

[Home](#)-immediately access 800+ free online publications. **[Download](#)** CD3WD (680 Megabytes) and distribute it to the 3rd World. CD3WD is a 3rd World Development private-sector initiative, mastered by Software Developer **[Alex Weir](#)** and hosted by **[GNUveau_Networks](#)** (From globally distributed organizations, to supercomputers, to a small home server, if it's Linux, we know it.)

[home.cd3wd.ar.cn.de.en.es.fr.id.it.ph.po.ru.sw](#)

INDUSTRY PROFILE #10

LIQUEFIED

PETROLEUM GAS

Prepared By

Jon I. Voltz

Reviewed By

Glenn H. Dale

John P. Hyde

Published By

VITA

1600 Wilson Boulevard, Suite 500

Arlington, Virginia 22209 USA

Tel: 703/276-1800 . Fax: 703/243-1865

Internet: pr-info@vita.org

Liquid Petroleum Gas

ISBN: 0-86619-297-2

[C]1988, Volunteers in Technical Assistance**INDUSTRY PROFILES****Introduction**

This Industry Profile is one of a series briefly describing small or medium-sized industries. The Profiles provide basic information for starting manufacturing plants in developing nations. Specifically, they provide general plant descriptions, financial, and technical factors for their operation, and sources of information and expertise. The series is intended to be useful in determining whether the industries described warrant further inquiry either to rule out or to decide upon investment. The underlying assumption of these Profiles is that the individual making use of them already has some knowledge and experience in industrial development.

Dollar values are listed only for machinery and equipment costs, and are primarily based on equipment in the United States. The price does not include shipping costs or import-export taxes, which must be considered and will vary greatly from country to country. No other investment costs are included (such as land value, building rental, labor, etc.) as those prices also vary.

These items are mentioned to provide the investor with a general checklist of considerations for setting up a business.

IMPORTANT

These profiles should not be substituted for feasibility studies. Before an investment is made in a plant, a feasibility study should be conducted. This may require skilled economic and engineering expertise. The following illustrates the range of questions to which answers must be obtained:

- * What is the extent of the present demand for the product, and how is it now being satisfied?
- * Will the estimated price and quality of the product make it competitive?
- * What is the marketing and distribution plan and to whom will the product be sold?
- * How will the plant be financed?
- * Has a realistic time schedule for construction, equipment, delivery, obtaining materials and supplies, training of personnel, and the start-up time for the plant been developed?

- * How are needed materials and supplies to be procured and machinery and equipment to be maintained and repaired?
- * Are trained personnel available?
- * Do adequate transportation, storage, power, communication, fuel, water, and other facilities exist?
- * What management controls for design, production, quality control, and other factors have been included?
- * Will the industry complement or interfere with development plans for the area?
- * What social, cultural, environmental, and technological considerations must be addressed regarding manufacture and use of this product?

Fully documented information responding to these and many other questions should be determined before proceeding with implementation of an industrial project.

Equipment Suppliers, Engineering Companies

The services of professional engineers are desirable in the design of industrial plants even though the proposed plant may be small. A correct design is one that provides the greatest economy in the investment of funds and establishes the basis of operation that will be most profitable in the

beginning and will also be capable of expansion without expensive alteration.

Professional engineers who specialize in industrial design can be found by referring to the published cards in various engineering magazines. They may also be reached through their national organizations.

Manufacturers of industrial equipment employ engineers familiar with the design and installation of their specialized products. These manufacturers are usually willing to give prospective customers the benefit of technical advice by those engineers in determining the suitability of their equipment in any proposed project.

VITA

Volunteers in Technical Assistance (VITA) is a private, non-profit, volunteer organization engaged in international development. Through its varied activities and services, VITA fosters self-sufficiency by promoting increased economic productivity. Supported by a volunteer roster of over 5,000 experts in a wide variety of fields, VITA is able to provide high quality technical information to requesters. This information is increasingly conveyed through low-cost advanced communication technologies, including terrestrial packet radio and low-earth-

orbiting satellite.

VITA also implements both long- and short-term projects to promote enterprise development and transfer technology.

LIQUEFIED PETROLEUM GAS

PREPARED BY: Jon I. Voltz

REVIEWED BY: John P. Hyde

Glenn H. Dale

PRODUCT DESCRIPTION

1. The Product

Liquefied petroleum gas (LPG) is a class of petroleum products produced from natural gas or as a by-product from refined crude oil. Types of LPG available in the United States and elsewhere are commercial grade propane, butane, butane-propane mixed, and HD-5 (a propane for engine fuel).

2. The Facility

This profile describes two plants, operating with three shifts for 52 weeks per year. The smaller has an annual manufacturing capacity of 2,220,000 barrels; the larger has an annual capacity of 4,440,000 barrels.

The methods of LPG recovery fall into four general classifications: (1) absorption, (2) absorption plus turbo-expander, (3) adsorption, and (4) compression. Absorption uses liquid such as naphtha or kerosene to recover LPG from gas. The rate of recovery can be increased by reducing the temperature. As a result, oil absorption plants often use refrigeration in the process.

LPG is distilled from the absorption oil by heating the oil. It is possible to recover virtually 100 percent of the propane and butane by maintaining a temperature of -40[degrees]C and by controlling the oil rate. The recovered LPG is fractionated into separate components such as propane and butane and must be further purified to remove hydrogen sulfide, organic sulfur compounds, and water in order to meet specifications. Among the purification processes are: amine and caustic treatment, solid bed dehydration, and molecular sieve absorption.

Absorption is used in both lean recovery (recovery of gases low in LPG content, such as propane) and heavier recovery. An oil absorption plant is relatively easy to operate and maintain, but it requires more energy than the turbo-expander process.

The turbo-expander process recovers propane and butane by a combination of compression and refrigeration, followed by expansion of the gas through a turbine. When the gas expands, it cools to about -100[degrees]C. The turbo-expander process is used when it is desirable to recover ethane. The process requires less energy but more skill to maintain and operate than the absorption process.

The absorption and turbo-expander processes are the two most practical commercial ways of recovering LPG, and are used in this profile.

GENERAL EVALUATION

The success of this industry depends to a great extent on the availability of natural gas. Marketwise, the sales potential for LPG should be good, particularly in areas or homes where natural gas by direct pipeline or other cheaper fuels are not available locally. The fixed capital requirements are fairly moderate in comparison with the annual estimated profits, and only one skilled worker is needed.

1. Outlook

A. Economic

The economics is good if the natural gas from which much of LPG is manufactured is higher in the components of LPG. However, available natural gas is becoming leaner in ethane and heavier products. Rich gas is defined as containing more than 5.0 gallons of LPG components plus/1000 cu. ft. per day of produced gas.

B. Technical

Most developments in LPG plants are in the acid gas removal and water removal section of the plants.

2. Manufacturing Equipment Flexibility

Most plants can produce butane and propane, but the plants may not have adequate equipment to produce the purity required or to obtain the necessary recoveries.

3. Knowledge Base

The following information is required: The estimated production rate of the field over a period of years, the components of the gas with time, the hydrogen sulfide and carbon dioxide content, nitrogen content and the field pressure. For plant design, a knowledge of thermodynamics is required.

4. Quality Control

Chromatographic analysis, a technique used to identify and separate LPG from the gas stream, is very important. It is also used to test for and remove impurities from the LPG as well as fractionate the recovered LPG into its separate components.

5. Constraints and Limitations

Ethane, propane, and butane are commodities used for fuel and chemical manufacturing. Seasonal changes in demand may occur. The products are explosive and most products for fuels contain odorants for detection. Plants must remove and handle the hazardous hydrogen sulfide with care.

MARKET ASPECTS

1. Users

LPG is used in homes, restaurants, hotels, etc. (mostly as utility gas), industrial plants, refineries, chemical manufacturing, and as engine fuel.

2. Suppliers

The source of LPG is about 2/3 from natural gas (mostly ethane and butane) and 1/3 from refineries.

3. Sales Channels and Methods

The product is sold in bulk to distributors for sale to ultimate users. consumers include homes, restaurants, hotels, trailers, camps, boats, farms, and industrial plants.

4. Geographic Extent of Market

Production capacity may limit this product to domestic consumption, but the possibility exists for export. (The U.S. LPG Industry exports about 500 million gallons a year. In 1986 the industry exported to 47 countries, with Mexico getting the most.)

5. Competition

Sales of LPG are competitive where piped natural gas, wood for fuel, or other cheaper fuels are not readily available.

6. Market Capacity

An accurate estimate of market potential cannot be made unless a comprehensive survey of sales potential is undertaken, because so many variable factors come into play.

PRODUCTION AND PLANT REQUIREMENTS

Requirements Annual Output:

Barrels

2,220,000 4,440,000

1. Infrastructure, Utilities Small Plant Medium Plant

Plant size (cu. ft. per day) 50,000,000 100,000,000

Utilities

Investment Equipment

Materials

Labor

2. Major Equipment & Machinery Small Plant Medium Plant (units)

Tools & Machinery

towers 3

accumulator tanks 3

vent tank

lean oil tank
surge tank
heat exchangers 2
condensers 2
coolers 3
recompressor
pumps 4
steam generator
water cooler
piping and valves
Support equipment & parts
pickup truck

(*) TOTAL ESTIMATED COST
of equipment & machinery \$25,000,000 \$40,000,000
completely installed

(*) Cost of major equipment only would be about 40 percent of the
above.

(*) Based on \$US 1987 prices. The costs provided are estimates and
are given only to provide a general idea for machinery costs.
They are not intended to be used as absolute prices. Costs still
need to be determined on a case by case basis. In addition, the
costs are for production grade purities only and do not include
costs for extra purification systems.

3. Materials & Supplies Small Plant Medium Plant
Raw Materials

natural gas (cu. ft. 18,250 36,500

Supplies

lubricants & hand tools

absorber oil

maintenance & spare parts

office supplies

gas, oil & truck maintenance

Packaging

Normally not much done. Perhaps
a small amount in steel cylinders.

4. Labor Small Plant Medium Plant

Skilled 2/shift

Semiskilled 2/shift

Unskilled 2

Indirect

supervisor/manager 1

chemist 1

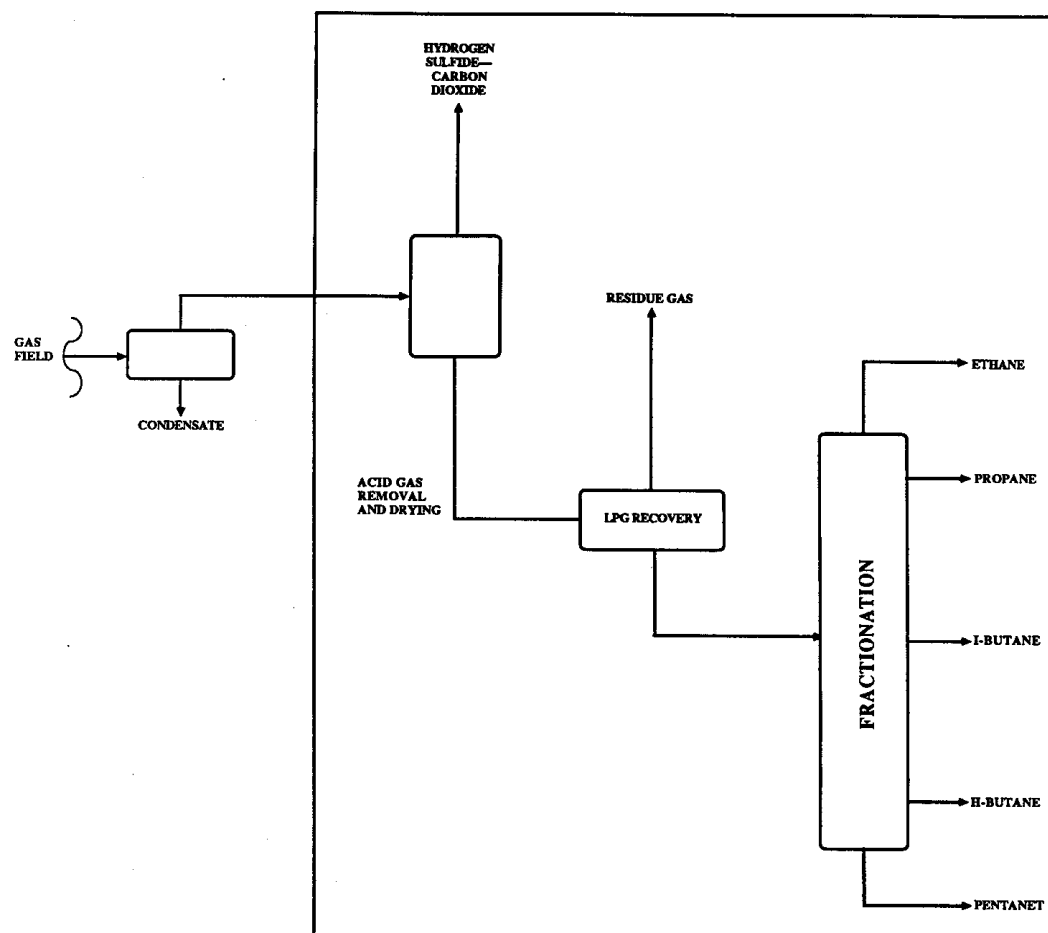
office 1

truck driver 1

PROCESS DESCRIPTION

The diagram below shows a generalized flow scheme for LPG recovery.

lpgx6.gif (540x540)



GAS PROCESSING PLANT

The natural gas containing the LPG is first treated to remove the acid gases: hydrogen sulfide, carbon dioxide, and carbonyl sulfide. The gas is then sent through a process to remove the water content. Very low water contents are required for cryogenic processes.

The next part of the process is LPG recovery, which includes absorption (refrigerated absorption), turbo-expander (cascade refrigeration), adsorption, and compression.

The final section of an LPG plant is the fractionation facility. The products to be produced and their purity will determine the size of this facility. For example, if n-butane is to be produced as a specialty, polymerization grade solvent, extensive fractionation, and adsorption processes may be required.

The final section of an LPG plant is the fractionation facility. The products to be produced and their purity will determine the size of this facility. For example, if n-butane is to be produced as a specialty, polymerization grade solvent, extensive fractionation, and absorption processes may be required.

REFERENCES

Unless otherwise stated, these addresses are in the United States.

1. Technical Manuals & Textbooks

Adams, J.L. and Boyer, W.C., What Makes a Good NGL Unit? Vol. 60, No. 5, Hydrocarbon Processing, May 1981, pp. 108-112.

Crum, F.S., Use J-T Plants for LPG Recovery (Joule-Thompson Adiabatic Expansion - Alternate to Expander and Refrigeration), Vol. 160, No. 5, Hydrocarbon Processing, May 1981, pp. 113-117.

Kaura, M. L., Plot Plans Must Include Safety, Vol. 59, No. 7, Hydrocarbon Processing, July 1980, pp. 183-194.

Kensell, W.W., How to Pick a Treating Plant, Vol. 58, No. 8, Hydrocarbon Processing, August 1979, pp. 143-145.

Encyclopedia of Chemical Technology, Vol. 14, 3rd. Edition, John Wiley and Sons, New York, 1981.

Engineering Data Book, Ninth Edition, Gas Processor Supplier's Association, Tulsa, Oklahoma, 1972.

Liquefied Petroleum Gas Specifications and Test Methods, Gas Processor Association, GPA Publ. 2140-75, Tulsa, Oklahoma.

ASTM Standard D 1835-76, Part 24, American Society for Testing and Materials, Philadelphia, Pennsylvania, 1978.

Storage and Handling of Liquefied Petroleum Gases, National Fire

Protection Association, NFPA 58, Boston, Massachusetts, 1979.

Design and Construction of LP-Gas Installations at Marine Terminals, Natural Gas Processing Plants, Refineries and Tank Farms, API Standard 2510., 4th Edition, American Petroleum Institute, Washington, D.C., December, 1978.

LP Gas Market Facts, National LP-Gas Association, Oak Brook, Illinois, 1977.

Process Economics Program Report No. 135, Oct. 1979, SRI International, Menlo Park, California 94025. This report includes plant designs for turbo-expander, cascade refrigeration, and refrigerated absorption.

2. Periodicals

Oil and Gas Journal
1301 W. 22nd Street
Oak Brook, Illinois 60521 USA

Weekly Propane Newsletter
P.O. Box 5000, Suite 331
Delmar, California 92014 USA

3. Trade Associations

National LP-Gas Association
1301 W. 22nd Street

Oak Brook, Illinois 60521 USA

National Petroleum Refiners Association
1899 L Street, NW
Washington, D.C. 20036 USA

4. Equipment Suppliers, Engineering Companies

AMETEK

Heat Transfer Division
P. O. Box 534004
Grand Prairie, Texas 75053 USA

Eastern Tank Fabricators, Inc.
74 Plandome Road
Manhasset, New York 11030 USA

Atlas Copco Comptec, Inc.
Department A
20 School Road
Voorheesville, New York 12186 USA

5. Directories

Thomas Register
Thomas Publishing Company
One Penn Plaza
New York, New York 10001 USA

6. VITA Venture Services

VITA Venture Services, a subsidiary of VITA, provides commercial services for industrial development. This fee-for-service includes technology and financial information, technical assistance, marketing, and joint ventures. For further information, contact VITA.

`INDUSTRY PROFILE SERIES'

VITA is pleased to present this series of industrial profiles. These Profiles provide basic information for starting manufacturing plants in developing nations. Specifically, they provide general plant description, financial, and technical factors for their operation, and sources of information and expertise. Dollar values are listed only for machinery and equipment costs, and are primarily based on equipment in the United States. The price does not include shipping costs or import-export taxes, which must be considered and will vary greatly from country to country. No other investment costs are included (such as land value, building rental, labor, etc.) as those prices also vary.

The series is intended to be useful in determining whether the industries described warrant further inquiry either to rule out or to decide upon investment. The underlying assumption of these Profiles is that the individual making use of them already has some knowledge and experience in industrial development.

These profiles should not be substituted for feasibility studies.

Before an investment is made in a plant, a feasibility study should be conducted. Each profile contains a list of questions to which answers must be obtained before proceeding with implementation of an industrial project.

All profiles are available in English only. They are priced at \$9.95 each. You may take advantage of the introductory offer and order any three Profiles for just \$25.00 or order the entire set of nineteen Profiles for a bargain price of only \$150.00.

BAKED, LEAVENED BREADS

Richard J. Bess

Describes a small bakery operating with a single shift and producing 100 tons of baked products a year. It also describes a medium-sized plant operating on the same basis but producing 250 tons of baked goods a year.

(IP #19) 6pp.

BLUE JEANS

Edward Hochberg

Describes one plant operating with one shift and making 15, 000 dozens of blue jeans a year, and another that produces 22,000 dozens a year.

(IP #6) 8pp.

DIMENSION HARDWOOD

Nicolas Engalichev

Describes a medium-sized mill operating with one shift that

produces 4,500 cubic meters of dimension hardwood per year. Some information is also provided for a mill twice as large.

(IP #16) 8pp.

FISH OIL AND FISH MEAL

S. Divakaran

Describes two plants. The first is a 20-ton per day plant operating with an eight-hour shift and producing 8,000 tons of fish meal and 4,000 tons of fish oil a year. The second is a 40-ton plant operating an eight-hour shift and producing 8,000 tons of fish oil and 16,000 tons of meal per year.

(IP # 8) 8pp.

GLASS CONTAINERS (BATCH PROCESS)

William B. Hillig

Describes small batch production plants with a work force of 10 to 50 people that produce 500 to 25,000 containers per day.

(IP #18) 8pp.

GLUCOSE FROM CASSAVA STARCH

Peter K. Carrell

Describes a plant that can operate 250 days a year on a three-shift continuous basis and produce 2,500 tons of glucose syrup.

(IP #17) 8pp.

LIQUID PETROLEUM GAS

Jon I. Voltz

Describes two plants, operating with three shifts for 52 weeks per year. The smaller has an annual manufacturing capacity of 2,220,000

barrels; the larger plant has an annual capacity of 4,440,000 barrels.

(IP #12) 8pp.

MEN'S DRESS SHIRTS

Edward Hochberg

Describes one small plant operating with one shift and manufacturing 15,000 dozen men's dress shirts a year. It also describes a larger plant running a single shift and manufacturing 22,000 dozen shirts a year.

(IP #13) 8pp.

MEN'S WASH AND WEAR PANTS

Edward Hochberg

Describes one plant operating with one shift and producing 15,000 dozens pairs of pants a year, and another that produces 22,000 dozens a year.

(IP # 4) 8pp.

MEN'S WASH AND WEAR SHIRTS

Edward Hochberg

Describes a plant operating with one shift, manufacturing 15,000 dozen men's wash and wear shirts a year, and another that manufactures 22,000 dozen shirts a year.

(IP # 5) 7pp.

MEN'S WORK SHIRTS

Edward Hochberg

Describes one plant operating with one shift and manufacturing

15,000 dozen men's shirts a year. It also describes a larger plant running a single shift and producing 22,000 dozen shirts a year.
(IP # 2) 8pp.

PAINT MANUFACTURING

Philip Heiberger

Describes a small plant that will serve local needs, mainly in the trade-sales sector. Its output may exceed 4,000 liters per week (L/wk).
(IP #14) 10pp.

PORTABLE METALLIC STOVE

Andre Charette

Describes a facility that accommodates two workers, a work table, and storage of materials and products. The hammer and chisel method permits production of five stoves daily. The tooling-aids permits production of up to 25 units daily.
(IP #10) 9pp.

PORTLAND CEMENT

Dave F. Smith & Alfred Bush

Describes a small plant producing 35,000 metric tons of cement a year.
(IP # 9) 10pp.

ROUGH-SAWN LOGS

Nicolas Engalichev

Describes plants (sawmills) operating with one shift that can produce 10,000 and 30,000 cubic meters (cu m) of product per year.

(IP #15) 8pp.

SMALL CERAMICS PLANT

Victor R. Palmeri

Describes a small plant operating with one shift and producing 16,000 pieces a year. It also describes a medium-sized plant running a single shift producing about 80,000 units a year.

(IP #11) 8pp.

STARCH, OIL, AND FEED FROM SORGHUM GRAIN

Peter K. Carrell

Describes a small plant operating with three shifts on a seven-day work schedule and processing about 200 tons of sorghum a day. Two shifts are down per week for maintenance. This facility may be considered a heavy industry because of the emission from the boiler and dryers and the noise from its high speed machinery.

(IP # 1) 8pp.

UNFERMENTED GRAPE JUICE

George Rubin

Describes a plant operating with one shift and producing 125,000 gallons of grape juice a year, and another that produces 260,000 gallons a year.

(IP # 7) 8pp.

WOMEN'S BROADCLOTH DRESSES

Edward Hochberg

Describes a plant operating with one shift and manufacturing 72,000 women's dresses a year (1,440/week, 288/day). It also describes a

**larger plant-running a single-shift and producing
104,000 dresses a year.
(IP # 3) 8pp.**

=====
=====