EXPERIMENTAL AND ANALYTICAL STUDIES ON 'STRATIFIED CHARGING' AND 'SELECTIVE EXHAUST GAS RECIRCULATION' IN CRANKCASE SCAVENGED TWO-STROKE SI ENGINE FOR REDUCTION OF HYDROCARBON EMISSIONS AND SPECIFIC FUEL CONSUMPTION

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TO MY SONS AKAR AND SAAKAR

CERTIFICATE

I, the undersigned, certify that the thesis entitled, "Experimental and Analytical Studies on 'Stratified Charging' and 'Selective Exhaust Gas Recirculation' in Crankcase Scavenged Two Stroke Engine for Reduction of Hydrocarbon Emissions and Specific Fuel Consumption" which is being submitted by Mr. Mukesh Saxena in fulfilment of the requirements for the award of the degree of 'Doctor of Philosophy' in the Faculty of Engineering of the Indian Institute of Technology, New Delhi, is a record of the Candidate's own bonafide research work carried out under my guidance. The matter embodied in this thesis has not been submitted in part or in full, elsewhere, for the award of any degree or diploma.

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ABSTRACT

So far two stroke engines have been competitive prime movers for light vehicles and portable equipments due to their advantages of high specific power, simplicity, low costs, etc. However, these engines have serious drawbacks of high hydrocarbon (HC) emissions and specific fuel consumption (SFC). The principal reason for these drawbacks is the loss of fresh charge during scavenging process. In the present studies an attempt has been made to investigate into the history of these losses (or HCs) and consider reorganisation of flows for cylinder charging/scavenging in order to reduce HC emissions and SFC.

The investigations into the history of HC concentration in exhaust showed that during scavenging initially it decreased and then increased to the maximum level, which remained practically constant during the period exhaust port closed and then opened in the next cycle. The average HC concentration in the exhaust is thus the result of this specific HC history which could be affected in two ways; The Stratified Charging' (SC) and the 'Selective Exhaust Gas Recirculation (SEGR).

The 'SC' could be acomplished by making fresh

charge mixture non-uniform with respect to time, that is the cylinder charging should start with air, leaner mixtures and end up with rich mixtures. In 'SEGR' the portion of exhaust gas, corresponding to the period of maximum HC concentration, was recirculated back to the crankcase. This was accomplished by dual intake system consisting of the primary and secondary circuits. The primary circuit supplied air fuel mixture as in conventional engines but rich mixtures in case of SC and normal mixtures in SEGR. The secondary circuit supplied air in SC, and it was connected to the probe near the exhaust port in case of SEGR. The secondary circuit included reed valve to check the flow. The conventional 150 cc two stroke engine was suitably modified to accomodate the reorganised flows as mentioned above.

Experimental and analytical studies were carried out to analyse and understand the concepts of 'SC' and 'SEGR' and evaluate engine performance particularly in terms of HC emissions and SFC. Comparision of each was also made with conventional engine.

The effects of operating parameters like air fuel ratio, flow through the circuits (primary/secondary) and load with stratified charging were experimentally

studied. The performance under simulated road load was also taken. The results showed improvements in HC and SFC in the entire test range of engine operation. However, it was found that the percentage reduction mainly depended upon the flow through the circuit and load. For the analysis of the concept, the loss contribution of the circuits towards the total losses were evaluated, both experimentally and analytically.

For analytical studies it was assumed that the scavenging process takes place as per perfect mixing law and for a given delivery ratio the total flow was assumed to be consisting of number of fractions. For each fractions the amount lost and trapped were calculated. These results showed that the loss corresponding to secondary were higher as compared to primary. The theoretically predicted results were compared with experimental results and these were analysed for the scope of improvements for both the concepts.

The effect of air fuel ratio, recirculation ratio and spark advance were experimentally studied for SEGR. These results showed that for higher improvements higher recirculation with higher spark advance was required. For understanding of the concept the cylinder

gas compositions were sampled with the help of high speed gas sampling valve and the gas composition of the recirculated gases were also analysed.

In case of 'SC' the reduction in HC concentration upto about 32 % and the improvements in SFC upto 12% could be achieved. For the conditions tested the SEGR showed HC reduction upto about 34%.And 12% reduction in SFC were obtained. These studies established the feasibility of the concepts in reducing the HC emissions and specific fuel consumption without much affecting its existing advantages.

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