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Products Tanker Shipping and Shipbuilding

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PRODUCTS TANKER SHIPPING AND SHIPBUILDING

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ABSTRACT

First the entire products tanker market system, including the petroleum products market, products tanker shipping market and the products tanker shipbuilding market, is introduced. The relationship among principal elements is discussed. General information about petroleum products and products tankers is described. Then, the world petroleum products market and products tanker shipping market are examined referring to 1985 Drewry report. Finally, the analysis of products tanker shipbuilding market is made by analyzing the statistics of the products tankers ordered between 1980 and 1986 according to Fairplay orderbook. Major aspects, such as flag, owner, shipbuilder, vessel tonnage, dimensions, speed and engine, are examined. Conclusions and predictions are then made.

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CHAPTER ONE

INTRODUCTION

Background

According to the Shipping Information Services of Lloyd's Register of Shipping, in mid-1985 the world fleet consisted of 673.7 million deadweight tons (dwt) of various types of ships. Among them 39.8 percent were oil tankers which can be divided into crude oil tankers carrying dirty (or black) oil and products tankers carrying clean (or white) oil. At the same time, the tonnage of the products tanker fleet was 35.5 million dwt as reported by Drewry Shipping Consultants. Therefore, products tankers only accounted for about five percent of the total world fleet, a small sector of the world shipping market (see Table 1).

However, if one looks at the figures from the same sources, in mid-1985, world ships on order amounted to 41.8 million dwt, while products tankers on order amounted to 5.9 million dwt, accounting for 14 percent the orderbook.

These statistics relate that

1) the products tanker market is a small sector compared with other shipping markets such as crude oil tankers, dry bulk carriers and general cargo ships; and
2) since the percentage of products tankers in the world orderbook is greater than those in present fleet, the products tanker sector is expanding.

TABLE 1

WORLD FLEET BY PRINCIPAL TYPES OF VESSEL: MID-1985

PRINCIPAL TYPES	'000 DWT (%)	PERCENTAGE CHANGE 1984/1985
Oil tankers	268,355 (39.8)	- 6.5
Liquified gas carriers	10,249 (1.5)	+ 1.0
Chemical carriers	5,832 (0.9)	+ 0.7
Miscellaneous tankers	431 (-)	- 1.8
Bulk/oil carriers (inc. ore/oil carriers)	45,024 (6.7)	- 3.9
Ore and bulk carriers	192,288 (28.5)	+ 6.3
General cargo (inc. passenger cargo)	108,329 (16.1)	- 2.7
Container ships (fully cellular) and lighter carriers	19,939 (3.0)	+10.6
Vehicle carriers	3,339 (0.5)	- 8.9
Fish factories and carriers, and Fishing (inc. factory trawlers)	7,995 (1.2)	+ 1.3
Ferries and passenger vessels	2,622 (0.4)	+ 2.7
All other vessels	9,287 (1.4)	+ 3.1
World total	673,692 (100.)	- 1.4

Source: Shipping Information Services of Lloyd's Register of Shipping, and Lloyd's of London Press Ltd. UNCTAD, 1985.

The principal reason why the products tanker fleet is so small is that most refineries are located in consumption regions. Therefore, traditionally crude oil rather than oil products has been transported from its source to consumer markets by crude oil tankers or pipelines. Crude oil is found and extracted worldwide from Alaska to Arabia, from beneath both land and sea. Since the major consumption places are in developed nations, crude oil is refined and refined products are consumed in these countries. On the other hand, it is very convenient and economical that large amounts of crude oil are transported by large tankers such as Very Large Crude Carriers (VLCCs) and Ultra Large Crude Carriers (ULCCs). Therefore, the future crude oil tanker fleet will still be the predominant force of seaborne transportation, although the fleet has been shrinking.

Because of the small size of the products tanker fleet and its close relationship with the crude oil tanker fleet, since both are influenced by the world oil market, researchers usually examine the entire tanker market rather than treat products tankers as a separate category, although from a technical point of view there are many differences between the two ship types in both construction and operation. Most institutions do not even designate a specific sector for products tankers in their statistics, like in Table 1.

In the area of academic research, unlike the crude oil tanker market, only short articles about products tankers exist in publications such as Seatrade, Fairplay and Lloyd's List. An exception is Products Tanker Trade and Employment Prospects, a study by Drewry Shipping Consultants Ltd in 1985. That study examined recent trends in the petroleum products trade between and within major geographical regions and outlined its implications for products tanker employment. By utilizing the sector by sector oil consumption forecasts of the International Energy Agency, the report generated forecasts of the demand for each major product grouping. This provided one element in deriving likely future trade flows in petroleum products and forecasting products tanker employment generated by these flows.

In six sections, the report describes the products tanker market in the following steps: examining oil products demand; looking at refining capacity, reviewing throughput and product supply; examining the major inter-area trade flows; forecasting products tanker employment; looking at products tanker supply; and finally examining the market prospects in view of the projected demand and supply balance.

This a very comprehensive report. Much of the information contained within the report will be drawn upon in the following chapters. Other studies in this field include a Master's thesis, <u>Trading Potential and Economics of Product Tankers</u>, written by N.G. Fistes (1983) at Massachusetts Institute of Technology. The paper assessed the magnitude of shift in refinery location together with the changes in oil refinery technology, examined their effect on the trading patterns of petroleum products; analyzed all possible operating constraints and criteria for products tankers; made suggestions for cost minimization and operational flexibility. Further, the paper carried out an investment sensitivity analysis and assessed the effect of the financial and operational variables. Finally, the paper dealt with the demand and supply schedule for oil products and products tankers showing the trends for the products tanker fleet.

As indicated by the figures mentioned at the beginning of this research, the percentage of products tankers in the world fleet is increasing. Products tankers are becoming more and more important. This is mainly due to the shift of the oil transport pattern. With increased industrial development in developing countries, oil producing countries are keen to refine their own crude, thereby adding value to the exports. Thus, the oil trades are constantly evolving with a greater dependence on products tankers. Therefore, more academic research on the entire products tanker market is needed with regard to all relevant technical, economical, social, political and legal factors.

Statement of Purpose

The general objectives of this study are to examine the recent developments in the products tanker market and to predict the future of the market. Specifically, the shipbuilding market is to be examined by analyzing the products tanker newbuilding orderbook. As stated in the previous section, the products tanker industry needs this kind of research. Looking at the orderbook, one can analyze the products tanker market through a new approach. The advantages of this approach are as follows:

1) to include the shipbuilding market into the analysis, thus enabling the study of the products tanker market become more comprehensive;
2) as the shipbuilding market is influenced by the shipping market, the newbuilding orderbook is an objective record of the things happening in the shipping market; and
3) the newbuilding orderbook can help one to better understand the present products tanker fleet and predict its future.

Furthermore, the efforts made in this study are a part of a thrust to develop academic research concerning the modern shipping and shipbuilding industry, which is, of course, a contribution to Marine Affairs.

Hypothesis

It is hypothesized that with the development of oil refinery capacity in oil producing countries seaborne transportation of oil products will increase and products tankers will be of greater importance. Therefore,

1) The demand for products tankers will increase.
2) There will be a wider range of products tanker flag distribution.
3) There will be more products tanker shipowners.

4) There will be more countries constructing products tankers.
5) Products tankers will be larger.
6) Propulsion of the products tankers will be developed to meet the demand of the new market.

Methodology

The methodology used in this study involves the following steps:

1) The entire products tanker market, market elements and their relationships, petroleum products, and products tankers are described.
2) The oil products market, its present situation and future demand is examined. The analysis is mainly qualitative and the assessments are adapted from the Drewry study and other relevant publications.
3) The products tanker shipping market, its present and future demand for products tankers is discussed. The analysis is also mainly qualitative and forecasts by Drewry and other institutions are adopted.
4) The products tanker shipbuilding market is analyzed. This is a quantitative analysis based upon data of products tankers ordered between 1980 and 1986. The data are collected from the World Ships on Order compiled by

Fairplay International Research Services and published quarterly in <u>Fairplay International Shipping Weekly</u>. The data set was created on URI's main frame computer. The data set includes 13 variables for each products tanker: Issue Number, Unique Number, Flag, Owner, DWT, Propulsion Type, Propulsion Make, Speed, Length Overall, Beam, Draft, Builder and Delivery Due Date. The statistical analysis gives information on the shipbuilding market and products tanker market, such as Flag, Owner, Builder, Tonnage, Dimensions, Speed and Engine.

5) Summaries and Conclusions are made.

CHAPTER TWO

GENERAL INFORMATION

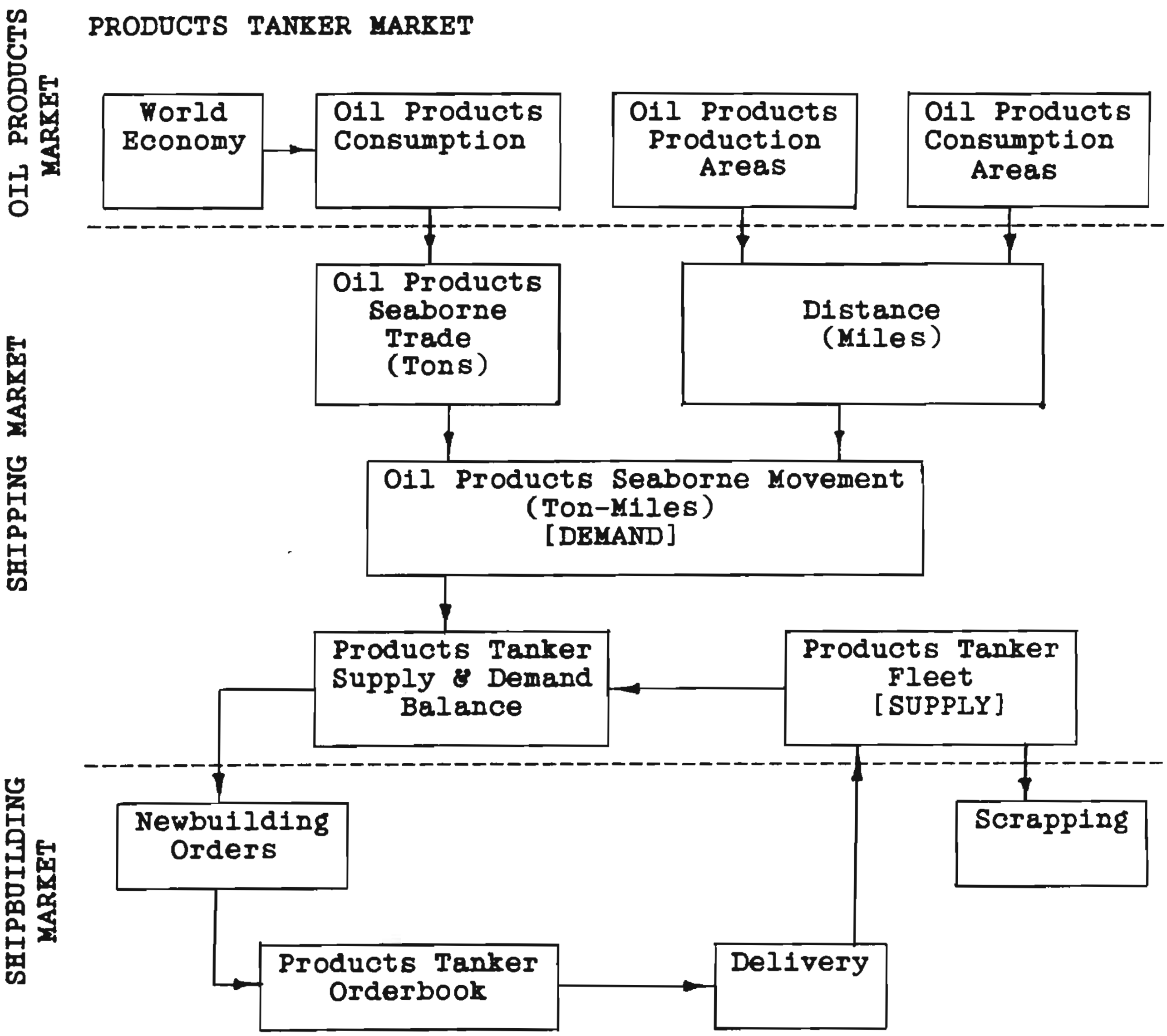
Products Tanker Market

The products tanker market can be divided into three sections, the oil products market, the products tanker shipping market and the products tanker shipbuilding market. These three sections are closely related to each other. It is impossible to examine the shipping market without reference to either the oil products market or the shipbuilding market. However, the affects of these three markets are in one direction, which means that the shipbuilding market is decided by the shipping market and the shipping market is decided by the oil products market. For example, the world economy has a very strong influence on the world shipping market, but the shipping industry has little influence on world economy. Although all three sections will be discussed in this paper, emphasis is on the shipbuilding market, especially on products tanker newbuilding orders.

Figure 1 is a very brief description of the products tanker market. The actual market is much more complex. In the Figure, the oil products market consists of four elements, the world economy, oil product consumption, areas of oil product production and areas of oil product consumption. The model is driven by the world economy which is the decisive element. Oil product consumption is decided by world economy. However, the

FIGURE 1

PRODUCTS TANKER MARKET



Source: Author.

relationship between these two elements is not as simple as indicated in Figure 1. In fact, the world economy influences total energy consumption which includes both oil and non-oil energy, such as coal, gas, hydroelectric and nuclear energy. Oil products are only one sector within the oil category. As the internal structure of total energy consumption may change, increases in energy consumption do not necessarily mean increases in oil products consumption. In certain cases, for instance when the oil prices are very high, the coal sector may increase faster than the oil sector. On the other hand, an increase in world economy may not necessarily lead to the same amount of increase in energy consumption. This situation is influenced by a wide application of energy saving devices induced by oil crises and the development of science and technology. The areas of oil products production and consumption are two important elements in the model. These places are the result of the history of industrial development. Although the places, especially the production places, are shifting, these two elements are less dynamic than the economy.

In Figure 1, the shipping market consists of oil product seaborne trade (tons), distance (miles), oil product seaborne movement (ton-miles), the products tanker fleet and the products tanker supply and demand balance. These elements reflect the general supply and demand of products tankers. There are many other elements including shipping operations, finance and other aspects which are important but beyond the scope of this study. Demand for products tankers is decided by both the volume of oil products seaborne trade and transport distance. When seaborne trade remains constant, a distance increase will lead to increases in seaborne movements and demand rises for products tankers.

The relationship between oil products consumption and oil products seaborne trade is not as simple as indicated in Figure 1. Seaborne trade is affected by many factors. Besides elements such as oil product consumption and areas of production and consumption, the method of transport also affects seaborne trade. For example, the amount of oil products transported by pipelines can have strong impacts on seaborne trade. On the supply side the products tanker fleet is, of course, not the only element. Laid up tonnage, slow steaming, partially loaded vessels and technological improvements on ships are important elements.

The supply and demand balance can be reflected by the freight rate and other shipping market indices. In Figure 1, the shipbuilding market consists of newbuilding orders, the products tanker orderbook and deliveries. In fact, newbuilding orders are decided by not only the supply and demand balance but also many other factors such as government policy toward shipping and shipbuilding, financial terms, newbuilding and second hand prices, shipbuilding technology and so on. There are also many speculative orders. The amount of ships on order is decided by both the rate of placing newbuilding orders and the rate of delivery which is affected by both shipbuilding technology and shipping market situations. For instance, when the market is depressed, shipowners prefer to get their ships as late as possible. Shipyard work load is another important factor affecting the elements in the shipbuilding market. Another important element in the model is scrapping which is mainly decided by the ages of ships. Delivery and scrapping rates decide the products tanker supply in the shipping market. In general, Figure 1 briefly summarizes the principal elements and the causal relationships in the products tanker market system which are also influenced by many other political, legal, economic, financial, technical and social factors.

Petroleum Products

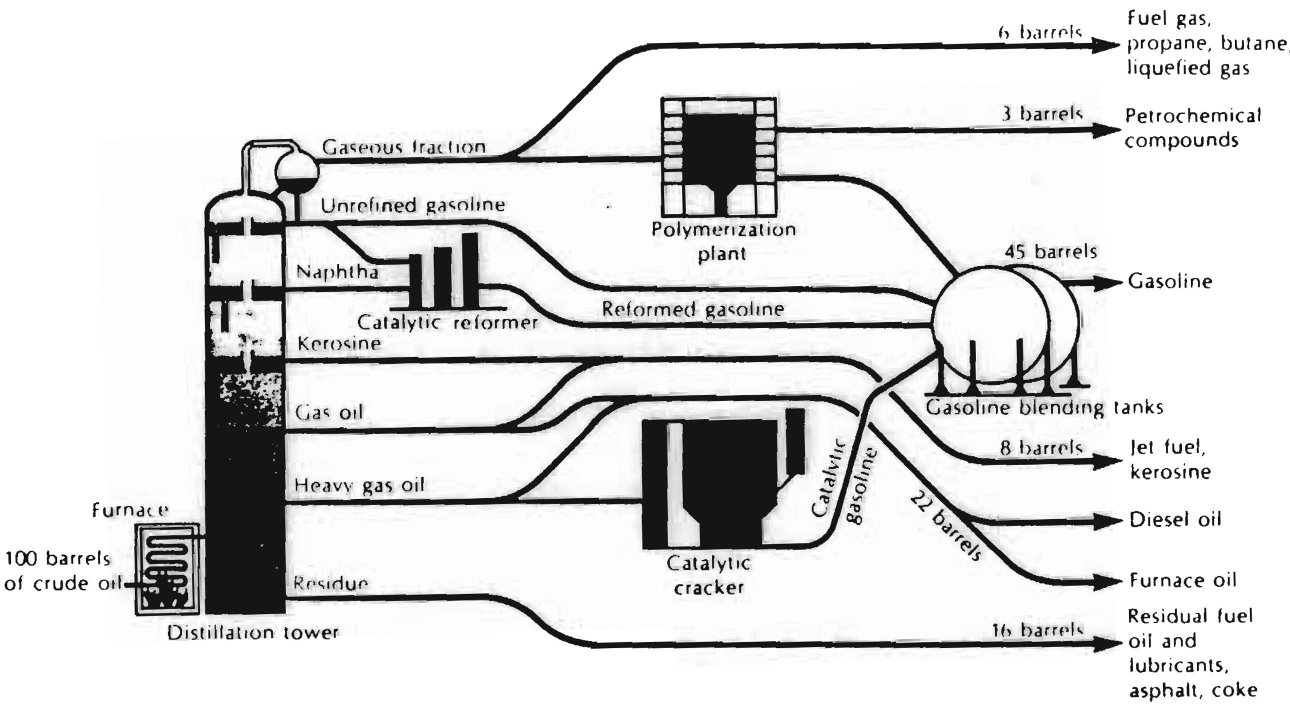
Unlike coal and gas, oil has to be refined before it can be used. In the past, this process was not always necessary. But demand for oil soon focused on petroleum products such as gasoline, kerosine and gas oil, which required a relatively simple refining process. Now demand is oriented toward complex products that require more and more costly refineries.

Petroleum products are derived from crude oil at oil refineries. Crude petroleum contains a wide range of hydrocarbons from light gases to residuum. The processes that characterize an oil refinery are distillation and "cracking". Progressive distillation or vaporization of the various components of crude oil results in an initial separation of the lighter petroleum products, such as gaseous hydrocarbons, gasoline, kerosine, and heating oil, from the heavier products such as lubricating oil and residual fuel oil. "Cracking" refers to the production, through the application of heat and pressure, with or without catalysts, of lighter and more volatile hydrocarbon compounds from the heavier and less volatile compounds. By cracking the fuel oil product of the distillation tower, the proportion of gasoline or any desired lighter fraction can be increased over that obtainable by distillation. Through this process, refineries in the United States of America convert about 45 percent of each barrel of crude oil into gasoline. European refineries, responding to a different set of demands for fuel, transform only about 20 percent of their crude into gasoline. Other refinery processes such as hydrogenation, hydroforming, polymerization, and alkylation produced gasoline and other substances with particular physical and chemical properties. Seldom are the distillation fractions suitable as finished products; consequently, they are blended, cracked, re-formed, or changed in other ways to produce more than a thousand specialized products. Almost 15 percent of the crude oil consumed goes into products such as lubricants, waxes, solvents, paving materials, insulation, insecticides, fungicides, herbicides, and petrochemical products -- none producing energy (Cook, 1976).

Figure 2 is a highly generalized sketch of hydrocarbon flow through a modern oil refinery in the United States. The principal products are gasoline which accounts for about 45 percent of the crude oil input. Table 2 represents the fractions obtainable from the distillation of crude oil. Table 3 summarizes petroleum

FIGURE 2

A HIGHLY GENERALIZED SKETCH OF HYDROCARBON FLOW THROUGH A MODERN OIL REFINERY IN THE UNITED STATES



Source: Cook, Earl (1976) Men, Energy, Soceity. San Francisco: W.H. Freeman and Company. p 93.

TABLE 2

FRACTIONS OBTAINABLE FROM THE DISTILLATION OF CRUDE OIL

Boiling range (°F)	Fraction	Uses
−259° to −44°	Methane, ethane	Refinery fuel; petrochemical feedstock
−44° to 11°	Propane	Liquefied petroleum gas (LPG); petrochemical feedstock
11° to 30°	Butane	Blended with motor gasoline; petrochemical feedstock
30° to 300°	Light naphtha	Component of gasoline
300° to 400°	Heavy naphtha	Feedstock for catalytic cracking; blended with light gas oil to make jet fuel
400° to 500°	Kerosine	Component of jet fuel and heating oil; used as solvent and illuminant
400° to 600°	Light gas oil	Component of fuel oil and diesel fuels
600° to 800°	Heavy gas oil	Blended with vacuum gas oil into feedstock for catalytic cracking
800° to 1100°	Vacuum gas oils	Source of lubricating oils and distillates; feedstock for catalytic cracking
More than 1100°	Residue	Blended with gas oils to make heavy fuel oils; source of asphalts or waxes.

Source: Cook, Earl, 1976.

TABLE 3

PETROLEUM PRODUCTS, THEIR USES AND COMPOSITIONS

Product	Application	Typical composition
Power fuels		
automotive gasoline		
regular leaded	passenger cars and trucks; engines up to about 9:1 compression ratio	blend of thermally or catalytically cracked, reformed, or straight-run naphthas
premium leaded	passenger cars; engines over about 9:1 compression ratio	blend of catalytically cracked, reformed, isomerized, and straight-run naphthas; alkylate
unleaded	passenger cars and trucks with engines having catalytic mufflers	similar to premium leaded but without any lead antiknock additives
aviation gasoline		
grade 80	small civilian aircraft	blend of catalytically cracked and straight-run naphthas; alkylate; isopentane
grade 100	large civilian and commercial aircraft with supercharged engines	blend of catalytically cracked naphthas, alkylate, and isopentane
grade 100LL	same as grade 100	similar to grade 100 except with lower lead-additive content
aviation turbine fuel		
jet A or jet A-1	jet-propulsion aircraft	high-flash-point distillate of the kerosene type
jet B	jet-propulsion aircraft	more volatile distillates than for type A or A-1 giving a wider boiling range and including gasoline
diesel fuel oil		
grade 1-D	mobile service such as trucks, railroad, and submarines; high speed engines with wide variations in loads and speeds; low temperature service	straight-run fractions including kerosene to intermediate distillates from paraffinic crude or treated fractions from mixed-base crudes
grade 2-D	industrial and heavy mobile service; high speed engines with high loads and uniform speeds	similar to grade 1-D but with lower volatility
grade 4-D	large stationary installations; engines with sustained loads and constant speeds	residual fuel oils blended with more viscous distillates
gas-turbine fuel oil		
grade 0-GT	gas turbines requiring fuels with clean burning characteristics	naphthas and other low flash distillates
grade 1-GT	suitable for nearly all gas turbines; not primarily for aircraft use	light distillates including some gas oil fractions
grade 2-GT	gas turbines requiring low ash fuel but not requiring the clean burning characteristics of grade 1-GT	heavier distillates than grade 1-GT; similar to no. 2 fuel oil
grade 3-GT	gas turbines operating at gas inlet temperatures below 650°C; usually requires fuel-heating equipment	residual fuel that meets the low ash requirements

TABLE 3 (CONTINUED)

Product	Application	Typical composition
grade 4-GT	gas-turbine operations where progressive reduction in power output and thermal efficiency can be tolerated; requires periodic shutdown for cleaning	similar to grade 3-GT but without restriction on the quantity of ash
Heating oils		
LPG	resident and commercial fuel, chemical raw material, industrial fuel, and internal-combustion engine fuel	mostly from natural-gas processing plants; unsaturated compounds in refinery streams only a. propane and/or propylenes b. butane and/or butylenes c. butane and/or butylenes with propane and/or propylenes d. propane (for engines)
fuel oils		
no. 1, kerosene, range oil	vaporizing pot-type burners	straight-run distillate; treated for stability
no. 2	general-purpose domestic fuel for atomizing-type burners	straight-run or catalytically cracked distillates
no. 4	light industrial installations not equipped with preheating facilities	light residual fuels; sometimes heavy distillates
no. 5	burners capable of handling heavier fuels than no. 4 fuel oils; may require preheating	residual fuel
no. 6, bunker C	burners with preheaters permitting high viscosity fuels	straight-run or cracked residuums; high viscosity oils
Illuminating oils		
kerosene	for wick lamps	straight-run treated distillate from paraffinic or mixed-base crude; solvent-treated distillate from aromatic crude
mineral seal oil, long-time burning oils, 300 oil, mineral colza oil	for prolonged burning, railway semaphore, lighthouse, and similar wick lamps	straight-run treated distillate from paraffinic or mixed-base crudes
Solvents		
Stoddard solvent	dry cleaning of clothes; degreasing of metal parts	straight-run naphtha, chemically treated, from paraffin-base or mixed-base crudes
petroleum spirits, mineral spirits; VM&P naphthas[a]	general-purpose thinner and solvent for paint, varnish, and similar industries	same as for Stoddard solvent
petroleum extender oils	processing styrene–butadiene and butadiene rubbers	straight-run naphthas from paraffin-base crude
aromatic solvents, eg, benzene, toluene, xylene	quick-evaporating, high solvent-power thinner for synthetic resins, paints, varnishes, and lacquers; thinners and plasticizers for synthetic rubbers, plastics, and toxicants	petroleum aromatics in a specified boiling range derived from various aromatization processes

TABLE 3 (CONTINUED)

Product	Application	Typical composition
Lubricants		
automotive lubricants		
crankcase oils	general engine lubrication; sealing the combustion chambers and partial cooling of engines	well-fractionated and refined cuts from paraffin-base, mixed-base, or cycloparaffinic crudes; best grades from paraffinic or solvent-refined mixed-base crudes; contain a variety of additives, eg, oxidation inhibitors, pour depressants, viscosity builders, detergents, antiwear compounds, etc
transmission and axle lubricants	for transmission and rear axles (differentials) in automotive equipment	well-refined heavy lubricating oils; contain film-strength improvers or extreme pressure additives (particularly for hypoid gear service)
antifriction bearing and chassis greases	for wheel and other bearings, chassis, parts, water pumps, universal joints, and other nonsealable parts	medium and high viscosity, well-refined lubricating oils gelled by addition of metallic soaps or other thickeners; contain additives
industrial lubricants		
machine and engine oils	general lubrication of machinery	mostly straight-run refined, medium-viscosity oils from paraffinic, mixed-base, and naphthenic crudes; may contain additives in special applications
steam-turbine oils	lubricants, coolants, and rust preventives for use in oil-circulating systems of steam turbines	highly refined paraffin-base or solvent-refined mixed-base medium-viscosity oils (150–450 SUs at 38°C); contain oxidation inhibitors and rust preventives
steam-engine oils, cylinder oils	lubricants and sealing fluid for cylinders of steam engines	refined high viscosity oils, mostly paraffin-base; contain compounding (2–5% fat) when used with wet or saturated steam
textile-machinery oils	for high speed parts of textile machinery	highly refined, light-colored, low viscosity (60–200 SUs at 38°C) paraffin-base or solvent-refined oils, sometimes with antiwear and antioxidant additives and rust preventives
refrigerating-machine oils	for refrigerating machines in direct contact with refrigerants such as fluorochemicals and ammonia	highly refined, medium-viscosity (150–450 SUs at 38°C) waxfree oils
gear oils	for closed and open gears	variety of oils, from highly refined bright stocks (90–150 SUs at 99°C) to black residual oils and cutbacks thereof with volatile oils; may contain film-strength improvers or extreme pressure additives
industrial greases	for moving parts not lending themselves to sealing	variety of oils gelled by metallic soaps or nonsoap thickeners

TABLE 3 (CONTINUED)

Product	Application	Typical composition
Building materials		
asphalt cements	binder of mineral aggregate in hot-mix paving compositions such as asphalt concrete and sheet asphalt, and for hot-penetration road surfaces such as macadam	mostly solid and semisolid waxfree residua from vacuum or steam distillations of asphalt-base and mixed-base crudes; also combinations of crude residua with solvent extraction residuum
liquid asphalt, cutback asphalt)		
rapid-curing type	binder in surface treatments, and road-mix construction with open-grade aggregate; for cold patches; macadam construction in cold weather	softer grades of paving asphalts cut back with naphtha
medium-curing type	similar to rapid-curing type, except solvent evaporation is slower	paving asphalts cutback with kerosene
joint filler	resilient joint filler for waterproofing expansion joints on concrete roads and brick or cutstone pavements	oxidized air-blown asphalts with 50% sample compression from pressures in the range of 0.67–5.2 MPa[b]
roofing asphalts		
type I	susceptible to flow at roof temperature with good adhesive and self-healing properties; for inclines up to 4.17% slope	asphalt softening at 57–66°C
type II	moderately susceptible to flow at roof temperature; for built-up roof construction with inclines of 4.17–12.5% slope	asphalt softening at 70–80°C
type III	relatively nonsusceptible to flow at roof temperature; for built-up roof construction with inclines of 8.3–25% slope	asphalt softening at 85–96°C
type IV	generally nonsusceptible to flow at roof temperature; for inclines of 16.7–50% slope	asphalt softening at 99–107°C
emulsified asphalts	same as for cutback asphalts; road-repair work	asphalt cement emulsified with water
dust-laying oils	surface spraying of earthen roadways; lighter duty than slow-curing asphalts	nonviscous, low volatility, untreated distillates; sometimes light-grade fuels oils
Insulating and waterproofing materials		
transformer oils	oil-filled transformers, circuit breakers, and switches, as insulators and coolants	highly refined low viscosity oils traditionally from cycloparaffinic bases but recently from paraffinic bases

TABLE 3 (CONTINUED)

Product	Application	Typical composition
cable oils		
light grade	oil-filled cables	conventionally refined naphthene-base oils
heavy grade	paper-wrapped cables	same as above
waterproofing asphalt	for foundations, draining systems, culverts; impregnation of insulating boards; water-stop backings of building slabs, revetment of river banks, lining of irrigation ditches	oxidized asphalts in three types with softening points of 46–60°C, 145–170°C, and 180–200°C, respectively
waxes		
paraffin wax	saturants, laminants, coatings for paper, textiles, electrical insulating, and building materials; rubber compounding; scalers for food products	highly refined mixture of solid crystalline hydrocarbons, mostly straight-chain
crude-scale wax	same as above	semirefined grade of above
microcrystalline waxes	laminating and coating material for waterproofing and electrical insulation	mixtures of refined solid microcrystalline hydrocarbons, largely branched-chain, of higher molecular-weight than in paraffin wax
wax emulsions	cold application of waxes to manufactured products as above, except for electrical insulation	wax-in-water emulsions containing 40–50% wax (paraffin, microcrystalline, or both)
Other products		
cutting oils		
nonsoluble	lubricants and coolants in cutting, threading, and similar metal-working operations	refined lubricating oils containing film-strength additives, or sulfurized base oils; can contain sulfurized, chlorinated, or fatty additives
soluble	same as above but used in dilution with water (1:10 or 1:15) as an emulsion	same as above, with emulsifying agents added
heat-treating oils		
quenching oils	quenching medium for case-hardening of metal parts	refined high-flash distillate oils; straight or blended with viscous residual oils or selected additives
tempering and annealing oils	heat-treating medium for relieving stresses in metal parts and controlling the degree of hardness	similar to quenching oils, usually high viscosity
heat-transfer oils	heat-transfer medium for indirect heating by hot-oil circulation up to 330°C; used in industrial processes where overheating is objectionable	refined mineral cylinder oils, 150–300 SUs at 99°C; brightstocks, 90–150 SUs at 99°C; refined paraffinic or aromatic oils, 150–300 SUs at 38°C
hydraulic oils	power-transmitting fluids in hydraulic drives and controls; fluid media in shock absorbers and recoil mechanisms; lubricant and coolant for moving parts of the hydraulic power	predominantly paraffin-base or solvent-refined mixed-base oils, 100–800 SUs at 38°C, with fire point above 93°C, containing one or more additives (viscosity-index improvers, rust

TABLE 3 (CONTINUED)

Product	Application	Typical composition
	transmissions; rust preventive	preventives, film-strength improvers and antiwear additives)
tree-spray oils		
dormant-spray oils	insect control on defoliated trees in winter	conventionally refined paraffin-base or mixed-base oils, 80–125 SUs at 38°C
verdant-spray oils	insect control on verdant trees in summer	highly refined oils from paraffin-base or solvent-refined mixed-base stocks, 40–80 SUs at 38°C
insecticide-base oil	solvent for pyrethrum, rotenone, nicotine, and synthetic insecticides, for household sprays, and special plant sprays	highly refined, colorless, odorless grade of light kerosene fraction
weed-control oil		
light oils	selective deweeding of vegetables	refined naphtha, boiling range 150–200°C, from mixed-base crudes
medium oils	general deweeding	thermally and catalytically cracked distillate oils
heavy oils	railroad-track deweeding and similar applications where black color is not objectionable	cracked residual oils
medicinal white oils	ingredient of medicinal preparations for internal and external use; laxative	highly refined, colorless, tasteless, and nearly odorless cycloparaffin-base hydrocarbon oils
petroleum jelly	ingredient of various medicinal and cosmetic preparations having an unctuous consistency	highly refined, colorless to yellow, tasteless, and nearly odorless, semisolid mixture of hydrocarbons derived from dewaxing of heavy paraffin-base lubricating oils, 90–200 SUs at 99°C

[a] Aliphatic petroleum fractions, bp 90–150°C.
[b] To convert MPa to psi, multiply by 145.

Source: Kirk-Othmir (1982) Encyclopedia of Chemical Technology, Third Edition, Vol 17, New York: John Wiley & Sons, Inc. pp 260 - 265.

products and includes their uses and compositions.

Petroleum products are a convenient source of energy. Since petroleum liquids are easy to handle and store, they are especially suited for transportation fuels, eg, for automobiles and air planes. The importance of petroleum products is reflected in the increasing consumption of crude oil, the starting material for these products. The relative amount of various products are influenced by several factors, especially feed stock and processing costs and market demands. For example, as mentioned above, a greater proportion of gasoline is produced in the United States as compared to Western Europe where distillate and residual fuel are more in demand. Distillate fuels usually denote burner fuels, diesel fuels and similar intermediate-volatility products taken from a distillation process. Gasoline also is a distillate product, but it is identified separately. Residual fuels are the bottom products from distillation and include asphalts, petroleum coke, and heavy industrial and burner fuels.

Petroleum products marketing and distribution are large scale operations involving delivery of large amounts and wide range of products from refineries and storage points to consumers. The major transportation means are products tankers, barges, and pipelines. It should be pointed out that gaseous or solid petroleum products can not be transported by products tankers. Normal cargoes carried on products tankers include: gasoline, naphtha, aviation fuel, diesel oil, gas oil, paraffin (kerosine), lubricating oils and greases. All are products which require particular care and cleanliness in handling and transporting to avoid contamination. These petroleum products are so called clean (or white) oil.

Products Tankers

Oil tankers generally are engaged in one of two distinct types of service, distinguished as "clean" or "black" (sometimes also called "dark oil" or "dirty") trades. Ships in the latter trade carry only crude, residual, and darker oil up to the diesel grade. Many of the very heavy crude oils require heating to reduce viscosity before they can be pumped ashore (Kendall, 1986).

Products tankers are the special vessels carrying clean products. The clean trade, as the name implies, demands that the ship be very carefully prepared before any oil cargoes are pumped into the tanks. Certain jet engine fuel must be carried only in the tanks coated with inorganic, non-ferrous compounds to eliminate contamination through corrosion of the tank walls. Lubricating oil may be emulsified if any water is left on the tank walls, and therefore all these surfaces must be wiped by hand to assure that no trace of moisture remains which could pollute the cargo. It is customary to fill the tanks to capacity so that there is no void space in which condensation can form. In those instances where several grades of lubricating oil, varying in color from grade to grade, must be pumped through the same piping system, the lightest colored oil is pumped first. This assures against contamination from any residue encountered in the pipes (Kendall, 1986).

Shipbuilders consider products tankers as one of the most sophisticated types of vessels mainly because:

1) The high requirements of the cargoes demand special and extra work on the cargo tanks, such as protectively-coating the cargo compartments with epoxy type paints which assist cleanliness and the ease of transfer between products. Different oil products have different requirements for the tanks.
2) The complicated pumping system and other cargo handling equipment. Usually, the cargo is loaded by shore-based facilities, but discharged by a vessel's own high capacity main centrifugal pumps operating at speed.
3) The safety equipment, such as an Inert Gas System (IGS). As oil products are highly flammable and vapors are explosive, the safe measures are of paramount importance.
4) Oil pollution prevention measures. MARPOL 73/78, effective October 1983, requires existing products tankers of 40,000 dwt and above have Segregated Ballast Tanks (SBT) or Clean Ballast Tanks (CBT). All new products tankers of 30,000 dwt or above must possess SBT. The difference between SBT and CBT is that, besides the separate tanks for clean water ballast, SBT has an entirely separate piping system, while CBT does not.

5) Following international conventions under the leadership of International Maritime Organization (IMO), many tankers are today fitted with sophisticated equipment and even computers. For instance, "Lodicators" can draw attention to ways of avoiding accidents when handling cargo and/or ballast water (Packard, 1984).

Tankers can "migrate" from clean to dirty cargoes and vice-versa, but the cost of cleaning cargo tank of those vessels previously engaged in dirty trades may prove prohibitive. Nevertheless, some products tankers, particular the older vessels, may carry dirty products or crude oil from time to time. Categorizations of products tankers are fairly loose. The dividing line between clean and dirty tankers is not always unambiguously defined (Drewry, 1985)

The following are two examples of modern products tankers:

1) The first is the Norita, a 84,000 dwt products tanker constructed by the Burmeister & Wain Shipyard in Copenhagen, Denmark, and delivered to Uglands Rederi, Norway, in 1986. A double skin, resulting from double bottom, double sides and double deck, contributes to safety and insulation of the cargo against thermal loss or "superheating" by strong sunlight. Up to 12 different oil products and chemicals including methanol can be carried simultaneously and two special deck hatches allow for loading of grains. Each tank is served by an individual stainless steel piping system and hydraulic deepwell pump. Daily fuel consumption is 22 metric tons

at 13 knots due to the hull lines and the MAN B&W 5L70MCE low speed main diesel which drives a 7.2 m diameter, four bladed F.P. propeller.

Its brief specifications are:

Length, OA	228.60 m
Length, BP	218.70 m
Beam, molded	32.24 m
Depth, molded	21.60 m
Draft, design	11.58 m
Draft, scantling	16.00 m
Corresponding deadweight	54,000/84,000 t
Propulsion	MAN B&W 5L70MCE

(ME/LOG, 1986)

2) The second is the USNS Paul Buck, a 30,000 dwt products tanker, constructed by the American Shipbuilding Co.'s Tampa Shipyard, and delivered in 1985. She incorporates a new generation of hull lines and is powered by Japanese-built Sulzer 5RTA76 super long stroke, slow speed diesels. The propulsion plant operates completely unmanned. Main propulsion is direct drive through a solid shaft to a fixed 4-blade propeller. The main engine has been deliberately derated and is especially adapted to drive a 750 kW, 3-phrase, 60 Hz shaft generator through a speed-increasing gearbox. The vessel is designed to deliver or receive 30,480 metric tons of products worldwide and is ice strengthened for the Arctic or Antarctic service. Cargo is carried in seven pairs of tanks, each pair segregated from any other pair to allow seven different liquid cargoes to be carried. Each tank has a stainless steel, high-pressure, hydraulic cargo

pump. Pumps are sized to discharge the entire cargo within 16 hours. All cargo tanks are fully inerted by inert gas generators. Inert gas system piping and cargo piping are of stainless steel. There are facilities for refueling at sea from two stations as well as over the stern. Tampa Shipyard developed the unique construction of the vessel's cargo tanks with a substantially reduced surface area that results in significant cost reduction in epoxy coating maintenance inside. The ship's entire hull, except for the foundations and superstructure, is constructed of AH36 higher-strength steel, providing a 15 percent savings in steel weight over Grade A steel, and is designed using a scantling draft of 10.97 m. This allows the owner the flexibility of deeper drafts. Auxiliary power is provided by three 800 kW, 40 v, three phase, 60 Hz ship service generators. The emergency generator is a 300 kW diesel engine of 480 v, 3-phase, 60 Hz.

The vessel's brief specifications are:

Length, OA	187.45 m
Length, BP	179.07 m
Beam, molded	27.43 m
Depth, molded	16.36 m
Designed draft	10.36 m
Full loaded displacement	39,664 t
Deadweight	30,480 t
Main engine	IHI-Sulzer 5RTA76
Horsepower @mcr	15,300bhp

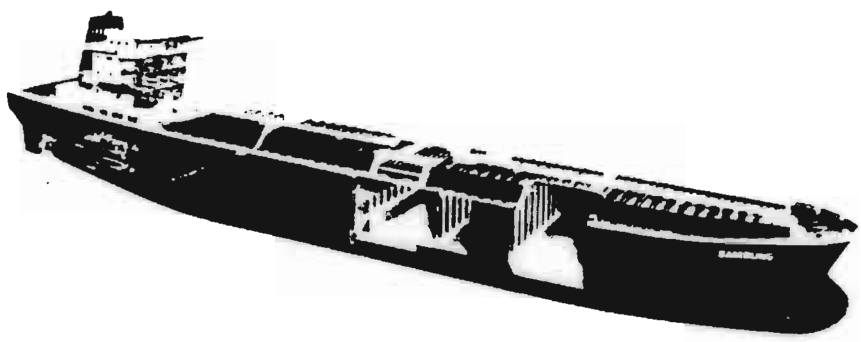
(<u>ME/LOG</u>, 1985)

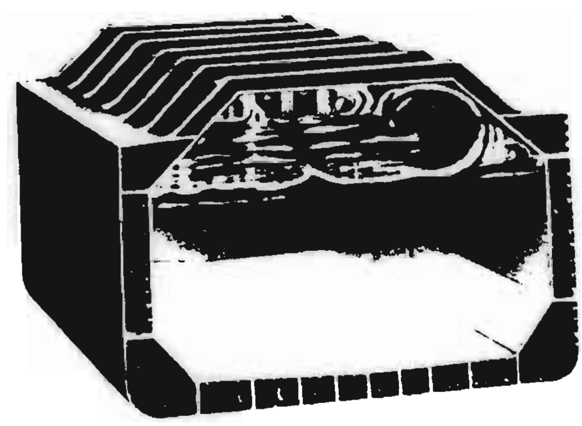
The development of products tanker design and construction has been significant. One of the developments is cargo tank design. Oil, being a liquid, will follow all movement of the ship, and thus have a large free surface, unless some method is employed in breaking up its surface. This is normally done by the use of longitudinal bulkheads, which divide the vessel in to either three or four sections. Other bulkheads athwartship divide the longitudinal sections into tanks (Branch, 1975). Recently, Samsung Heavy Industries Co. Ltd. of South Korea has completed an innovative design for products tanker tanks.

Figure 3 shows a 47,700 dwt products tanker with its interior tank design which utilizes features common in liquefied natural gas carriers to counter free surface effect in full wide cargo compartments. The cargo tank has a high dome top and sloping sides which can counter sloshing of oil cargoes (Fairplay, 1987 b).

FIGURE 3

SHI NEWLY DESIGNED PRODUCTS TANKER AND THE SHAPE OF THE CARGO TANKS





Source: Fairplay (1987 b) Fairplay International Shipping Weekly, April 2, p 36.

CHAPTER THREE

THE PETROLEUM PRODUCTS MARKET

Petroleum Products Demand and Refinery Trend

Economic Growth and Energy Demand

Energy demand is a function of economic growth. Economic growth leads to an energy demand increase. However, the inter-relationship (the elasticity) between energy demand and economic growth is not constant. In the past 15 years, because of energy conservation effects and the widespread introduction of energy saving equipment across all economic sectors after the first oil crisis, the elasticity is getting smaller and smaller. Between 1973 and 1984 Gross Domestic Product (GDP) growth in the developed countries averaged 2.3 percent each year. Over the same period, International Energy Agency (IEA) member countries' total primary energy requirements (TPER) grew by only 4.5 percent or 0.4 percent per annum. Over the period 1973/79, GDP registered an annual growth of 2.7 percent and TPER at an annual growth of 1.5 percent. Between 1979 and 1983, GDP grew by 5.3 percent in total. In sharp contrast, TPER fell by over eight percent. Energy consumption actually increased in 1984 for the first time since 1979, registering a growth of 4.4 percent. GDP growth in 1984 was 4.9 percent (Drewry, 1985).

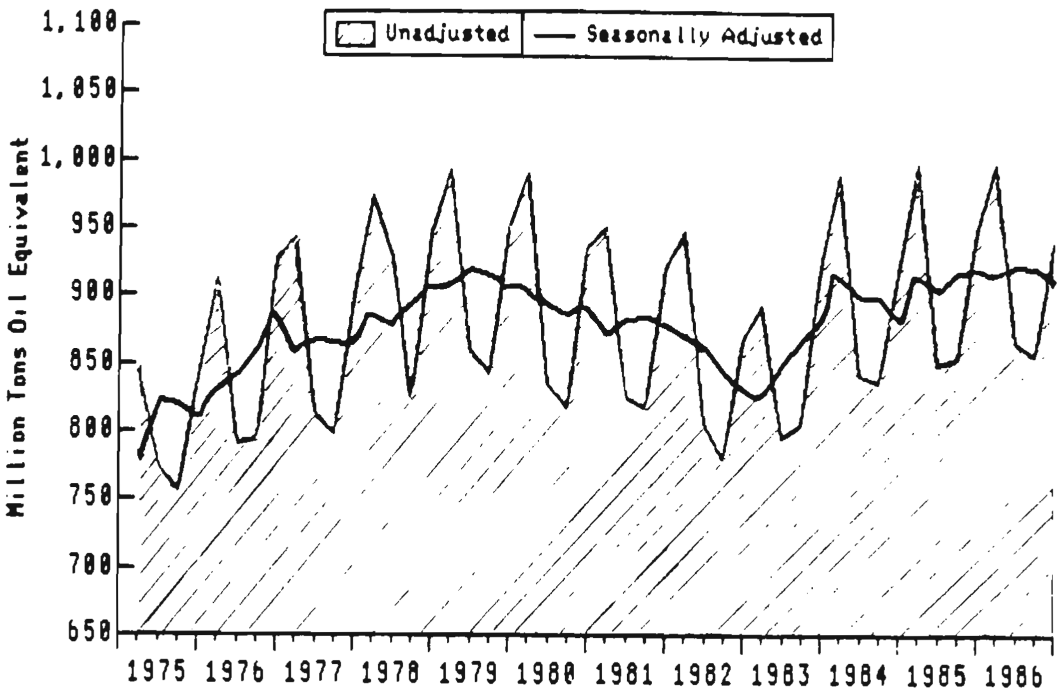
In 1985 and 1986, there were small increases in energy consumption. Figure 4 is the Organization for Economic Cooperation and Development (OECD) quarterly energy consumption between 1975 and 1986. Table 4 indicates historical and future reduction of TPER per unit of GDP by region. IEA expects that until 1990 GDP will grow at 3.1 percent annually among member countries. Between 1990 and 2000 growth will be 2.8 percent per annum. The TPER per unit of GDP is expected to decline 0.69 percent in 1990 and 0.63 percent in 1995 for the IEA member countries.

Historical and future IEA country energy consumption by region and economic sector is presented in Table 5. Energy consumption is measured by total final consumption (TFC). This differs from TPER primarily in that the energy loss in electricity generation due to the transformation process is excluded from TFC. Refinery losses and energy losses are also excluded from TFC. The largest growth in the past was in the transportation sector, while in the future it will be in the industrial sector. However, the total annual growth rate will be very slow in the future, 0.8 percent between 1990 and 1995.

On the other hand, according to forecasts by the Chevron Corporation, future energy consumption in developing countries including Africa, Middle East, Latin America and South East Asia should increase at a much faster rate, 4.1 percent a year between 1983 and 2000. South and East Asia is the fastest growing region at 5.4 percent a year. In the centrally planned economies, including USSR, East Europe, China and others, the growth rate will also be faster, 3.1 percent between 1984 and 2000. Among

FIGURE 4

QUARTERLY ENERGY CONSUMPTION - TOTAL OECD



Source: OECD-IEA, (1987) Quarterly Oil and Gas Statistics, No.1, 4th Quarter, 1986, Paris.

TABLE 4

TPER PER UNIT OF GDP : 1973-1995

	1973	1980	1983	1984	1990	1995
IEA Total	0.90	0.81	0.73	0.73	0.69	0.63
North America	1.14	1.04	0.93	0.91	0.88	0.79
Pacific(1)	0.70	0.59	0.53	0.53	0.47	0.44
Europe	0.70	0.63	0.59	0.59	0.56	0.52

(1) Japan, Australasia

Source : IEA Energy Policies and Programmes,
1983 and 1984 Reviews published in 1984 and 1985

Drewry, 1985.

TABLE 5

FORECAST IEA ENERGY CONSUMPTION BY GEOGRAPHICAL REGION AND ECONOMIC SECTOR

	MTOE				AVERAGE ANNUAL RATE OF CHANGE (%)		
	1973	1983	1990	1995	1973/83	1983/90	1990/95
NORTH AMERICA							
TFC	1,451	1,389	1,579	1,640	- 0.4	1.8	0.8
Industry	527	434	589	631	- 1.9	4.5	1.4
Transport	445	472	444	452	0.6	- 0.9	0.4
Residential(1)	479	484	546	557	0.1	1.7	0.4
IEA EUROPE							
TFC	746	700	783	815	- 0.6	1.6	0.8
Industry	341	268	320	337	- 2.4	2.6	1.0
Transport	138	169	182	189	2.0	1.0	0.8
Residential(1)	267	262	281	289	- 0.2	1.0	0.6
PACIFIC							
TFC	293	292	336	378	-	2.0	2.4
Industry	173	145	169	186	- 1.8	2.2	1.9
Transport	59	68	88	101	1.4	3.7	2.8
Residential(1)	61	79	79	91	2.6	0.1	2.9
IEA TOTAL							
TFC	2,490	2,381	2,699	2,833	- 0.4	1.8	0.8
Industry	1,041	848	1,079	1,154	- 2.0	3.5	1.4
Transport	642	709	714	742	1.0	0.1	0.8
Residential(1)	807	825	906	937	0.2	1.3	0.7

(1) Includes public, commercial and agricultural use.

MTOE - Million tons of oil equivalent.

Sources: IEA Energy Policies and Programmes, 1983 and 1984 Reviews,
Drewry Shipping Consultants Ltd.
Drewry, 1985.

the centrally planned economies, China is the fastest growing country. Therefore, the future share of developed countries of world TPER will reduced from 52 percent in 1984 to 44 percent in 2000; while the shares of developing and centrally planned economies will increase from 14 percent in 1984 to 18 percent in 2000 and from 34 percent in 1984 to 37 percent in 2000 respectively (Drewry, 1985).

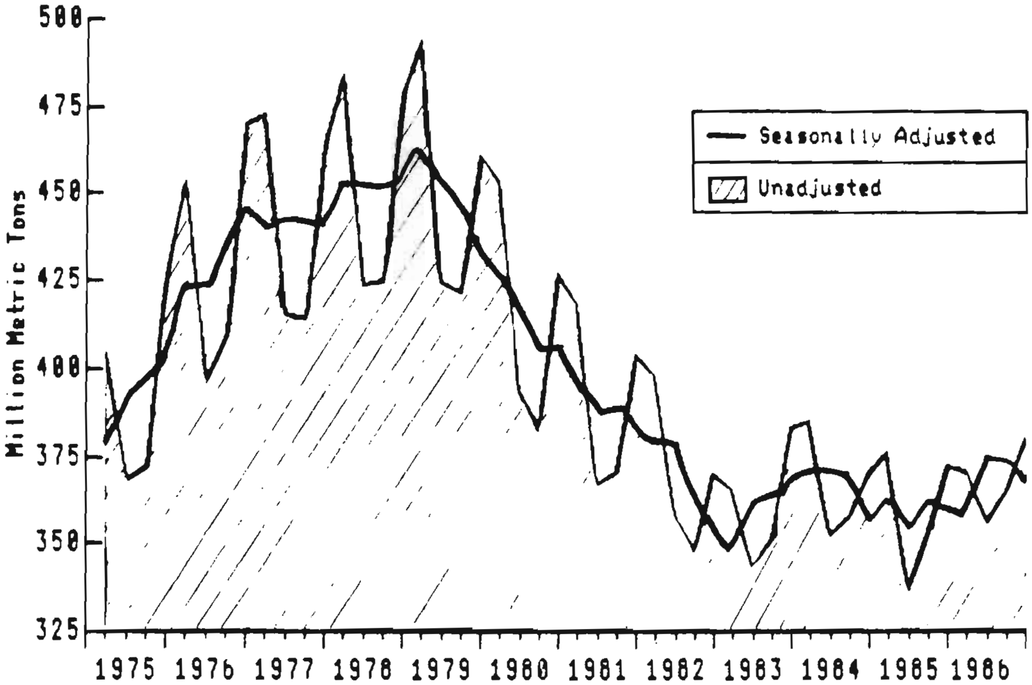
Oil Demand and Oil Products Demand

World oil consumption experienced a sharp decline between 1979 and 1983 and then remained at a low level. Figure 5 shows the total OECD oil consumption. Comparing Figure 5 with Figure 4, one can find that after 1983, although the energy consumption has increased back to pre-oil crisis levels, oil consumption has remained at a low level.

In fact, within the IEA member countries the share of oil in TPER has continued to slump from over 50 percent in 1973 to 44 percent in 1983. In the early 1980s, substitution of other fuels for oil has proceeded at an accelerated pace. Relatively high oil prices coupled with depressed prices for alternative fuels such as coal has led to widespread displacement of oil for electricity generation and in industrial use. Table 6 indicates the past and future oil shares of IEA TPER by different sectors. The Table reveals that the share of oil in TPER has fallen by eight points

FIGURE 5

QUARTERLY OIL CONSUMPTION - TOTAL OECD



Source: OECD-IEA, (1987) Quarterly Oil and Gas Statistics, No.1, 4th Quarter, 1986, Paris.

TABLE 6

THE SHARE OF OIL IN IEA TPER BY SECTOR (Per Cent)

	1973	1979	1983	1990	1995
TFC	57	57	53	49	47
Industry	41	43	36	33	32
Transport	99	99	99	99	99
Residential	45	38	32	27	26
Electricity Generation	24	19	11	9	6
TPER Oil(2)	52	50	44	39	37

(1) Includes commercial, agricultural and public use
(2) Includes refinery losses etc. Excludes bunkers

Source : IEA Energy Policies and Programmes 1985

Drewry, 1985.

to 44 percent between 1973 and 1983. In contrast to other sectors, oil accounts for 99 percent of total energy consumption in the transport sector. There has been no substitution by other fuels and the oil share is forecast to remain unchanged. Almost 80 percent of oil used in the transport sector relates to road vehicles. In general, the contribution of oil to TPER will continue to diminish, while coal, hydro and geothermal energy consumption are forecast to grow in excess of six percent per annum, natural gas consumption is forecast to increase by 10 percent per annum and nuclear energy by 12 percent each year (Drewry, 1985).

Table 7 summarizes the oil consumption data and forecasts. It is apparent that world oil consumption is forecast to grow at an average annual rate 1.1 percent between 1984 and 1990 and 0.7 percent per annum between 1990 and 1995. This compares with 0.15 percent annually over the period since 1973. Much of the growth will occur outside the developed economies, particularly after 1990. Growth in the developing economies and centrally planned economies will be maintained, while the share of developed economies will continue to decline.

Figure 6 shows historical OECD oil consumption by product group. The Figure reveals that the decline in demand for oil since the first oil price shock of 1973 has been largely due to a collapse in fuel oil demand. The share of each product in total OECD consumption is shown in Table 8. The Table reveals that the fuel oil share fell from 30 percent in 1973 to 19 percent in 1984. Gasoline and middle distillates both increased their share

TABLE 7

OIL CONSUMPTION : HISTORICAL AND FORECAST

	MTA				AVERAGE ANNUAL RATE OF CHANGE (%)		
	1973	1984	1990	1995	1973/84	1984/90	1990/95
DEVELOPED							
North America	901.7	791.4	831	806	- 1.2	0.8	- 0.6
Western Europe	748.9	591.0	610	605	- 2.1	0.5	- 0.2
Japan	269.1	214.6	203	214	- 2.0	- 0.9	1.0
Australasia	34.8	35.5	36	37	0.2	0.2	0.5
DEVELOPING							
Latin America	160.3	217.7	245	271	2.8	2.0	2.0
South East Asia	72.3	117.6	136	153	4.5	2.4	2.4
Middle East	62.2	94.9	108	121	3.9	2.2	2.2
Africa	49.5	82.4	93	103	4.7	2.0	2.0
South Asia	31.3	49.2	57	64	4.2	2.4	2.4
CPEs							
USSR	325.7	447.8	475	500	2.9	1.0	1.0
China	53.8	85.8	111	136	4.3	4.3	4.3
Other CPEs	88.4	116.6	124	130	2.5	1.0	1.0
WORLD TOTAL	2,798.0	2,844.5	3,029	3,140	0.1	1.1	0.7

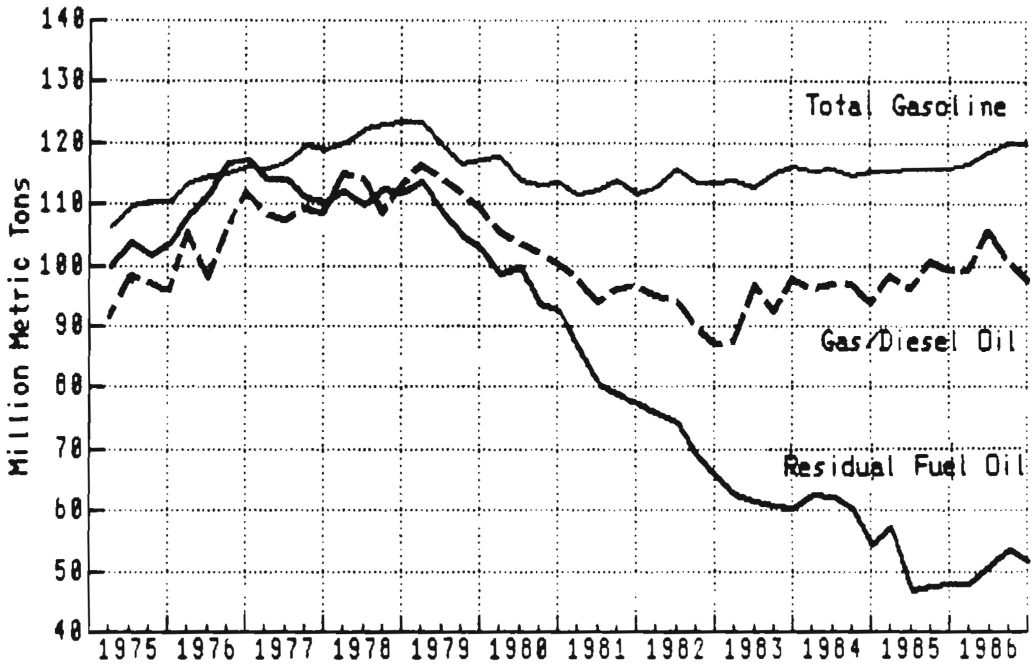
Note : Includes bunkers, refining fuel, energy sector use, etc.

Sources : BP Statistical Review of World Energy, June 1985
World Energy Outlook, Chevron Corporation, July 1984
IEA Energy Policies and Programmes, 1984 Review, 1985
IEA Oil Market Report - monthly - various issues
Drewry Shipping Consultants Ltd.

Drewry, 1985.

FIGURE 6

SEASONALLY ADJUSTED OIL CONSUMPTION - TOTAL OECD



Source: OECD-IEA, (1987) Quarterly Oil and Gas Statistics, No.1, 4th Quarter, 1986, Paris.

TABLE 8

THE SHARE OF EACH PRODUCT GROUP IN TOTAL OECD CONSUMPTION (Per Cent)

	1973	1979	1984
Gasolene	27	28	32
Middle Distillate	27	29	32
Fuel Oil	30	26	19
Other Products	16	16	18
TOTAL	100	100	100

Source: Derived from data in BP Statistical Review of World Energy, June, 1985.
Drewry, 1985.

by 5 percent over the period -- each accounting for roughly one third of total consumption in 1984. Table 9 summarizes forecasts by Texaco of the changing pattern of products demanded in developing economies. From the Table it is apparent that apart from middle distillates and residual fuel oil the shares of the other products remain largely unchanged. Middle distillates increasing share of total consumption is almost exclusively at the expense of heavy fuel oil (Drewry, 1985).

Historical and forecast oil consumption for each product group is presented in Tables 10 through 12. Comparing Table 11 and 12 with Table 10 reveals that the share of the U.S. in world gasoline consumption is forecast to fall from 45 percent in 1984 to 37 percent in 1995. In general, gasoline consumption is expected to fall in North America and that decline will more than offset widespread increases in consumption elsewhere.

Overall demand for other products is forecast to increase. Over the period to 1995, consumption of distillates (kerosine, jet fuels, gas oil and diesel oil) will increase by between 19 percent and 27 percent. Consumption of fuel oil is expected to grow by six percent despite its relative loss of share. Base year data on naphtha consumption is somewhat incomplete, but an increase of 14 percent is assumed over the 1984/1995 period. Of the products listed in Tables 10 to 12 the share of gas/diesel oil is forecast to increase from 30 percent to 33 percent between 1984 and 1995. The share of gasoline, on the other hand, is expected to fall from 28 percent to 25 percent (Drewry, 1985).

In general terms, oil consumption growth will be limited to

TABLE 9

PERCENTAGE SHARE OF EACH PRODUCT IN TOTAL OIL DEMAND OF THE DEVELOPING ECONOMIES(a)

	MOTOR GASOLENE	JET FUELS	MIDDLE DISTILLATES	RESIDUAL FUEL OIL	OTHER	TOTAL
1983	19	5	33	26	17	100
1990	20	5	35	25	16	100
1995(b)	19	5	37	23	16	100

(a) Includes Australasia
(b) Estimates for 1995 are the mid-point of forecasts for 1990 and 2000

Source : Free World Energy Survey, Texaco, December 1983

Drewry, 1985.

TABLE 10

ESTIMATED WORLD PETROLEUM PRODUCTS CONSUMPTION 1984(a) (MTA)

	GASOLENE	KEROSENE	JET FUELS	GAS/DIESEL OIL	RESIDUAL FUEL OIL	NAPHTHA(b)
Middle East	10.7	4.4	4.4	19.4	24.8	-
East Mediterranean	3.1	0.8	1.0	6.3	10.2	1.0
North Europe	63.1	2.4	11.8	103.1	82.0	19.0
South Europe	46.8	0.9	7.0	91.5	73.8	14.7
Canada	25.4	0.7	2.4	19.9	8.4	2.5
US East	243.0	5.1	40.0	120.7	60.6	10.2
US West	47.4	0.3	14.8	17.9	13.8	1.1
Caribbean	29.2	3.9	2.5	25.3	49.6	1.0
South America East	11.1	1.2	2.6	24.2	17.3	5.0
South America West	4.1	1.5	0.8	4.2	4.9	-
North Africa	4.9	2.4	2.1	10.8	15.1	-
West Africa	5.0	2.2	1.2	6.2	4.6	-
South and East Africa	6.0	0.9	1.1	8.2	6.9	-
Japan	26.6	21.0	2.3	38.5	61.0	17.8
Indian Sub-Continent	3.2	7.0	2.3	17.9	9.9	3.6
South East Asia	12.8	9.6	4.8	30.1	60.7	3.0
China	10.6	3.6	-	16.6	30.2	-
Australasia	13.4	0.3	2.0	8.1	3.9	-
USSR	69.4	34.1	-	98.4	140.3	-
E. Europe	12.2	1.9	-	26.2	32.5	1.2
TOTAL	648.0	104.2	103.1	693.5	710.5	80.1

(a) For a number of the developing and centrally planned economies, 1984 demand has been estimated from changes in overall consumption and from the product mix evident in preceding years.

(b) Data on naphtha consumption outside the developed economies have been estimated from production and net imports.

Source: Drewry, 1985.

TABLE 11

FORECAST WORLD PETROLEUM PRODUCTS CONSUMPTION 1990 (MTA)

	GASOLENE	KEROSENE	JET FUELS	GAS/DIESEL OIL	RESIDUAL FUEL OIL	NAPHTHA
Middle East	12.3	5.2	5.1	23.0	26.8	-
East Mediterranean	3.4	1.0	1.2	7.5	11.2	1.1
North Europe	67.4	2.4	15.1	103.3	78.1	21.3
South Europe	50.1	0.9	9.0	91.6	70.2	16.5
Canada	22.0	0.8	2.4	23.9	11.2	2.8
US East	210.0	6.2	40.7	145.1	80.9	11.5
US West	41.0	0.4	15.0	21.5	18.4	1.2
Caribbean	33.5	4.6	2.5	30.2	53.4	1.1
South America East	10.2	1.4	2.8	28.3	18.0	5.5
South America West	4.7	1.8	0.9	5.0	5.2	-
North Africa	5.6	2.9	2.4	12.7	16.3	-
West Africa	5.6	2.6	1.3	7.3	4.8	-
South and East Africa	6.8	1.0	1.3	9.6	7.3	-
Japan	29.1	19.7	3.4	36.1	48.4	18.1
Indian Sub-Continent	3.7	8.4	2.8	21.5	10.3	4.2
South East Asia	15.0	11.8	5.5	37.3	66.9	3.5
China	13.4	4.9	-	22.7	37.9	-
Australasia	14.2	0.3	2.2	8.5	3.0	-
USSR	72.6	38.3	-	110.5	141.6	-
E. Europe	13.2	2.2	-	29.6	33.3	1.3
TOTAL	633.8	116.8	113.6	775.2	743.2	88.1

Source : Drewry Shipping Consultants Ltd.

Drewry, 1985.

TABLE 12

FORECAST WORLD PETROLEUM PRODUCTS CONSUMPTION 1995 (MTA)

	GASOLENE	KEROSENE	JET FUELS	GAS/DIESEL OIL	RESIDUAL FUEL OIL	NAPHTHA
Middle East	13.8	6.2	5.7	27.1	28.4	-
East Mediterranean	3.8	1.1	1.4	8.9	12.0	1.3
North Europe	66.0	2.4	17.8	103.5	73.2	21.7
South Europe	49.0	0.9	10.5	91.9	65.9	16.8
Canada	20.3	0.9	2.5	24.5	10.7	2.8
US East	194.0	6.4	41.7	148.9	77.1	11.6
US West	37.9	0.4	15.5	22.1	17.5	1.3
Caribbean	37.1	5.5	2.7	35.8	56.3	1.2
South America East	8.9	1.6	3.1	32.8	18.3	6.1
South America West	5.2	2.1	1.0	5.8	5.4	-
North Africa	6.2	3.3	2.6	14.7	17.2	-
West Africa	6.2	3.0	1.4	8.5	4.8	-
South and East Africa	7.5	1.2	1.4	11.2	7.5	-
Japan	29.7	21.7	4.4	39.9	50.7	18.5
Indian Sub-Continent	4.2	9.7	3.1	24.9	10.5	4.7
South East Asia	16.9	14.1	6.1	44.3	72.2	3.9
China	16.5	6.4	-	29.4	44.5	-
Australasia	14.7	0.3	2.3	8.9	3.0	-
USSR	76.4	42.3	-	122.0	141.4	-
E. Europe	13.8	2.4	-	32.5	33.3	1.3
TOTAL	628.1	131.9	123.2	837.6	749.9	91.2

Source : Drewry Shipping Consultants Ltd.

Drewry, 1985.

the U.S., the developing economies and China. In Europe and Japan, consumption is expected to stagnate. In the developed economies, the increase in demand will be confined to the period up until 1990, thereafter a fall in consumption is forecast. On a product-by-product basis world gasoline consumption is forecast to fall. Greatly reduced automotive use in the U.S. will exceed increases in demand elsewhere. Demand for middle distillates is forecast to rise sharply; there will also be modest increases in residual fuel oil demand, particularly in the period up to 1990. (Drewry, 1985).

Refinery Locations and Capacities

According to Oil & Gas Journal, as of January 1, 1987, the following countries have operating refinery capacity exceeded one million barrels per calendar day (b/cd):

Brazil,
Canada,
China,
France,
West Germany,
Italy,
Japan,
Mexico,
Netherlands,
Saudi Arabia,
Spain,
U.K.,
U.S.A., and
U.S.S.R.

(OGJ, 1986)

As to worldwide refinery construction, the journal indicates that the following countries have many projects under way:

Brazil,	Korea,
Canada,	Kuwait,
China,	Mexico,
Egypt,	Nigeria,
Greece,	Peru,
India,	U.S.A., and
Iraq,	U.S.S.R.
Italy	

(OGJ, 1987)

The divergent trends in refinery capacity is apparent. In fact, between 1980 and 1984, almost 200 million tons of European capacity had been shut down -- this represents almost 20 percent of 1980 capacity. In North America, 130 million tons of capacity has been scrapped over the same period. Many more closures have been announced. In the Caribbean, 38 million tons of capacity was shut down between 1980 and 1984. In sharp contrast, in the Middle East and North Africa 140 million tons of complex and sophisticated capacity will be added by the end of the decade. Apart from changes in overall capacity, between 1.5 and 2 million barrels per day (b/d) of upgrading investment is planned over the next five years. Thus, the yield of middle distillates is likely to be boosted at the expense of residual fuel oil (Drewry, 1985).

On the other hand, despite the increase in refining capacity in the major oil exporting countries of the Middle East and North Africa, the bulk of refinery capacity remains located near the major consuming regions, i.e. North America, Europe and Japan. Table 13 summaries world refining capacity. In the areas where cutbacks were made, world refining capacity fell by over 393

TABLE 13

AVERAGE ANNUAL WORLD REFINING CAPACITY (Million Tonnes p.a.)

	1980	1984	1985	1986	1987	1988	1989	1990	1995	CHANGE 1980/84	CHANGE 1984/95
Arabian Gulf	122.4	128.2	128.4	149.7	158.4	160.9	160.9	160.9	160.9	+ 5.8	+32.7
Red Sea	2.7	6.6	23.0	33.5	41.8	41.8	41.8	41.8	41.8	+ 3.9	+35.2
East Mediterranean	33.0	39.8	45.0	46.5	46.5	46.5	46.5	46.5	46.5	+ 6.8	+ 6.7
North Europe	551.1	445.7	426.0	410.1	405.0	405.0	406.4	407.7	407.7	-105.4	-38.0
South Europe	465.6	384.3	382.5	385.3	384.5	384.5	384.5	384.5	384.5	- 81.3	+ 0.2
Canada	108.3	92.0	93.5	93.5	93.5	93.5	94.9	96.2	96.2	- 16.3	+ 4.2
US East	732.3	621.5	611.7	615.5	615.5	615.5	615.5	616.2	617.0	-110.8	- 4.5
US West	157.2	152.9	148.8	150.0	151.2	152.5	152.5	152.9	153.4	- 4.3	+ 0.5
Caribbean	303.2	265.6	224.0	188.7	188.7	196.2	206.9	210.1	210.1	- 37.6	-55.5
South America (East)	96.4	101.7	104.4	106.9	106.9	106.9	106.9	106.9	106.9	+ 5.3	+ 5.2
South America (West)	23.5	23.7	23.8	23.8	24.9	25.9	25.9	25.9	25.9	+ 0.2	+ 2.2
North Africa	26.4	45.5	61.6	74.5	82.4	88.7	97.9	109.6	115.9	+ 19.1	+70.4
West Africa	31.1	37.2	38.2	38.8	39.2	39.2	39.2	44.7	50.2	+ 6.1	+13.0
South & East Africa	34.6	30.0	30.3	30.3	30.3	30.3	30.3	30.3	30.3	- 4.6	+ 0.3
Japan	285.4	253.6	248.5	248.5	248.5	248.5	248.5	248.5	248.5	- 31.8	- 5.1
Indian Sub-Continent	38.0	50.6	54.4	56.4	56.4	56.4	56.4	62.4	68.4	+ 12.6	+17.8
South East Asia	156.5	184.4	189.3	192.0	195.6	195.6	196.0	200.4	204.6	+ 27.9	+20.2
China	80.0	96.5	102.5	102.5	102.5	102.5	102.5	104.0	105.5	+ 16.5	+ 9.0
USSR/E. Europe	677.4	720.9	726.2	727.0	727.0	727.0	727.0	727.0	727.0	+ 43.5	+ 6.1
Australasia	39.9	39.2	39.2	40.1	40.1	40.1	40.1	40.1	40.1	- 0.7	+ 0.9

Note: Projects with no completion date are assumed to become operational in 1990

Sources : Appendix One
International Petroleum Encyclopedia, 1980

Drewry, 1985.

million tons annually (mta) (7.9 million b/d) between 1980 and 1984. On the basis of existing refinery projects or refineries already under construction over the next decade, it is expected that the capacity outside the centrally planned economies (CPEs) to grow by 216 mta. This increase, which is concentrated in North Africa and the Middle East, will be partially offset by closures elsewhere (Drewry, 1985).

World refining output in 1984 is presented in Table 14. Countries such as the U.S.A., Canada and Australia with a high proportion of upgrading capacity produce relatively little fuel oil, but a disproportionately large volume of gasoline. By way of contrast, the Caribbean and Europe, with less cracking capacity, produce a greater proportion of heavier products. Excluding the major centrally planned economies, 55 percent of world gasoline production occurs in North America. This is broadly in line with North America's share of gasoline consumption.

The Drewry forecasts are presented in Table 15 and 16. One problem is that in 1990 and 1995, the output mix produces too much white product -- particularly gasoline -- and too little residual oil. However, in view of the sophistication and flexibility of the world's modern complex refinery capacity, an alteration of the output mix to meet the consumption is feasible.

TABLE 14

ESTIMATED WORLD REFINERY OUTPUT[a] 1984[b] (MTA)

	GASOLENE	KEROSENE	JET FUELS	GAS/DIESEL OIL	RESIDUAL FUEL OIL	NAPHTHA
Middle East	11.8	7.9	3.8	28.9	44.3	5.6
East Mediterranean	3.5	1.3	1.5	7.2	13.7	1.6
North Europe	68.1	3.3	14.8	102.0	72.7	19.6
South Europe	44.8	3.0	7.0	74.7	69.1	11.6
Canada	25.1	1.8	2.4	20.1	8.8	3.4
US East	235.1	5.0	39.1	112.2	29.9	7.3
US West	44.3	0.3	13.9	18.5	19.0	0.4
Caribbean	35.4	4.8	6.0	35.7	86.2	4.7
South America East	13.1	1.0	2.9	22.5	19.9	3.4
South America West	3.6	1.4	0.8	3.3	5.3	0.1
North Africa	5.5	2.4	1.6	12.6	19.2	4.1
West Africa	4.6	2.0	0.7	5.8	5.8	-
South and East Africa	6.0	0.8	1.1	8.0	6.7	-
Japan	26.8	21.8	2.9	37.1	15.4	8.6
Indian Sub-Continent	2.8	4.3	1.9	13.4	11.2	3.6
South East Asia	12.7	10.5	6.4	31.8	63.0	8.3
China	11.1	3.8	-	17.5	30.0	-
USSR	77.0	38.0	-	121.0	153.0	-
E. Europe	13.9	1.7	-	27.0	35.4	1.6
Australasia	12.7	0.3	2.1	7.8	3.1	0.1
TOTAL	657.9	115.4	108.9	707.1	711.7	84.0

(a) Excludes LPG, petroleum coke and waxes, bitumen, lubricants etc.
(b) For a number of developing countries and CPEs 1984 output has been estimated from changes in overall refining throughput and from the product mix evident in preceding years.

Sources : OECD Oil and Gas Statistics 1985/No.1; Petrole 84 - Comité Professionel du Petrole; BP Statistical Review of World Energy, June 1985; UN Yearbook of World Energy Statistics, 1982; US Energy Information Administration, Petroleum Supply Monthly, various issues - 1984; International Petroleum Encyclopedia, 1984; Drewry Shipping Consultants Ltd.

Drewry, 1985.

TABLE 15

FORECAST PETROLEUM PRODUCTS OUTPUT 1990 (MTA)

AREA	GASOLENE	KEROSENE	JET FUEL	GAS/DIESEL OIL	RESIDUAL FUEL OIL	NAPHTHA
Arabian Gulf	17.5	10.4	5.9	35.6	46.5	7.4
Red Sea	4.7	2.8	1.4	9.3	12.4	1.9
East Med	3.8	1.4	1.9	8.9	15.7	1.9
North Europe	59.3	2.9	14.5	98.5	64.8	18.1
South Europe	42.2	2.7	7.4	76.4	69.6	11.6
Canada	24.4	1.8	2.6	21.6	8.4	3.5
US East	216.8	4.5	40.4	111.8	27.2	7.1
US West	41.2	0.3	14.5	19.5	18.1	0.4
Caribbean	30.2	4.4	5.7	36.6	76.1	4.2
South America (East)	12.8	1.1	3.1	24.8	19.6	3.5
South America (West)	3.6	1.4	0.9	3.9	5.4	0.1
North Africa	12.3	6.3	4.1	37.4	38.1	9.7
West Africa	5.1	2.1	0.8	6.8	7.2	0.0
South & East Africa	5.7	0.7	1.1	7.9	7.0	0.0
Japan	24.5	19.1	2.9	36.0	14.6	8.2
Indian Sub-Continent	3.3	5.1	2.4	17.9	12.0	4.3
South East Asia	12.6	10.4	7.2	34.8	67.6	8.7
Australasia	12.1	0.3	2.2	8.4	2.7	0.1
TOTAL(a)	532.1	77.7	119.0	596.1	513.0	90.7

(a) excludes CPEs

Source : Drewry Shipping Consultants Ltd.

Drewry, 1985.

TABLE 16

FORECAST PETROLEUM PRODUCTS OUTPUT 1995 (MTA)

AREA	GASOLENE	KEROSENE	JET FUEL	GAS/DIESEL OIL	RESIDUAL FUEL OIL	NAPHTHA
Arabian Gulf	17.1	11.8	6.4	38.8	46.3	7.5
Red Sea	4.6	3.2	1.5	10.1	12.4	1.9
East Med	3.7	1.6	2.0	9.7	15.7	1.9
North Europe	58.1	3.3	15.5	107.1	64.6	18.5
South Europe	41.3	3.1	7.9	83.1	69.3	11.9
Canada	23.8	2.0	2.8	23.5	8.3	3.6
US East	212.4	5.0	43.3	121.8	27.1	7.2
US West	40.4	0.3	15.5	21.3	18.1	0.4
Caribbean	29.6	4.9	6.1	39.8	75.8	4.3
South America (East)	12.6	1.2	3.3	27.0	19.6	3.6
South America (West)	3.5	1.6	1.0	4.2	5.4	0.1
North Africa	12.7	7.5	4.6	43.0	40.2	10.5
West Africa	5.6	2.7	1.0	8.3	8.0	0.0
South & East Africa	5.6	0.8	1.2	8.6	7.0	0.0
Japan	23.9	21.6	3.1	39.2	14.5	8.4
Indian Sub-Continent	3.5	6.3	2.9	21.2	13.1	4.9
South East Asia	12.6	11.9	7.8	38.4	68.4	9.0
Australasia	11.8	0.3	2.3	9.1	2.7	0.1
TOTAL(a)	522.8	89.1	128.2	654.2	516.5	93.8

(a) excludes CPEs

Source : Drewry Shipping Consultants Ltd.

Drewry, 1985.

Trade in Petroleum Products

An identification of petroleum products trades is not easily accomplished. Refinery output, exports, imports and consumption may be linked in a simple identity. At the simplest level of analysis, refinery output plus imports minus exports is equal to consumption. However, in reality the identity is far more complex. There are other factors such as, refinery fuel, international marine bunkers and stock changes. Imports and exports are closely related. In fact, gross exports are dependent not only on the increase in the exportable surplus, but also on the level of gross imports. For example, the vast expansion in refinery output forecast for North Africa will lead to more exports. However, North Africa also imports some products and these could be replaced by locally produced supplies.

Not all trade movements are relevant in forecasting products tanker employment. Overland shipments, including pipeline movements, do not generate tanker employment. On the other hand, some seaborne oil movements neither appear as exports nor imports. Commerce between one part of a country and another is not included in foreign trade statistics. For example, shipments from the U.S. Gulf coast to the U.S. Atlantic coast includes a large volume of tanker tonnage, but does not appear as U.S. exports or imports. Also, movements within the same coastal zone -- intra-area movements -- are excluded from the data presented here. Such movements include cabotage, but may also include foreign trade, for example among the countries of North Europe (Drewry, 1985).

Table 17 contains historical and forecast inter-area seaborne movement by destination for petroleum products. A steady decrease in the imports of South Europe is forecast. This stems from an expected decline in residual consumption, together with an increasing forecast for gas/diesel oil production. Both developments will tend to reduce imports. North European imports will rise sharply up to 1990, falling back substantially in 1995. Rising consumption of gas/diesel oil and residual fuel oil will boost U.S. East coast imports by almost 30 million tons by the end of the decade. Thereafter, rising production will cut back the need for gas/diesel oil imports, and reduced heavy fuel oil use for electricity generation will lead to a decline in residual import requirements. Add to this the virtual elimination of U.S. gasoline imports, and the combined effect is to trim U.S. East coast import requirements by 25 million tons, leaving it only slightly above the 1984 level (Drewry, 1985).

Table 18 includes movement of products by origin. Total products movements are expected to grow by 75 million tons or 26 percent between 1984 and 1990, reaching 364 million tons. After this there will be a reduction by 26 million tons and products trade will total 338 million tons in 1995.

The reduction between 1990 and 1995 will be caused by a number of factors. Between 1984 and 1990 export refineries in

TABLE 17

FORECAST PRODUCTS[1] MOVEMENTS BY DESTINATION[2] (Million Tonnes)

	1984[3]	1990	1995
Middle East	5.3	6.1	7.4
North Europe	68.5	95.2	81.9
South Europe	27.0	23.5	13.5
USSR/E. Europe	3.1	3.1	3.1
Canada	3.5	8.8	7.1
US East Imports	72.0	109.3	90.4
US East Cabotage	23.8	15.4	9.2
US West	3.0	8.6	6.7
Caribbean	11.3	14.3	19.2
S. America East	3.8	4.7	7.0
S. America West	1.2	2.3	3.5
North Africa	3.9	4.4	5.0
West Africa	1.8	2.4	2.2
South & East Africa	3.2	6.3	8.3
Japan	23.4	17.9	20.0
Indian Sub-Cont.	9.4	9.1	9.4
S.E. Asia	21.8	28.8	40.1
Australasia	3.0	3.8	4.4
TOTAL	289.0	364.0	338.4

(1) Gasolene, naphtha, kerosene, aviation kerosene, gas/diesel oil and residual fuel oil

(2) For all products except kerosene excludes intra-area trades. Data for naphtha relate to inter-area trades involving imports or exports of OECD member countries only

(3) Provisional

Source: Drewry, 1985.

TABLE 18

FORECAST PRODUCTS[1] MOVEMENTS BY ORIGIN[2]
(Million Tonnes)

	1984[3]	1990	1995
Middle East Gulf	32.1	51.9	48.8
Red Sea	-	27.7	29.0
East Mediterranean	5.1	6.9	5.4
North Europe	14.6	10.6	10.1
South Europe	23.2	16.6	17.1
USSR/E. Europe	55.2	55.2	25.5
Canada	5.1	7.5	9.1
US Gulf Exports	7.1	14.8	20.4
US Gulf Cabotage	23.8	15.4	9.2
US West Coast	7.4	9.2	11.6
Caribbean	53.2	26.8	21.9
S. America East	9.2	7.3	7.7
S. America West	1.9	1.7	1.5
North Africa	15.5	73.9	81.4
West Africa	3.1	4.4	5.5
South & East Africa	0.6	0.6	0.6
Japan	2.9	3.1	0.9
Indian Sub-Cont.	1.3	1.8	3.0
S.E. Asia	19.9	20.9	21.9
China	6.3	6.3	6.3
Australasia	1.5	1.4	1.5
TOTAL	289.0	364.0	338.4

(1) Gasolene, naphtha, kerosene, aviation kerosene, gas/diesel oil and residual fuel oil

(2) For all products except kerosene excludes intra-area trades. Data for naphtha relate to inter-area trades involving imports or exports of OECD member countries only

(3) Provisional

Source: Drewry, 1985.

North Africa and the Middle East will benefit from the increase in petroleum product consumption. This will cause the observed increase in trade. In the 1990s, increasing consumption and reduced supplies from the CPEs will create product shortages at existing capacity utilization rates. Given the relative lack of additional capacity available from the export-oriented refineries, a general increase in capacity utilization is assumed which generates increased output, particularly of those products in short supply. Thus, for net importing regions much of the increased consumption and the reduced CPE supplies will be made up from domestic production, and so imports and trade volumes will be reduced in the early 1990s (Drewry, 1985).

As to the principal shipping routes for products tankers, at present there are seven major products trades between:

(1) Caribbean and U.S. East coast;
(2) U.S.S.R./ E. Europe and North Europe;
(3) U.S. Gulf and US East coast;
(4) South East Asia and Japan;
(5) Middle East and South East Asia;
(6) South Europe to North Europe; and
(7) U.S.S.R./E. Europe to South Europe.

The first three trades account for 95 million tons -- 36 percent of the total. In total, the seven account for more than 50 percent of world products movements. By 1990, a large trade will have developed between North Africa and the U.S. East coast. The trade between the Caribbean and the U.S. East coast will diminish in importance however. By 1995, the North Africa to North Europe route will be of considerable importance also. Among the individual products, residual fuel oil will remain the largest trade, although gas/diesel oil will become increasingly important (Drewry, 1985).

CHAPTER FOUR

PRODUCTS TANKER SHIPPING MARKET

Products Tanker Demand

Table 19 shows tanker inter-area movements in 1984. Excluding U.S. domestic trades, inter-area employment totalled 18.9 million dwt. The Table reveals that there are only five trades near or exceeding 1 million dwt. They are Arabian Gulf (AG) to Japan and South East Asia, U.S.S.R./E.Europe to North and South Europe and Caribbean (Caribs) to U.S. East coast (USEC). The largest trade is Caribs-USEC, totalling 1.6 million dwt. The most important loading zones are Middle East, U.S.S.R./E. Europe, Caribbean, North Africa and South East Asia. The most important discharge zones are North and South Europe, USEC, Japan and South East Asia (Drewry, 1985). Over seven million dwt was employed in intra-area trade. The bulk of tonnage activity on these short-haul routes is on smaller vessels below 45,000.

Table 20 summarizes employment by loading zone. Overall Employment is forecast to increase by 9.6 million dwt between 1984 and 1990. Virtually all of this growth is confined to three loading zones - North Africa, Middle East Gulf and Red Sea. Employment loading in South East Asia is also up, by 1.5 million dwt. This is more than offset by a fall in Caribbean loadings of 1.7 million dwt. Assuming no change in the size distribution of

TABLE 19

TANKER EMPLOYMENT ON INTER-AREA TRADES 1984 ('000 DWT)

DESTINATION:	EUROPE		CANADA	UNITED STATES			CARIBBEAN	S.AMERICA		AFRICA		JAPAN	INDIAN SUB-CONT.	S.E. ASIA	AUSTRA-LASIA	OTHER	TOTAL
ORIGIN:	NORTH	SOUTH	EAST	EAST	GULF	WEST		EAST	WEST	WEST	SOUTH/ EAST						
Arabian Gulf	511	340	-	130	20	40	20	-	-	-	370	960	260	1,111	60	110	3,932
Red Sea	30	100	-	-	-	-	-	-	-	-	-	30	60	-	-	20	240
North Europe	-	140	30	330	-	-	-	10	-	60	-	-	20	10	-	30	630
South Europe	370	-	30	210	20	-	-	-	10	20	20	-	-	10	10	50	750
USSR/E. Europe: Baltic	1,020	20	-	30	-	-	30	20	-	30	20	-	-	60	-	50	1,280
Black Sea	220	1,290	-	220	-	20	490	40	-	50	90	-	340	250	-	220	3,230
Caribbean	430	300	130	1,580	550	90	-	70	320	40	-	-	-	-	40	-	3,550
Canada : East Coast	-	-	-	80	-	-	-	-	-	-	-	-	-	-	-	-	80
West Coast	-	-	-	-	-	10	-	-	-	-	-	110	20	20	-	-	160
United States : East Coast	-	10	-	-	-	-	20	-	-	-	-	-	10	-	-	-	40
: Gulf Coast	10	20	20	-	-	-	10	20	-	-	-	-	-	-	20	-	100
: West Coast	10	-	40	-	-	-	-	-	-	-	-	20	-	20	10	10	110
South America : East Coast	-	-	-	130	90	10	40	-	-	200	50	-	70	-	-	-	590
Africa : North	430	530	10	250	280	-	30	-	-	10	-	-	-	-	-	-	1,540
: West	30	30	-	90	20	-	-	-	-	-	-	-	-	-	-	-	170
South East Asia	80	-	-	520	40	100	20	-	-	-	20	650	180	-	250	10	1,870
China	-	-	-	-	-	120	-	-	-	-	-	130	-	90	-	-	340
Others	40	-	-	-	10	20	-	-	-	-	-	10	10	60	-	-	150
TOTAL	3,181	2,780	260	3,570	1,030	410	660	160	330	410	570	1,910	970	1,631	390	500	18,762

Source : Drewry Shipping Consultants Ltd.

Drewry, 1985.

TABLE 20

HISTORICAL AND FORECAST INTER-AREA PRODUCTS TANKER EMPLOYMENT BY LOADING ZONE ('000 DWT)

VESSEL SIZE:	10-25,000 DWT			25-45,000 DWT			45-65,000 DWT			65-90,000 DWT			90-125,000 DWT			TOTAL		
LOADING ZONE:	1984	1990	1995	1984	1990	1995	1984	1990	1995	1984	1990	1995	1984	1990	1995	1984	1990	1995
Middle East: Gulf	228	506	413	1,679	2,471	2,166	1,254	2,103	1,752	661	776	768	110	142	106	3,932	5,998	5,205
Red Sea	30	95	102	210	1,190	1,325	-	825	902	-	360	386	-	35	48	240	2,505	2,763
North Europe	140	154	149	360	321	292	130	116	103	-	-	-	-	-	-	630	591	544
South Europe	290	231	237	290	212	212	140	98	97	30	17	17	-	-	-	750	558	563
USSR/E. Europe	1,580	1,455	829	2,530	2,442	1,294	370	361	157	30	34	15	-	-	-	4,510	4,292	2,295
Caribbean	130	86	75	1,750	1,013	883	1,190	532	430	480	246	196	-	-	-	3,550	1,877	1,584
Canada	100	100	120	140	188	387	-	-	70	-	-	-	-	-	-	240	288	577
US Gulf*	10	40	45	90	441	468	40	166	240	-	-	-	-	-	-	140	647	753
US West Coast	10	10	10	70	189	175	30	85	121	-	-	-	-	-	-	110	284	306
South America (East)	90	90	90	480	435	401	20	20	20	-	-	-	-	-	-	590	545	511
North Africa	170	456	472	680	1,981	2,334	530	2,901	2,836	160	1,372	1,261	-	-	-	1,540	6,710	6,903
West Africa	80	140	180	90	138	135	-	-	-	-	-	-	-	-	-	170	278	315
South East Asia	90	438	303	1,450	2,251	2,168	150	420	278	180	269	299	-	-	-	1,870	3,378	3,048
China	100	34	36	230	219	225	10	8	8	-	-	-	-	-	-	340	261	269
Other	70	70	70	50	50	50	30	30	30	-	-	-	-	-	-	150	150	150
TOTAL	3,118	3,905	3,131	10,099	13,541	12,515	3,894	7,665	7,044	1,541	3,074	2,942	110	177	154	18,762	28,362	25,786

* Excludes tonnage employed to US Atlantic Coast

Source : Drewry Shipping Consultants Ltd.

Drewry, 1985.

vessels operating on each route, the increased employment forecast between 1984 and 1990 benefits the larger tankers to a disproportionate extent. This implies that growth will be centered on routes where vessels above 45,000 dwt are currently employed. The 25-45,000 dwt category will experience growth in employment of 3.4 million dwt. Although this is considerable, the share of this size category will fall from 54 percent of total employment in 1984 to 48 percent in 1990 (Drewry, 1985).

The pattern of employment by discharge zone is presented in Table 21. In 1984, the major destinations were Europe, USEC, Japan and South East Asia. These areas will remain important, particularly USEC, which will increase its share of total discharges from 25 percent in 1984 to 33 percent in 1990. Europe will also remain an important destination, although increases in North European discharge will be partly offset by reduced discharges to South Europe. In voyages to USEC and Europe vessels above 45,000 dwt will become increasingly important, indicating a relative increase in long-haul shipments where these large vessels predominate (Drewry, 1985).

The Drewry forecasts presented above are based on the assumption that the size composition of vessels operating on a given route remains unchanged from the base year. However, given widely anticipated increases in long-haul shipments of refined products, relatively larger size products tankers have become more popular. This increased popularity is manifested in the pattern of newbuilding orders. Therefore the Drewry report made further adjustment on the shares of different tonnage.

TABLE 21

HISTORICAL AND FORECAST INTER-AREA PRODUCTS TANKER EMPLOYMENT BY DISCHARGE ZONE ('000 DWT)

VESSEL SIZE:	10-25,000 DWT			25-45,000 DWT			45-65,000 DWT			65-90,000 DWT			90-125,000 DWT			TOTAL		
DISCHARGE ZONE:	1984	1990	1995	1984	1990	1995	1984	1990	1995	1984	1990	1995	1984	1990	1995	1984	1990	1995
North Europe	592	1,053	803	1,434	2,377	2,196	957	2,170	1,942	198	514	442	-	-	-	3,181	6,114	5,383
South Europe	740	624	336	1,290	1,190	847	510	396	296	220	236	105	20	24	11	2,780	2,470	1,595
Canada	40	68	65	160	318	270	60	294	219	-	123	83	-	-	-	260	803	637
USES*	210	207	230	2,630	4,439	3,805	1,170	3,238	2,874	590	1,482	1,372	-	-	-	4,600	9,366	8,281
USWC	120	81	88	230	399	429	20	20	20	40	204	231	-	-	-	410	704	768
Caribbean	270	276	239	340	439	628	50	66	126	-	-	-	-	-	-	660	781	993
South America (East)	80	276	212	80	253	195	-	-	-	-	-	-	-	-	-	160	529	407
South America (West)	10	10	10	170	86	143	150	84	138	-	-	-	-	-	-	330	180	291
West Africa	80	78	80	320	373	357	10	8	10	-	-	-	-	-	-	410	459	447
South & East Africa	220	525	412	330	803	610	-	-	-	20	55	40	-	-	-	570	1,383	1,062
Japan	110	104	104	840	664	666	750	1,144	1,067	120	43	50	90	153	143	1,910	2,108	2,030
Indian Sub-Cont.	160	139	121	780	568	502	30	28	36	-	-	-	-	-	-	970	735	659
South East Asia	336	314	281	795	931	1,263	167	195	298	333	395	601	-	-	-	1,631	1,835	2,443
Australasia	-	-	-	350	351	254	20	22	18	20	22	18	-	-	-	390	395	290
Other	150	150	150	350	350	350	-	-	-	-	-	-	-	-	-	500	500	500
TOTAL	3,118	3,905	3,131	10,099	13,541	12,515	3,894	7,665	7,044	1,541	3,074	2,942	110	177	154	18,762	28,362	25,786

* Excludes tonnage employed from US Gulf

Source : Drewry Shipping Consultants Ltd.

Drewry, 1985.

Products Tanker Supply

Characteristics of the existing fleet are summarized in Tables 22 to 25. Products tankers over 10,000 dwt amount to almost 1,200 vessels. Total products tanker supply approached 35.5 million dwt in mid-1985. The categorization is a fairly loose one, however, as some products tankers, particularly older vessels, may carry dirty products or crude oil from time to time. Where the cargo tanks are old or improperly maintained, a products carrier may end up carrying only crude or dirty products. Thus, the dividing line between clean and dirty tankers is not always unambiguously defined. In terms of dwt, it is apparent that almost 80 percent of the fleet is below 45,000 dwt. More than half of the fleet is between 25-45,000 dwt. In terms of vessel numbers, 36 (or 3%) of the fleet are above 65,000 dwt (Drewry, 1985)

Regarding the age of the fleet in dwt terms, almost 60 percent of products tankers are less than ten years old. In fact, almost a third of the fleet was constructed after 1980. Only 15 percent exceed 20 years in age. Focusing on vessel draft, Table 23 reveals that almost half the tankers currently in the fleet have a draft of less than 10 meters. Only 10 percent of vessels

TABLE 22

PRODUCTS TANKER FLEET BY AGE AND SIZE : END JUNE 1985 (Million DWT)

	SHIP SIZE ('000 DWT)	10-25	25-45	45-65	65-90	90-125	125+	TOTAL
Pre-1960	NO.	73	32	3	-	-	-	108
	DWT	1.3	1.0	0.2	-	-	-	2.5
1960-64	NO.	53	46	1	1	-	-	101
	DWT	1.0	1.5	0.1	0.1	-	-	2.7
1965-69	NO.	96	35	1	1	1	-	134
	DWT	1.9	1.1	0.1	0.1	0.1	-	3.3
1970-74	NO.	104	124	1	2	2	-	233
	DWT	1.9	3.9	0.1	0.1	0.2	-	6.2
1975-79	NO.	81	189	27	9	-	-	306
	DWT	1.4	6.4	1.5	0.6	-	-	9.9
1980+	NO.	76	144	56	17	2	1	296
	DWT	1.3	5.0	2.9	1.2	0.2	0.3	10.9
TOTAL	NO.	483	570	89	30	5	1	1,178
	DWT	8.8	18.9	4.9	2.1	0.5	0.3	35.5

Notes : Totals may not add due to rounding
Excludes vessels for which size or draft is unknown

Source : Drewry Shipping Consultants Ltd.

Drewry, 1985.

TABLE 23

PRODUCTS TANKER FLEET BY SIZE AND DRAFT : END JUNE 1985 (Million DWT)

DRAFT METRES	SHIP SIZE ('000 DWT)	10-25	25-45	45-65	65-90	90-125	125+	TOTAL
< 10	NO.	458	66	5	1	-	-	530
	DWT	8.2	1.9	0.3	0.1	-	-	10.5
10-10.99	NO.	23	263	6	-	-	-	292
	DWT	0.5	8.4	0.3	-	-	-	9.2
11-11.99	NO.	-	222	18	1	-	-	241
	DWT	-	7.7	0.9	0.1	-	-	8.7
12-12.99	NO.	-	23	49	13	-	-	85
	DWT	-	0.9	2.7	0.9	-	-	3.5
13-15.99	NO.	1	1	11	15	4	-	32
	DWT	*	*	0.6	1.0	0.4	-	2.0
16+	NO.	-	-	-	-	1	1	2
	DWT	-	-	-	-	0.1	0.3	0.4
TOTAL	NO.	482	575	89	30	5	1	1,182
	DWT	8.7	18.9	4.8	2.1	0.5	0.3	35.4

* less than 50,000 dwt

Notes : Totals may not add due to rounding
Excludes vessels for which size or draft is unknown

Source : Drewry Shipping Consultants Ltd.

Drewry, 1985.

TABLE 24

PRODUCTS TANKER FLEET BY FLAG : END JUNE 1985

COUNTRY	NO.	MILLION DWT
Liberia	170	5.7
USSR	156	3.8
USA	94	3.6
UK	77	2.3
Panama	77	2.1
Greece	62	2.0
Denmark	31	1.5
Italy	45	1.0
Norway	25	1.0
Cyprus	29	0.9
Kuwait	13	0.8
Chinese P.D.R.	33	0.6
Japan	20	0.6
Singapore	15	0.6
Other	336	9.0
TOTAL	1,183	35.5

Source : Drewry Shipping Consultants Ltd.
Drewry, 1985.

TABLE 25

PRODUCTS TANKER FLEET BY OWNERSHIP AND SIZE : END JUNE 1985

	SHIP SIZE ('000 DWT)	10-25	25-45	45-65	65-90	90-125	125+	TOTAL
SEVEN MAJORS	NO.	53	93	8	4	1	-	159
	Million DWT	1.1	3.0	0.4	0.3	0.1	-	4.9
OTHER OIL COMPANIES	NO.	275	177	18	10	-	1	481
	Million DWT	4.8	5.9	1.0	0.7	-	0.3	12.7
INDEPENDENTS	NO.	154	306	63	16	4	-	543
	Million DWT	2.9	10.1	3.4	1.1	0.4	-	17.9
TOTAL	NO.	482	576	89	30	5	1	1,183
	Million DWT	8.7	19.1	4.8	2.1	0.5	0.3	35.5

Note : Totals may not add due to rounding

Source : Drewry Shipping Consultants Ltd.

Drewry, 1985.

have a draft of 12 meters or over. Berthing facilities for products tankers are often shallow draft and there are usually restrictions on vessel length, limiting any tendency towards size increases in products tankers.

Details of vessel registry may be found in Table 24. As with crude oil carriers, in tonnage terms, Liberian-flag vessels are most common. Other important flags include the U.S.S.R., U.S.A., U.K., Panama and Greece. It is interesting to note that Japanese-flag products tankers are a fairly small minority. This contrasts with the situation for crude oil carriers where the Japanese-flag ranks second behind Liberia.

In terms of ownership Table 25 reveals that between 13 and 14 percent of all products tankers are owned by the seven majors. Other oil companies account for up to 41 percent of vessels, with independents accounting for the remainder (Drewry, 1985). In 1985, the orderbook consisted of 5.9 million dwt. Over 40 percent of the new orders were for vessels exceeding 65,000 dwt, which contrasts with the size structure of the existing fleet, where only 8 percent (in terms of tonnage) of vessels currently exceed 65,000 dwt.

Table 26 is the Drewry forecast of products tankers supply. The forecast is based upon the analysis of the future scrapping rate and new deliveries. The analysis was made on 1985 fleet age structure and relevant factors, and the 1985 orderbook. The Table reveals that the fleet above 65,000 dwt would grow until the late 1980s. On the other hand, after 1986 the number of smaller products tankers is forecast to fall steadily throughout

TABLE 26

PROJECTED PRODUCTS TANKER FLEET (Million DWT)[a]

SHIP SIZE ('000 DWT)	10-25	25-45	45-65	65-90	90-125	125+	TOTAL
1985	8.7	18.8	4.7	2.1	0.5	0.3	35.1
1986	8.6	19.4	5.5	3.5	0.8	0.3	38.1
1987	8.1	18.8	5.8	3.9	1.0	0.3	37.9
1988	7.6	18.1	5.8	3.9	1.0	0.3	36.7
1989	7.1	17.6	5.8	3.8	1.0	0.3	35.6
1990	6.6	17.1	5.8	3.8	1.0	0.3	34.6
1991	6.1	16.5	5.7	3.8	1.0	0.3	33.4
1992	5.4	15.7	5.7	3.8	1.0	0.3	31.9
1993	4.7	14.9	5.6	3.8	1.0	0.3	30.3
1994	4.3	14.1	5.5	3.8	0.9	0.3	28.9
1995	4.0	13.3	5.4	3.7	0.9	0.3	27.6

(a) Mid-year

Note : Assumes no further orders; excludes vessels for which year of build or size is unknown

Source : Drewry Shipping Consultants Ltd.

Drewry, 1985.

the forecast period. Without further orders, the total fleet is expected to decline marginally to 34.6 million dwt by 1990. By 1995, a substantial decline to 27.6 million dwt is projected (Drewry, 1985).

Supply and Demand

Figures 7 to 10 summarizes Drewry forecasts of supply and demand for products tankers. For the 10-25,000 size range, if scrapping proceeds as anticipated, a shortage of tonnage will arise by 1989. For the 25-45,000 category, a surplus of roughly two million dwt will gradually dwindle until a situation of approximate balance is reached in 1990. Thereafter, continued scrapping will result in a growing deficit. Vessels above 45,000 dwt are apparently already in short supply. New deliveries will temporarily restore balance for the 45-65,000 dwt size range until 1988, when employment will again overtake available supply. Employment for vessels above 65,000 dwt is expected to increase by a factor of five. Without further new orders, this will rapidly result in large deficits. A shift in owners' preferences in favor of larger products carriers has been assumed (Drewry, 1985)

FIGURE 7

FORECAST PRODUCTS CARRIER EMPLOYMENT AND SUPPLY :
10-25,000 DWT VESSELS

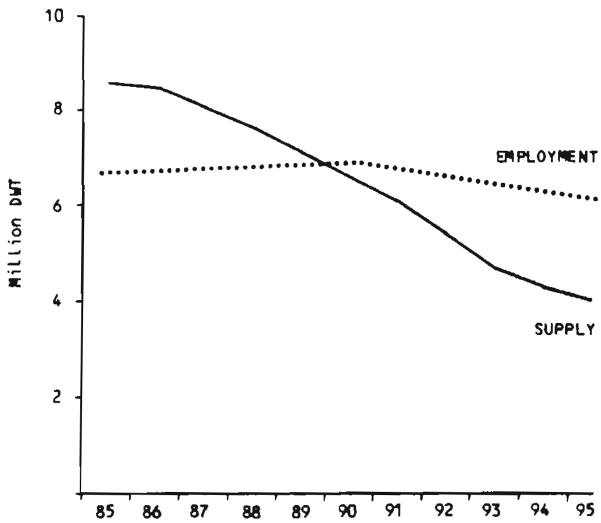


FIGURE 8

FORECAST PRODUCTS CARRIER EMPLOYMENT AND SUPPLY :
25-45,000 DWT VESSELS

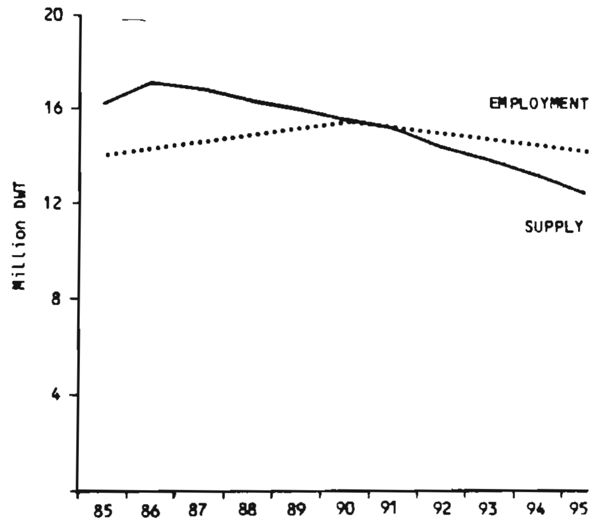


FIGURE 9

FORECAST PRODUCTS CARRIER EMPLOYMENT AND SUPPLY :
45-65,000 DWT VESSELS

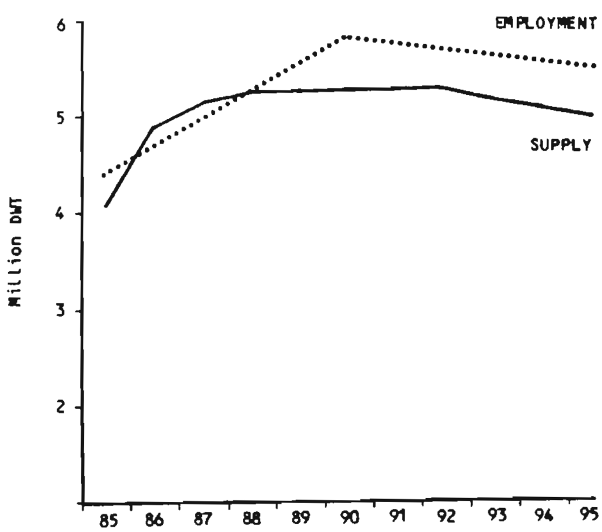
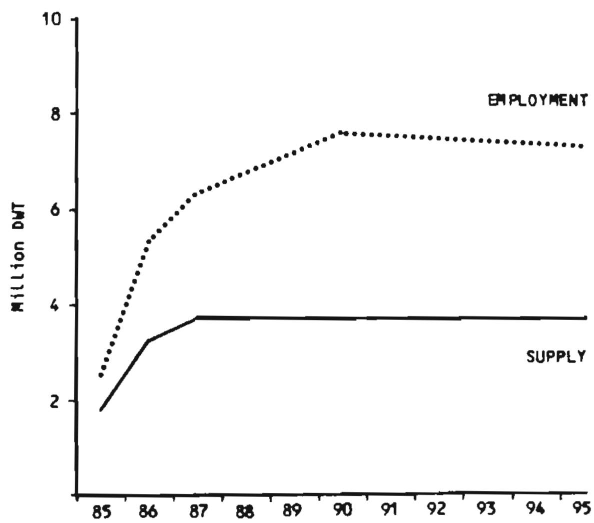


FIGURE 10

FORECAST PRODUCTS CARRIER EMPLOYMENT AND SUPPLY :
65-90,000 DWT VESSELS



Source : Drewry Shipping Consultants Ltd. (all graphs)

Drewry, 1985.

CHAPTER FIVE

PRODUCTS TANKER SHIPBUILDING MARKET

Data

The data used in this analysis are from the quarterly report, World Ships on Order, produced by Fairplay International Research Services (Fairplay Information Systems Ltd., after 1986). World Ships on Order is reported in various issues of Fairplay International Shipping Weekly and includes statistics of commercial vessels, other than fishing vessels, of 1,000 dwt and above. The statistics are arranged by flag and shipyard.

Each ship ordered has 12 descriptive variables:

Unique Number	Length Overall
Owner	Beam
Tonnage (dwt)	Draft
Ship Type	Shipbuilder
Propulsion & Machinery Type	Hull Number
Speed	Delivery Due

The reporting format has changed since April, 1987.

Products tankers are in the tanker category including more than 10 types of tankers. Products tankers are represented by a two letter code: TR.

For the purpose of this study, all variables are adopted except for Ship Type, as only TRs are analyzed, and Hull Number, as a Unique Number is used. In addition to the 10 reported variables, three additional variables were added: Issue Number (of the report), Flag and Propulsion Make. Therefore, the raw data base created for this research contains 13 variables for each products tanker:

Issue Number	Speed
Unique Number	Length Overall
Flag	Beam
Owner	Draft
DWT	Builder
Propulsion Type	Delivery Due
Propulsion Makes.	

Data were collected from 24 issues of the World Ships on Order, published between February 19, 1981 and January 15, 1987, shown in Table 27. The Table also provides the number of products tankers on order in each issue. There are 3,762 reportings in the 24 issues. However, 3,762 is not the number of vessels ordered during this period of time. There were many duplicates in the reports, since a specific ship could be reported several times from order to delivery. Duplication can be identified by the vessel's unique number.

Another problem was that there were some flag or owner changes prior to ship delivery. For example, a vessel was reported to fly a British-flag when it was ordered, but later the same vessel was reported to fly Liberian-flag. Therefore, when choosing the data for each vessel the last reporting according to the unique number was kept. At the end of this step, 703 reportings were selected and coded.

As to the coding, the following abbreviations were used:

INO	Issue Number
UNO	Unique Number
FLG	Flag
OWN	Owner
DWT	dwt

TABLE 27

NUMBER OF PRODUCTS TANKERS IN FAIRPLAY ORDERBOOK

ISSUE NO.	DATE ISSUED	NUMBER OF VESSELS
66	2/19/81	208
67	5/21/81	215
68	8/20/81	210
69	11/19/81	199
70	4/22/82	181
71	7/22/82	155
72	10/21/82	135
73	1/20/83	125
74	4/21/83	115
75	7/21/83	129
76	10/20/83	146
77	1/19/84	162
78	4/19/84	152
79	7/19/84	170
80	10/18/84	154
81	1/17/85	169
82	4/18/85	168
83	7/18/85	147
84	10/17/85	144
85	1/16/86	147
86	4/17/86	141
87	7/17/86	138
88	10/16/86	127
89	1/15/87	125
		Total: 3762

Source: Fairplay data and author's calculation.

PRT	Propulsion Type
PRM	Propulsion Makes
SPD	Speed
LEN	Length
BM	Beam
DR	Draft
BUD	Builder
DEL	Delivery Due.

Among them INO, UNO, DWT, SPD, LEN, BM, DR and DEL are numerical variables. For FLG, PRT and PRM, alphabetical codes, Fairplay Flag Codes, Propulsion Type Codes and Propulsion Makes Codes published in each issue were utilized. However, as OWN and BUD are company names in Fairplay report, all the names were coded numerically by the author. All 703 coded reports were imputed into the computer.

For any ship Fairplay assigns an unique number according to the time when it was ordered. Therefore, according to a table in each issue of the Fairplay report, one can identify the year when the ship was ordered. Since, the period from a ship order to delivery is normally longer than one year, it was assumed that the first issue (Issue 66) of the Fairplay report in 1981 includes all the vessels ordered during 1980.

By using Statistical Analysis System (SAS) on URI's main frame, the data were sorted by the unique number and some duplicates were found and deleted. Then the data were sorted by year and all ships ordered before 1980 were deleted. The final count indicated that 512 products tankers were ordered between 1980 and 1986. The analyses in the following sections are based upon these 512 ships.

Newbuilding Market Analysis

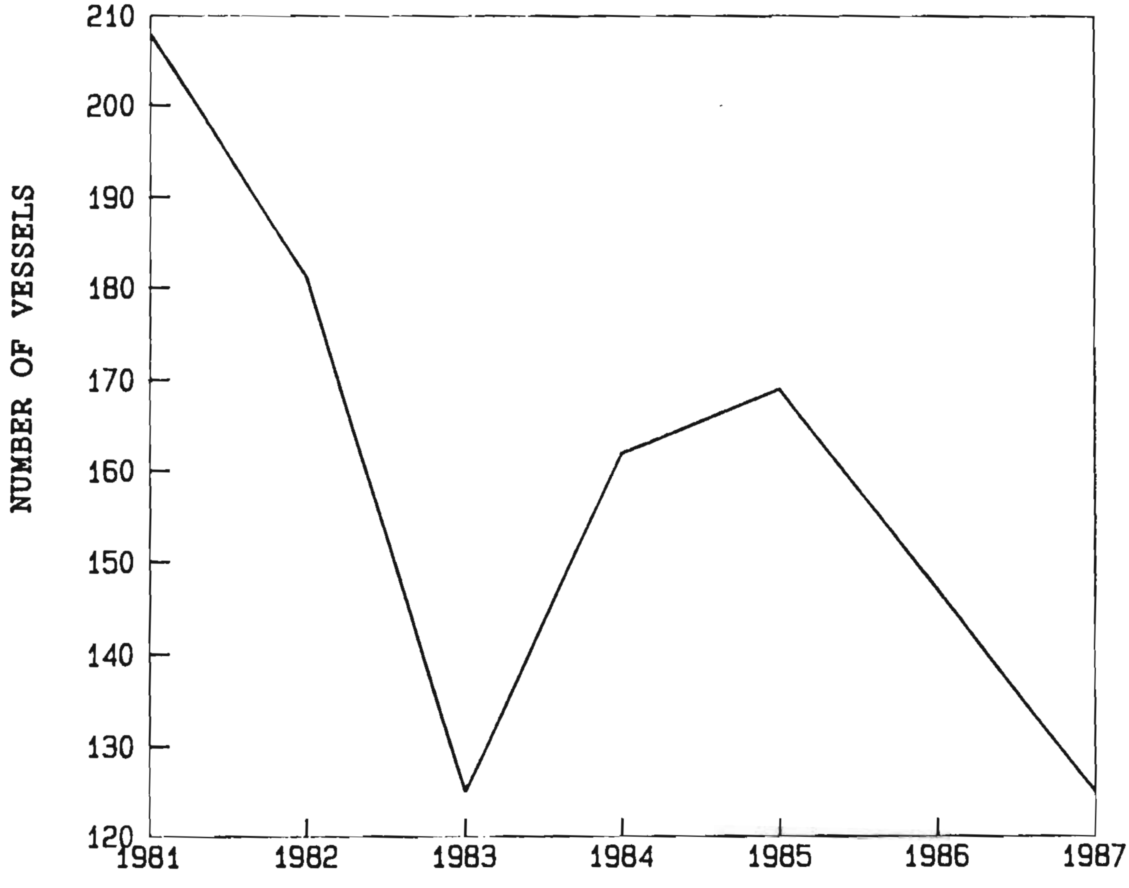
Figure 11 shows the number of ships on order derived from Table 27 and Figure 12 the number of ships ordered each year. Between 1980 and 1986 512 products tankers were ordered, equalling over 18 million dwt. These two Tables reveal that the number of products tanker newbuilding orders declined after 1980 and reached the low point in 1982. After a short recovery in 1983, the number of newbuilding orders declines. During 1986, 57 new products tankers were ordered and at the beginning of 1987, there were 125 products tankers on order.

Figure 13 represents the new products tankers tonnage ordered by year. The Figure shows a little different picture. The newbuilding tonnage ordered in 1983 was actually larger than that of 1980, which implies that the size of products tankers was growing. Figure 14 represents the world ships on order, including all types of ships. The products tanker market follows the general trend in the shipbuilding market.

Figure 15 is the newbuilding price of 30,000 dwt products tankers. The prices fluctuate with changes in supply and demand of the newbuilding market. In 1986, newbuilding price are in the range of $22.5-25.0 million.

FIGURE 11

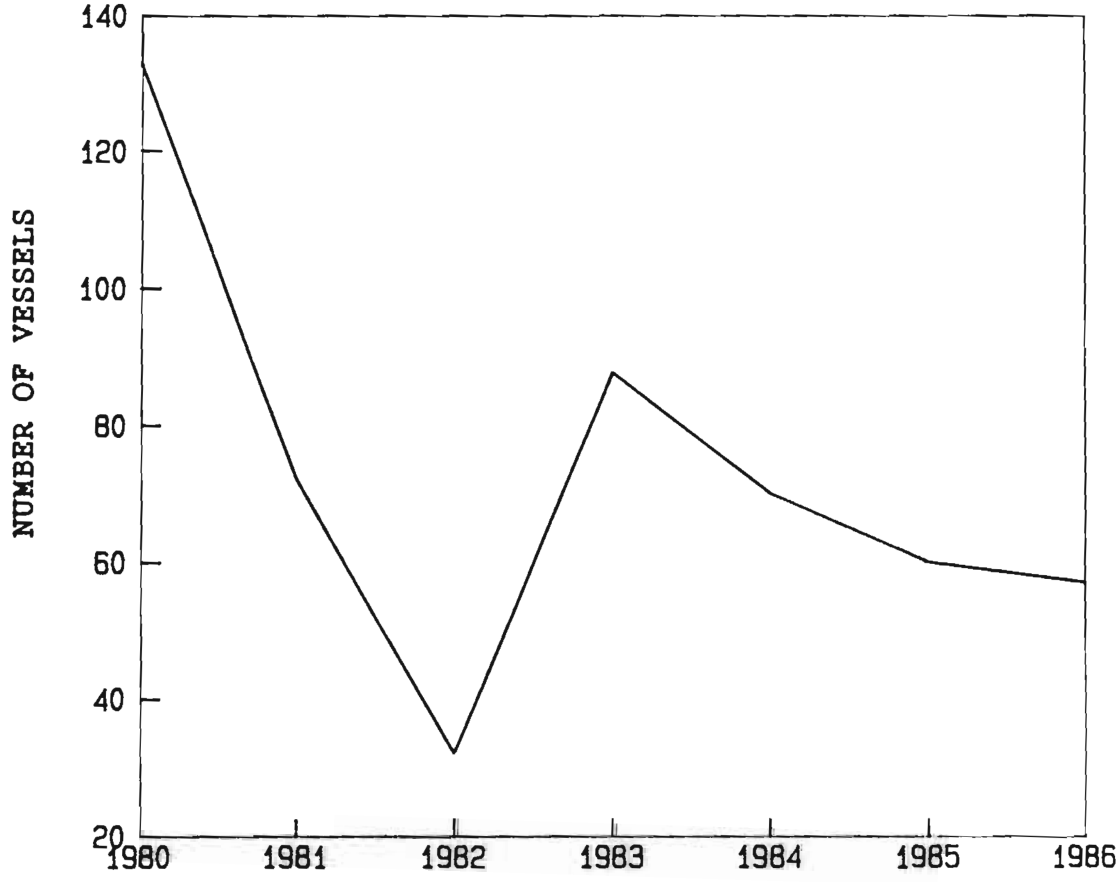
NUMBER OF PRODUCTS TANKERS ON ORDER BY YEAR
(YEAR BEGINNING FIGURE)



Source: Fairplay data and author's calculation.

FIGURE 12

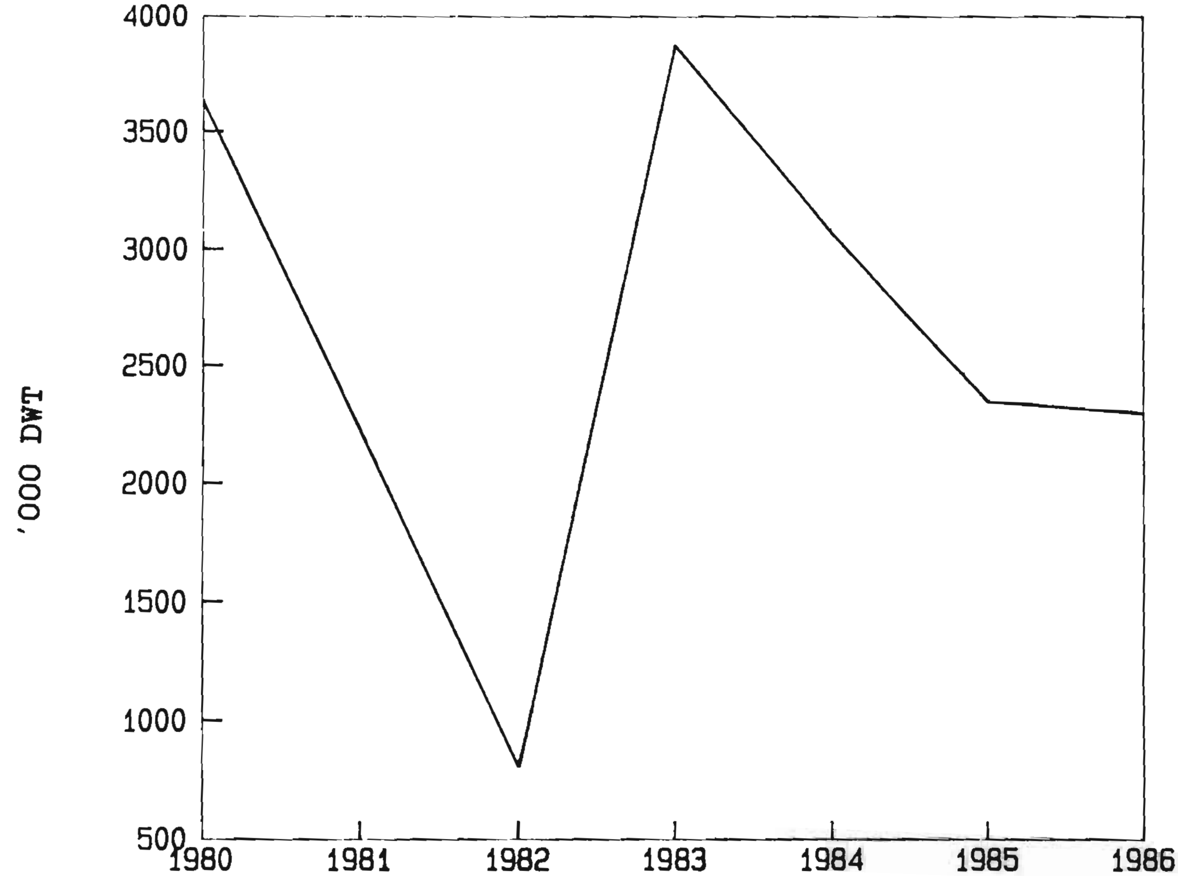
NUMBER OF PRODUCTS TANKERS ORDERED BY YEAR



Source: Fairplay data and author's calculation.

FIGURE 13

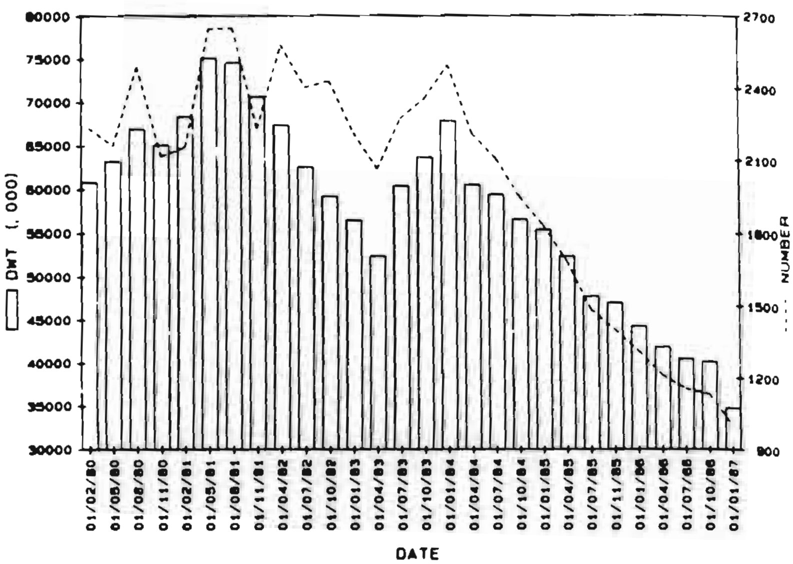
TONNAGE OF PRDUCTS TANKERS ORDERED BY YEAR



Note: There is one missing value in 1983.
Source: Fairplay data and author's calculation.

FIGURE 14

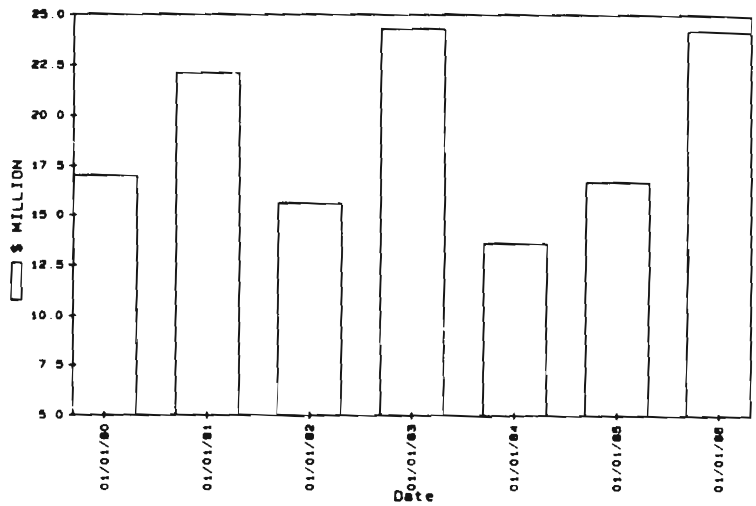
WORLD SHIPS ON ORDER 1980 - 87



Source: Fairplay (1987 c) World Shipping Yearbook, London: A Fairplay Publication.

FIGURE 15

NEW BUILDING PRICE - PRODUCTS TANKER 30,000 DWT
(BUILT FAR EAST YARD)



Source: Fairplay (1987 c) <u>World Shipping Yearbook</u>,
London: A Fairplay Publication.

Flag

The 512 products tankers ordered between 1980 and 1986 fly flags of 43 countries and regions. There are six vessels marked as "flag unknown" in the Fairplay orderbook. Table 28 represents the top 15 flags arranged in the order of their tonnage. The top part of the list includes flags of convenience, Liberia and Panama, and traditional maritime powers, Greece, Denmark and Norway. In the middle part there are developing countries, Brazil and Singapore, and other developed countries, U.S.A., Holland and U.S.S.R. In the bottom part, there are more developing countries, such as India, Kuwait and China. Compared with the list in Table 24 (p. 69), Table 28 shows that the fleets of some developing countries are growing. Countries, like Brazil and India, may enter the major fleet list in the future if their growth rates continues. Other developing countries, such as Kuwait, China and Singapore, will continue to expand their fleet. On the other hand, the fleets of U.S.S.R., U.S.A. and U.K., which are now among the largest on the list, may lose their position in the future. The small number of U.K.-flag vessels is not included in Table 28 and the U.K. fleet will certainly continue to shrink.

Table 29 represents both the tonnage and the number of vessels ordered in each year by the 15 major countries. The Table shows the changes of newbuilding orders during the study period. Again, it can be seen that in the past two years some developing countries, such as Brazil, Singapore, Kuwait and China, ordered many products tankers. The difference between the number of ships

TABLE 28

TONNAGE AND NUMBER OF PRODUCTS TANKERS ORDERED BETWEEN 1980 AND 1986 BY FLAG

FLAG	NUMBER	'000 DWT
Liberia	96	3,755
Greece	47	1,707
Denmark	32	1,481
Norway	28	1,342*
Panama	23	826
Brazil	22	755
USA	21	745
Singapore	17	737
USSR	36	661
Holland	10	603
India	16	470
Kuwait	8	433
Japan	23	427
China	13	417
Australia	5	408

Note: * There is one missing value.
Source: Fairplay data and author's calcualtion.

TABLE 29

TONNAGE AND NUMBER OF PRODUCTS TANKERS ORDERED BETWEEN 1980 AND 1986 BY FLAG AND YEAR
'000 DWT
(NUMBER)

FLAG	1980	1981	1982	1983	1984	1985	1986
Liberia	844	530	169	1,196	488	185	343
	(27)	(15)	(5)	(25)	(10)	(5)	(9)
Greece	259	59	59	120	580	491	140
	(8)	(2)	(2)	(4)	(15)	(12)	(4)
Denmark	63	219	0	370	333	60	436
	(6)	(3)	(0)	(7)	(9)	(1)	(6)
Norway	347	177	71	525*	177	0	45
	(9)	(4)	(2)	(9)	(3)	(0)	(1)
Panama	175	225	0	227	80	119	0
	(4)	(9)	(0)	(6)	(2)	(2)	(0)
Brazil	0	54	54	0	0	262	385
	(0)	(3)	(3)	(0)	(0)	(7)	(9)
USA	375	35	60	90	124	31	31
	(9)	(1)	(2)	(3)	(4)	(1)	(1)
Singapore	104	114	0	114	84	162	159
	(5)	(3)	(0)	(2)	(1)	(2)	(4)
USSR	246	0	29	0	6	229	150
	(15)	(0)	(1)	(0)	(1)	(13)	(6)
Holland	75	70	0	250	41	168	0
	(2)	(2)	(0)	(3)	(1)	(2)	(0)
India	99	0	0	371	0	0	0
	(5)	(0)	(0)	(11)	(0)	(0)	(0)
Kuwait	53	0	0	0	0	0	380
	(2)	(0)	(0)	(0)	(0)	(0)	(6)
Japan	149	4	16	232	15	11	1
	(6)	(2)	(1)	(9)	(3)	(1)	(1)
China	6	45	0	0	0	356	11
	(1)	(3)	(0)	(0)	(0)	(7)	(2)
Australia	0	0	0	0	280	128	0
	(0)	(0)	(0)	(0)	(3)	(2)	(0)

Note: * There is one missing value.
Source: Fairplay data and author's calculation.

ordered by the top five flags and that ordered by the above developing countries has become very small. For example, in 1985 and 1986 the newbuilding tonnage of Brazilian-flag ships was the highest of the 15 flags. On the other hand, a decrease can be seen of the tonnage ordered by some of the developed countries. For example, the U.S. ordering rate decreased between 1980 and 1986. Between 1980 and 1981 there were 10 U.S.flag ships ordered, however in the last two years there were only two.

<u>Owner</u>

The 512 products tanker newbuildings between 1980 and 1986 were ordered by 178 owners. Table 30 represents the top 12 owners arranged by tonnage ordered. Petrobras of Brazil ordered 25 products tankers, totalling 755 thousand dwt, which puts it on the top of the list. The list includes Kuwait Oil Tanker, China, Pertamina of Indonesia, and Abu Dhabi National Oil Co. This reflects the efforts of many developing countries to develop petroleum refineries and oil products transportation capacities. On the other hand, it can be seen that some traditional shipping companies are still in an important position, such as Moller, A.P. of Denmark.

Table 31 shows the numbers of ships ordered in each year by the 12 owners. The Table reveals that in the last two years orders by Petrobras, U.S.S.R. and China are the most active.

TABLE 30

PRODUCTS TANKERS ORDERED BETWEEN 1980-1986 BY OWNER

OWNER	NUMBER	'000 DWT
Petrobras	22	755
Moller, A.P.	14	670
Ceres Hellenic Shpg.	17	666
USSR	36	661
Kuwait Oil Tanker	8	433
Shell Group	8	426
China	13	417
Transocean Shpg. & Trad.	5	415
Difko	10	388
Maritime Overseas	5	346
Pertamina	12	308
Abu Dhabi Nat. Oil Co.	8	301

Source: Fairplay data and author's calculation.

TABLE 31

NUMBER OF PRODUCTS TANKERS ORDERED BY OWNER AND YEAR

OWNER	1980	1981	1982	1983	1984	1985	1986
Petrobras	0	3	3	0	0	7	9
Moller,A.P.	4	3	0	3	0	0	4
Ceres Hellenic Shpg.	0	0	0	0	10	7	0
USSR	15	0	1	0	1	13	6
Kuwait Oil Tanker	2	0	0	0	0	0	6
Shell Group	3	0	0	3	0	2	0
China	1	3	0	0	0	7	2
Transocean Shpg. & Trad.	0	0	0	0	5	0	0
Difko	0	0	0	1	9	0	0
Maritime Overseas	0	0	0	2	2	1	0
Pertamina	1	11	0	0	0	0	0
Abu Dhabi Nat. Oil Co.	0	8	0	0	0	0	0

Source: Fairplay data and author's calculation.

Builder

Table 32 represents the top 10 countries constructing products tankers arranged in the order of tonnage they secured between 1980 and 1986. The data for each country are the sum of the figures of all the shipbuilders in that country. Japan is still number one. Although products tankers are considered to be a sophisticated vessel type, many developing countries are now able to construct them. As low labor cost is a very important factor in the shipbuilding industry, it is not surprising at all that South Korea, Yugoslavia, Brazil and China are among the major builders.

Table 33 represents the tonnage and vessel number secured each year by the 10 countries. The Table reveals the increased tonnage secured by South Korea, Yugoslavia, Brazil and China and decreases in Japan, U.S.A. and Norway in the last two years.

Table 34 includes the number of countries which secured products tanker newbuilding orders in each year. Due to sharp competition in the shipbuilding market, the number of countries constructing products tankers has been reduced from nearly 20 in 1980 to about 10 at present.

The 512 orders between 1980 and 1986 were secured by 100 shipbuilders. Table 35 shows the top 12. Here one can only find shipbuilders of four countries: South Korea, Yugoslavia, Denmark

TABLE 32

TONNAGE AND NUMBER OF PRODUCTS TANKERS SECURED BETWEEN 1980 AND 1986 BY SHIPBUILDING COUNTRY

COUNTRY	NUMBER	'000 DWT
Japan	140	4,894
South Korea	105	4,643
Yugoslavia	64	2,139
Denmark	29	1,233
Brazil	23	825
USA	21	745
China	12	534
USSR	13	362
Sweden	12	358
Norway	8	316*

Note: * There is one missing value.
Source: Fairplay data and author's calcualtion.

TABLE 33

TONNAGE AND NUMBER OF PRODUCTS TANKERS SECURED BETWEEN 1980 AND 1986 BY SHIPBUILDING COUNTRY AND YEAR
'000 DWT
(NUMBER)

COUNTRY	1980	1981	1982	1983	1984	1985	1986
Japan	1,364	578	146	1,268	838	425	274
	(44)	(23)	(4)	(35)	(19)	(9)	(6)
South Korea	302	529	21	1,511	913	529	837
	(14)	(16)	(1)	(28)	(17)	(10)	(19)
Yugoslavia	564	209	80	40	455	609	183
	(23)	(5)	(3)	(1)	(6)	(21)	(5)
Denmark	40	219	0	370	336	0	268
	(4)	(3)	(0)	(7)	(11)	(0)	(4)
Brazil	0	54	54	0	70	262	385
	(0)	(3)	(3)	(0)	(1)	(7)	(9)
USA	375	35	60	90	124	31	31
	(9)	(1)	(2)	(3)	(4)	(1)	(1)
China	0	30	0	69	69	356	11
	(0)	(1)	(0)	(1)	(1)	(7)	(2)
USSR	0	59	118	0	0	35	150
	(0)	(2)	(4)	(0)	(0)	(1)	(6)
Sweden	10	0	16	229	80	0	23
	(2)	(0)	(1)	(4)	(4)	(0)	(1)
Norway	117	111	55	20*	14	0	0
	(3)	(2)	(1)	(2)	(1)	(0)	(0)

Note: * There is one missing value.
Source: Fairplay data and author's calculation.

TABLE 34

NUMBER OF COUNTRIES SECURING PRODUCTS TANKER ORDERS BY YEAR

YEAR	NUMBER OF COUNTRIES
1980	18
1981	16
1982	15
1983	11
1984	12
1985	9
1986	12

Source: Fairplay data and author's calculation.

TABLE 35

TONNAGE AND NUMBER OF PRODUCTS TANKERS SECURED BETWEEN 1980 AND 1986 BY SHIPBUILDER

SHIPBUILDER	NUMBER	'000 DWT
Hyundai H.I.	27	1,483
Samsung Sb.	24	1,426
Korea Sb.	28	869
Brod. Split	25	866
Daewoo Sb.	21	825
Lindovaerft	15	666
Mitsubishi	16	663
Kasado Dkyd.	15	609
Brod. Uljanik	18	561
B & W	8	524
Brod. Treci Maj	16	513
Mitsui Zosen	9	505

Source: Fairplay data and author's calculation.

and Japan. The top three are all South Korean shipyards. Table 36 includes the number of vessels secured each year by the 12 shipbuilders. The Table reveals that in the past two years, three South Korean shipyards, Hyundai, Samsung and Daewoo, and three Yugoslavian shipyards, Split, Ujanik and Treci Maj, are the most competitive yards, while the Japanese and Danish yards were losing their markets.

Table 37 lists the major shipyards securing orders of products tankers above 65,000 dwt between 1980 and 1986. Included in the top four are two South Korean shipyards, one Chinese Shipyard and one Japanese shipyard. The rest are all among the top 12 major shipbuilders. Most of the big products tankers have been built in the Far East, and Samsung of South Korea is the major shipyard in the construction of large products tankers.

Products Tankers Analyses

The Fariplay statistics of the products tankers ordered between 1980 and 1986 have some missing values. For example, some ships do not have reported lengths, while others do not have reported speeds. Table 38 represents some general statistical information about the 512 vessels. Looking at these data, a general concept about present and future products tankers can be

TABLE 36

NUMBER OF PRODUCTS TANKERS SECURED
BETWEEN 1980 AND 1986 BY SHIPBUILDER AND YEAR

SHIPBUILDER	1980	1981	1982	1983	1984	1985	1986
Hyundai H.I.	0	0	0	13	1	9	4
Samsung Sb.	7	2	0	4	4	1	6
Korea Sb.	4	11	1	9	0	0	3
Brod. Split	9	2	0	0	3	11	0
Daewoo Sb.	0	3	0	2	2	0	4
Lindovaerft	0	3	0	5	5	0	2
Mitsubishi	6	0	1	2	4	3	0
Kasado Dkyd.	0	0	0	10	4	1	0
Brod. Uljanik	6	2	1	1	0	4	4
B & W	0	0	0	2	4	0	2
Brod. Treci Maj	6	0	2	0	2	5	1
Mitsui Zosen	2	3	0	1	1	0	2

Source: Fairplay data and author's calculation.

TABLE 37

NUMBER OF PRODUCTS TANKERS SECURED BETWEEN
1980 AND 1986 BY SHIPBUILDER AND TONNAGE RANGE

SHIPBUILDER	65,000-90,000 DWT	90,000-125,000 DWT
Samsung Sb.	5	6
Hyundai H.I.	9	0
Dalian Shpyd.	6	0
Mitsui Zosen	4	0
Brod. Split	3	0
Brod. Treci Maj	3	0
B & W	3	0
Kasado Dkyd.	3	0
Lindovaerft	3	0

Source: Fairplay data and author's calculation.

TABLE 38

GENERAL INFORMATION OF PRODUCTS TANKERS ORDERED BETWEEN 1980 AND 1986

VARIABLE	NUMBER OF OBSERVATIONS	MEAN	STANDARD DEVIATION	MINIMUM	MAXIMUM
DWT	511	35,674.4	20,796.9	1,350.0	120,000.0
LEN (m)	315	172.9	36.0	56.0	288.6
BM (m)	414	27.8	6.4	11.0	46.0
DR (m)	394	10.1	2.0	3.6	16.0
SPD (k)	405	14.6	1:2	11.0	20.0

PEARSON CORRELATION COEFFICIENTS

	DWT	LEN	BM	DR	SPD
DWT	1.00	0.88	0.91	0.82	0.15
LEN	0.88	1.00	0.87	0.84	0.38
BM	0.91	0.87	1.00	0.83	0.29
DR	0.82	0.84	0.83	1.00	0.33
SPD	0.15	0.38	0.29	0.33	1.00

Source: Fairplay data and author's calculation.

discerned. However, the dimensions of the largest, 120,000 dwt, vessel were not reported.

Tonnage

Deadweight tonnage of 511 of 512 vessels are reported between 1980 and 1986. The smallest and largest vessels are 1,350 dwt and 120,000 dwt respectively. The mean size is 35,674.4 dwt. Table 39 shows the statistics of vessels in different tonnage ranges. The statistics reveal that most new products tankers are in the 25-45,000 dwt range by both number and the total tonnage. There are 235 vessels over eight million dwt in this category, 46 percent by number. The interesting thing here is to find whether or not the size of products tankers is increasing as a result of oil refinery relocations leading to increased petroleum products shipping distances.

Figures 16 and 17 represent the results of statistical calculations. The curve of the maximum ship ordered in each year in Figure 16 is a good indication of the increase in vessel size. In 1986, two 120,000 dwt vessels were ordered by Kuwait Oil Tanker, and will be built by Samsung Shipbuilding of South Korea. The curve of average tonnage reflects the trend of general size increase, although the standard deviation is high. The predicted dwt curve in Figure 17 also indicates the trend of increasing size with time. However, it should be noticed that the

TABLE 39

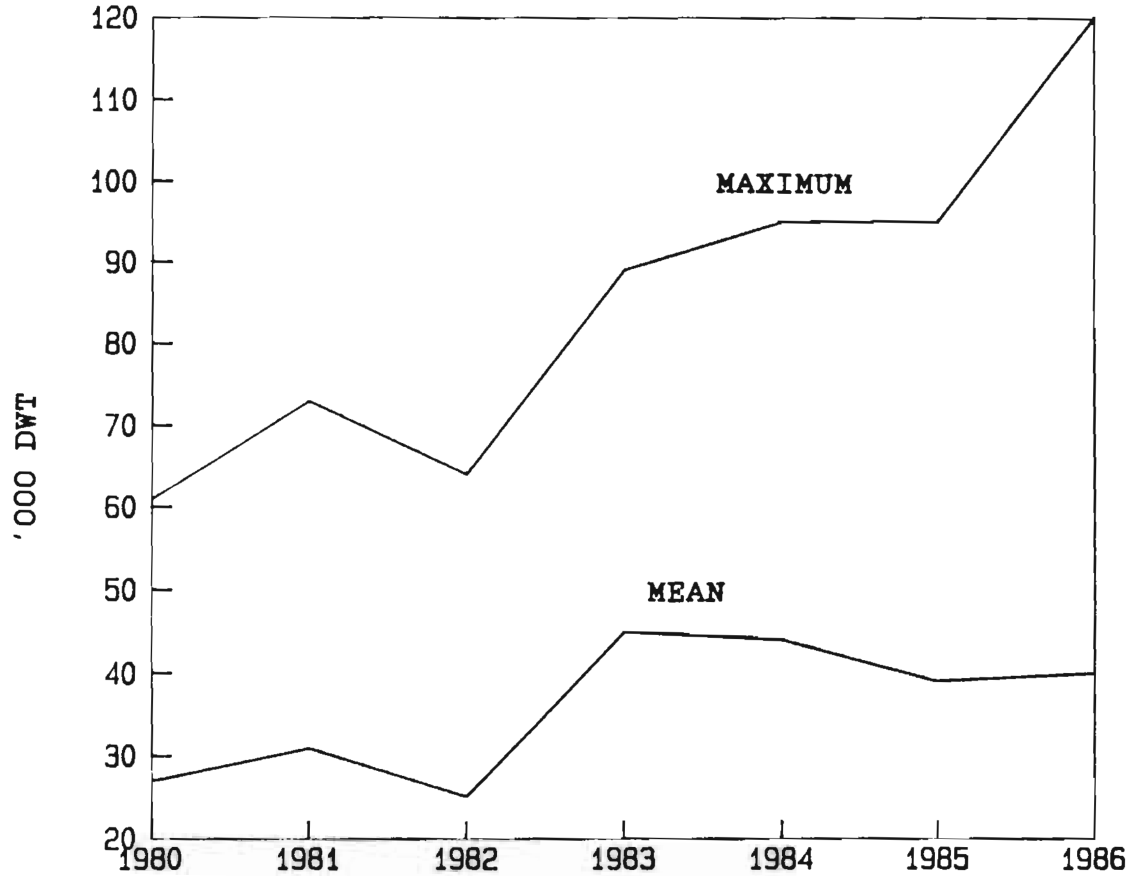
TONNAGE STATISTICS OF THE PRODUCTS TANKERS BY TONNAGE RANGE

RANGE		NUMBER OF OBSERVATIONS	MEAN (DWT)	SUM (DWT)
< 10,000	dwt	42	4,956.5	208,173.0
10,000-25,000	dwt	106	17,285.4	1,832,250.0
25,000-45,000	dwt	235	34,121.6	8,018,584.0
45,000-65,000	dwt	76	51,846.6	3,940,339.0
65,000-90,000	dwt	46	78,588.8	3,615,083.0
90,000-125,000	dwt	6	102,533.3	615,200.0

Source: Fairplay data and author's calculation.

FIGURE 16

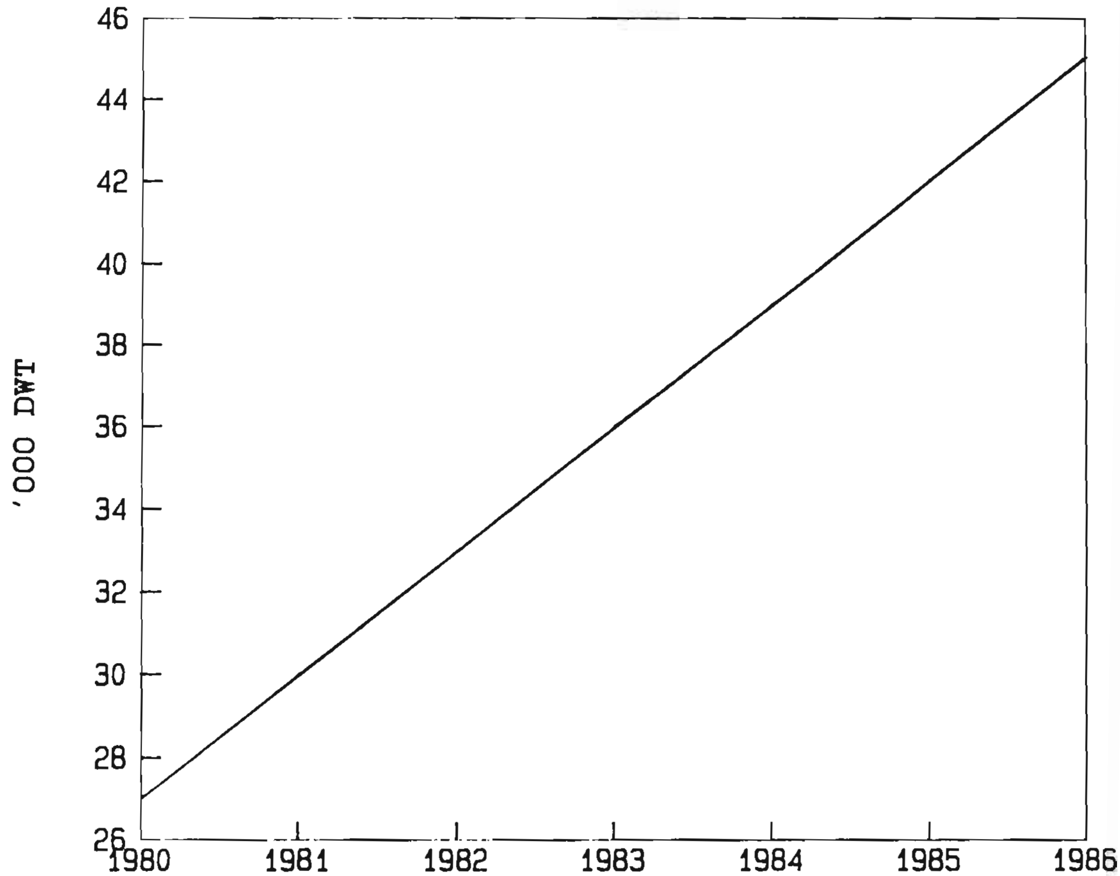
MEAN AND MAXIMUM VALUES OF PRODUCTS TANKERS ORDERED BY YEAR



Source: Fairplay data and author's calculation.

FIGURE 17

RESULTS OF THE REGRESSION ANALYSIS - THE PREDICTED DWT OF THE PRODUCTS TANKERS ORDERED BY YEAR



Note: R-Square = 0.087.
Source: Fairplay data and author's calculation.

R-Square is only 0.087 which means the model is not well fit. The result may be due to the fact that while products tankers for long-distance shipping are getting larger, many small tankers are still ordered for coastal transportation.

Dimensions

Table 38 shows that among the 512 products tankers ordered between 1980 and 1986, 315 different lengths, 414 beams and 394 drafts were reported. Therefore, there are many missing values. However, the data still reflects the general trend in products tankers dimensions. The maximum values for length, beam and draft are 288.6 m, 46 m and 16 m respectively. The pearson correlation coefficients included in Table 38 (p. 99) indicate that LEN, BM and DR are all well positively correlated with DWT and the highest correlation is between the ship tonnage and its beam.

Tables 40, 41 and 42 represent the changes of length, beam and draft with the increases in tonnage. Beam increases very fast and draft increases relatively slow. Although, length increases with tonnage increases, this is not the case for the ship with largest tonnage. The maximum value, 288.6 m is in the 45-65,000 dwt range and the mean of 90-125,000 dwt range is smaller than that of the 65-90,000 dwt range. Therefore, the data confirm that most new products tankers increase their carrying capacity by increasing beams. The slow increase of draft is mainly controlled

TABLE 40

LENGTH STATISTICS OF THE PRODUCTS TANKERS
BY TONNAGE RANGE

RANGE		NUMBER OF OBSERVATIONS	MEAN (M)	MINIMUM (M)	MAXIMUM (M)
< 10,000	DWT	22	91.5	56.0	113.0
10,000-25,000	DWT	87	150.5	119.7	177.0
25,000-45,000	DWT	133	177.3	161.0	241.0
45,000-65,000	DWT	47	206.2	171.8	288.6
65,000-90,000	DWT	23	235.3	224.5	244.5
90,000-125,000	DWT	3	230.0	230.0	230.0

Source: Fairplay data and author's calaulation.

TABLE 41

BEAM STATISTICS OF THE PRODUCTS TANKERS
BY TONNAGE RANGE

RANGE		NUMBER OF OBSERVATIONS	MEAN (M)	MINIMUM (M)	MAXIMUM (M)
< 10,000	DWT	34	14.7	11.0	19.5
10,000-25,000	DWT	97	22.9	18.0	26.0
25,000-45,000	DWT	182	29.1	24.8	32.2
45,000-65,000	DWT	60	31.8	28.4	35.4
65,000-90,000	DWT	38	38.1	32.2	42.7
90,000-125,000	DWT	3	46.0	46.0	46.0

Source: Fairplay data and author's calculation.

TABLE 42

DRAFT STATISTICS OF THE PRODUCTS TANKERS
BY TONNAGE RANGE

RANGE		NUMBER OF OBSERVATIONS	MEAN (M)	MINIMUM (M)	MAXIMUM (M)
< 10,000	DWT	33	5.7	3.6	8.0
10,000-25,000	DWT	90	8.7	7.0	10.3
25,000-45,000	DWT	174	10.5	7.8	12.8
45,000-65,000	DWT	59	12.1	10.0	13.3
65,000-90,000	DWT	35	12.6	11.5	16.0
90,000-125,000	DWT	3	13.6	13.6	13.6

Source: Fairplay data and author's calculation.

by draft limitations in many ports. On the other hand, since the speed of large ships are in the 14 - 15 knot range, a full ship hull with relative short length and wide beam is widely used. A reduction in ship length can also lead to a reduction in building costs. As to the beams, although the sizes of products tankers are increasing, they are still much smaller than those of super tankers. As discussed in Chapter Three, no major oil products shipping routes pass through narrow channels.

Speed

Among the products tankers ordered between 1980 and 1986, 405 speeds are reported. The fastest speed is 20 knots and slowest is 11 knots. As shown in Table 43, the most popular speeds of new products tankers are either 14 or 15 knots. Of the 405 vessels, 160 are of 15 knots accounting for 39.5 percent and 155 are of 14 knots accounting for 38.3 percent. Therefore, 77.8 percent of the new products tankers are in the 14 - 15 knot range.

However, the Fairplay orderbook reveals that the average speed of products tankers is declining, as a result of efforts to reduce fuel costs. Figure 18 represents the shares of products tankers of 14 and 15 knots in the past seven years. It can be seen that before 1984 15 knots was a more popular speed. Recently 14 knots has become more and more popular. In 1986, 83

TABLE 43

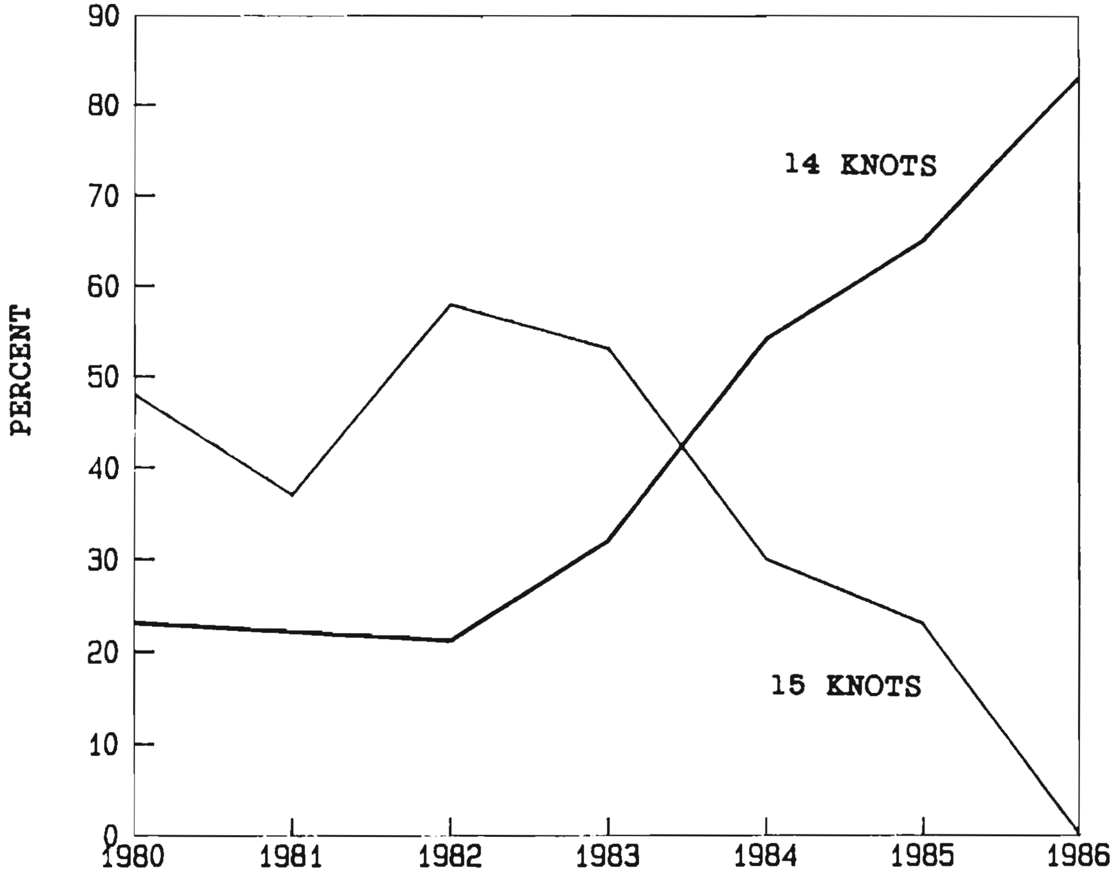
NUMBER OF THE PRODUCTS TANKERS BY SPEED AND YEAR

SPEED (K)	1980	1981	1982	1983	1984	1985	1986	TOTAL
11	0	2	0	2	4	0	1	9
12	2	1	0	0	1	1	0	5
13	8	9	0	0	0	4	2	23
14	27	11	5	25	31	36	20	155
15	55	19	14	42	17	13	0	160
16	23	7	5	8	0	0	0	43
17	0	2	0	0	0	0	0	2
20	0	0	0	2	4	1	1	8
TOTAL	115	51	24	79	57	55	24	405

Source: Fairplay data and author's calculation.

FIGURE 18

SHARES OF THE SPEEDS BY YEAR



Source: Fairplay data and author's calculation.

percent of newly ordered products tankers were of 14 knots while no vessels of 15 knots were ordered.

Table 44 is the average speed of products tankers ordered each year. The Table also indicates speed reductions in recent years. From 1982 to 1986, the average speed reduced from 15 knots to 14.04 knots. What is the relationship between tonnage and speed? The Pearson correlation coefficients in Table 38 (p. 99) reveal that there is little correlation between DWT and SPD. However, Table 45 indicates that speeds of small ships below 25,000 dwt are not faster than 16 knots while the speeds of large ships above 65,000 dwt are in the range of 14 - 15 knots, ships between 25,000 and 65,000 dwt have a wider range of speed.

Engines

Although there is still a small number steam ships in the present products tanker fleet, the Fairplay orderbook indicates that there have been no products tankers with steam propulsion units ordered. Since 1980, all reported propulsion types of new products tankers are diesels. Therefore, in the future the products tanker fleet will include only motor ships.

The statistics on propulsion makes reveal that although there were 17 brands of diesel engines reported to be equipped on new products tankers, only two brands of engines, B&W and Sulzer, are predominant. For products tankers ordered between 1980 and

TABLE 44

AVERAGE SPEED OF THE PRODUCTS TANKERS BY YEAR

YEAR	NUMBER OF OBSERVATIONS	MEAN (K)
1980	115	14.77
1981	51	14.43
1982	24	15.00
1983	79	14.81
1984	57	14.47
1985	55	14.24
1986	24	14.04

Source: Fairplay data and author's calculation.

TABLE 45

NUMBER OF THE PRODUCTS TANKERS BY
TONNAGE RANGE AND SPEED

RANGE	SPEED (K)	11	12	13	14	15	16	17	20
< 10,000	DWT	9	3	8	7	1	0	0	0
10,000-25,000	DWT	0	2	8	49	20	15	0	0
25,000-45,000	DWT	0	0	5	52	98	18	0	8
45,000-65,000	DWT	0	0	2	22	24	10	2	0
65,000-90,000	DWT	0	0	0	23	16	0	0	0
90,000-125,000	DWT	0	0	0	2	1	0	0	0

Source: Fairplay data and author's calculation.

1986, 459 vessels propulsion makes were reported. As shown in Table 46, the three major engine makes are B&W, Sulzer and SEMTP-ielstick. B&W engines account for 44.7 percent of the total, while Sulzer engines account for 36,8 percent. There are only 25 Pielstick engines accounting for only 5.5 percent. Therefore, between 1980 and 1986, 81.5 percent of the engines equipped on the new products tankers are B&W and Sulzer diesels. Table 46 also indicates that in 1980, 13 brands of engines were ordered, but in 1986 only five brands were ordered. This reflects the sharp competition in the engine market. Only few engine makes can survive the competition. The general trend is less brands, but better quality which is good for standardization and easy repairs.

Figure 19 represents the market share of the three major engine makers. The competition between B&W and Sulzer over the past seven years can be readily seen. There are not any other engines which can compete with them. In the past two years, B&W has captured a larger and larger market share, while Sulzer has been losing its market. In 1986, 63 percent of the newly ordered engines of products tankers are B&W.

Table 47 shows the number of engines by makes and tonnage range. Almost all ships above 45,000 dwt are equipped with B&W or Sulzer engines and ships above 90,000 dwt use only B&W engines.

TABLE 46

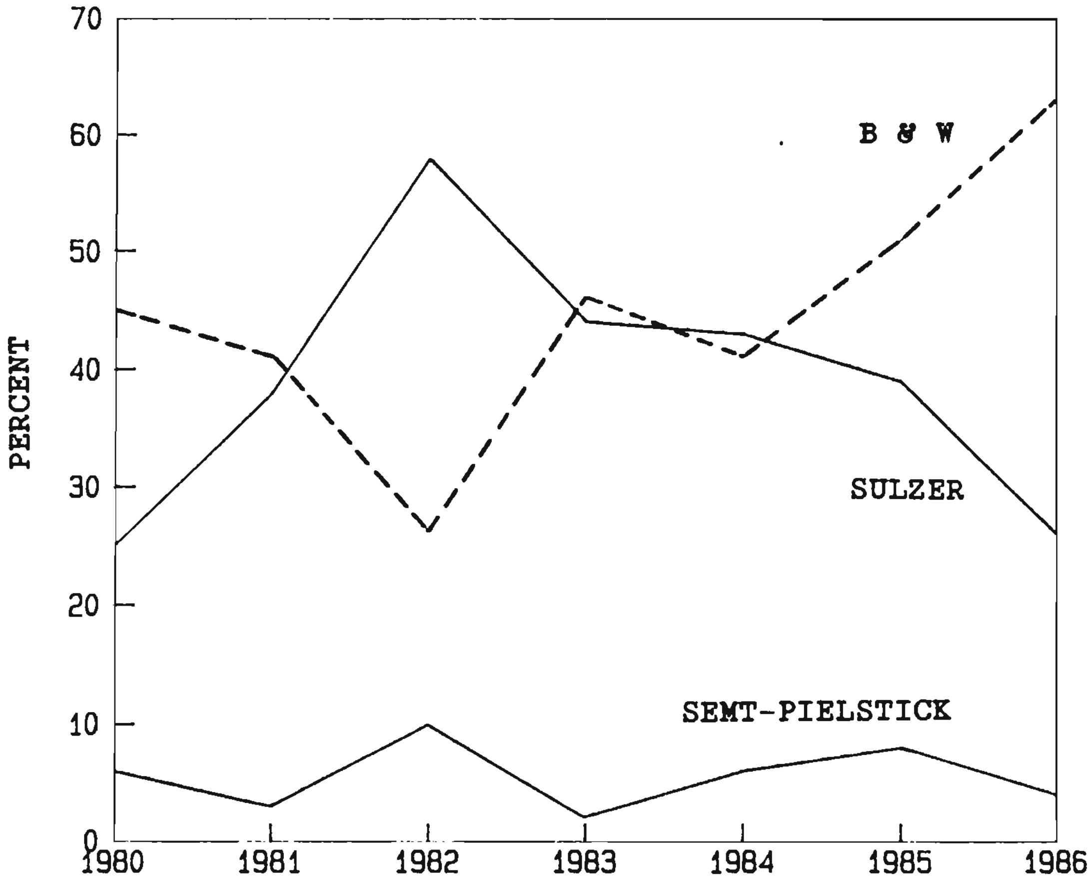
NUMBER OF THE PRODUCTS TANKERS BY ENGINE MAKES AND YEAR

MAKES	1980	1981	1982	1983	1984	1985	1986	TOTAL
Akasaka	2	0	0	0	2	0	0	4
B & W	57	27	8	38	28	30	17	205
Callesen	0	0	0	0	2	0	0	2
De Laval	1	1	0	0	0	0	0	2
Deutz	2	0	0	0	0	0	0	2
Fiat	0	2	0	0	0	0	0	2
G.M.T.	0	1	0	0	0	0	0	1
Hanshin	0	4	0	3	0	1	1	9
Mitsubishi	2	2	1	2	0	0	0	7
MaK	3	1	0	1	0	0	0	5
M.A.N.	13	0	1	0	0	0	0	14
Mirrlees	3	1	0	0	0	0	0	4
M.W.M.	1	0	0	0	0	0	0	1
SEMT-Pielstick	8	2	3	2	4	5	1	25
S.W.D.	2	0	0	0	0	0	0	2
Sulzer	31	25	18	36	29	23	7	169
Wartsila	1	0	0	0	3	0	1	5
TOTAL	126	66	31	82	68	59	27	459

Source: Fairplay data and author's calculation.

FIGURE 19

SHARES OF MAJOR ENGINE MAKES BY YEAR



Source: Fairplay data and author's calculation.

TABLE 47

NUMBER OF THE PRODUCTS TANKERS BY
MAJOR ENGINE MAKES AND TONNAGE RANGE

RANGE		B & W	SEMT-PIELSTICK	SULZER
< 10,000	DWT	5	0	5
10,000-25,000	DWT	41	12	27
25,000-45,000	DWT	91	13	92
45,000-65,000	DWT	31	0	34
65,000-90,000	DWT	34	0	11
90,000-125,000	DWT	3	0	0

Source: Fairplay data and author's calculation.

CHAPTER FIVE

CONCLUSIONS

This study has shown that with a slow increase of world economy and the decline of the oil share in the total energy consumption, the oil demand remains at low levels. No large increase in demand is forecast. Furthermore, with the development of competitive oil transport means, seaborne oil transportation will remain at low levels. Petroleum products seaborne transportation will increase if oil refinery capacity in oil producing countries in North Africa and Middle East increases. However, the pace of the expansion should be slow. At present, the world's major oil refinery capacity is still located in the major oil consumption regions, such as North America and Europe. A large demand for increases in products tankers is not foreseen. However, because the products tanker fleet is aging and the demand for long-haul transportation is increasing products tankers will be in short supply around 1990. In the large vessel category, a short supply exists already. Therefore, increases in large products tankers is predicted.

In general, the tonnage of the products tanker fleet should not increase in the future, but its share of total seaborne oil transportation will increase slowly. Products tankers will become more important in oil trades. Therefore, the hypothesis that with the development of oil refinery capacity in oil producing countries seaborne transportation of oil products will increase and products tankers will be of greater importance is basically correct.

Against this background, it has been shown that:

1) The demand for products tankers will not increase in terms of tonnage. However, the demand for large products tankers will rise.
2) The products tanker flag distribution will be wider. Since, on one hand the number of products tankers flying the flags of developing countries, such as Brazil and India, are increasing, and on the other hand the fleets of some developed countries like U.K. are shrinking.
3) As some owners in developing countries, such as Petrobras and Kuwait Oil Tanker, are expanding their fleet, products tanker shipping will no longer be dominated by the traditional owners.
4) There are fewer countries engaged in products tanker construction today than before. Traditional shipbuilders of products tankers in Northern and Western Europe have been replaced by low labor cost countries in the Far East and Eastern Europe. Major shipbuilders are now located in countries like South Korea and Yugoslavia.
5) The average size of products tankers is slowly increasing, while their operational speed is declining. A common way of increasing carrying capacities of the products tankers is by increasing their beams
6) Only B&W and Sulzer can survive the high competition in

the engine market. There are fewer engine makes today than before. The market share of B&W is still increasing. All engines ordered between 1980 and 1986 are diesels.

Generally speaking, one of the major features of the current products tanker shipping and shipbuilding market is the increasing of the role of developing countries. Another feature is that there are fewer shipbuilders and engine makes today than before as a result of the sharp competition in this market.

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