# ACOUSTIC DESIGN OPTIMIZATION OF CLOSE-FITTING ENCLOSURE USING GENETIC ALGORITHM TOOL FOR DIESEL POWER GENERATOR SOUNDPROOFING APPLICATION



Isanka Ehelepola

108854J

Dissertation submitted in partial fulfillment of the requirements for the degree

Master of Science

Msc in Industrial Automation

Department of Electrical Engineering

University of Moratuwa

Sri Lanka

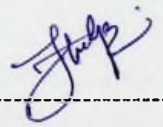


May 2015

## DECLARATION OF THE CANDIDATE AND SUPERVISOR

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or institute of higher learning and to the best of my knowledge and believe it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my dissertation, in whole or in part in print electronic or other media. I retain the right to use this content in whole or part in future works (such as articles or books).



Date: 28th May 2015

Isanka Ehelepola
Candidate

The above candidate has carried out research for the master Dissertation under my supervision.

***UOM Verified Signature***

Date: 28/05/2015

Dr. D.P. Chandima
Research Supervisor

## ABSTRACT

Reciprocating engine power generator sets produce uncomfortably loud noise when it is in operation. Installation of Power Generator (PG) shall comply with local noise regulations. Further price, space and weight ensure a commercially appealing product in PG market. However in Sri Lanka most of the locally fabricated soundproof PGs has failed to meet SPL regulations even though it is in reasonable low price compared with imported soundproof PG. Open discussion about this problem with the local PG suppliers revealed that, absence of simple and fast acoustic enclosure design procedure customized with the SPL spectrum of open PG and the customer requirement of space, weight and cost has created this problem.

Close-fitting enclosure fabricated with sheet metal enclosure face insulated with sound absorption materials is method of Passive Noise Controlling (PNC) used in PG soundproofing. SPL model of soundproof PG was developed considering Insertion Loss (IL) of the enclosure and SPL spectrum of the open PG. The model was constrained for customer required SPL, cost and weigh. Effective deign variables of the model were identified and developed an optimization code for selecting optimum minimum values for the identified variables using Genetic Algorithm (GA) optimization tool in MATLAB. Optimization were converted to user friendly deign application through a Graphical User Interface (GUI).

Validity of the developed design methodology was done by comparing the model predicted data with manufacturer given data for selected set of "Cummins" power generators. After that design variables were predicted for open type standby power 22kVA "Cummins" PG with 75% load at 3m distance and the acoustic enclosure for the model was fabricated accordingly. SPL measurement of fabricated enclosure realized the developed methodology is substantially accurate and result can be used for the preliminary design of the enclosure. Accuracy of deign can be developed further by considering the effect of noise leak through opening and the effect of sound attenuator.

## DEDICATION

To my family who proved lovely relationships beyond the logic

## ACKNOWLEDGEMENT

I would like to gratefully acknowledge research supervisor Dr. D.P. Chandima, Senior Lecturer, Department of Electrical Engineering, University of Moratuwa for his dedication, inspiration and great effort throughout the research. Also I would like to thank senior lecturers of Department of Electrical Engineering, University of Moratuwa for their valuable feedbacks and advices during progress reviews that directed my research towards a realistic end.

I gratefully thank Eng. P.K. Chadrasekars, Chef Engineer, Power Plant section, Ceylon Electricity Board for providing entire resource for the research.

I am thankful Power Generator engineering team of the Trade Promoters (Pvt) Ltd, Hayleys Industrial Solutions (Pvt) Ltd and Metropolitan Engineering (Pvt) Ltd. for their immense support on problem oriented survey and providing manufacturer data of commercially available Power Generators.

Last but not least, I am grateful to Department of Electrical Engineering, University of Moratuwa for providing me the opportunity to read MSc in Industrial Automation successfully.

## TABLE OF CONTENT

## LIST OF FIGURES

## LIST OF TABLES

## LIST OF ABBREVIATIONS

| Abbreviation | Description |
|---|---|
| SIL | Sound Insertion Loss |
| dB | Decibel |
| OSHA | Occupational Safety and Health Administration |
| dB(A) | A weighted Decibel |
| ANC | Active Noise Control |
| PNC | Passive Noise Control |
| TL | Transmission Loss |
| IL | Insertion Loss |
| GA | Genetic Algorithm |
| GUI | Graphical User Interface |

## LIST OF APPENDIXES