

EXECUTIVE SUMMARY

0.1 INTRODUCTION

In the contemporary industrial world, fluid power, particularly the hydraulics branch of it, is a magic world for energy transmission. The application of fluid power is causing many positive changes in the world around us. The application of hydraulic control and drive systems has resulted in new designs and improved efficiency for machines and installations. The use of fluid under pressure to transmit power and to control intricate motions is relatively modern and has had its greatest development in the past two or three decades.

Industrial hydraulics is necessary it can move rapidly in one part of its length and slowly in another. No other medium combines the same degree of positiveness, accuracy, and flexibility, maintaining the ability to transmit a maximum of power in a minimum of bulk and weight.

0.2 APPLICATIONS OF HYDRAULIC COMPONENTS AND SYSTEMS

Broadly, the hydraulic products from application angle are classified as under :

- Industrial
- Mobile
- Marine
- Aerospace

The above major segments can be further sub divided into specific categories as follows :

Industrial

- Plastic Processing machinery
- Steel making and primary metal extraction industry
- Machine tool industry
- Others : cover in general, furnace equipment, rubber machinery, textile machinery, general mechanical industry, etc.

Mobile hydraulics

- Agricultural tractors
- Earthmoving equipment
- Material handling equipment
- Others : cover general areas such as rail equipment, road building and construction machinery, drilling rigs, commercial vehicles, industrial tractors etc.

Marine application

This will cover mostly ocean going vessels, fishing boats and naval equipment.

Aerospace application

There are equipment and systems, e.g. transmission, rudder control, which are used in aeroplanes, rockets and spaceships.

0.3

PRODUCTS COVERED UNDER THE STUDY

Generally following are the elements of hydraulic systems :

Pumps

Actuators -	Liner (cylinders), Rotary - (motors)
Control Elements -	Valves : pressure, Flow and Directional
Accessories -	Reservoirs, coolers, filters, storage units tanks, accumulators

Each of the elements can be further divided into different type depending on design.

Pumps

Fixed Volume

- a. **Vane Type**
 - Balanced Vane
 - a. Intra Vane
 - b. Spring Loaded
 - c. Pin Vane
 - d. Angled Vane
 - Unbalanced Vane
- b. **Gear Type**
 - Internal
 - External

Variable Volume

- A. **Vane Type**
 - Balanced Vane
 - Unbalanced Vane
- B. **Piston Type**
 - Axial - Bent Axis
 - Inline Swashplate
 - Radial
- C. **Special Pumps**

- c. Gerotor Pump
- d. Screw Type
 - Single Screw
 - Twin Screw
 - Three Screw
- e. Piston Type
 - Axial
 - Bent Axis
 - Radial

Actuators :

**Linear
CYLINDERS**

- Single Acting
- Spring Return
- Ram Cylinder
- Double Acting
- Single Rod
- Double Rod
- Telescopic
- Tandem
- Duplex

**Rotary
MOTORS**

Vane Type

- Direct Vane Motor
- High Performance Motor
- HLS High Torque Motor

Gear Type

- External
- Internal

Gerotor

Piston Type

- Inline
- Radial

Valves

a. Pressure Control Valve

- Sequence Valve
- Counter Balance Valve
- Compound Relief Valve
- Pilot Operated Relief Valve
- Pressure Reducing Valve
- Direct Acting Pressure Reducing

b. Directional Control Valve

TYPES ACTUATORS

- 4 Way - Manual Actuator/Sol/Hyd/Pneu. Pilot operated
- 3 Way - Mechanical Actuator/Hyd Pilot

- 2 Way - Hyd./Pneu.-Pilot Operation
- Electrical -Solenoid Opn.

- c. **Flow Control Valve**
 - Direct Function By-Pass Function
 - Gate Valve - **Restrictor Type**
 - Globe Valve **Pressure Compensated**
 - Needle Valve

- d. **Check Valve**

- e. **Pilot Operated Check Valve**

- f. **Servo Valves**
 - Electro-Hydraulic
 - Single Stage Spool Type
 - Two Stage Type
 - Flaper Type

- g. **Proportional Valve**
 - Pressure Control
 - Direction Control
 - Flow Control

- h. **Cartridge Valve**
 - Logic Elements

Accessories

- a. **Reservoirs**
 - Overhead Type
 - L-Shaped

- b. **Oil Coolers**
 - Air Cooler
 - Water Cooler

- c. **Filters**
 - Suction Filter
 - Pressure Filter
 - Return Line Filter

- d. **Couplings**

- e. **Fittings**

- f. **Display/Control Devices**
 - Instrument
 - Pressure Gauge
 - Flow Meter

Storage Unit

Accumulators

- a. **Weight Loaded**
- b. **Spring Loaded**
- c. **Hydro-Pneumatic**
 - Piston Type
 - Diaphragm Type
 - Bladder Type

0.4 INDUSTRY PROFILE

0.4.1 General

The Indian hydraulic industry started in early sixties primarily with an objective of import substitution of some of the hydraulic products being used by the industry in various applications. Since most of the Indian industries have been set up, based upon the variety of technological sources, the range of their specifications is very wide. Due to this the range of products in the oil hydraulic industry is also quite wide resulting in a very small batch for each product. It is, therefore, difficult to specify a minimum economically viable capacity for the industry. While there has been a continued overall growth in the oil hydraulic products business due to large variety of specialised products to meet specific individual applications, volume growth in individual products has been very low. With low volumes and high development costs concerning tooling, casting and forging, the industry has not been able to adopt modern production methods.

Current production technology in use is largely dictated by production volumes, quality requirements and costs. Since the Indian industry has to manufacture a large variety of products with low volumes, the industry is not able to use the modern high production lines. Most the manufacturers, with exception to some (who have installed dedicated SPM's and CNC Machines for the manufacture of components), are currently using general purpose machines with special toolings and some special purpose machines for specialised metal cutting operations.

Although the industry has shown a reasonable growth over the years, but it is still far away from the volumes which would lead to adopting modern production methods. Also the limited demand is being shared

by over 20 firms resulting in uneconomical volumes for most of them. It is unlikely that the situation would change drastically in the coming decade due to variety of factors mentioned above.

0.4.2 Size of Industry

The production during 1994-95 of hydraulic components and systems directly manufactured by the organised sector units is estimated to be over 5,50,000 units, which includes around 2,65,000 nos. of Gear Pumps manufactured for the Tractor Industry.

The Industry covered under the study has total market demand in the year 1995-96 of about Rs. 595 crores, which includes an import content of approximately Rs. 110 crores, which is approx. 26% of the total market.

	<i>Rs. Crores</i>
Estimated demand of Hydraulic 1995-96	595/-
Domestic Production	450/-
Imports	145/-

0.4.3 Products Classification Based On Manufacturers, Application And Component Type

There are total fourteen key manufacturers of hydraulic components which can be categorised in four broad categories viz : A, B, C and others

The seven manufacturers under category A provide for 29.3% of the total hydraulic market, the manufacturers under category B account for almost 32.3% of the total market while two manufacturers under the category C, namely L&T and BEML, manufacture components of value upto 29.6% of the total market for the captive plants with marginal sales to outside specialised customers applications like defence and others account for 8.7.

Out of total production of approximately 5,00,000 units per year, tractor pumps constitute 2,50,000 units. If tractor pumps are excluded (for the purpose of this study), all other category of pumps share is 20% valves constitute 65%, cylinders 11%, motors 4%, and accessories constitute 5%.

Within the valves category, Directional Control Valves share 50%, Pressure control valves 20%, flow control valves 7% Mobile valves 5%, Check valves 5%, While cartridge valves/servo proportional valves together are just 1% (of the total production by nos.).

Industrial hydraulics (value wise) account for 42% of the market while mobile hydraulics account for major share of 58%. Within the Industrial sector, share of various segments is as follows :

In the Industrial Hydraulics, the break-up of application Industry-Wise is : Machine Tools-18%, Plastics-13%, Steel Plants-30%, Material Handling- 13% and Others 26%.

In the Mobile Sector, the share of each type industry is : Earth Moving and construction-60% Mining-30% and Defence-10%.

0.4.4 Manufacturers and Design

Almost all the major manufacturers of hydraulic equipments have collaboration with foreign companies. Only two Companies viz. Polyhydron and Oscar Equipment are manufacturing product based on indigenous development. There has been very little attempt at developing indigenous technology for these products, although barring few items, all other equipments have been indigenised.

Table below gives details of major manufacturers covered in the study.

MANUFACTURER OF HYDRAULIC COMPONENTS AND FOREIGN COLLABORATION

S.NO.	COMPANY	INSTALLED CAPACITY 1993/94	PRODUCTS MANUFACTURED	COLLABORATION		STATUS
				COMPANY/COUNTRY	EQUITY	
1.	BEML, Bangalore	N.A.	Pumps Motors Cylinders Mobile Valves			
2.	Dynamics Ltd., Bangalore	85,000	Gear Pumps Mobile valves Power Packs	DOWTY, U.K.		
3.	Escorts Herion Ltd. Faridabad	30,000	Valves Power Packs	Herion Werke KG., Germany	40%	Active
4.	G.L. Rexroth Industries Ltd., Ahmedabad	40,000	Pumps, Motors, Valves Cylinders Power Packs Accessories	Mannesmann Rexroth Germany	51%	Active

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S.NO.	COMPANY	INSTALLED CAPACITY 1993/94	PRODUCTS MANUFACTURED	COLLABORATION		STATUS
				COMPANY/COUNTRY	EQUITY	
5.	Hagglunds Denison Ltd., Hyderabad	40,000	Pumps Valves Motors Power Packs	Originally with Abex Denison, USA, now taken over by Hagglunds Denison,	N.A.	Active
6.	L&T Ltd., Earth Moving Machinery & Hydraulic Division, Bangalore	40,000	Pumps Motors Cylinders Mobile Valves	POCLAIN Hydraulics S.A., France SAUER Sundstrands, USA	N.A. NL	Active Active
7.	Oscar Equipment Pvt. Ltd., Calcutta	5,000	Hydraulic Cylinders	Indigenous Develop	Nil	
8.	Polyhydron Pvt. Ltd. Belgium	N.A.	Pumps Valves Accessories	Nil		
9.	SAI India Ltd., Bangalore	N.A.	Motors	SAI Spa., Italy	51%	Active
10.	Usha Telehoist Ltd. Calcutta	1,73,500	Gear Pumps Cylinders			
11.	Vickers Systems International Ltd. Bombay	1,10,000	Pumps, Motors, Valves Cylinders Power Packs Steering Unit Accessories	Vickers Inc. U.S.A.	39.54%	Active
12.	Veljan Hydrair Ltd.	N.A.	Cylinders, Marine Hydraulics	N.A.		
13.	WIPRO Ltd., Bangalore	12,000	Cylinders			
14.	Yuken India Ltd., Bangalore	40,000	Pumps, Motors, Valves Cylinders Power Packs Accessories	Yuken Kogyo Ltd.,	40%	Active

0.4.5 Historical growth of industry

In terms of turnover, the Hydraulic Industry seems to have grown rapidly in the past 3 years. While the growth of turnover figures,

which show a steep rise of average over 18% per annum, the actual growth in terms of production has not increase beyond 6 to 7%. From the turnover figures, one may conclude that the domestic production has grown at a rate of 26% in terms of Sale Values but it is to be taken into consideration that almost 12% of this has been due to increase in prices which the manufacturers have been repeatedly undertaking due to rising cost of imported components resulting from depreciation of Indian Rupees against Dollar.

0.4.6 Demand

With the Auto Industry returning to path of recovery and engineering industry showing signs of growth, the demand for hydraulic products is going to increase after three successive years of demand recession.

Based on latest data, it is expected that the capital goods industry during the next 5 years would grow at a rate of approximately 8% per annum. With the user industries/SSI's/Rebuilding activities growing at another 6%, the physical growth in the hydraulic equipment industry is expected to be 10%. With the price increase of average 8% to cover inflation and increasing input costs, the total growth in the industry can be averaged at 9 to 10% per annum.

The Table below indicates the growth of hydraulics industry in the next 5 years.

**DEMAND PROJECTION - HYDRAULIC INDUSTRY
(1995-96 to 2000-2001)**

Rs. Crores

	1995/96	1997/98	1999/2000	2000/2001
Domestic	450	495	545	595
Production	145	165	180	195
Total Demand	595	660	725	790

Source : Based on survey conducted by the Consultant.

0.5 IMPORTS & EXPORTS

The major raw materials requirement for the hydraulic industry are CDC tubes, castings, forgings, alloy steels, non ferrous metals such as aluminium, copper, brass. Some of the above materials are imported and others are available indigenously.

Also, the hydraulic industry is dependent on imported components

for their production. The major components import requirement of the industry is in respect of 'O' rings, oil seals, springs vane blanks, bearings etc. Rotating block for axial piston pumps/motors, special bearings etc., the requirements for each type is so small that it has not been possible to develop regular and good quality from indigenous sources.

The total requirements of imported raw materials and components for current level of production is estimated to be :

Imported raw materials	..	Rs. 4000 lacs
Imported Components	..	Rs. 3200 lacs
		Rs. 7200 lacs

The requirements of components and raw material for 1995-96, 1998-99 and 2001-2002 is as under :

1995-96	..	75 crores
1998-99	..	88 crores
2001-2002	..	110 crores

The bulk of the exports of the Oil hydraulic products are taking place as indirect exports, namely, as components of larger plant and machinery being exported. By and large direct exports by individual companies are minimal. It is also to be recognised that to be able to export these products, it is necessary to have a highly technical marketing and after sales service set up in the countries in which exports have to be made. These are at present above the capability of the industry.

0.6 INTERNATIONAL SCENARIO

In connection with oil hydraulic technology, it is widely acknowledged that it is undergoing changes mostly determined by the user sector who have undergone revolutionary changes in their product designs in the recent years. According to present indications some of the changes in technology in respect of design, materials and manufacturing will be as under :

- Increased power/weight ratio
- Increased system pressures
- Extensive use of manifold systems avoiding extensive piping and relative leakage problems
- Reduced noise levels
- Increased use of proportional valve technology, interfacing with electronics and microprocessor systems.

- Improved sealing technology suitable for varying operating conditions
- Increased use of load sensing and energy saving technologies.

In line with product technology changes, the following material changes are foreseen :

- Graded iron castings
- Castings of aluminium pressure die casting/aluminium forgings
- Graded cast iron to spheroidal grade castings
- High temperature resistant/low friction sealing materials
- Special alloy steels with low thermal expansions
- Hydraulic fluid medium capable of working under wide fluctuations of temperature
- Variety of semi-finished and pre-finished raw material inputs like pre-honed tubes, induction hardened and chrome plated rods will help in cost reduction and improve manufacturing lead times.
- In low pressure areas the use of engineering plastics in place of metals.

It is expected that integration of electricals, electronics and oil hydraulic industry would play a very vital role in the future development of all sectors of industry where hydraulic equipment are used.

0.7 RESEARCH & DEVELOPMENT

The current set up of the industry is such that most companies are not engaged in major R&D activities. Activities in this area are more in the form of development of existing products, product modifications, product applications to suit specific customer's requirements and not in the area of new products development. It is felt that with most individual companies, being small to medium in size, more of product development and re-engineering than pure research will be the area of activity in future. Futuristic R&D will have to be developed, preferably, in a national laboratory or institute that can be established for this purpose.

Major breakthroughs and new concept developments involve very large amounts of funds and it is not foreseen that in the near future individual indian companies in the country would be able to undertake basic R&D.

0.8

RECOMMENDATIONS

0.8.1 The manufacture of oil hydraulic products involves highly precision manufacture of components, their inspections and testing. The tolerance involved in the various components are in microns. Due to sophistications involved in the manufacture, testing and components of the fluid power products, the industry needs high capital investment. However, there are specialised areas of manufacture and process which continue to need imported machine tools.

Some of the units also have requirements for replacement of the old and worn out machines. They would need to modernise their manufacturing facilities. The recent notification of package for technology upgradation scheme for machine tool industry would also cover hydraulic industry. Though custom duties on imported machine tools have been reduced, industry requires low cost financial support from Banks / Financial Institutions.

The study has brought out that like so many other industries the major impediment in modernisation is resource constraints. The profitability of the Oil hydraulic industry has been eroding with increased competition of fully imported components of cheaper prices and increasing labour costs. Further, for the high cost of modernisation, the industry is not able to raise resources.

0.8.2 The bulk of the exports of the oil hydraulic products are taking place as indirect exports, namely, as components of larger plant and machinery being exported. By and large direct exports by individual companies are minimal. It is also to be recognised that to be able to export these products, it is necessary to have a highly technical marketing and after sales service set up in the countries in which exports have to be made. These are at present above the capability of the industry. Therefore a joint effort should be made by the industry in this direction.

0.8.3 The manufacturing of Oil hydraulic components has been delicensed under the new policy of Government of India. With the liberalisation of Indian economy, a number of multinational companies are making investments in India for different products and technologies. Even in the field of hydraulic components, some new entrants with 100% owned or Joint Venture Companies are expected to enter the market of such products with the latest technologies.

The new entrants should bring in latest technology and plan manufacturing base which has less number of sortiments and high volumes to achieve competitiveness. They should identify range of products which can be manufactured in volumes and quality and market through their distribution network at international level.

Also some existing manufacturers have got or in the process of getting ISO 9000 accreditation of their manufacturing facilities and also have increased the foreign equity of the principals. These companies should make extra efforts to promote exports of hydraulic products through their collaborator's international marketing network. These companies should identify range of products which can be manufactured in volumes and quality and market through their distribution network at international level.

0.8.4 One important aspect that needs attention is in the area of technical education concerning application and maintenance of oil hydraulic components and systems. It has been recognised widely today that there is no systematic and adequate knowledge being imparted to students and users on applied fluid power. It is necessary to take steps to ensure systematic and adequate facilities for imparting knowledge on fluid power at three different levels, namely:

- Craftsmen level (foreman)
- Undergraduate level
- Graduate level

Efforts to integrate and introduce such a system in the country is of prime importance for the future growth of oil hydraulic and fluid power in the country.

0.8.5 As a major and vital industry connected with the capital equipment industry, there is no national level research and development and technology coordinating institution. A national fluid power technology centre with industry participation requires to be created which can work towards developing future technologies, provide test facilities and co-ordinate efforts in the area of standardisation and performance certification of the products of the industry.

0.8.6 Castings for hydraulic components are of high grade and precision, and require mechanised moulding machines, electric furnace and elaborate quality control equipment.

Manufacturers of hydraulic components always had problem in establishing a source which can meet their requirements of castings. Since the castings required for hydraulic components are of small size, foundries do not get attracted in developing the same. Basic manufacturing technology is available but foundries require mechanised equipment for moulding and for preparation of elaborate testing facilities. Investment required for creating such facilities could not be justified for the returns. Hydraulic components manufacturers continue to face high castings rejections ranging from 10% to sometime upto 50%.

If Indian Companies could develop castings in quality as required by the hydraulic component manufacturers, there is a good scope for export of these castings in large volumes to their parent companies. There is a need for technology input to such foundries and incentives to foundries which should import foundry equipment and export high grade castings for hydraulic components.