Research Topic Acceptance Request Cover Sheet

Date: **23-Aug-2017**

(Please Check to Insure the Following Information is in the RTAR)

Title:

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Dielectric Properties of Lower GWP Refrigerants

RTAR #

(To be assigned by MORTS)

Results of this Project will affect the following Handbook Chapters, Special Publications, etc.:

Handbook of Fundamentals – Chapter 29

Research Classification:

Basic/Applied Research	
Advanced Concepts	
Technology Transfer	

Responsible Committee: **TC 3.1**

Date of Vote:

For		
Against	*	
Abstaining	*	
Absent or not returning Ballot	*	
Total Voting Members		

RTAR Authors

Lead: **Julie Majurin**

Others:

Co-sponsoring TC/TG/MTG/SSPCs (give vote and date)

Expected Work Statement Authors

Lead: **Julie Majurin**

Others: **Phil Johnson**
Ken Schultz

Potential Co-funders (organization, contact person information):

AHRI (Xudong Wang, XWang@ahrinet.org)

	Yes	No
Has an electronic copy been furnished to the MORTS?		
Has the Research Liaison reviewed the RTAR?		

* Reasons for negative vote(s) and abstentions

RTAR # _____

Title:

Dielectric Properties of Lower GWP Refrigerants

Executive Summary

Describe in summary form the proposed research topic, including what is proposed, why this research is important, how it will be conducted, and why ASHRAE should fund it. (50 words maximum)

Measure the dielectric properties of several new refrigerants to fill gaps in published literature so that the industry can accelerate adoption of these new fluids.

Background

Provide the state of the art with key references (at the end of this document) substantiating it. (300 words maximum)

Refrigerants, and in some cases lubricants, are in direct contact with electrical motor and magnetic bearing components in hermetic and semi-hermetic compressors used in HVACR. For these applications, it is important to understand the electrical properties of the circulating fluids to ensure optimal design, performance, and reliability. Electrical properties of interest include dielectric strength (breakdown voltage), dielectric constant (relative permittivity), dielectric dissipation factor (loss factor), and resistivity. The dielectric strength of a medium is the maximum electric field that the material can withstand before losing its electrical insulating properties. The dielectric constant is the ability of a material to shield a charge from surrounding charges, and will determine the capability of a system to store electric charge. Dielectric dissipation factor is a measure of the amount of energy loss from the material due to an external electric field. Resistivity quantifies how strongly a material opposes the flow of electric current. It is important to understand these electrical properties for refrigerants, as they can differ significantly from those of air.

In the early 2000s, ASHRAE Research Project 1074 was conducted to acquire these properties for 17 different refrigerants. The information is included in the ASHRAE Refrigeration Handbook in Chapter 29, along with electrical property data from other sources for the same refrigerants as well as electrical property data for other refrigerants (ASHRAE (2017), Gbur and Byrne (2001)).

There is little to no information available on the electrical properties of lower GWP olefin refrigerants or refrigerant blends that are being considered or already being applied in HVACR systems.

Research Need

Use the state of the art described above as a basis to specify the need for the proposed effort. (250 words maximum)

Many new single-component refrigerants, and multi-component refrigerant blends, have been proposed as alternatives to current and historic refrigerants. For example, R-1234yf, R-1234ze(E), R-1233zd(E), and R-1336mzz(Z) are single-component halogenated olefin refrigerants that have been included in the 2016 update to ASHRAE Standard 34 and are components of almost all of the new 400-series and 500-series refrigerant blends. More recently proposed Addendum C for R-1224yd(Z) and Addendum F for R-1132a went out for public review in July 2017. These new chemicals have been developed in response to regulations on currently applied refrigerants with higher ozone depletion potential (ODP) and Global Warming Potential (GWP). In addition to refrigerant regulations, standards are in place or being developed in many regions for higher equipment efficiency. As new refrigerant, compressor and motor technologies are being developed and deployed in response to the changing regulatory requirements – often simultaneously - it's important to understand the potential impacts of the fundamental properties of new refrigerant chemistries on their intended applications in current or new equipment. Electrical properties of refrigerants including dielectric constant and dissipation factor are used to describe the performance change of a motor between operation in an air environment to operation in a refrigerant environment. These assessments typically result in inputs into hardware decisions, such as motor terminal spacing, or in software (controls) settings.

Project Objectives

Based on the identified research need(s), specify the objectives of the solicited effort that will address all or part of these needs. (150 words maximum)

1. Literature review of state of the art test methods and equipment including comparison to those used in RP-1074. Proposal of recommended test methods and equipment to measure the dielectric properties of refrigerants.
2. As a function of temperature and pressure (or other suitable state variable such as density), at relevant frequency value(s), make measurements for 8-10 refrigerant samples of the following properties:

Parameter	Subcooled Liquid	Saturated Vapor	Superheated Vapor
dielectric strength (breakdown voltage) [Paschen curve]			●
dielectric constant (relative permittivity)	●	●	●
dielectric dissipation factor (loss factor)	●	●	●
resistivity (volume)	●	●	●

3. Report summarizing the results, conclusions and any critical considerations relevant to the subject matter under study for application of new refrigerants in current or new equipment designs.

Expected Approach

Describe in a manner that may be used for assessment of project viability, cost, and duration, the approach that is expected to achieve the proposed objectives (200 words maximum).

Check all that apply: Lab Testing ☒ Computations ☐ Surveys ☐ Field Tests ☐
Analyses and modeling ☒ Validation efforts ☐ Other (specify) ( )

The electrical properties of refrigerants are not known to be routinely measured.
Phase 1 - The bidder would review previous test methods and current state-of-the-art and make a proposal on the equipment and procedures to be used. This is expected to take <3 months.
Phase 2 - The bidder will also recommend a validation plan summarizing the validation procedures and methods to assess it as successful or unsuccessful. If unsuccessful, changes will be proposed and the validation will be re-assessed prior to moving to the next phase. It is expected that the test set-up and validation would take no longer than 3 months.
Phase 3 – Measurements of refrigerant properties will be conducted and reported. This is expected to take no longer than 2 months.

Relevance and Benefits to ASHRAE

Describe why this effort is of specific interest to ASHRAE, its impact, and how it will benefit ASHRAE and the society. How does it align with ASHRAE Strategic Plans and Initiatives? How does it advance the state of the art in this area in general? Are there other stakeholders that should be approached to obtain relevant information or co-funding? (350 words maximum)

This information is required to enable the implementation of new refrigerant technologies. In accordance, this research is very tightly aligned to ASHRAE's 2010-2018 Strategic Plan (Navigation for a Sustainable Future), in particular to the following two specified goals:

- Goal #8 – Facilitate use of natural and low Global Warming Potential (GWP) synthetic refrigerants and seek methods to reduce refrigerant charge
    - Objective #1 – Effectively incorporate natural and low GWP synthetic refrigerants in Air Conditioning & Refrigeration (AC&R) equipment.
- Goal #9 – Support the development of improved HVAC&R components ranging from residential through commercial to provide improved system efficiency, affordability, reliability, and safety

This work advances state-of-the-art through understanding of fundamental differences between current/historic refrigerants and their alternatives. This will be done through measurement of currently unavailable fundamental property data that is needed to apply new refrigerants in current and new component and system designs. The measured data from new refrigerants will be compared to data on previously or currently applied refrigerants. This information will also be incorporated into future handbook updates. It is expected that AHRI would have interest in supporting this work, and should be engaged for co-funding.

Anticipated Funding Level and Duration

Funding Amount Range: $100,000

Duration in Months: 9-12

References

List the key references cited in this RTAR.

ASHRAE. 2017. Handbook of Fundamentals. Chapter 29 – Refrigerants.

Gbur, A.M., and J.J. Byrne, 2001. Determination of Dielectric Properties of Refrigerants. ASHRAE Research Project RP-1074, Final Report.

Feedback to RAC and Suggested Improvements to RTAR Process

Now that you have completed the RTAR process, RAC is interested in getting your feedback and suggestions here on how we can improve the process.