

USER'S GUIDE TO NATURAL GAS TECHNOLOGIES

EDITED BY F. WILLIAM PAYNE

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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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Contents

PART 1 NATURAL GAS COOLING

Chapter 1	
Overview of Natural Gas Cooling Technologies and Applications	1
Milton Meckler, P.E., CPC	
Design Build Systems	
Chapter 2	
Gas Absorption Cooling	25
Richard L. Itteilag	
Columbia Energy Services	
Chapter 3	
Large Tonnage Absorption Cooling	63
Bill Plzak	
The Trane Company	
Chapter 4	
Operations and Maintenance Considerations for Gas Cooling Equipment	75
J. Douglas Rector	
Carrier Corporation	
Chapter 5	
Hybrid Gas/Electric Cooling Plants	87
American Gas Cooling Center	
Chapter 6	
Gas Cooling Strategy in a Deregulated Electric Environment	91
H. Ian McGavisk	
York International	

PART 2
CHILLERS

Chapter 7
Applying Absorption Chillers—
Recent Technological Advances 113
 Mike R. Thompson
 LaCrosse Business Unit, The Trane Company

Chapter 8
Engine-Driven Chillers—A New/Old Technology 119
 Kirby Brown
 Cummins Southwest, Inc.

Chapter 9
Technical Considerations—Replacing Electric Chiller Plants 123
 Mike R. Thompson
 LaCrosse Business Unit, The Trane Company

Part 3
DESICCANT SYSTEMS AND EQUIPMENT

Chapter 10
Desiccants: Benefits for the
Second Century of Air Conditioning 131
 Kevin McGahey, Englehard/ICC Technologies
 L. Harriman

Chapter 11
Desiccant Drying in the Commercial and Industrial Market 151
 David Simkins
 Munters Corporation—Cargocaire Division

Chapter 12
Desiccant Dehumidification 167
 American Gas Cooling Center

Chapter 13
 How to Analyze the Feasibility of
 Desiccant Dehumidification Applications 181
 Larry R. Rowland, C.E.M. and Gopal S. Shiddapur, P.E.
 Savage Engineering

Chapter 14
 Advances in Desiccant Technologies 203
 Davor Novosel
 Semco

Chapter 15
 Desiccant Systems for Operating Room
 Temperature and Humidity Control 217
 Jerry M. Ivey; P.E.
 Willis-Knighton Health System

Chapter 16
 Preconditioning Outside Air with Heat Regenerated Desiccants 227
 W. Bruce Longino, P.E.
 Mingeldorff, Inc.

Chapter 17
 ASHRAE 62-1989 Compliance in a Retail Store
 Using Desiccant Systems—A Case History 231
 John W. Spears, C.E.M.,
 Sustainable Design Group
 Jim Judge, P.E.
 Linric Company

PART 4
 COGENERATION

Chapter 18
 A Cost-Effective Natural Gas Combined
 Cycle/ TES Cogeneration Plant 243
 Milton Meckler, P.E., CPC
 Design Build Systems

Chapter 19
Sterling Engines for Gas-Fired Micro-Cogen and Cooling 283
Neill W. Lane and William T. Beal
Sunpower, Inc.

Chapter 20
Desiccant Cooling Systems for Cogeneration 301
Milton Meckler, P.E., CPC
The Meckler Group

PART 5
HEATING WITH NATURAL GAS

Chapter 21
Gas-Fired Radiant Heating Technologies 333
Dr. Robert V. Gemmer
Gas Research Institute

Chapter 22
Gas-Fired Low Intensity Infrared Improves
Productivity and Product Quality 337
W.G. Connors, P.E.
Atlanta Gas Light Company

Chapter 23
Modular Gas-Fired Boilers 345
George A. Kritzler
Imagineers Unlimited

Chapter 24
Cost Effectiveness of a Residential Gas-Engine-Driven Heat Pump ... 355
James D. Miller
Pacific Northwest National Laboratory

PART 6
OTHER NATURAL GAS TECHNOLOGIES

Chapter 25
Natural Gas Applications at the Kennedy Space Center 391
Roberta L. Sirmons, P.E., CEM, CCP
Kennedy Space Center

Chapter 26	
New Natural Gas Driven Compressors	403
Joe Lester	
JPL Consulting Services	
Chapter 27	
Economic Analysis of Gas Engine Driven Air Compressors	413
Wayne R. Turner, Ph.D., P.E., CEM and	
Nehru R. Chedella, D.B.M., Oklahoma State University	
Jorge B. Wong, Ph.D., Dr. Ing, P.E., General Electric Company	
Chapter 28	
Energy and Demand Savings with	
Engine-Driven Air Compressors	433
A. Steven Bruntlett, Mississippi Valley Gas Company	
Michael W. Hall, Strategic Resource Solutions	
Chapter 29	
Reducing Operating Costs in Stoker Boilers	
With Natural Gas Cofiring	447
John R. Puskar, P.E.	
CEC Consultants, Inc.	
Chapter 30	
Gas-Fueled Diesel Power Plants—Over 50% Efficient	459
Torsten J. Åström	
Wartsila Diesel North America	
Chapter 31	
Natural Gas Fuel Cell Technologies and Applications	467
Clint Christenson	
Oklahoma Industrial Assessment Center	
Index	479

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. There 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.

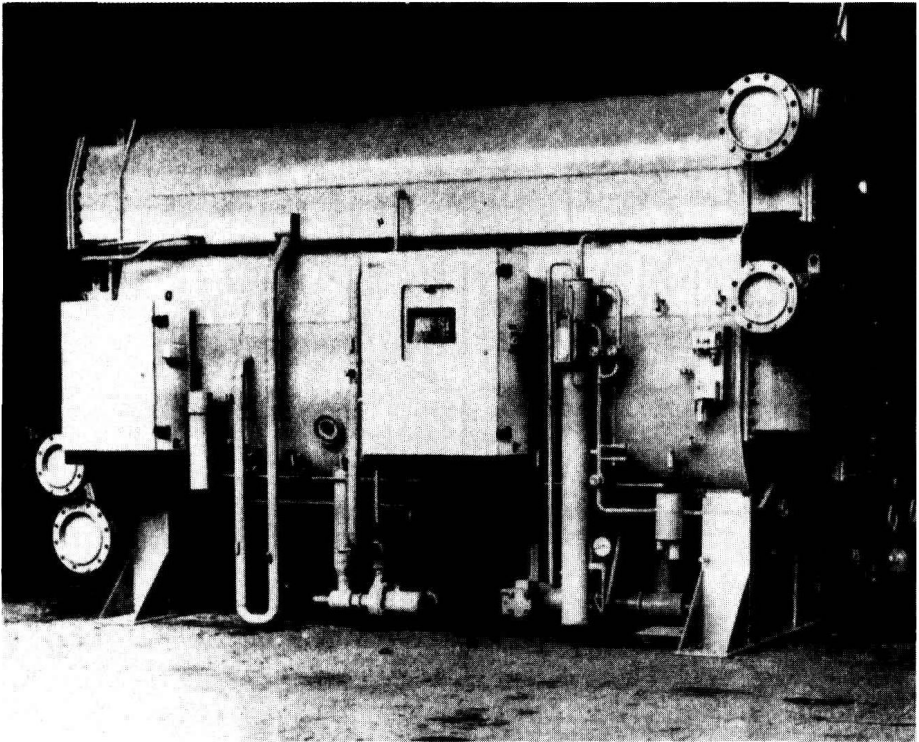


Figure 1-1. Direct-fired double-effect absorption chiller.

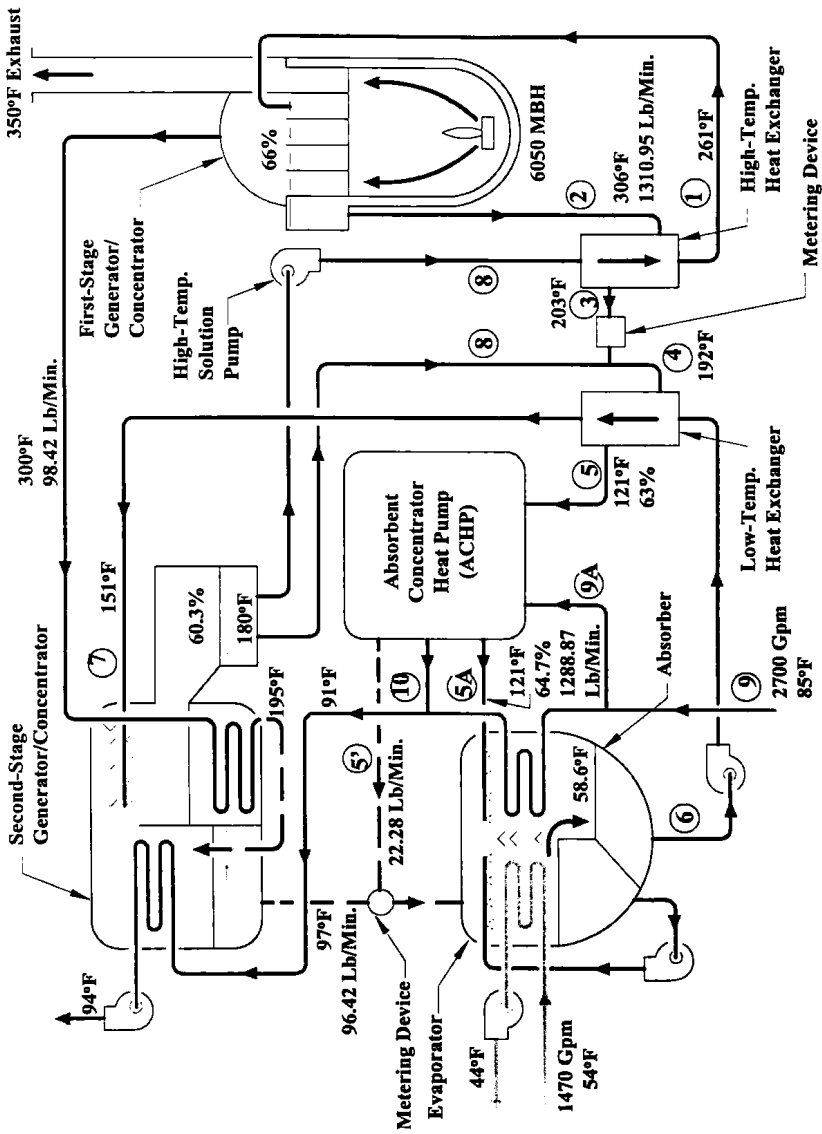


Figure 1-2. A reverse-flow enhanced double-effect direct-fired absorption cycle with impulse-turbine assisted motor-drive (ACHP).