STUDIES ON PRESSURE PULSATIONS AND CONDITION MONITORING OF RECIPROCATING COMPRESSOR

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CERTIFICATE

This is to certify that the thesis entitled, '**Studies on Pressure Pulsations and Condition Monitoring of Reciprocating Compressor**' being submitted by Gajraj Singh Yadava to Indian Institute of Technology, Delhi, for the award of '**Doctor of Philosophy**' is a record of bonafile research work carried out by him. He has worked under our guidance and supervision and fulfilled the requirements for the submission of this thesis, which to our knowledge, has reached the required standard.

The results obtained in this thesis have not been submitted to any other university or Institute for the award of any degree or diploma.

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ABSTRACT

Pressure pulsations of considerable magnitude are present in a reciprocating compressor system. This may result in noise and mechanical vibration causing fatigue failure of pipe-work, loosening of fastenings and excessive number of valve failures. The discharge valves are subjected to most severe service, experiencing the high heat and pressure. In addition, it is felt that the pressure pulsations might change with defects like the valve failures, the piston ring wear/failure etc and may be used as signatures for the condition monitoring work.

This work has been undertaken to determine theoretically & experimentally the pressure pulsations in the reciprocating compressor & the piping system and look into the possibility of using it for the condition monitoring of the reciprocating compressor. For analysis and formulation of the theoretical method, a single cylinder reciprocating compressor with a disc type of valve has been considered. A simple system consisting of the compressor, the piping and a receiver has been taken for study. The formulation of the theoretical method using a digital computer is based on the transfer equations approach. The valve effect has been incorporated in the analysis. The basic equations of fluid flow used are based on the theory of non-compressible fluid and the acoustic theory. Factors accounting for the sudden change of the pulsating pressures at the receiver inlet and outlet as noticed during experimentation have been incorporated.

The theoretical method developed has been verified experimentally. The effect of some of the input parameters on

the pressure pulsation have been studied theoretically. The common type of compressor defects like the leaking discharge & suction valves and worn-out piston rings have been simulated. The effect on the pressure pulsations and the harmonics have been studied theoretically. The experimental studies have been carried out to verify the trend of simulated faults on the pressure pulsations and the harmonics. The trends of variation of the cylinder pressure-time diagram and harmonics have also been studied.

This study gives a theoretical method using a digital computer for calculating the magnitudes of the pulsating pressure and the harmonic components for the discharge side of a compressor piping system. The method gives reasonable degree of accuracy, keeping in view the uncertainties involved in the input data. The computed results are influenced by the parameters like the initial force on the valve disc(Finit), the damping ratio of the valve spring(ξ), the pipe flow damping factor(α), the polytropic index of compression(N1), the cylinder pressures at the end of suction stroke(P_s) & at the time of discharge(P_d), the cylinder clearance(cl) and the pipe diameter and the length. The leaking outlet & inlet valves and piston rings change the pressure pulsation signature across the defective cylinder. With the defective condition, the pressure pulsations increase at a section before the inlet valve and decrease at a section after the outlet valve. Both the theoretical and experimental simulations have shown that the pressure pulsation signatures may be used as an indication for condition monitoring of a reciprocating compressor.

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