DEFINITION OF AIR FLOW EFFICIENCY

The air flow % efficiency of a fan motor is usually defined as the product of the airflow times the pressure at a given operating point divided by the power consumed by the fan motor: **$\eta=\{(P x Q)/W\} x 100\%$**

[P= Pascals, Q=m^3/Sec, W=Watts]

AIR FLOW EFFICACY OF A FAN MOTOR

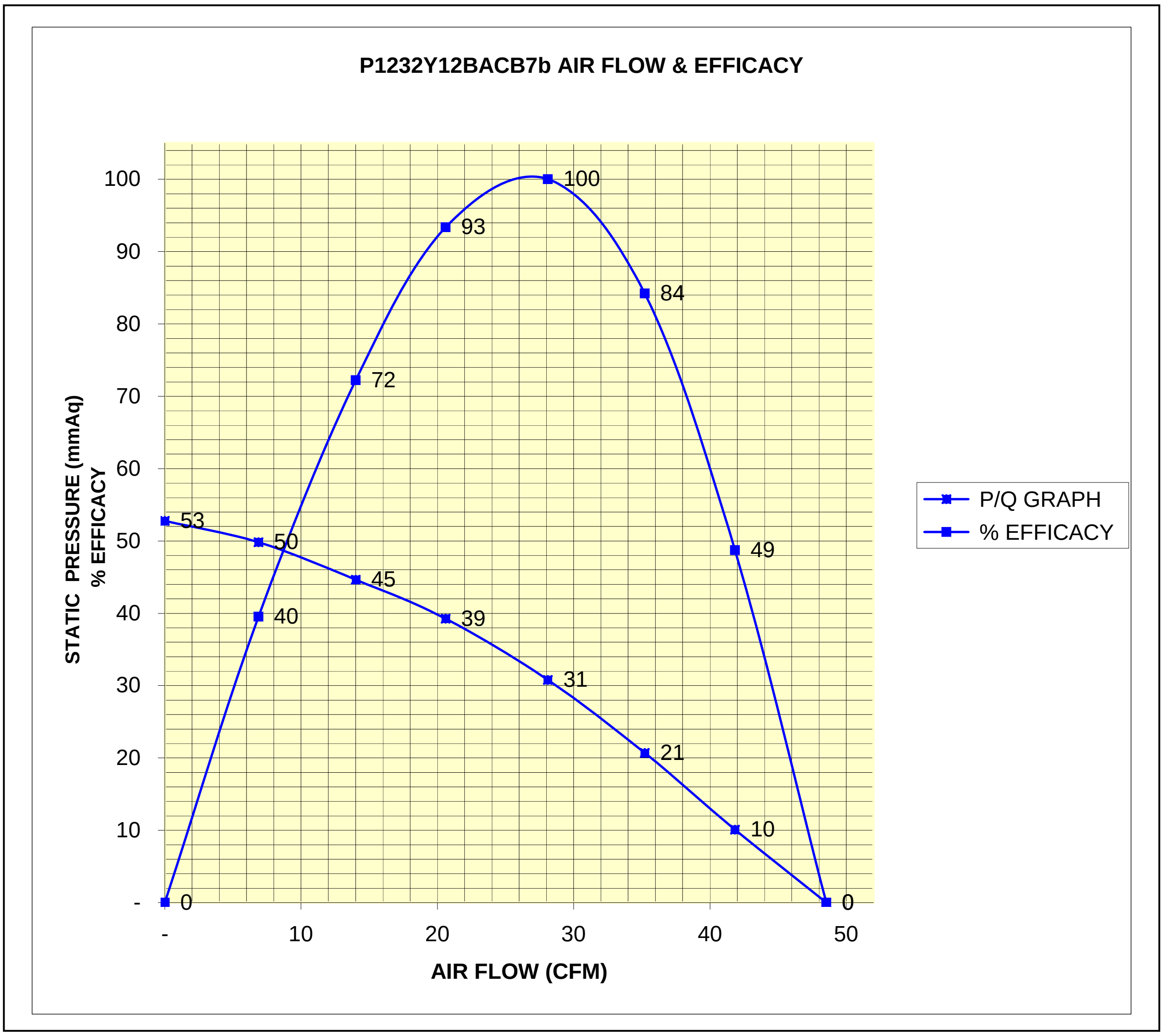
It is understood that a fan motor is used in general for the purpose of cooling equipment or for circulating free air.

In the case of equipment cooling the airflow is restricted by airflow obstacles presented by the equipment (system impedance).

It is obvious that under zero pressure (free air) the fan motor can deliver the maximum airflow and under zero airflow conditions (max pressure), no air is passing through the equipment in order to remove heat. In neither of the above fan conditions the fan motor is of any use for cooling equipment purposes.

In order to determine the most efficient operating point of the fan motor engaged in cooling given equipment we must calculate the maximum PQ product and thus determine the optimum ability of a given motor to cool.

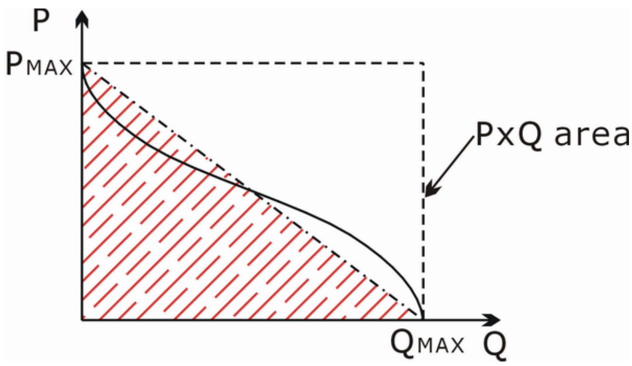
This can be illustrated by an example based on *Pelko Motors* PQ characteristic of a 1232 blower shown below:



From the above graphs we can see that if we accept over 80% efficacy, then the fan motor can optimally cool a system when it delivers 18 ~ 34 CFM under static pressure of the range 22~ 42 mmAq with optimum point of 24 ~ 30 CFM and pressure of 28 ~ 36 mmAq.

THE (PQ/W) CRITERION

Given the fact that the materials used for DC fan motor production by all the manufactures is pretty much the same and assuming no significant construction shortcomings, which will mainly have a bearing on the product life, the most important criterion remains the product's performance during its life span.
The fan motor's performance can be visualized by its PQ graph shown below:



PQ characteristics of a typical fan motor.

The higher the P and the higher the Q of a fan motor of a given size, the more airflow will be driven into the system to achieve a better cooling result. However at which cost is this accomplished? In order to appreciate the motor's performance one must consider the product of P times Q result divided by the power that the product consumes. It is obvious that the lower the power dissipation for the highest possible PQ can characterize the fan motor's performance. If we were to draw a line from the maximum point of P and the maximum point of Q we could determine easily the shaded area to be (PxQ)/2. We could then define as performance criterion the (PxQ)/W which represents twice the shaded area divided by the consumed power. Certainly one could argue that the power dissipation at maximum Q is lower than the power dissipated at maximum P for an axial fan motor, but for comparison reasons this point becomes of no importance. Also it must be noted that in the case of a blower type fan motor at maximum P the power consumption is less than at maximum Q point.

The higher the PQ/W, the better the fan motor's performance.

THE (RPM/W) CRITERION

One other way to detect if the fan motor is properly designed and it can perform under the lowest running temperature rise conditions is to check the ratio of RPM increase over the consumed power increase. As a rule, to increase the RPM by 10% one needs to increase the power by about 30%. A well-designed fan motor will always stay below the 30% of power increase or else the motor is overdriven, which will result on premature failure. To maintain this criterion one needs to increase the cost by increasing the silicon steel size or restrict the PQ performance of the product or else high running motor temperature will de-rate the life of the product.

Higher RPM/W means more efficient and better-designed fan motor.

WHY ARE THE (PQ/W) AND (RPM/W) CRITERIA IMPORTANT?

Both of the above mentioned criteria are important and their value should be the highest possible because:

1. They indicate how good the performance is for the running power cost.
2. They indicate the lowest running temperature (which is proportional to the power input), which is inversely proportional to the product life. It must be noted that in industry as a rule of thumb the product life is reduced by 1/2 for every 10℃ increase of its running temperature.