	2008	
Kash Oza	2008	John Judge	2004	
Ben Dingel	2007	Lorenzo Cremaschi (prov)	2009	
Ebrahim Al Hajri	2009	Mahesh Valiya-Naduvath	2008	
Stanislav Perencevic	2009	Jamal Yagoobi	2008	
Omar Abdelaziz	2009	Olivier Pelletier	2004	
Justin Kauffman	2009	Steve Eckels	2008	
Andreas Beutler	2009	Art Fovargue	2009	
Samuel Yana-Motta	2009	Michael Taras ; Jeb Schreiber	2009	
		Dan Kihm, Harry Li	2009	

DISTRIBUTION

All Members of TC/TG/TRG plus the following:	
TAC SECTION HEAD:	**William McQuade**
TAC CHAIR:	**Donald Brundage**
ASHRAE MANAGER OF RESEARCH AND TECHNICAL SERVICES:	**Michael R. Vaughn, P.E.**
ALL COMMITTEE LIAISONS AS SHOWN ON TC/TG/TRG ROSTERS:	Dan Dettmers —Handbook Liaison Florentino Mendez — ALI/PDC Richard Hermans — RAC Research Liaison Nathan Hart — Chapter Technology Transfer Liaison Stanley Mumma – Special Publications Martin Dieryckx– Standards Liaison
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AMERICAN SOCIETY OF HEATING, REFRIGERATION, AND AIR-CONDITIONING ENGINEERS, INC.

Minutes
Technical Committee 8.5
Liquid-to-Refrigerant Heat Exchangers
January 25, 2010
2010 ASHRAE Winter Conference, Orlando, FL, January 23-27, 2010

1. Call to Order and Reading of TC8.5 Scope

Chairman Amir Jokar called the meeting to order at 4:16 pm. The scope of TC 8.5 was read: "TC8.5 is concerned with the thermal and mechanical design, performance, and application of devices for accomplishing heat transfer between refrigerants (including secondary refrigerants) and liquids. Such devices include liquid cooled refrigerant condensers and refrigerant evaporators for cooling liquids".

2. Introduction of Members and Guests (Sign attendance sheet)

Members and guests introduced themselves. Please note that attendees should provide their email address on the circulated sign-up sheet at the meeting if they want to be assured of receiving committee meeting minutes. The following were present:

Amir Jokar	ThermoFluids Tech
Ben Dingel	Trane
John Thome	EPFL
Ken Schultz	Trane
Petur Thors	Wolverine Tube, Inc.
Satheesh Kulankara	Johnson Controls
Joe Huber	Alfa Laval
Kash Oza	Alfa Laval
Samuel Yana Motta	Honeywell
Axel Kriegsmann	Wieland-Werke AG
Andreas Knoepfler	Wieland-Werke AG
Andreas Beutler	Wieland-Werke AG
Justin Kauffman	JCI
Jon Hartfield	Trane
Omar Abdelaziz	Oak Ridge National Laboratory
Ebrahim Alhajri	The Petroleum Institute
Rupal Choksi	AHRI

Stanislav Perencevic	Gunter AG&Co KG
Omar Feliciano	SWEP North America
Avinash Gholap	Carrier Corp.
Evraam Gorgy	Kansas State University
Augusto Zimmermann	University of Illinois
Scott Wujek	University of Illinois
Chad Bowers	Creative Thermal Solutions
Kurt Zoellick	University of Illinois

3. Establish Quorum Requirements

Voting members present were: Amir Jokar, John Thome, Andreas Knoepfler, Ken Schultz, Joe Huber, Petur Thors, and Satheesh Kulankara. Voting members absent were: Jim Bogart, James Bryan, and Zahid Ayub. With seven of ten voting members present, the quorum was satisfied.

Votes below are listed as [for-against-abstain] and should add up to seven.

4. Review/Approve Previous Meeting Minutes

Minutes from the previous meeting (Louisville) were circulated prior to the meeting. The committee voted [7-0-0] to approve the minutes as circulated. Meeting minutes will become official and re-circulated.

5. Chairman's Comments

Chairman Amir Jokar shared some comments from the Section Chair's Breakfast meeting.

- TAC (Technical Activities Committee) is encouraging members of technical committees to increase communication with local chapters to increase awareness of the research and activities that the TCs are involved in.
- According to an update of the TC/TG/TRG Manual of Procedures (MOP), the term "international member" is no longer used. Instead, there are now two types of members, called members-quorum and members-non-quorum. Two members on the roster can be designated as members-non-quorum, and these voting members do not count against the quorum if absent. A geographic requirement for members-non-quorum does not apply, allowing any member from the U.S. or Canada to be eligible for this designation.
- ASHRAE Distinguished Service Awards and Exceptional Service Awards utilize ASHRAE's online biographical system. Members should make sure their biography is up to date.
- The ASHARE Board of Directors has adopted a policy that all standards include the use of "mandatory language". Guidance notes have been provided to Joe Huber (Standards Sub-committee chair).
- The 2009-2010 Hightower Award Recipient is Dharam V. Punwani, from Technical Committee 1.10.

6. Section Head Comments

Bill McQuade introduced himself as the new Section 8 head and offered the following comments:

- Bill has asked for further clarification on plans for Seminar recording policies and options. He will share with the committee as information is available.
- Bill has offered to get clarification of the policy of A/V equipment reservation, specifically a screen projector for TC 8.5/1.3 research review sessions. ASHRAE meeting policy allows for the reservation of equipment if the request is received 90 days in advance, although it is not clear if this would apply to a research review session.

7. Comments from Liaisons (Handbook, Standards, Journal, Research, Program, TEGA, Technical Services, Refrigeration)

Although no liaisons were present, a member of TC 3.6 presented the title of a research project and was interested in knowing if TC8.5 would be willing to co-sponsor the project. The project was titled "How Mechanical Filtration of Cooling Loops Affects Efficiency of Equipment with Enhanced Tubes". The committee agreed that this project fits the interests of the committee. Ken Schultz (research chair) agreed to be the point of contact for communication with TC8.5 regarding co-sponsorship.

8. Handbook Subcommittee Report

Subcommittee chair Jim Bogart was absent.

TC8.5 is responsible for Chapters 38 and 41 in the 2012 Systems and Equipment Handbook. The Systems and Equipment Handbook was last published in 2008. Andreas Knopfler, Kash Oza, and Satheesh Kulankara all agreed to assist in the review of chapter updates when necessary.

9. Program Subcommittee Report

Subcommittee chair Omar Abdelaziz reported on Program status.

TC8.5 co-sponsored Seminar 75 "Recent Advances in Heat Transfer and Fluid Flow" to be held during this meeting on Wednesday, January 27. Four speakers will be presenting recent research in the fields of heat transfer and fluid flow.

Currently, no programs have been identified for submission for either the Albuquerque or Las Vegas meetings. Omar solicited the committee for ideas. Suggestions included: working with TC1.3 on a forum focused on Nanofluids, a session consisting of committee sponsored and other relevant research topics submitted for publication in the HVAC&R Journal, or a seminar/forum focused on secondary coolants.

10. Membership Subcommittee Report

Subcommittee chair Kash Oza reviewed the list of current members. It was reported that the committee currently consists of 36 total members and 10 voting members. To increase the total number of voting members, Steve Eckels and Omar Abdelaziz will be added as voting members. Because of their inconsistent attendance, Jim Bogart and James Bryan will be designated as members-non-quorum for TC8.5. The current international members are very regular meeting attendees and using the non-quorum designation for existing U.S. members that have not been regular attendees is in the committee's best interest.

Ben Dingel is the current Vice Chairman and will become Charmain following the June meeting. Ebrahim Al-Hajri volunteered to serve as Secretary following the next meeting, when Ben becomes Chairman. The Vice-Chair position following the June meeting is currently blank. That position will need to be filled at a later date.

11. Standards Subcommittee Report

Joe Huber reported that there were two standards requiring the committee's attention at this meeting. Addressed first was Standard 22 - Methods of Testing for Rating Water-Cooled Refrigerant Condensers. This standard is due to be reaffirmed, revised, or withdrawn. An ASHRAE staff review identified a number of references that should be updated. In addition, Joe identified a number of instances where the standard should be revised in order to be in accordance with ASHRAE's policy of mandatory language. Joe stated that if the standard is reaffirmed, then no changes can be made to the standard and the questionable non-mandatory language and out of date references cannot be updated. If the standard is revised, then it is more work for the committee and there will be reviews/approvals involved. An additional point was made that there is the potential to improve the technical accuracy of the standard by including the effect of pressure drop on the waterside capacity calculation. After discussion, a motion was made to pursue a revision to Standard 22 - Methods of Testing for Rating Water-Cooled Refrigerant Condensers. The motion was seconded and approved unanimously [7-0-0]. Ken Schultz, Satheesh Kulankara, and Steve Eckels offered to participate in revising of this standard.

Also discussed was the status of Proposed Standard 181 - Methods of Testing for Liquid-to-Liquid Heat Exchangers. Several years ago, AHRI asked ASHRAE to develop the standard in support of an AHRI standard on Liquid-to-Liquid Heat Exchangers. Previously, TC 8.5 voted to develop the standard. An SPC was formed with James Bryan as the chair, and some preliminary meetings were held. The last recorded activity was in 2007. ASHRAE has now asked what TC 8.5 intends to do with this project. If the standard is to move forward, a new SPC (Standard Project Committee) chair is needed and a corresponding standard committee will need to be repopulated. Joe stated that if TC8.5 would like to pursue the development of this standard, he would volunteer to be SPC chair. After discussion, Joe made a motion to pursue the development of Standard 181 – Methods of Testing for Liquid-to-Liquid Heat Exchangers with the appropriate reformation of a supporting SPC. The motion was seconded and approved unanimously [7-0-0]. Attendees that volunteered to assist in this effort included Justin Kauffman, Ken Schultz, Rupal Choksi, Avinash Gholap, and Steve Eckels.

Amir asked a question of the committee relating to standard terminology used for brazed plate heat exchangers. Amir wondered if it might be appropriate for an ASHRAE standard to capture standard definitions of the physical characteristics of brazed plate heat exchangers that might help standardize the definitions used in the open literature. After discussion, it was suggested that perhaps additions to the handbook might be a more appropriate place for this material.

12. Journal/Insights/Webmaster Subcommittee Report

Webmaster Joe Huber reported that he continues to update the committee website as needed. Please contact Joe with material to publish or with any website errors or omissions. The URL for TC 8.5's website is: http://www.tc85.ashraetcs.org/.

As a point of information, it was noted that TC8.2 has voted to add .pdfs of previously sponsored presentations to the website. Also, a number of people noted that ASHRAE is supporting the use of Google Groups as a collaboration tool and committee member communication.

13. Research Subcommittee Report

[Secretary's Note: Ken prepared a summary of TC8.5 research activities and circulated this via email (dated 1/29) to the committee. Material reprinted from this email is highlighted in *italics* below, (thank you - Ken)]

In addition to the discussion of specific research projects (see below), Research Subcommittee Chairman Ken Schultz reported on information shared at the 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.*
- *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.*

Following is a summary of TC8.5 sponsored research projects and the status of each project.

1316-RP – Experimental Evaluation of the Heat Transfer Impacts of Tube Pitch in a Highly Enhanced Surface Tube Bundle
Current Status: Active

The Principal Investigator for this project is Steve Eckels at Kansas State University. A summary of the research progress was presented at the Sunday research review.

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.

<u>1345-RP – Waterside Fouling Performance of Brazed-Plate Type Condensers in Cooling Tower Applications</u>
Current Status: Active.

The Principal Investigator for this project is Lorenzo Cremaschi at Oklahoma State University. A summary of the research progress was given at the Sunday research review.

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℉ refrigera nt saturation temperature. The fouling resistance steadily increased to a value of ~0.002 hr-ft²-℉/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, UAclean 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 UAclean 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
Current Status: Active

The Principal Investigator for this project is Amir Jokar previously of WSU-Vancouver. A summary of final data and correlations was presented during the research review on Sunday.

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 original deadline for the final report was September, 2, 2009 and an original draft of the final report was submitted on August 31. An initial list of comments and revisions was suggested by the PMS and a revised report along with an 8-page response to their questions was submitted on November 30 for their final approval.

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 PI proposed attempting to standardize the definitions of *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 Projects
The topic of potential future research projects was discussed.

Jon Hartfield has completed a work statement (1556-WS) for the research project "Characterization of Liquid Refrigerant Flow Emerging from a Flooded Evaporator Tube Bundle". This project is being led by TC 1.3, with co-sponsorship from TC 8.5. The work statement is already approved and will be released for bidding when funding is available.

Other potential ideas include:

- *"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 "β2·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).*
- *"CO2 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.*

14. New Business

No additional items.

15. Schedule Next Meeting

The next committee meeting will be held on June 28, 2010 at 4:15 PM in Albuquerque, NM.

16. Adjourn

The meeting was adjourned by unanimous vote [7-0-0] at 6:34 pm.