Energy Savings From Axial Fans



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ENERGY consumption has become an important consideration to every individual globally. The word "efficiency" comes to our mind as soon we come across topics related to energy. As the development around us rapidly progresses, the importance of energy efficiency proportionally increases. Efficient energy usage will in the long run reduce the burden on our pockets. The business sector especially will feel and benefit from the vast impacts when efficiency plays its role in saving energy.

In my previous article pertaining to the jet fan and computational fluid dynamics (CFD), there was discussion regarding the replacement of conventional ducting design for ventilation with a Jet Fan system. This replacement represents a positive step in recovering the energy losses in a ducting system and is also shown to be cost-efficient. Often the case is that fan systems directly support production processes. Hence, many fans operate continuously but such long running time will result in significant energy consumption and substantial annual operating costs.

Another investigation has been carried out on the main fans in a ventilation system. Among the many types of fans used, the most common is the axial flow fan. The axial flow fan drives the air through the impeller in approximation of an axial direction. The axial fan utilises blades that force air to move parallel to the shaft around which the blades rotates. Owing to its cost effectiveness and multi-functional nature, the axial fan has been widely adopted in the industrial, commercial, consumer, institutional, and residential applications. In a typical car park ventilation system, these axial flow fans are known as fresh air supply and exhaust fans.

The energy consumption of these fans was investigated at two basement car parks of a 10-storey and 14-storey office building. An enhanced guide vane design was installed downstream of the ventilation main fans for a better efficiency. Economical comparison was made between the existing fan models and the enhanced model with guide vane by measuring the power consumption in KW. The guide vane used in this investigation is of the adjustable type. Table 1 shows the compilation results of the total power consumption (KWh) and the annual electricity costing for the existing fan model on a normal mode of operation. The annual electricity calculation (Eq.1) was done based on a 12-hour, 6 day per week operating duration.

TOTAL
ANNUAL ELECTRICAL =
COST (RM)

$$(wattmeter\ reading\ 3-phase)x\ (annual\ hours\ of\ op.)\ x \left(avg.elect.cost\ in\frac{RM}{Kwh}\right)x\ (\ motor\ load\ factor) \quad \text{(Eq.1)}$$

The guide vane was designed using Computational Fluid Dynamics (CFD) as a tool to determine the flow pattern. Figure 1 below illustrates the two-dimensional cascaded flow simulation of the 30° pitch angled rotor blade velocity distribution. The flow is accelerated after the blade with the momentum of the rotating velocity at the rotor side.

The high velocity region at the trailing edge of the fan blade has been cushioned out with the guide vane and,

Table 1: Comparison of annual electricity cost for the existing fan models

			Axial Fans without Guide Vane		Axial Fans with Guide Vane	
Basement	**Type of Fan**	**Total number of fans**	**Total power consumption (KWh) per year**	**Annual electricity cost (RM)**	**Total power consumption (KWh) per year**	**Annual electricity cost (RM)**
basement 1	supply and exhaust fan	8	80,179.20	25,857.79	73,764.90	23,789.17
basement 2	supply and exhaust fan	12	171,417.60	55,282.18	157,704.20	50,859.60
			Total Cost without vane	81,139.97	Total Cost with vane	74,648.77
Savings for Basements 1 and 2, per year (RM)						**6,491.20**

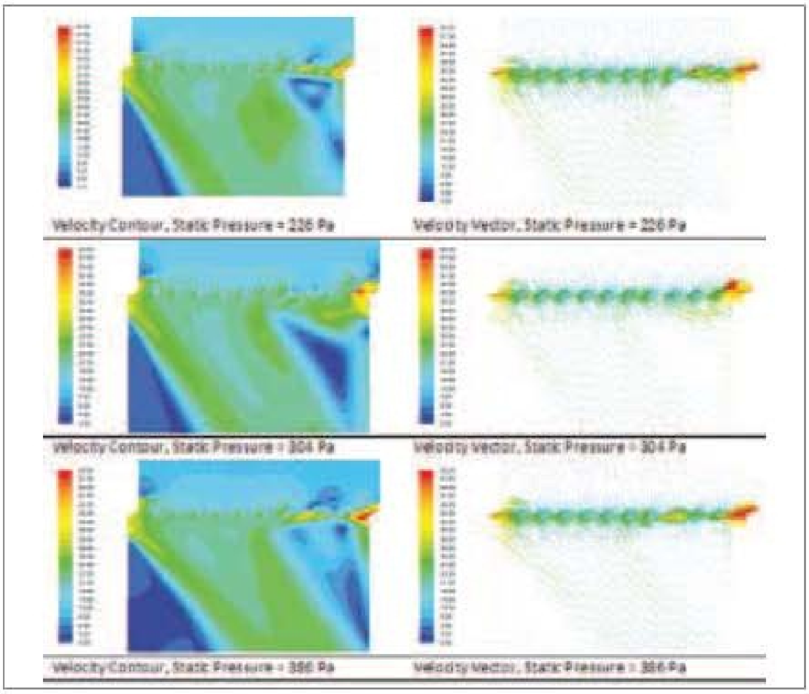

Figure 1: Velocity distribution of cascaded axial fan blade section flow without guide vane (stator) at different back pressure conditions

thus, the streamlining of the flow in the direction of flow is done with reducing swirling. As the guide vane is of a proprietary design, details of it cannot be published.

The experimental analysis was carried out in accordance to AMCA testing procedure. The total efficiency, η_t, for the adjustable guide vane application had increased by 8% as compared to the axial fan without the guide vane. Referring to the AMCA-210 standard, the relationship between power, H and the total fan efficiency η_t is:

$$H \propto \frac{P_t Q K_p}{\eta_t}$$

(Eq. 2)

Where, P_t is total pressure, Q is the air flow rate and K_p is the compressibility coefficient.

From that relationship, the power is proportional to the total efficiency. Therefore, when the total efficiency increases by 8%, the fan power will decrease by 8%. The assumption of an 8% reduction in the power consumed is presented in Table 1. Two basements were considered for the office tower.

The result is shown in Table 1 and indicates that savings of RM 6,491.20 per year can be accrued if adjustable guide vanes are installed for the supply/ exhaust fans.

In summary, the operating cost of large fans is often high enough to justify improving the fan system efficiency which can offer a quick payback. Thus, the application of Computational Fluid Dynamics (CFD) allows a system to be optimised at a much lower cost than the traditional 'cut and dry' method. ■