Chapter I

INTRODUCTION
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1.1. Features of two-stroke engine:
The two-stroke spark ignition engine has some significant features which make it particularly suitable for light engine applications like individual transportation. It has the advantages of low specific weight, compactness and simplicity of operation and offers greater flexibility in the design. In addition to this, from the principle of two-stroke working, it follows that the frictional loss in the case of two-stroke engine is lesser compared to the four stroke engine due to absence of two idle strokes. Hence the effective power is higher in the two-stroke engine than in the four stroke engine for the same indicated power. Therefore the mechanical efficiency is also higher in the two-stroke engine.

1.2. Drawbacks of two-stroke principle:
The two-stroke spark ignition engine used in the two wheelers has inherent drawbacks of poor part load efficiency, high exhaust emissions and direct fuel loss due to short circuiting. Average fuel consumption of two-stroke engines ranges from 1.5 to 2 times that of the four stroke engines. In practice it is found that the hydrocarbon emissions are about five times that of four stroke engines. In view of the rapid depletion of the fossil fuels and also due to the increase in demand, there is a steep rise in the oil prices. In addition to this, the ever increasing number of two-stroke engines on the road has created harmful effects on the environment. Hence, research is being directed towards more fuel efficient two-stroke engines with reduced emissions.
1.3. In-cylinder petrol injection:
The two-stroke S.I. engines with in-cylinder fuel injection is expected to be a cost effective alternative to the present day carburated two-stroke engines and can be equally competitive to the four stroke engines too. To be a successful alternative, it must demonstrate efficiency and emission levels comparable to those of four stroke engines. Thus currently in-cylinder fuel injection is receiving more and more attention as it can completely eliminate the short circuit loss. In-cylinder fuel injection, however, will result in a stratified fuel-air mixture inside the cylinder.

1.4. Stratified charge engine:
Stratified charge engines have held an exciting place in the development of internal combustion engines. Inventors, engineers and research scientists have repeatedly, through historical developments, turned to the stratified engine concept as a solution to many problems that have plagued conventional homogeneous charge engines since its inception. Problems like mechanical loading, fuel economy, engine knock, combustion, emission and alternative fuel utilization, to mention a few, have all been investigated in the stratified charge engines, with the idea that the stratified charge concept would offer unique solutions to these problems. Despite the dire optimism of engine developers, the stratified charge engines have suffered several setbacks. Although the stratified charge engine has had limited success in production, today the concept is as viable as it has been throughout its historic development. Yet, stratification of present day engines still remains in the active areas of research.

The concept of in-cylinder fuel injection in the two-stroke engines leads to the formation of a stratified mixture as mentioned earlier, from which, the advantages mentioned above can be possibly realized. It is with this idea that an attempt is made to analyze the combustion process in such a mixture and to build up a model to
simulate the combustion process, which would enable continuing research with innovative combustion chamber designs for future engines.

1.5. **Combustion simulation:**

Computer simulation of various processes of the I.C. engine cycle would be of tremendous use for the engine designer to predict the performance of the would be engine, with regard to power, efficiency and emission characteristics. Since, it has been established that the phenomena occurring during the combustion and expansion phases of the spark ignition cycle grossly control the efficiency and pollutant levels in the engine exhaust, research programs are directed towards understanding the character and behaviour of normal combustion and expansion phases of the S.I engine cycle. The accuracy of such a simulation directly depends on the accuracy with which the combustion process can be predicted and the validity of assumptions and the approximations made in the synthesis of other events preceding and following the combustion phase. Assumption of isentropic processes and constant volume combustion would be far from reality and would overestimate the combustion temperatures and consequently the equilibrium mole fractions of the pollutants CO and NO. The extremely complex nature of almost all the disciplines associated with the spark ignition engine combustion becomes obvious, when one attempts to accurately simulate such a process. The accurate synthesis of the engine cycle requires a complex model for flame propagation which takes into consideration, the effect of various engine operating variables on turbulent combustion.

The combustion of fuel-air mixture takes place as the flame traverses through the combustion chamber, and the rate of heat release at any given instant of time, is governed by the rate of flame propagation. The velocity of flame progress is predominantly governed by the characteristics of gas turbulence, combustion
chamber design and the physico-chemical properties of the working fluid. Therefore, it will be influenced to a varying degree by factors like engine speed, compression ratio, ignition timing, fuel air ratio, fuel quality, engine intake conditions and heat transfer.

The performance of two-stroke S.I. engine with in-cylinder fuel injection largely depends on the rapidity of mixture formation from the wall impinged as well as airborne fuel. The vaporization and combustion of this spray directly affects the efficiency, output and exhaust emissions. If the vaporization and combustion characteristics of the fuel spray could be accurately predicted, the design of the combustion chamber could be optimized without unduly voluminous and laborious experimental work.

1.6. Scope of the present work:

In the present work, therefore, an attempt is made to develop a model for flame propagation in the stratified mixture of petrol-air caused by in-cylinder fuel injection in a typical two-stroke engine. This simulation of combustion process in such a system is carried out on the presumption that the injected fuel is fully vaporized before the spark occurs, resulting in a stratified mixture. In order to ensure that the vaporization is completed before the occurrence of the spark, theoretical studies are carried out on the fuel penetration, wall impingement and evaporation characteristics based on available models.

The predicted $P - \phi$ diagrams from the combustion models so formulated are compared with the experimental $P - \phi$ diagrams for the same engine input and operating conditions. Thus the validated model has been tested for various engine operating conditions and the results are presented in the work.
Chapter II

LITERATURE SURVEY