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Energy saving on 90TR chiller system at SASTRA deemed university

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ABSTRACT

The Energy saving on the Chiller systems has many advantages such as cost reduction due to power savings and the reduction of the maximum demand without changing on the cooling effect. The old chiller models have a compressor driven by a constant-speed induction motor directly connected the 3phase power supply with separate Air handling unit (AHU). This system takes large starting current and the large variation in room temperature which is controlled by the static on-off controller. The energy loss is owing to frequent on-off cycles when the room temperature is close to the preset value. Hence the inverter system is introduced on the chiller for the significant energy saving and demand reduction on the power supply. The practical results on power consumption were compared and the energy consumption can be reduced to less than half that of an old one, with chiller inverter model. The investment cost in the replacement of chiller by new VRV system can be recovered in short duration by the amount of saved energy.

Keywords— *Chiller, VRV, AHU, Units*

1. INTRODUCTION

This work is focused on the comparison of energy between Variable Refrigerant Flow (VRF) new chiller system and old chiller system in the Animal house building of SASTRA Deemed University. The old chiller consists of a compressor driven by a constant speed induction motor, an evaporator, an expansion valve, and a condenser. Nowadays per capita, energy consumption is increased due to the development of IT sectors and apartments, additional building like shopping malls etc., this old chiller at Animal house is consuming huge power and having high maximum demand.

Fig. 1: Chiller unit– Blue Star

This inefficient model can no longer be used in the industry, considering the huge energy consumption and more recurring expenditure on every monthly electricity bill. The VRF modal is good energy efficiency and there is energy saving potential up to 40-50% in this building.

Fig. 3: Old Chiller at building floor level [Disconnected]

Fig. 2: New LG Chiller ODU at building roof top

Fig. 4: New indoor unit connected with ODU

2. DESIGN AND DETAILS OF THE NEW MODEL CHILLER

2.1 Description

The Variable Refrigerant Flow technology was introduced in the chiller system also to minimize losses in the conventional HVAC systems. This air-cooled VRF system is reduced ductwork, large distribution fans, water pumps, and piping and also provides exceptional dehumidification and temperature control by rapidly adapting to changing loads. This modular design is Energy efficient, easy to design, install and maintain, a VRF system has a low lifecycle cost compared to CC. This system precisely matches the load with compressors optimized around R410A and animal will stay comfortable.

2.2 Design Details

Table 1: Design details

LAB	Type	Air Qty in CFM	Capacity	Connected ODU	Diversity
Animal House	Air Handling Unit	16,000	2 x 45 TR	2 x 60HP	94%

2.3 Equipment new and old comparison

Table 2: Comparison

S. No	Description	Old Chiller	New Chiller
1.	Make	Blue Star	LG
2.	Gas	R-22	R410A
3.	Normal Capacity	90TR	2 x 45TR
4.	Power supply	380-420V	380-420V
5.	Phase Frequency	3 phase, 50Hz	3 phase, 50Hz
6.	Rated in amps	184amps	70 Amps
7.	Starting Current In amps	975amps	10Amps Only
8.	Running load amps (RLA)	207amps	60 Amps

2.4 Installing the higher-efficiency chiller

The old 90TR chiller packages with the special ducting arrangement at this building used for cooling the rooms of various animals and this was installed and commissioned during 2007. The new VRF system, limit the current, modify machine operation depends on the condition of the occupied room by monitoring current, temperature, and humidity. The smart control panel is a field selectable option that substantially enhances VRF system energy saving during off-peak cooling by reducing the amount of work the compressor. There is a significant saving in energy cost from this new system will be sufficient to meet out the expenses for replacement of old chiller system. The monthly demand saving in kVA rating is also achieved apart from saving in energy and compared after installing new chiller units.

3. WORKING ON SAVING FOR POWER, ENERGY, AND COST

3.1 Power and Energy savings

The following two objectives are considered while calculating energy conservation for all HT consumers.

(i) kWh [Energy] savings.
(ii) kVA [Maximum Demand] savings

The old chiller system is working for peak load conditions and consequently circulated much more cooling air then the needed. This draws high starting current, due to the operation of the chiller at full load. The control system of the new VRV system minimizes loses, due to reduced duct area, large distribution fans, water pumps. This modular design provides exceptional dehumidification and temperature control by rapidly adopting to changing loads and overall demand reduced by limiting the maximum load in the animal room

3.2 Reduced fixed charges in the Electricity Bill

The tariff structure is an important role to analyze the utility of electricity bill. The 90TR old chiller unit alone consumes demand of 200kVA considering running and starting current. The maximum demand is reduced to 100kVA after the introduction of 2 x 45TR new VRV System in the Animal house building. The cost of saving due to demand reduction is projected and compared for old and new chiller in the Tabulation – 1 and 2

3.3 Energy savings and cost saving in the electricity bill

The new chiller unit offers exceptional energy performance by using the controls, high-efficiency variable speed condenser an evaporator, fan assemblies, and combination of variable and constant speed compressor. Also, the compressor optimized around R410A with inverter technology precisely matches this type of load. This prevents constant cycling and optimized system efficiency. Animals were staying comfortable while reducing utility costs. The inverter drive on the first compressor matches the load exactly regain the efficiency of a partially loaded compressor while eliminating compressor cycling. The cost of saving on energy consumption is projected and compared for old and new chiller in the Table 3.

Table 3: Energy calculation for an old chiller at animal house building

TR	90	Capacity	90TR
Input Kw per TR	2.0	Total AH Load	250kW
Total kW	180	Required MD	200kVA
Total Hours per year [365days x 24hrs]	8,760	Operating months Per year	12

Total units [kWH] per year	15,76,800	MD reset	Monthly
Rupees per unit	6.35	Rupees per kVA	350
Yearly Units amount in Rs.	1,00,12,680	Fixed Charges	8,40,000
Fixed plus Variable cost in Rs./Year	1,08,52,680		

Table 4: Energy calculation of new chiller at animal house building

Description	Variable	Description	Fixed
TR	45	Capacity	60HP
Input kW per TR	0.8	Load reduction	125KW
Total kW	36	MD reduction	100kVA
Total Hours per year [365days x 24hrs]	8,760	Operating Months Per year	12
Total units [kWH] per year	3,15,360	MD reset	Monthly
Rupees per unit	6.35	Rupees per kVA/Month	350
Annual Units charges	20,02,536	Annual Charges	4,20,000
Fixed plus Variable cost/Year	24,22,536 for 1 x 45TR		
Total Cost per year	48,45,072 for 2 x 45TR		

3.4 Abstract of actual saving from Table 3 and 4

Table 5: Amount of actual saving after commissioning new Chiller

Annual Energy cost for old chiller unit 90TR capacity	108,52,680.00
Annual Energy cost for new chiller unit 2 x 45TR	48,45,072.00
Annual saving in Electricity consumption	60,07,608.00
Bank Interest 6.5% on saving	3,90,495.00
Total Saving	63,98,103.00

3.5 Pay Back Period and Implementation cost

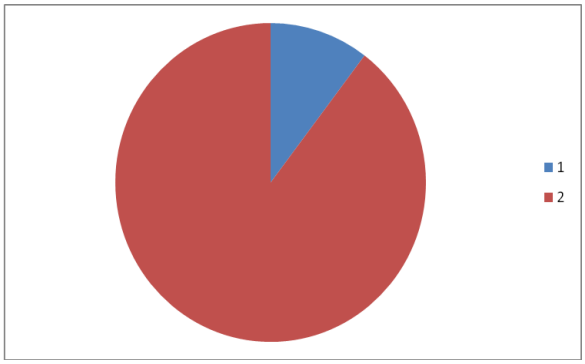
It is the time in which the initial cash outflow of an investment is expected to be recovered from the cash inflows generated by the investment. The maintenance charges for new chiller are not involved since the system is offered with 5 years warranty after commissioning by M/s Lakshmi Aircons Pvt. Ltd/Chennai. The average cost to replace the existing units with higher-efficiency ones is Rs.1,40,00,000/-. Therefore, the total implementation cost difference for replacing existing chiller with new higher –efficiency air conditioners would be than the lower-efficiency unit, based on current market costs and manufacturers quotes. The implementation cost is recovered within the period of 6 months. This working is noted in the Table 6.

Table 6: Payback period working details

Initial Investment for new VRV Chiller unit - 2 x 45TR (a)	1,40,00,000.00
Annual Energy saving as in Table 5	63,98,103.00
Annual saving in Maintenance of chiller	11,13,000.00
Resale amount of old chiller unit	1,12,000.00
Total savings (b)	76,23,103.00
Investment minus total savings (a) – (b)	63,76,897.00
Payback period Maximum	0.5 Years

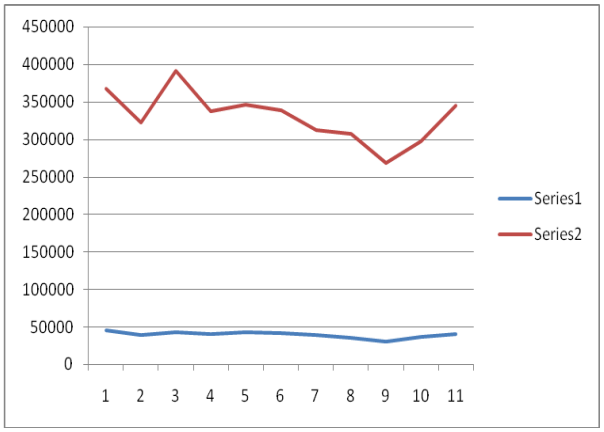
By introduction of this system for the replacement of chiller solve the other power quality problems. The objective to formulate the models of 90TR Chiller system components and simulate several processes related to power quality problems is not at all needed. The VRV system gives the solution for power surges and control problems.

3.5 Pictorials representation for practical energy savings



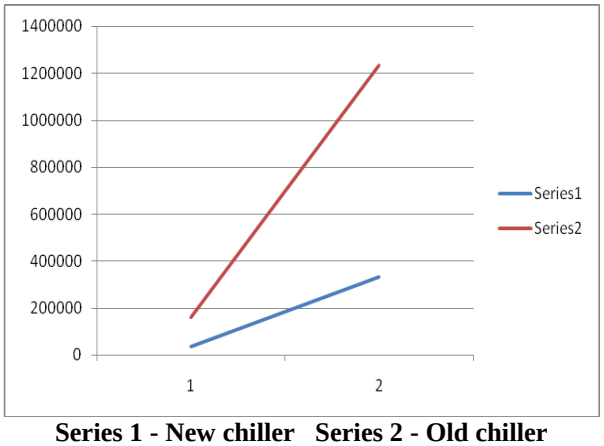
1. Consumption of new chiller
2. Consumption of old chiller

Fig. 5: Bill amount for old and new chiller



Series 1- Units Series 2 – Amount

Fig. 6: Actual Electricity bill amount for a new chiller from April- 2017 to March- 2018



Series 1 - New chiller Series 2 - Old chiller

Fig. 7: Average bill amount for old and new chiller

4. CONCLUSION

In the current paper, it is demonstrated that considerable energy and money can be saved in a chiller system by installing higher- efficiency VRV air conditioners. The calculation procedures are illustrated with realistic examples. The potential savings and payback periods are evaluated. The actual saving in energy and demand are projected for the new chiller system at Animal house of SASTRA campus after

commissioning of 1 number 45TR LG new VRV Chiller system at one side of Animal house building in SASTRA Deemed University.

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