

**POTENTIAL OF USING VARIABLE AIR VOLUME SYSTEMS
AGAINST CONSTANT AIR VOLUME SYSTEMS FOR MEDIUM SIZE
OFFICE BUILDINGS**

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Department of Mechanical Engineering

University of Moratuwa

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Thesis submitted in partial fulfilment of the requirements for the award of

Master of Science in Building Services Engineering

Department of Mechanical Engineering

University of Moratuwa

Sri Lanka

January 2016

DECLARATION

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ABSTRACT

It is a popular fact among HVAC designers that variable air volume (VAV) systems are energy efficient than more common constant air volume systems. Despite that information, when comes to the selection stage of the most suitable air side system for the project, the designers falter to suggest a VAV system to the client with the higher installation cost yielded by the VAV system in his mind. It is nice if he has the luxury finding the pay back of the VAV system after modelling the building and doing a simulation. But, in reality it is a time consuming and tedious task in a busy schedule. It will be immensely helpful if the HVAC designer can decide whether to go for VAV or Constant Air volume (CAV) by just a careful study on some straight forward facts of the building.

Therefore, this research is focused on developing a guideline in to decide whether to go for VAV or CAV for a midrise office building. It was done with the help of TRACE 700 energy simulation software. Few sample buildings are modelled with TRACE 700 in few orientations and a comparison was done taking the CAV system as base design and VAV as alternative. Life cycle analysis is done using the present tariff structures of Ceylon Electricity Board.

The results of this research are based on two defined parameters as solar gain factor (SGF) and occupancy diversity factor (ODF). SGF is defined as ratio of solar gain to total cooling load of the building which can be obtained by basic cooling load calculation. ODF is a measure of average occupancy variation of the building. Lower the ODF value means higher the occupancy variation. The building category underwent to this research is mid-rise office buildings (i.e. height between 18m – 30m) and the ODF value for those buildings are between 64% and 80%. For a highly varied occupancy schedule, ODF is 64% and for a uniform occupancy schedule, it is 80%. For those ODF value range, the VAV benefited SGF value range is identified as 11.9-13.4 for a payback period of five years. That means, for a mid-rise office building, VAV system is benefitted for a SGF value range of 11.9 – 13.4. If the SGF is lower than 11.9 in a mid-rise office building, VAV systems are not economical when considered for a payback period of five years or less. For any SGF value in above range, the life cycle payback period can be determined using above linear relationship between SGF and life cycle payback period for a selected ODF value between 64% and 80%. For any exception with ODF values higher than 80%, a complete building simulation should be carried out to determine the required SGF value for that building. Otherwise, the investment for VAV will not be paid back within reasonable time (within five years as considered in this study). On the

other hand, for a building with lower ODF than 64%, the investment on VAV is worth even in a SGF value lower than 11.9. Further studies should be carried out for the situations out of those ranges.

The significance of some non-quantitative benefits of VAV systems is also highlighted.



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NOMENCLATURE

VAV	Variable Air Volume
CAV	Constant Air Volume
VSD	Variable Speed Drive
AHU	Air Handling Unit
CEB	Ceylon Electricity Board
CECB	Central Engineering Consultancy Bureau
G.P. - 2 CEB	General Purpose Tariff for each individual point of supply delivered and metered at 400/230 Volts nominal and where the contract demand exceeds 42 kVA
ASHRAE	American society of Heating, Refrigeration and Air Conditioning Engineers
TRACE 700	Trane Air conditioning Economics Software developed by Trane Air Conditioning Company, United States of America
TR	Tons of Refrigeration



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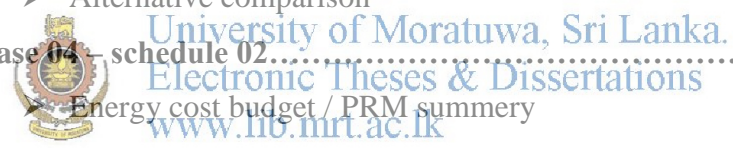


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