

EXECUTIVE SUMMARY

0.1 PROFILE OF FUEL INJECTION EQUIPMENT INDUSTRY

0.1.1 In 1922 Robert Bosch Company of Stuttgart, Germany decided to manufacture fuel injection equipment, and after years of development its popular jerk pump with helix control was introduced in 1927 in both single and multiple plunger types.

About the same time precision nozzle assemblies of the pintle and hole type were introduced and subsequently other items such as supply pumps, governors and filters were marketed. With the availability of this injection equipment the high speed diesel engine came into existence.

0.1.2 One of the most important parts of an engine is its injection system. Engine performance depends on the proper functioning of this injection system, which must supply, meter, inject and atomize the fuel.

Fuel Injection systems are manufactured with high accuracy, especially the parts that actually meter and inject the fuel. Some of the tolerances between the moving parts are very small - of the order of a few microns. Such closely fitting parts require special attention during their manufacture, and, as a result, injection systems are a costly item.

There are a number of fuel injection systems in use today. Each of the systems has its own peculiarities which make it perform better from one point of view or another. Before adapting any of these systems to a given engine, it is necessary to study the characteristics of an injection system in view of the engine requirements and engine design.

0.1.3 The components of a fuel injection system are the nozzles, nozzle holders, elements of the pump, delivery valves, filters and associated piping.

In 1990-91, the market size was Rs. 283.59 crores, an increase of 32.20% over the previous year. The production growth rate is roughly half of this.

Motor Industries Company (MICO), Bangalore is the market leader and has 85-90% of the market share. For multicylinder pumps it is the sole supplier of Fuel Injection system.

Lucas TVS is entering the market, with an investment of Rs. 90 crores in a new plant near Madras. It is expected to corner roughly 25% of the Market. Shri Ram Diesels, K.S. Diesels are the smaller companies, largely catering to the single cylinder pumps and the replacement market for multicylinder pumps.

- 0.1.4** The market has two segments; replacement and original market. Major original market customers are TELCO and Ashok Leyland for vehicles; Mahindra & Mahindra, Eicher, Escorts, Punjab Tractors and Gujarat Tractors for tractors; Enfield India Ltd., Kirloskar Oil Engines, Rallis India, Sigil (Inds.) Services Ltd. and Simpson and Co. for Diesel engines.

0.2 INTERNATIONAL SCENARIO

- 0.2.1** The international market is dominated by Bosch, Germany. Bosch technology and/or capital is in most parts of the world, including the erstwhile east bloc countries. Its fuel injection system are sold to over 120 engines in Europe. Almost every major company in Japan uses Bosch technology and/or has Bosch equity participation.
- 0.2.2** The world market of Fuel Injection System(FIS) is approximately of US \$ 15 billion. Other FIS manufacturers are Nippondenso, Japan and Lucas CAV, UK. Bosch and Lucas CAV offer a wide range of electronic unit injectors. Currently Bosch is tying up with Japanese firms to build fuel injection equipment for Japanese built autos in the US. Leading automakers in the USA are producing in-house FIS, such as GM, Cummins and Caterpillar.

0.3 RESEARCH AND DEVELOPMENT

- 0.3.1** Latest developments in fuel injection systems are the electronically controlled mechanical/hydraulic actuated unit injectors. The main features of these systems are higher rates of injection and precise timing control.
- 0.3.2** The motivation for the development of electronic systems has been the result of two factors, one legislative and the other competitive. The unit injector systems developed now are considerably more expensive.
- 0.3.3** The thrust of fuel injection is towards reduction of exhaust and noise emissions in conjunction with low fuel consumption. The injection equipment is of essential importance to the optimization of diesel injection combustion.
- 0.3.4** Rigorous use of simulation techniques (one and three dimensional) is made for the design/analysis of FIS.

0.4 CONCLUSIONS

- 0.4.1** Manufacturing capability for fuel injection systems is well established in India, however, the capability to create technology lies undeveloped.
- 0.4.2** Technology acquired in India is by purchase, through collaborations.
- 0.4.3** Fuel injection system development and advances in diesel engines are strongly interlinked. Progress in one is possible only with progress in the other.
- 0.4.4** Lack of competition has been a major constraint in evolving better engines/fuel injection equipment. Other reasons cited are small size of the market, long lead times for development and high costs.
- 0.4.5** R&D effort in industry is slanted more to testing, rather than new product development.

- 0.4.6** Lack of mathematical simulation techniques in industry is felt which is essential for design/analysis/prototype building of fuel injection systems.
- 0.4.7** Technology development in the industrially advanced countries is the result of stiff competition and Government legislation prescribing permissible pollution levels.
- 0.4.8** The latest development in fuel injection systems is the concept of 'unit injection' (a separate injector for each cylinder) coupled with electronic controls.
- 0.4.9** Electronics are playing a major role in fuel injection systems. They serve to give better control over timing and metering, and also possess diagnostic features. Unit injection coupled with electronic control makes it easier to achieve lower pollution levels, as well as, better fuel efficiency. In addition to the unit injection system, the following few major systems are currently used and are likely to be used in future depending upon their use.
- In line pump : with or without Electronic Diesel Control
 - Rotary pump : with or without Electronic Diesel Control
 - Unit Injection : With or without Electronic Diesel Control
 - Single Pumpline Injector : With or without Electronic Diesel control
- 0.4.10** Pollution control is restricted to only smoke. No standards are prescribed for carbon monoxide (except for cars and scooters) and nitrous oxides. The law is not applicable for stationary diesel engines. The light commercial vehicles of Japanese origin give 30 to 40% lower smoke levels.
- 0.4.11** The market at present is being catered by one supplier, mainly, which controls 85-90% of market. Another unit Lucas TVS has recently entered into collaboration with a leading British Co. for manufacture of fuel injection system. However, the industry feels that it is unlikely that the entry of Lucas TVS shall enhance the

available design capability, in the country, for fuel injection systems in the foreseeable future.

0.4.12 MICO, Bangalore, is having a good dealer network in the country which looks after sales and services.

0.4.13 Shriram Diesel Injections, Hyderabad, has a small portion of the original market for single cylinder diesel engines, and some of the replacement market for multicylinder fuel injection pump components. Collaboration with Union Resurgio, Italy has expired.

0.4.14 Kirloskar Oil Engines, a large diesel engine manufacturer, gave up the attempt to make fuel injection systems, due to financial reasons. CA Diesels, Faridabad, was unable to enter the market for similar reasons. However, it is continuing efforts in this direction to develop fuel injection equipment.

0.4.15 The market is expected to grow at a rate of approximately 8%, in terms of production volumes, to cater to the needs of the original and replacement market.

Bosch GmbH, Germany is the international leader with 55% of the world market. It is aggressively pursuing world markets. Others are Nippondenso, Japan and Lucas CAV, UK.

0.4.16 Complete fuel injection systems are imported for the light commercial vehicle of Japanese origin. Efforts to indigenise are being made.

0.4.17 Exports are limited to few components only, to a small extent.

0.5 RECOMMENDATIONS

0.5.1 The first and foremost task is to fix an objective to build better diesel engines/fuel injection systems for the domestic market.

0.5.2 Initiative is required to be taken by the diesel engine makers by setting a target to achieve better fuel efficiency and lower pollution levels, in line with international norms.

- 0.5.3** A joint effort of a diesel engine maker alongwith a fuel injection maker is required in the form of equity participation.
- 0.5.4** The introduction of electronics in fuel injection systems is strongly suggested. The fuel injection technology is, however, interlinked to the engine development, it is presumed that direct injection engines will dominate because of its low fuel consumption. However, worldwide development activity to tap low emission potential of indirect injection engines by reducing fuel consumption through engine changes is to be closely followed.
- 0.5.5** Building engineering expertise by setting up a team of engineers in the areas of design, analysis and testing.
- 0.5.6** Fuel Injection Equipment may use the services of consultants/ research/academic organisations in India or overseas to develop analytical and computational skills for analysing old/new fuel injection systems. Success in the domestic market may then be extended to the foreign market. Given the exchange rate of the Rupee, developmental costs in India would be lower significantly.
- 0.5.7** A committee, consisting of members from industry (diesel engine/fuel injection), the Government and the R&D institutes may be set up to determine performance and emission standards based upon the performance of engines internationally. These standards should be on the basis of engine size in the category of (i) single cylinder engines, (ii) multicylinder engines.
- 0.5.8** Leading suppliers should be encouraged to increase export of fuel injection components using the vast resources of their principals like Bosch GmbH, Germany of MICO.
- 0.5.9** Major manufacturers be encouraged to develop extensive servicing networks. Also, engine users be educated in the proper use of fuel injection equipment using audio visual techniques operated by service personnel.