

# AIR-CONDITIONING AND REFRIGERATION TECHNOLOGIES DATABASE

*Dan Manole, Ph.D., Manager Advanced Technologies,  
Tecumseh Products Company,  
Tecumseh, MI, USA*

## ABSTRACT

A database is set up to identify emerging technologies. The format and content of the database is designed to help the user in identifying emerging technologies and research areas that would benefit the heating, air conditioning, and refrigeration industry. Input was gathered from published information or provided by experts in this domain. The database is accessible to the public and it is being updated periodically. This paper introduces to the reader the database, outlines the design, and explains its goal.

**Key Words:** *database, emerging technology, air conditioning, refrigeration, heat pump.*

## 1 INTRODUCTION

Keeping track of the changes in technology can be daunting. Information can be acquired by training, conferences, books, journals, etc. All of those mean take time and cost money for individual researchers. As an alternative, collaborative efforts can be carried out to compile this information and its cost could be shared among the members of society. The general benefit of a collaborative effort is greater than the potential advantage gained through individual collection efforts.

The Air-Conditioning & Refrigeration Technology Institute (ARTI) Twenty-First Century Research (21CR) program is an Air-Conditioning and Refrigeration Institute (ARI) initiated private-public sector collaborative research effort of the heating, ventilation, air-conditioning and refrigeration (HVAC/R) industry. Its mission is to identify, prioritize, and undertake pre-competitive research that focuses on decreasing energy consumption, increasing indoor environmental quality, and safeguarding the environment.

The purpose of focusing on collaborative pre-competitive research is to encourage other entities (e.g., government laboratories, university researchers, etc.) to perform work of interest to the industry while also striving to minimize duplication of effort.

There are a large number of databases available. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) and International Institute of Refrigeration (IIR) provide search engines to their database of proceedings and journal papers. When evaluating the implementation of a technology into an application, one can reveal the technology's strengths and weaknesses. It is more common to find information in databases related to the strength of various technologies, new materials, and ideas. Information about the advantages and solutions in using one technology vs. another can be found in industry and literature reviews published in journal papers, books, and dissertations. By searching those databases, one can find out what can be done. One of the major goals of the ARTI Research Program is to continually review and monitor research in the HVAC/R arena and elsewhere for breakthroughs that could contribute to achieving goals in improving the HVAC/R in residential buildings, commercial buildings and refrigeration systems (ARTI 2004). This is why it was felt that there was a need to set-up a database with input on air conditioning and refrigeration technologies that will emphasize

identifying the limits and constraints experienced in implementing existing technologies and compare them with potential opportunities created by emerging technologies.

## 2 DATABASE DESCRIPTION

### 2.1 Database Organization

The database was populated initially with information gathered and provided by members of the ARTI 21CR Emerging Technologies Subcommittee. Since this database will be used to identify unexplored territories, the information gathered at this time is focused towards revealing hurdles and the limitations of technologies. Having identified those hurdles, ARTI and others can recommend research projects or guide funds to solve or better understand technological problems whose solutions could benefit the HVAC/R industry.

The AC&R Technologies Database's input and search structure is set-up to receive input from people with various background and expertise while making the information afterwards available to people with different interests. The database structure was designed from the start with the goal of making it useful and user friendly to various types of users. Researchers are interested in transferring technologies being tested in their laboratories to industry for commercialization. Manufacturers seek information on what technology implementations could make their products more efficient, more reliable, and easier and cheaper to manufacture. The database information storage format and data retrieval process was designed to accommodate users with various needs. A database user that is working in a research laboratory may have a different perception of various terms like, let's say, "availability." In order to filter the information gathered in the database so that it matches the user's perception of terms, like: "efficiency," "cost," and "availability," the criteria used to organize the information in the database are separated into four groups. The "General Information" group contains information considered to be of common interest to all users and the criteria for organizing the information in that group are presented in Table 1.

**Table 1. Criteria for organizing information of common interest**

GROUP: GENERAL INFORMATION	
Criteria	Device
	Hardware
	Technology Name
	Physical Principle
	Feasibility at present time
	R&D Goals, R&D Locations
	Availability of commercial equipment
	Availability of materials and components

The "R&D" group contains information believed to be of more interest to people working in research and development institutions. Its criteria, listed in Table 2, regard the fundamentals of the physical and chemical phenomena related to the technologies without reference to cost or ease of manufacturing.

**Table 2. Criteria for organizing R&D focused information**

Criteria	GROUP: PHYSICS	GROUP: FRAMEWORK
	Energy Type	Critical parameters
	Media	Power Sources and Thermal Sink
	Underlying phenomena	Comments
		References
		Environmental impact
		Contact Information

Criteria in the “Design” group, being used for organizing the database to make it accessible to users, filters information related to the design of systems using the cooling or heating technologies. Those criteria, listed in Table 3, include parameters that can be used to compare technologies and also the means to identify available technologies pertinent to performing specific tasks of interest to the user.

**Table 3. Criteria for organizing design focused information**

Criteria	GROUP: SPECIFICATIONS	GROUP: PERFORMANCES
	Size	Efficiency
	Constraints	2nd Law of Thermodynamics Analysis
	Advantages	System efficiency
	Disadvantages	Component efficiency
	Capacity	History, trend, limitations
	Components options	Alternative Applications
	Refrigerants (or Media) Used	Capacity range
	Critical or Specialty Materials	Hybrid Systems
	_____	Theoretical, economical, physically possible

The “Manufacturing” group of criteria used in organizing information in the database is listed in Table 4. Those criteria provide further means to compare the cost, availability, and manufacturability of systems using various technologies. This type of information is not meant to provide direct guidance on purchasing decisions but rather to identify the hurdles related to a certain technology implementation, which if removed, could enable the respective technology to be more affordable.

**Table 4. Criteria for organizing manufacturing focused information**

Criteria	GROUP: SYSTEM INTEGRATION	GROUP: ECONOMICS
	Manufacturing	Investment
	Service and Maintenance	Return
	Functionality	Life Time Cost
	Control and Artificial Intelligence	Maintenance
	Relevant performance test	Refrigeration hardware relative cost
	Relevant life test	Cost vs. efficiency vs. investment
Criteria	Accessories (required leak detectors, etc.)	_____

One may consider that criteria listed in different groups sound similar. That is because information to be inputted in the database is solicited from experts in various domains of activity. At the same time, people from various domains of activity are expected to search the database. The goal is to have the database analysis report friendly to the user, thus information about availability and performance is presented in a different format to a user seeking a report relevant to research and development compared to a user with interest in commercialization. The experts that provide information with regards to a specific technology would probably tackle only one or two groups of criteria, thus potentially similar criteria are not expected to create confusion to users. The information submitted to ARTI as input for the database is peer reviewed and edited for consistency prior to inclusion in the database.

## 2.2 Database Utilization

A search in the database is based on selecting the criteria listed in Tables 1 to 4. The database provides a means to compare technologies with regards to specified criteria. A dialog window, as presented in Figure 1, enables the user to select any number of technologies and criteria to be used for comparison. The report is presented in a table format. A more comprehensive report is generated as a Word document for each individual technology.

**AC&R Database Search Engine**

Save Selected List into:  
☒ New Workbook    Workbook Name: DB search results    Worksheet: search 1

**TECHNOLOGY**

- Liquid Desiccant System
- Magneto-caloric
- Malone
- Pulse tube
- Rev. Rankine - Subcritical - Dynamic Dev
- Rev. Rankine - Subcritical - Positive Disp
- Rev. Rankine - Transcritical
- Single Effect Absorption
- Solid Desiccant System
- Stirling
- Thermionic
- Thermoacoustic
- Thermoacoustic

**General Information**

- Device
- Hardware
- Technology Name
- Physical Principle
- Feasibility at present time
- R&D Goals, R&D Locations
- Availability of commercial equipment
- Availability of materials and component

**R&D**

**PHYSICS**

- Energy Type
- Media
- Underlying phenomena

**FRAMEWORK**

- Critical parameters
- Power Sources and Thermal Sink
- Comments
- References
- Environmental impact

**Design**

**SPECIFICATIONS**

- Size
- Constraints
- Advantages
- Disadvantages
- Capacity
- Components options
- Refrigerants (or Media) Used
- Critical or Specialty Materials

**PERFORMANCES**

- Efficiency
- 2nd Law of Thermodynamics Analysis
- System efficiency
- Component efficiency
- History, trend, limitations
- Alternative Applications
- Capacity range
- Hybrid Systems

**Manufacturing**

**SYSTEM INTEGRATION**

- Manufacturing
- Service and Maintenance
- Functionality
- Control and Artificial Intelligence (AI)(Va
- Relevant performance test
- Relevant life test
- Accessories (required leak detectors, etc

**ECONOMICS**

- Investment
- Return
- Life Time Cost
- Maintenance
- Refrigeration hardware relative cost
- Cost vs. efficiency vs. investment

Cancel    Help    OK

Fig. 1. Sample of usage of dialog window for AC&R technologies comparison

### **3 CONCLUSION**

The AC&R Technologies Database was designed and populated with information that can help to identify emerging technologies that would benefit the HVAC/R industry. Technological hurdles could be overcome by the joint efforts of HVAC/R industry members or by directing research towards projects that can bring the most benefit to HVAC/R industry. The database is in a pilot format for beta testing at this time and input for its improvement is solicited from experts in all fields related to technologies that can be of benefit to the HVAC/R industry.

### **REFERENCES**

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