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APPLICATION GUIDE FOR ABSORPTION COOLING/REFRIGERATION USING RECOVERED HEAT

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APPLICATION GUIDE FOR ABSORPTION COOLING/ REFRIGERATION USING RECOVERED HEAT

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CHAPTER 1
Introduction

1.1 BACKGROUND

ASHRAE commissioned this application guide in response to the need for a comprehensive reference manual for the application of indirect-fired absorption machines. *Indirect fired* is defined as an absorption machine that uses heat recovered from another process or heat cycle machine. Direct-fired absorption machines are not covered in the guide. This document will help engineers and owners to

- become familiar with the requirements of an absorption system,
- evaluate indirect-fired absorption machines for specific applications,
- evaluate the potential of available recovered heat sources, and
- select the most economical system.

The purpose of this guide is to provide the reader with information on the successful application of absorption machines. The actual design of an absorption system is covered in detail in other publications, which are listed in the bibliography of this guide. However, common areas of concern in the design of absorption machines are briefly discussed in the guide.

The application of absorption for the purpose of cooling has been a viable technology for more than a century. This guide contains the information required to properly incorporate absorption technology into a wide range of applications, including commercial space cooling, central plant cooling, and industrial applications where recoverable heat is available.

Absorption systems can provide an economical use for recovered heat energy. This guide assumes that a heat source is available, economically appropriate, and cannot be eliminated through modification of the process or power cycle. There is no higher economic use of the potential recovered heat than whenever there is a cooling or refrigeration requirement that can be satisfied with the recovered heat.

The guide is structured to provide a logical progression from vapor-compression technology to absorption technology. It is assumed that the reader of this guide understands the basic principles of refrigeration and the fundamentals of vapor-compression systems. The guide introduces the concepts of absorption cooling using the terminology of vapor-

compression systems. This information is expanded to enable the reader to apply absorption technology to many situations with available recovered heat.

The guide is organized into 11 chapters. Chapter 1, *Introduction*, provides basic background on the application of absorption systems and terminology. Chapter 2, *Required System Characteristics*, presents information on the fundamental requirements that make indirect-fired absorption systems feasible. Chapter 3, *Economics of Absorption Systems*, provides a discussion on the economics of absorption applications. Chapter 4, *Heat Recovery*, discusses the types and sources of heat and how to recover and use the heat in absorption applications. Chapter 5, *The Absorption Process*, presents general information on the absorption process. Chapter 6, *Lithium Bromide-Water Absorption Cycle*, provides a detailed discussion of lithium bromide-water (LiBr) absorption machines. Chapter 7, *Aqueous Ammonia Absorption Cycle*, provides a detailed discussion of water-ammonia absorption refrigeration machines (AAR). Chapter 8, *Matching Heat Sources, Cooling Load, and Heat Rejection Capability with an Absorption Machine*, provides detailed procedures for applying indirect-fired absorption machines to specific applications. Chapter 9, *LiBr Absorption Machine Applications*, presents specific information for the application of LiBr machines. Similarly, Chapter 10, *AAR Machine Applications*, presents specific information for the application of aqueous ammonia absorption machines. Chapter 11, *Other Technologies*, discusses technologies that incorporate absorption cycles for the heating, ventilating, and air-conditioning (HVAC) industry.

As this is an applications guide and not a design guide, detailed sizing procedures are not included.

References and bibliographies, where appropriate, are provided at the end of each section, and a comprehensive bibliography is included at the end of the guide. Definitions of terms used in the guide are included in the glossary.

1.2 BENEFITS OF ABSORPTION SYSTEMS

The first absorption machine was developed in the mid-nineteenth century by a Frenchman, Ferdinand Carre. Since this first machine, the popularity of absorption systems has risen and fallen due to economic conditions and technology breakthroughs from competing technologies. The benefits of absorption systems have remained constant and include the following:

- absorption systems have lower electrical needs compared to vapor-compression systems,
- absorption units are quiet and vibration free,
- recovered heat can be utilized to power the absorption refrigeration cycle,
- absorption units pose no threat to global environmental ozone depletion and may have less impact on global warming than most other options, and
- absorption units are economically attractive when fuel costs are substantially less than electric costs (typically, if fuel cost is 12% to 20% of electrical cost) (Smith 1994; Furlong 1994).

1.3 ABSORPTION SYSTEM APPLICATIONS

A refrigeration system uses an energy input to produce a cooling effect. In vapor-compression systems, the energy input is mechanical work, usually an electric motor. In absorption systems, the energy input is heat.

If a facility or process has the potential to recover heat, an absorption system can use the recovered heat to generate cooling. Typically, heat for absorption cooling is recovered from a process and used in process cooling or to reduce the temperature of the surrounding environment by use of an HVAC system. Figure 1-1 shows a variety of applications for absorption machines.

1.3.1 Heat Recovered from a Cogeneration System

Applying indirect-fired absorption machines with cogeneration systems is currently the most common approach. Heat recovered from the exhaust gas stream and the engine coolant system is used to power the absorption machine. When the heat from the cogeneration plant is used to power an absorption machine, this not only meets the cooling load but also reduces the peak electric demand on the system.

The cooling load on the absorption machine will vary depending on the local requirements. Several common applications include

- cooling occupied spaces (HVAC system),
- cooling inlet air for gas turbines (which increases gas turbine capacity and efficiency),
- providing refrigeration to a food processing plant or for ice production, and
- cooling an industrial process.

1.3.2 Heat Recovered from an Industrial Process

The application of absorption systems has typically been economical for many industrial facilities with both large heat rejection and cooling requirements. The heat source and cooling load in an industrial facility vary, depending on the processes. Examples of possible heat sources include

- exhaust gas from a drying process, such as in a paper plant;
- hot water produced in a wastewater treatment facility;
- gas vapor produced in an oil refinery from a distillation process;
- low-pressure steam from a backpressure steam turbine; and
- incinerator exhaust/coolant water.