Improving Energy Consumption and Reduce Noise in HVAC System using Electronically Commutated Motor

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ABSTRAK

Improving energy consumption and reducing noise on cinema building in Jakarta was study by replacing conventional motor with Electronically Commutated (EC) motor. The set up temperature and humidity follows the Jakarta Building Standard. It was found that replacement single conventional motor with single EC motor can reduce the significant amount of energy consumption and the noise level, and the Break Even Point (BEP) replacement of single EC motor will be reached around 4 year.

(keywords : HVAC : Heating, Ventilation, and Air Conditioning)

1. INTRODUCTION

Most modern buildings are designed to be fully or largely enclosed, protecting the occupants from direct contact with the outside environment. A modern building has a numerous requirement. Fresh air, Cooling and Heating play an important role in designing and managing a building [1].

The air conditioning system is used to regulate comfortable air temperature and humidity in the room. This is contrasts with traditional Indonesian architecture, which relies heavily on shade systems that protect the room from hot sunlight, as well as the presence of free gusts of wind through buildings. In the tropical climate of Indonesia especially Jakarta, thermal comfort is mainly provided by cooling indoor room temperature, decreasing air humidity levels that are supplied into the room, and ensure a clean air supply. Comfortable conditions as defined by Jakarta Green Building standards include room temperature of 25^{o}C and 54% to 66% relative humidity [2, 3, 4].

HVAC is a system that serves to organize temperature and humidity the air on a particular room, that make comfortable condition. HVAC system are provided so as to meet the requirement so comfort, cost, efficiency and aesthetic appeal. The energy consumption by building must be reduced without compromising in the service provided by buildings in a sustainable way, thus ensuring a comfortable indoor climate for the people. Reductions in HVAC (ventilation and air conditioning) energy consumption can be achieved by using motor with better energy efficiency.

HVAC system becomes a necessity for large buildings, especially in countries with humid

tropical climate like Indonesia. This is to provide comfortable for everyone in their activities. HVAC System inline use with concept of Green Building / Eco Friendly Building, which is currently widely discussed and will be widely used in Indonesia. The sequence of operations is one of the most important aspects of design in an HVAC system. Without a good sequence, the system cannot work optimally.

Along with the times, when conventional motor was broken, we changed it using EC Motor in order to improve the levels of energy consumption and reduction the noise [6]. In the other hand, green building or eco friendly building guidelines give a lot of emphasis on reducing loads of AC (Air Conditioning) and increase system efficiency, and AC systems are the single largest energy user in most buildings, increase the efficiency of AC systems provides enormous energy saving opportunities [5].

Green buildings or eco friendly building which designed with passive design of the building cover, which covered building orientation, window shade, glass selection, air tightness, natural lighting and natural ventilation can significantly reduce the cooling load on buildings, and this potential saving is around 30% of total energy consumption [7, 8].

In this paper, I will compare HVAC System in cinema using EC (Electronically Commutated) Motor compared with Conventional Motor with the same set up for temperature and humidity. In the nominal capacity 75, 100 and 125 thousand BTU/H using single EC motor and in the nominal capacity 150, 200 thousand BTU/H using two EC motor. The measurement of noise conducted follow the ASRAE recommendation (9).

2. INSTALLATION & DATA

The old box was still used in replacement from conventional motor to EC motor by adding simple bracket and air flow guide.

Testing Conventional Motor compared to EC Motor with the result in table below:

Table 1 : EC Motor Specification

1. System Operation	X = Split System
2. Type of Unit	B = Air Blower (Ductable)
3. Static Pressure	H = High Static
4. Nominal Capacity	75 = 75.000 BTU/H 100 = 100.000 BTU/H 125 = 125.000 BTU/H
5. Indicator	X = Refrigerant System
6. Body	DS = Double Skin (Polyurethane)
7. Thickness Body	25 = 25 mm

Table 2: EC vs Conventional Motor, Model 75

Model		Indoor	XBH X DS25	
			75	
		Outdoor	XCU	
		(Qty)	75 (1)	
Nominal Cooling Capacities		Btu/h	75,000	
		kW	21.96	
		kCal/h	18,900	
I	Motor		Conv.	EC
N	Power	V/Ph/Hz	220-240/1/50	

D	Supply			
O O R	Running Current	A	6.92	2.13
	Noise	dB	50	40

Table 3 : EC vs Conventional Motor, Model 100

Model		Indoor	XBH X DS25	
			100	
		Outdoor (Qty)	XCU	
			100 (1)	
Nominal Cooling Capacities		Btu/h	100,000	
		kW	29.28	
		kCal/h	25,200	
I N D O O R	Motor		Conv.	EC
	Power Supply	V/Ph/Hz	220-240/1/50	
	Running Current	A	9.86	3.74
	Noise	dB	50	40

Table 4 : EC vs Conventional Motor, Model 125

Model		Indoor	XBH X DS25	
			125	
		Outdoor (Qty)	XCU	
			125 (1)	
Nominal Cooling Capacities		Btu/h	125,000	
		kW	36.60	
		kCal/h	31,500	
I N D O O R	Motor		Conv.	EC
	Power Supply	V/Ph/Hz	380-415/3/5	
	Running Current	A	2.6	1.36
	Noise	dB	55	45

Table 5 : EC vs Conventional Motor, Model 150

Model		Indoor	XBH X DS25	
			150	
		Outdoor (Qty)	XCU	
			75 (2)	
Nominal Cooling Capacities		Btu/h	150,000	
		kW	43.92	
		kCal/h	37,800	
I N D O O R	Motor		AC	EC
	Power Supply	V/Ph/Hz	380-415/3/50	
	Running Current	A	3.4	1.36
	Noise	dB	55	45

Table 6 : EC vs Conventional Motor, Model 200

Model		Indoor	XBH X DS25	
			200	
		Outdoor (Qty)	XCU	
			100 (2)	
Nominal Cooling Capacities		Btu/h	200,000	
		kW	58.57	
		kCal/h	50,400	
I N D O O R	Motor		Conv.	EC
	Power Supply	V/Ph/Hz	380-415/3/50	
	Running Current	A	6.4	1.84

R	Noise	dB	55	45

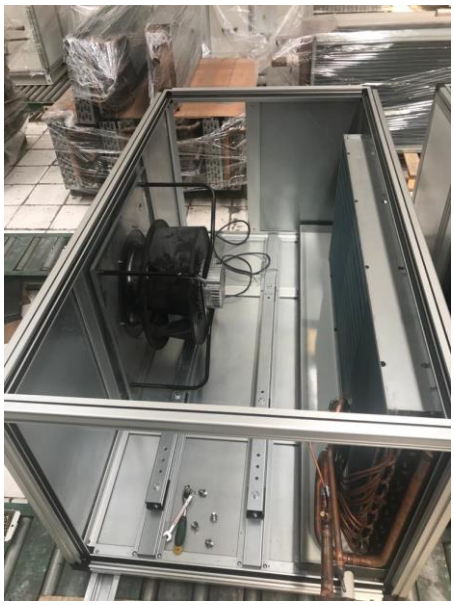

Figure 1: Location of EC Motor on the old box

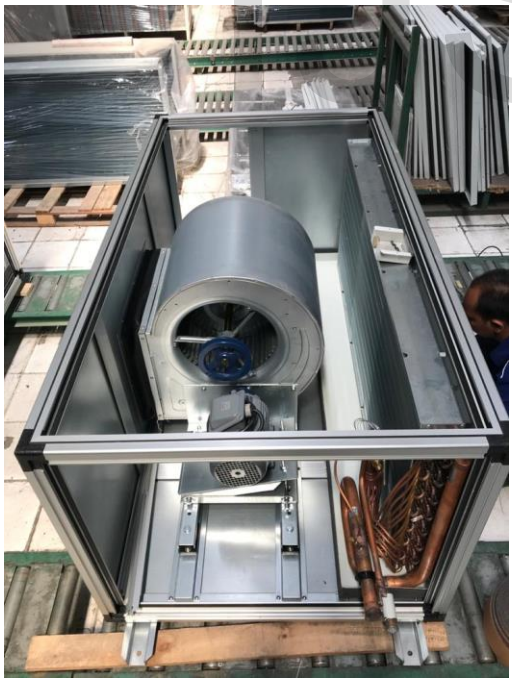

Figure 2: Conventional Motor with their box

Replacing Conventional Motor with EC Motor easy to do and does not take a long time. Actually, replacement Conventional Motor with EC Motor only takes 4 – 6 hours.

3. ANALYSIS

Table 7 : Reduction Running Current A and Noise Level, EC Motor vs Conventional Motor

Model XBH X DS25	Running Current (A)	Noise (dB)
75	66.62%	20%
100	62.07%	20%
125	47.69%	18.18%
150	60.00%	18.18%
200	71.26%	18.18%

As EC motor is designed to run in alternating current (AC) power supply, but it work like direct current (DC) motor, it has same advantages related to energy efficiency. By utilizing these technology allow an EC motor to combine the best feature from DC motor and EC Motor. In addition, the on board electronics could act as integrated controller could directs the right amount of current that needed by the blade rotation per minute.

The result from replacement motor using single EC Motor give reduction running current in significant amount. The bigger the model the higher energy consumption. But if we see from the side of the percentage reduction in energy consumption, the bigger the model the lower of reduction would be.

If we compare running current for each EC motor model 75, using single EC motor model 75, we get reduction current 66.62 % but , using two EC motor model 75, we get reduction current 60.00 %. More offer, if we used two EC motor model 10, we get reduction current 71.26 %. Therefore if we are running bigger nominal cooling capacity, using two motor EC will give better running

current reduction but it will increase the cost,

For reducing noise levels, relatively same for various model, around 20%.

With the same capacity, EC motor more costly compare to conventional motor, In the cost point of view, replacement using single EC motor, break event point will be achieved in 4 years for cinema that operated 8 hours every day, 365 day a year (refer to the price of energy in Indonesia)..

4. CONCLUTIONS

- Replacement Conventional Motor with EC Motor can reduce the energy consumption and the noise level, where Break Even Point (BEP) will be reached around 4 year.

- In the bigger nominal cooling capacity, using two motor EC will give better running current reduction.

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