GAS USAGE & VALUE

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Preface

The objective of this book is to give gas industry professionals an overview of the uses and value of gas to the process industries. The purpose of this book is to give an overview of the options and costs for utilizing natural gas. The first versions had the primary aim of helping companies to develop and value gas reserves by identifying possible uses for the gas and the kind of gas price a downstream industry will support. This book includes these features, which have been expanded and updated. It also includes work performed for a gas utilization workshop delivered by the author in Kuala Lumpur, which led to a gas marketing handbook that was written for BP-Amoco. This makes the book of wider appeal to anyone with an interest in developing, pricing, and selling gas.

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Introduction

The current era has been called the *Age of Gas*. This replaced the previous era, the *Petroleum Age*, when oil produced all transport fuels and chemicals, which in turn had replaced the *Coal Age*.

The prospects for the current era look good. There are vast reserves of gas, and most countries in the world have some gas assets. Technologies exist that can utilize gas for all of the duties provided by petroleum fuels and coal, whether for the generation of thermal energy and electricity or for the production of chemicals. For some of these technologies, gas offers a significant technical and cost advantage over petroleum and coal.

However, the substitution of gas for petroleum or coal products in many fields has been slow or has only occurred in exceptional circumstances. For example, gas and LNG have been available since the 1960s, but still lag well behind coal as a primary source of electricity generation. By contrast, the conversion of the chemicals industry from coal usage to petroleum took less than two decades in the 1940s and 1950s.

The reasons for the relatively slow uptake of gas are several. Many of the major gas reserves in the world are remote from the major energy markets in the industrialized nations. The remote sites are often costly to develop, and also it is costly to bring the gas to market. Further, developments in petroleum processing have maintained a competitive advantage for liquid products, particularly in the transport fuel sector (e.g., the production of clean fuels). Also, coal remains the cheapest energy source and is available in vast quantities in many parts of the world, often closer to the required market in the industrialized nations. In addition, developments in clean coal combustion have largely maintained the cost advantage of coal versus gas in electricity at 64.5 billion cubic meters (bcm) (2.3 Tcf) in 2005, and is expected to increase to 252 bcm (8.9 Tcf) by 2020.[25] This expansion will be achieved by both the development and transmission of the western gas reserves and by LNG imports on the eastern seaboard.

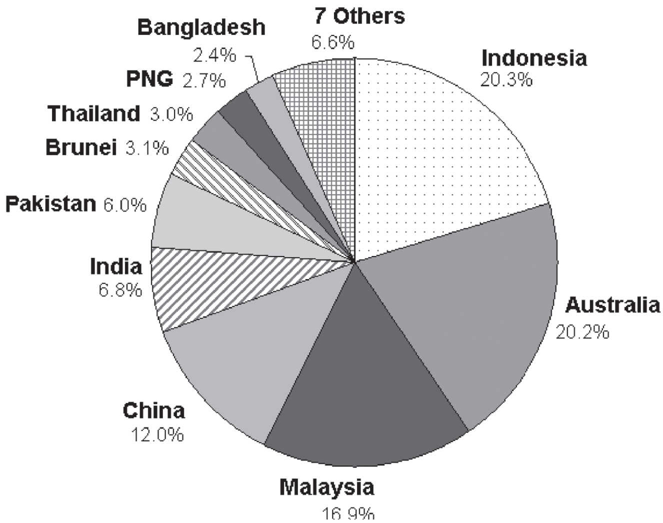

Fig. 2–7. Asia-Pacific gas reserves (445 Tcf). Source: "Worldwide Report," *Oil & Gas Journal*, December 2004. The data have been corrected for Australia.

Western Europe

The 2005 gas reserves of Western Europe are illustrated in figure 2–8.

The economies of the European Union (EU) utilize substantial volumes of gas for industry and power generation. The increasing use of gas has been at the expense of indigenous coal production. In the EU, only the United Kingdom (21 Tcf) and the Netherlands (62 Tcf) are self-sufficient in gas production (from associated gas and gas fields of the North Sea). Large volumes of gas are imported into the EU from Norway, North Africa (Algeria and Libya), and in particular Russia, which also supplies much of Eastern Europe with gas.

Norway has very large offshore reserves (74 Tcf) that have been developed to produce methanol as well as export to the EU.[26]

of the tower (lean oil). The solvent absorbs the heavier constituents, while the lighter sales gas rises to the top of the absorber and exits the top of the tower. The now-rich oil is collected on an absorber tray above the gas entry point and passes via heat exchangers to an ROD column. (The ROD column is variously described as a rich oil de-ethanizer when ethane and methane are to be expelled or a rich oil de-methanizer when methane alone is to be expelled.)

The ROD has the duty to remove any sales gas that may have dissolved and to return this to the sales gas stream. The rich oil enters near the top of the column and falls against warmed (about 50ºC to 60ºC) rich oil circulating through an exchanger. The degassed oil leaves the bottom of the tower, and the recovered gas leaves the top of the tower. This unit can be operated in two modes. If ethane is not a required product, the rich oil is heated sufficiently to expel ethane along with methane from the top of the tower. If ethane is to be extracted, the ROD is warmed to expel mainly methane.

The rich oil passes to the rich oil fractionator (ROF), where the solvent is boiled, regenerating the lean oil and expelling the LPG (and ethane) from the top of the tower.

As the fluids pass from the absorber to the ROF, the temperature rises from about –35ºC to about 200ºC (the b.p. of kerosene). This requires a considerable amount of heat exchanger capacity. Further, the pressure progressively falls from about 100 atm in the absorber to about 50 atm in the ROD to less than 10 atm in the ROF. This requires the lean oil stream to be pumped against this pressure rise.

The refrigerated absorber technology is complex and manpower intensive compared to the turbo-expander technology that has replaced it. However, where it still exists, it is particularly useful for recovering ethane, which is more difficult to extract in turbo-expander plants.

Gas treatment for LNG manufacture

For LNG manufacture, the gas has to be extensively treated in order to remove all of these products that are likely to freeze or cause damage to the liquefaction train. The flow sheet comprises the above unit operations plus mercury removal to produce the final gas. The cost of such gas treatment is high. LNG production is considered in more detail in chapter 11.

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Gas Transport

There are three modes of mass transport in which the energy (or hydrocarbon content) of natural gas can be transported over long distances to a user:

- By pipeline
- As LNG in specialized ships
- By conversion at or near the wellhead to a liquid product followed by transport by sea tankers—methanol and DME.

This chapter discusses the economics of gas transport through these three methods. An overview of the world's shipping fleet for transporting the products of interest is given.

Comparison of the Shipping Fleets

At present, contract shippers conduct most shipping of liquids (chemical and oil derivatives). The merchant fleet is extensive, and there is a variety of contracts available for the regular movement of product.

Large amounts of liquid product can be moved in large (> 125,000 t) tankers. These are generally referred to as dirty cargoes because the product transported is crude oil and residual fuel oil. Generally this fleet is unsuitable to transport a gas-derived liquid such as methanol, which is a clean cargo. For the transport of these gas products, dedicated ships may be required. This may be provided as a contract arrangement.

Gas versus LPG (propane)

The cost of transport and storage of LPG is significantly more than that for fuel oil. When gas is available, this tips the balance in favor of gas. Table 6–5 indicates LPG (propane) price equivalents.

Table 6–5. Price conversion factors for propane

$/GJ	$/t	$/bbl	cents/gal	cents/L
1.000	49.600	4.003	9.532	2.518
0.020	1.000	0.081	0.192	0.051
0.250	12.390	1.000	2.381	0.629
0.105	5.204	0.420	1.000	0.264
0.397	19.696	1.590	3.785	1.000

(density = 1969.7L/t; HHV = 49.6GJ/t)

Gas versus coal and electricity

Coal usually enters the smaller appliance market via its derivative, electricity. Gas versus electricity is a complex issue made more complicated by time-varying electricity tariffs. Efficiency considerations are also important.

On an energy equivalent basis, electricity is very expensive relative to all other fuels, but for many end uses, it remains the fuel of choice. Table 6–6 and table 6–7 give the price conversion factors of coal and electricity showing the relatively high price of electrical power. For many applications, power use is almost 100% efficient, whereas other fuels often have a thermal efficiency below 50%.

Table 6–6. Price conversion for coal

$/GJ	$/tonne	$/ton
1.000	27.000	24.494
0.037	1.000	0.907
0.041	1.102	1.000

(HV = 27GJ/t)

Table 6–7. Price conversion factors for electricity

$/GJ	c/kWh
1.000	0.360
2.778	1.000