USER'S GUIDE TO NATURAL GAS TECHNOLOGIES

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Dedication

Natural gas technologies that were new five years ago have now been tested in the real world. Those proven to be successful are being adopted quickly.

This book describes some of the important new engineering concepts and new products that have emerged. In other instances, natural gas technologies that have been around for many years have been modernized and made more efficient. On both fronts, innovation is continuous, and impressive.

This book is dedicated to the creative engineers who empower this remarkable evolution: First, to those who originate new products and ways to benefit industrial and commercial consumers... and then, equally-important, to those imaginative users who are willing to explore, finance, and help develop these natural gas innovations.

Acknowledgments

The authors of this book are all qualified technical experts, with "hands-on" experience in natural gas applications. Their chapters are drawn from a variety of resources. Some writers are with manufacturing teams that develop and then bring technical advances to their customers and prospects. Others are consultants who work for users, helping put innovative concepts to work.

Some chapters have been prepared by major users of natural gas; some, by distribution companies who work closely with their consumers; others have been written specifically for the User's Guide to Natural Gas Technologies.

Several chapters originated as papers presented at various technical Congresses offered by The Association of Energy Engineers. A special note of thanks is tendered to the American Gas Cooling Center, which provided additional material.

We would also like to acknowledge the help extended by other technical associations: the Gas Research Institute, the American Gas Association, and the Institute for Gas Research. Universities that have supported the development of this book include Georgia Tech and Oklahoma State University.

The list of contributing authors is diverse. Common to all of them, however, is their willingness to share information with the reader. Their openhearted help is the basic resource of the User's Guide to Natural Gas Technologies.

We acknowledge their importance, and thank them for their support.

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PART I

NATURAL GAS COOLING

Chapter 1

Overview of Natural Gas Cooling Technologies And Applications

Milton Meckler, P.E., CPC, President
Design Build Systems

REVIEW OF GAS COOLING BASICS

Recent advances in gas-engine-driven and direct gas-fired absorption chillers as well as in commercially viable solid- and liquid-desiccant cooling systems suggests a bright future for the gas industry. Furthermore, use of such equipment in combination with or in lieu of commercially available electrically powered alternatives can mean significant energy savings.

The discovery of absorption cycle principles goes as far back as 1777, and a patent was issued to Ferdinand Carre in 1860 for the first U.S. commercial absorption refrigeration machine. In fact, many large scale absorption units were used by the U.S. chemical and petroleum industries in the 1890s. These units gained widespread popularity for commercial and institutional applications between 1950 and early 1970s. The scare of a gas shortage in the late 1970s practically put an end to their popularity. But advances in technology, need to reduce energy consumption, an environmental issues such as "greenhouse effect" in the last decade have become the driving-force behind the new interest in using direct-gas-fired and gas-engine-driven cooling systems. Additionally, natural gas-engine-driven cooling systems coupled with desiccant dehumidification or absorption can be much more effective than many commercially available systems.

Gas companies support the use of natural gas cooling and absorption because of increased gas sales due to direct-fired system and year-around usage. Even some electric companies are in favor of gas cooling because it helps in solving their capacity problems.

ABSORPTION SYSTEMS VS. VAPOR-COMPRESSION SYSTEMS

In a conventional vapor-compression cycle, the work necessary to run the compressor is supplied by either an electric motor, a natural gas-fired engine or turbine. The compressor compresses the refrigerant vapor to a higher pressure and, therefore, its condensing temperature is increased. The high-pressure vapor is then condensed to liquid at this higher temperature and pressure. The heat released through the condensation process is rejected. The high-pressure liquid leaving the condenser then passes through a throttling valve which reduces its pressure prior to entering the evaporator. This low-pressure liquid is then vaporized in the evaporator at a temperature lower than the temperature of the conditioned air, and as a result, heat is removed from the conditioned air. The low-pressure vapor is then transferred back to the compressor, thus completing the cycle.

The absorption cycle is similar to the conventional vapor-compression cycle when one recognizes that the generator, pump and absorber merely replace the function of the compressor in the conventional vapor-compression cycle. One of the main differences between the two cycles is that large absorption refrigeration systems use distilled water while conventional systems mostly use fluorinated hydrocarbons as refrigerants. In this way, the use of chlorofluorocarbons (CFCs) are eliminated and, therefore reduced environment pollution and significantly reduced levels of earth's ozone depletion. An absorption cycle also requires heat to separate the refrigerant from the absorbent (lithium bromide).

The double-effect absorption cycle takes the single stage absorption cycle to the next level by increasing the coefficient of performance (COP) by a factor of approximately 2. These are several variations: series flow double-effect (used by McQuay and Sanyo), the parallel flow double-effect (used by York/Hitachi and Carrier/Ebara), and even reverse series-flow which combines features from both the series and parallel flow cycles. The Direct-Fired Absorption (DFA) chillers (shown in Figure 1-1) require lower cooling tower flow rates comparable to electric chillers by allowing for a high temperature rise (15°F) which permits better cooling tower performance.

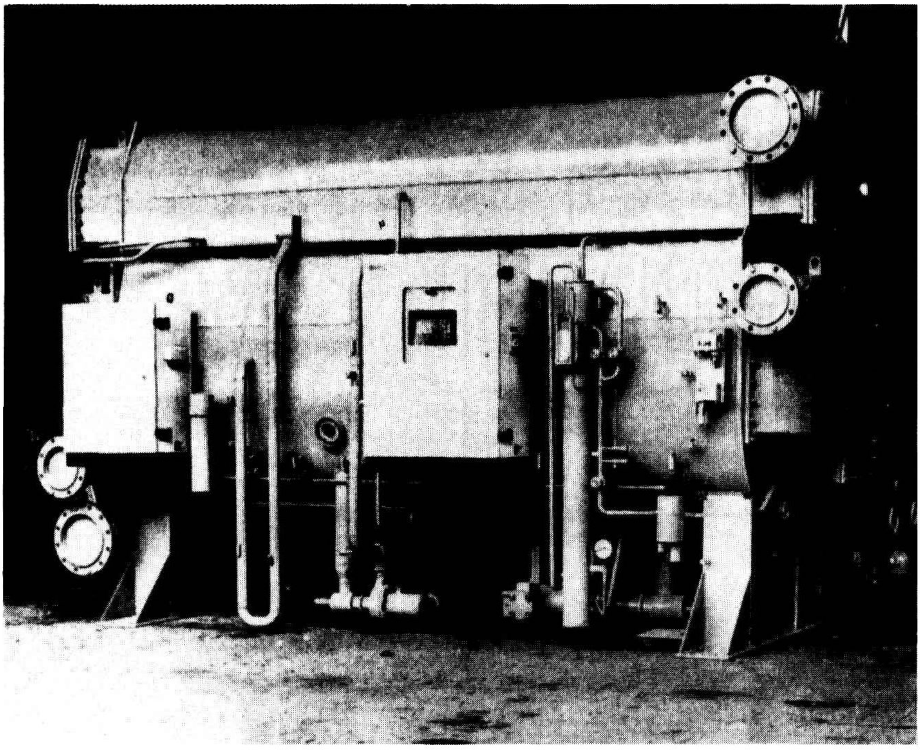

Figure 1-1. Direct-fired double-effect absorption chiller.

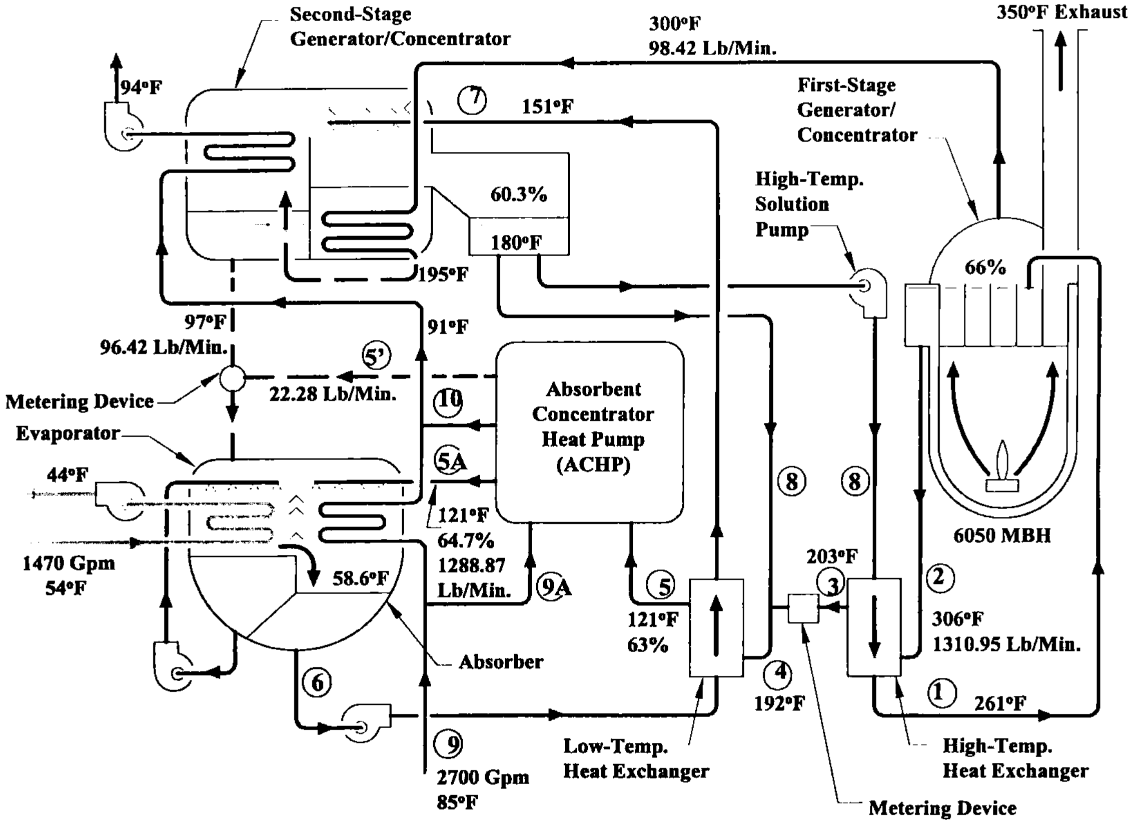

Figure 1-2. A reverse-flow enhanced double-effect direct-fired absorption cycle with impulse-turbine assisted motor-drive (ACHP).