ISSN 2250-3153

Selection of best Technical and Financial system for Resort in hilly region in the prospect of Vapor Compression and Absorption System

Rupak Paudel*, ManojDangal**

* Institute of Engineering
** Mechanical Engineering Department, Central campus, Pulchowk

Abstract
The existing vapour absorption system is compared with the vapour compression system designed with the detailed ASHRAE standard CLTD method along with software like e-solution. The pros and cons of the vapour compression system and vapour absorption system is compared in technical and financial reference. The research paper is based on the resort located in the hilly region projecting circumstances of modern rated star luxury facility. For calculated load of 60 TR, fuel consumption of boiler at different loading conditions is determined. Then actual and theoretical fuel consumptions are compared. For the analysis, existing VAS is replaced by the Variable Refrigerant Flow (VRF) system. Complete design of VRF system is performed separating the building in three zones: (a) upper two floor, (b) ground floor and (c) lobby. Energy consumption of VRF system is also calculated and compared with VAS. The research displays that load performance of VAS is poor and resort using VAS are losing large amount of fuel and associated financial resource at part load condition. When comparing VAS with VRF system, it is also found that large amount of money will be saved by replacement of VAS by VRF system with less payback period.

Index Terms-

CLTD- Cooling load temperature difference, VAS- vapor absorption system, VCS-vapor compression system, VRF- Variable refrigerant flow

Introduction

Even though air conditioning have jumped the great advancement in the technology with improvement in the cost and efficiency, the replacement of the older system with the newer always incudes the hectic work of risk in time and money frame. Due to such constraints, around 40-45% of hospitality and processing industry are operating the obsolete VAS due to lack of appropriate research work or study. The operation of VAS in processing industry is justifiable due to waste heat recovery but the operation of VAS system in resort hotel seems somewhat peculiar in terms of costly heat source. These hospitality industry are using the oil fired or some costly heat source to run VAS. VAS has to be operated in same rate irrespective of the load occupancy i.e. the burner/boiler takes the same amount of fuel and cost even at the variation of load. The part load performance curve of VAS and VCS also symbolizes it. So, to provide the concrete idea of VCS over VAS, retrofitting of the VRF system in the existing VAS is done with the cooling and heating load calculation.

Load Calculation

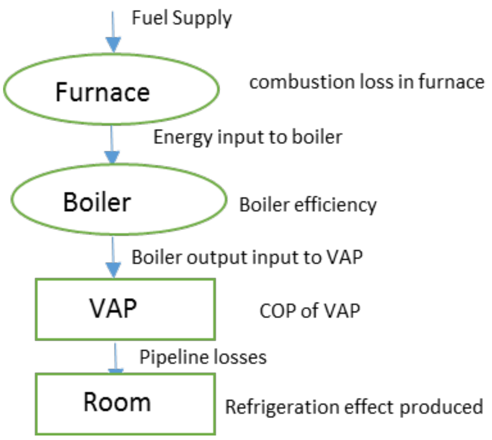
CLTD Method: This method is derived from Transfer function method and uses tabulated data to simplify the calculation process. The CLTD/CLF/SCL method is regarded as reasonable accurate approximation of heat gain through a building envelope. Error when using this method tends to be less than twenty percent over and less than ten percent under. However for strictly manual load calculation CLTD/CLF/SCL method is most practical method to use.

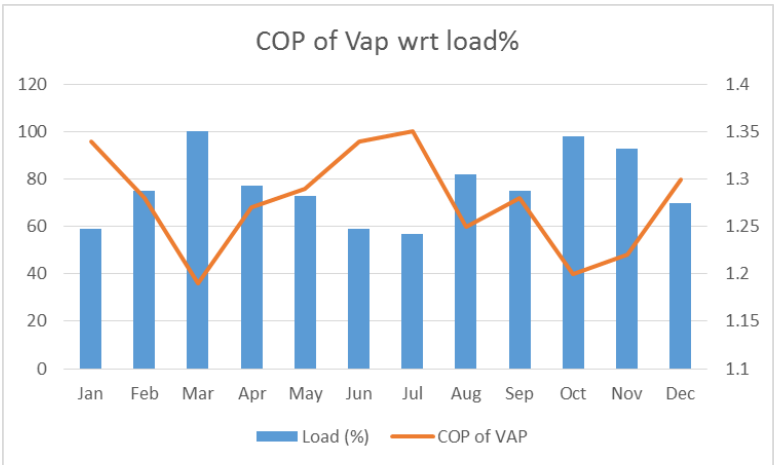
For cooling and heating load calculation, first of all area of rooms and lobby are calculated by measuring the dimensions of room and lobby. Overall heat transfer coefficient for wall materials is also calculated. Detailed calculation of cooling load is calculated using CLTD method. Since the calculation shows the peak hour of load is around the solar hour of 13:00 to 15:00, the load designation is based on these solar hour. The Tons of refrigeration or cooling load in solar hour 13:00 was 61.99 TR and for 15:00 was 59.99 TR whereas the heating load was 241.5 kW

Technical Analysis

The coefficient of performance of absorption chiller is high at half of the full load i.e. 50%. The chiller in our analysis is according to above calculated load of 60TR, double effect, and indirect fired absorption chiller.

Vap System energy Diagram





$$\text{Boiler Efficiency}=\frac{Energy\ \ Output}{Energy\ \ input}$$

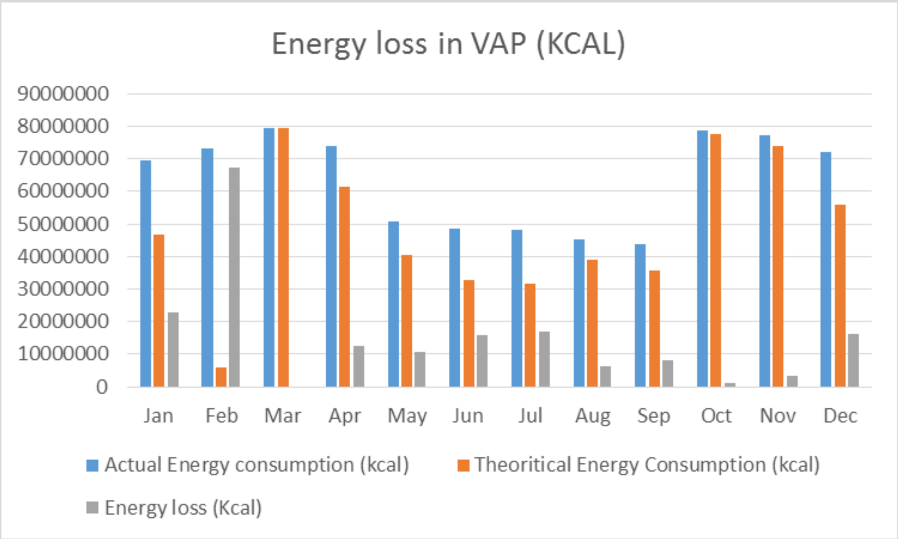
The type of boiler in our analysis is condensing boiler. The boiler efficiency at varying load condition is different. The boiler efficiency at part load is slightly higher than full load operation.The efficiency of condensing boiler varies from in between 86 to 89 Percent (Source: Annual efficiency calculation for condensing boiler)

$$\text{Combustion Efficiency}=\frac{Energy\ \ supplied\ \ to\ the\ boiler}{Fuel\ calorific\ \ value}$$

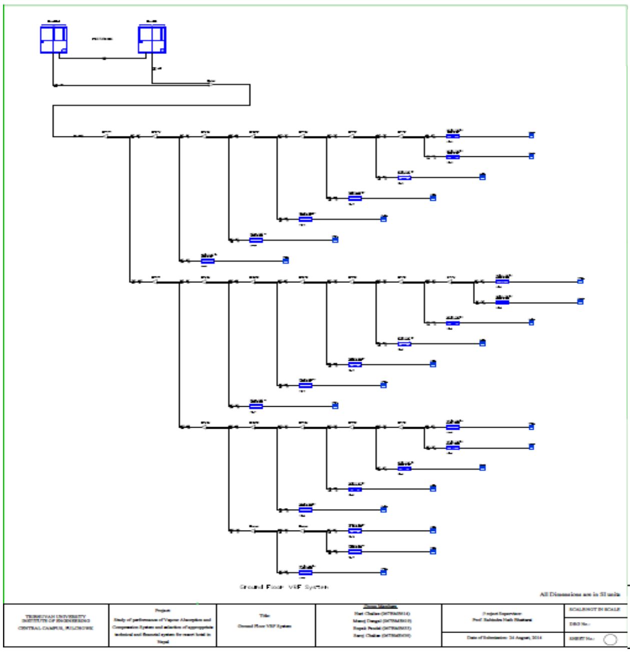
For oil burner heating system, combustion efficiency= 80% (Biarnes, 2013)

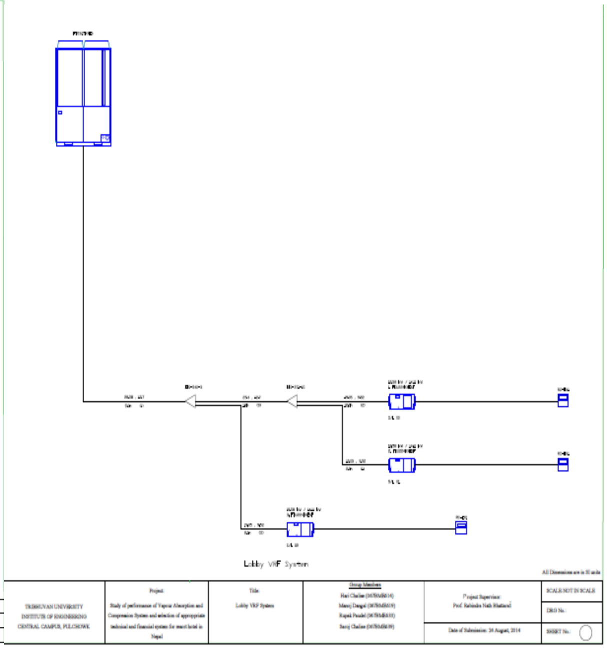
Combustion efficiency is assumed to be constant at part load also.

In our calculation pipeline loss is taken as 10% (Jae-Ki Byun, 2012) of total energy.



Now VRF system is designed for the same system operated with the VAS. VRF system is designed by dividing the building into three different zones: (a) Upper two floor, (b) Ground floor and (c) Lobby. The piping network and designed capacity are done in e.solution with following results.





Zone A (Zone B) Zone C

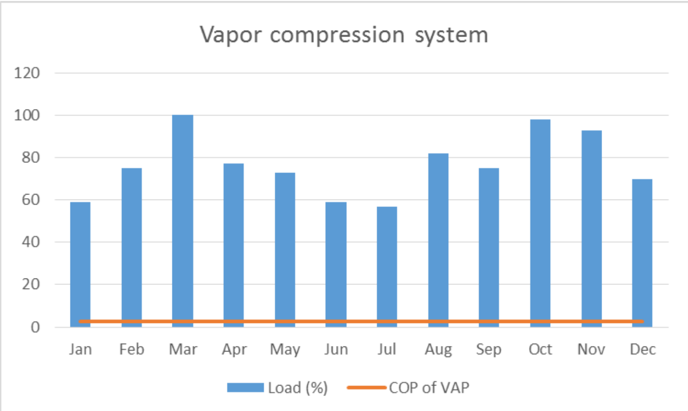
Fig: e.solution design

S.No.	Category	Zone A Upper two floor	Zone B Groundfloor	Zone C Lobby
1	**Branches**			
	Type 1	1	2	1
	Type 2	7	8	
	Type 3	12	11	
	Type 4	1		1
2	**Indoorunit**			
	CoolingCapacity (kW)	3.6	3.6	22.4 (3 nos)
	HeatingCapacity (kW)	4	4	25 (3 nos)
3	**OutdoorBranch**			
	Type 1	1	1	
4	Outdoor Unit			
	CoolingCapacity (kW)	33.5 ,40 (1 each)	33.5 ,40 (1 each)	61.5
	HeatingCapacity (kW)	37.5,45 (1 each)	37.5,45 (1 each)	69
5	**Pipe**			
	6.35 mm	85.8m	85.8m	
	9.52 mm	56.5m	45.5m	22.0m
	12.7 mm	115.2m	126.3m	6.0m
	15.88 mm	87.0m	83.5m	

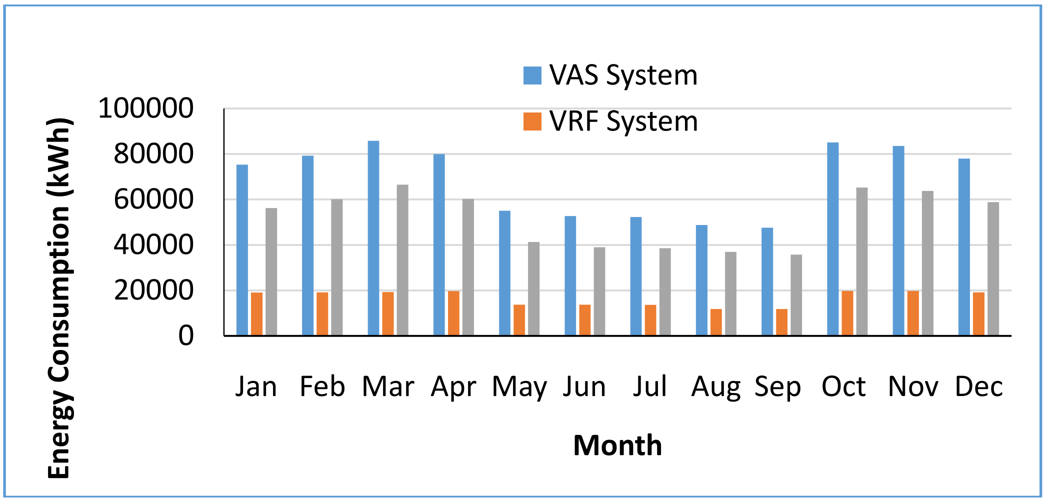
ISSN 2250-3153

	19.05 mm	27.4m	38.5m	22 m
	25.4 mm	5.0m	2.0m	1 m
	28.58		4.5m	5m
	31.8 mm	28.0m	34.0m	
6	**Refrigerant**	16 kg	18 kg	9.1 kg
7	**Remotecontrol**	22	22	3

COP of vapor compression system remains approximately constant with load variation. The energy loss on the system is also low.



Thus from technical analysis energy saving through vapor compression system is more



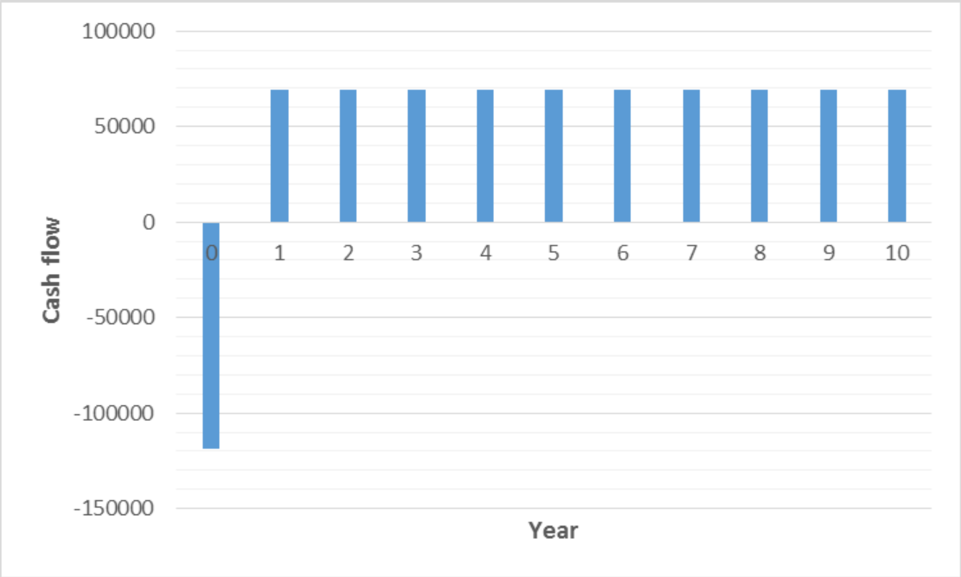
Financial Analysis

Bill of Quantity (BOQ) is prepared for the new material required for VRF which shows the total amount of USD

119024.28.

We have considered followings:

Life of Project = 10 years MARR = 15%



Calculated,

Internal rate of return= 58%
Payback period = 1.718 yrs

Conclusion

Unless and until energy is freely available, Variable Refrigerant Flow (VRF) System is more appropriate/economical than Vapor Absorption System (VAS). From the financial analysis for the replacement of Vapor absorption system by variable refrigerant flow system, it is clear the cost of replacement will be paid back in 1.718 years. Net Present Value of the project is highly positive which is greater than and the Internal Rate of Return is 58% which is very high as compared to the MARR of 15%. So, there is opportunity of high investor return in the project. Hence, the project is highly economically viable.

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