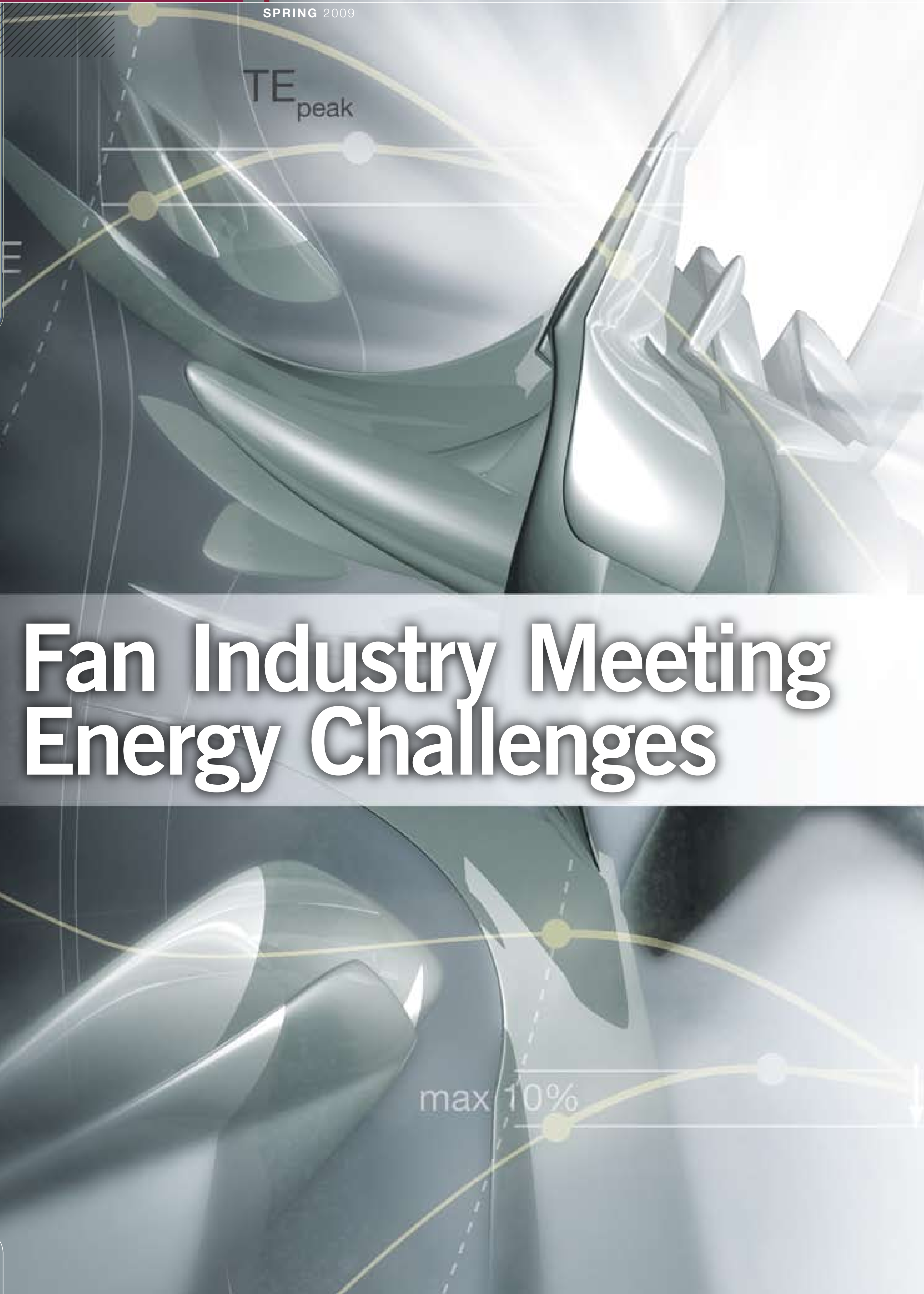

Fan Industry Meeting Energy Challenges

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How the industry is finding ways to improve the energy use of fans.

More than 50 years ago, the industry formed the Air Movement and Control Association (AMCA), now AMCA International. Right from the start, AMCA implemented a Certified Ratings Program (CRP) for fan performance. The HVAC industry in the United States and Canada accepted certified fan performance instantly. As AMCA spread outside of North America and became AMCA International, so too did the acceptance of AMCA-certified performance of fans in other regions of the world, including Europe, Asia, and India.

In addition to and complementing the needs of the CRP, AMCA first began to develop standards for air performance, sound, balance quality, and vibrations for fans. Some of these standards were further developed as joint standards in conjunction with ASHRAE. The next step, accomplished in the last two decades, was developing American National Standards in these fields. Through this process, almost all AMCA standards for fans became American National Standards.

Members of the fan industry also participate in ASHRAE technical committees, and specifically in ASHRAE TC 5.1, Fans. Also, AMCA International is active in developing international standards for fans in the International Organization for Standardization (ISO) through the American National Standard Institute (ANSI), the U.S. member body in this organization. The center of this activity is in the ISO Technical Committee for Fans. This committee developed a number of ISO standards for fans, and some of them were developed from ANSI/AMCA standards.

RECENT AND CURRENT DEVELOPMENTS

Both ASHRAE and ISO are presently working on standards leading to reduction of energy use by fans. While ASHRAE is addressing the needs for HVAC in nonresidential buildings in the United States, the ISO's work is geared toward the usage of fans, with specific regard to needs in the European Union (as required by the European Union's Energy Using Directive) and the United States.

In fall 2007, the ASHRAE Standing Standard Project Committee (SSPC) 90.1 Mechanical Subcommittee invited ASHRAE TC 5.1, Fans, to participate in the development of the requirements for fan efficiency. An ad hoc working group was formed promptly.

The group first developed a system for energy-efficiency classification of fans. It also recognized that requirements for the application of the fans was just as important; after all, it would not be wise to require a highly efficient fan if it was used on the low efficiency part of the fan curve!

In 2008, the British delegation to ISO/TC 117, Fans, submitted a proposal for developing a new ISO standard on efficiency classification for fans. The ISO committee established a Working Group to develop the new standard. At this time, the Working Group has completed its work on the committee draft, and the draft has been presented to all member bodies of the committee for comments.

AMCA International recognized the importance of this effort, and its Fan Committee is participating in developing these requirements through its members working in the ISO and ASHRAE committees. As a result, the members of AMCA International are actively participating in these efforts, sharing their ideas and proposals with the members of these committees. It should be noted that while the United States and the European Union approaches are not identical, they are complementary.

Furthermore the AMCA Fan Committee established a subcommittee for development of an ANSI/AMCA Standard on fan energy efficiency. This standard will be harmonized with the new ISO Standard 12759.

FAN ENERGY EFFICIENCY

Due to the historical practice in fan applications, fan energy-efficiency issues need to be addressed before the details of the energy-efficiency classification for fans.

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The roots of today's practice are based on using fan static pressure for fan selections. It is difficult to follow the trail all the way back, since the first historical record concerning fans is found in a book on mining written by Agricola in 1550. It is certain that the most important quantity sought has been the flow of air through a fan. Later, another quantity significant for fan selection was added—fan pressure—and that undoubtedly was the pressure we today call fan static pressure.

In the last five decades, it has been a common practice to select fans for applications using static pressure rather than total pressure, despite the fact that the pressure required by a system must be satisfied by the fan total, not static, pressure. As a result, static efficiency has been used as the measure of efficiency because it conveniently tied the fan power to the commonly used fan pressure. That is not to say that the fan total pressure has not been used at all; however, the use was limited primarily to selection of axial flow fans.

For HVAC systems, we define the fan as a motor-driven machine for delivering air. The fan energy input is from the motor shaft. The inlet and outlet of the fan are used as control surfaces in determining the energy transferred to the air by the fan. Therefore, the energy the fan delivers to the air is the difference in total energy between these control surfaces. This energy generally has two components: the dynamic one, because the air is in the motion, and the static one. The sum of both is the total energy delivered by the fan into the air.

The ratio of this energy to the energy delivered by the motor is the fan energy efficiency. It is also, and more frequently, called the fan total efficiency. This characteristic reflects the quality of the aerodynamic design of the fan and in no way reflects how this energy can be used in a fan application. However, there is no reason to condemn the use of the fan static efficiency because it may be used for other purposes.

Fan energy efficiency is a function of flow, even for operation at constant speed. At very low flow, this efficiency is low, but increases with increasing flow. At some particular flow, the efficiency reaches a maximum, and this value is frequently referred to as "peak" or "optimal" efficiency. With further increasing flow, the efficiency decreases.

The fan designer and manufacturer are responsible for the fan energy efficiency, while the HVAC system designer and the system user are responsible for the use of the fan energy. In other words, to get the minimum energy consumption for a given purpose, the fan efficiency has to be high and the fan has to be operated at or near its peak energy efficiency.

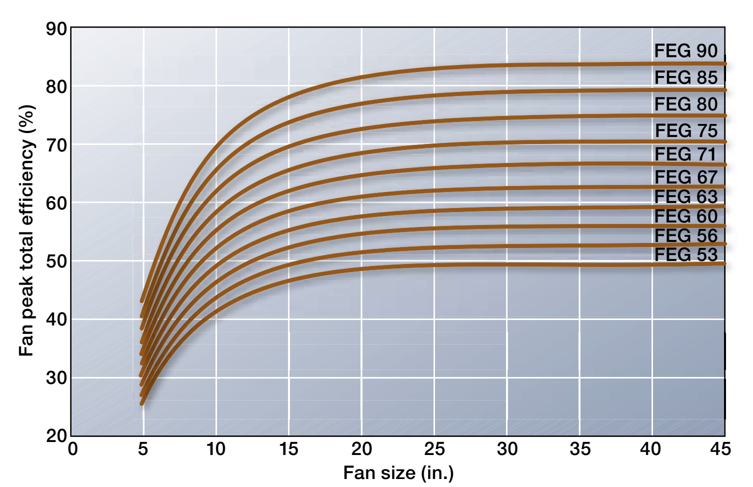
ENERGY-EFFICIENCY CLASSIFICATION FOR FANS

The U.S. approach to the energy classification for fans was designed by a large group of professionals organized in different bodies within AMCA International and ASHRAE.

The cornerstones of the approach were:

- The classification has to be based on the fan energy efficiency; i.e., fan total efficiency.
- The classification should allow regulatory bodies easy and meaningful declaration of fan energy-efficiency requirements for immediate needs as well as indicate the requirement for further reduction of fan energy use.
- The classification must encourage the fan manufacturers

Figure 1: Fan efficiency grades (FEGs) for fans without drives.



Notes:
1) Fan size is the impeller diameter.
2) The optimum (peak) fan efficiency can be calculated from the total fan pressure.
3) The FEG label for a given fan size is assigned when the optimum (peak) fan efficiency is equal to or lower than the efficiency at the grade upper limit and higher than the efficiency at the grade lower limit for the fan size.
4) No label is considered for the fans with the optimum (peak) efficiency below FEG 53.
5) For any fan size equal to or larger than 40 in., the values of the grade limits are the same as for the fan size of 40 in.
6) If this method is used for a direct-driven fan without the shaft and bearings integral to the fan, the fan efficiency is the impeller efficiency.

to improve the energy efficiency of their homologous products.

- The fan peak total efficiency of a fan series is dependent on fan size.
- The classification should, when possible, keep a series in one efficiency grade.

As a result, fan efficiency grades (FEGs) were defined as areas between two adjacent efficiency limits. The limits were shaped to follow the efficiency dependence on the fan size. The actual shapes of these limits were agreed upon after matching these shapes to the test data collected from national and international sources. The spacing of these limits was chosen to make the areas approximately equal for all grades. The relative difference between the upper and the lower limit for any grade is approximately 6%. The grade boundaries are depicted in Figure 1.

It was assumed that the FEG would be based on certified fan performance data and each fan size in the fan series would be assigned a grade label. In the proposed classification system, either all fan sizes of a series may be assigned the same grade label, or groups of adjacent sizes may be assigned the same label. For an example of grade assignment of a fan given the peak total efficiency, see Figure 2.

The ISO working group that is developing fan energy-efficiency grades is planning to define grades by fan type and include motor and drive losses.

The idea of establishing separate FEGs for each fan category (e.g., centrifugal fans with airfoil blades, vaneaxial fans, plenum fans, etc.) was abandoned in the early stages of the development process because it did not make sense to encourage the use of any fan category with low fan energy efficiency when the goal is to reduce the energy used by fans. Fans that do not fit into the energy-efficiency requirement should not be used regardless of category.

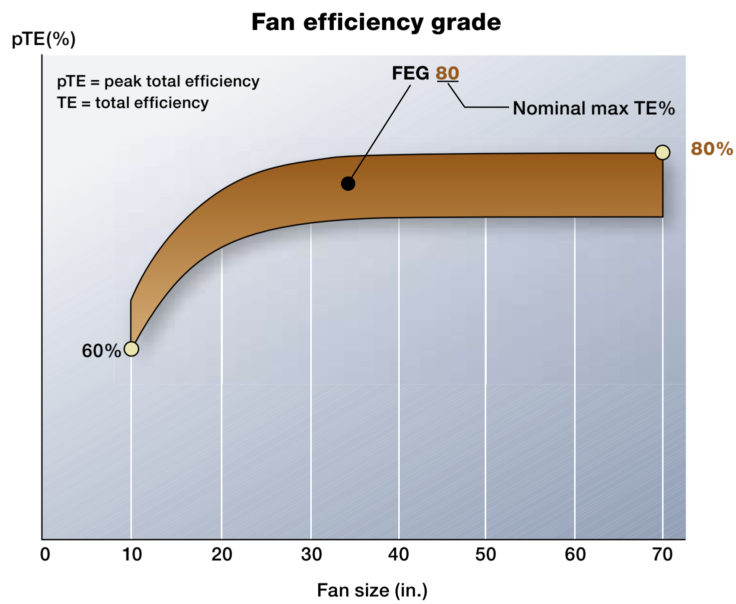


Figure 2: How a FEG is determined from a fan's peak total efficiency.

The combination of the fan and motor also was considered for classification, but it was concluded that would be counterproductive to the effort because it would make the responsibility areas ambiguous. In many instances, the motor is not part of the fan delivery, and in other instances, the motor efficiency level is dictated by the customer. Furthermore, during the fan selection process, it is acceptable to select the fan on the basis of its energy efficiency and make the requirements for the motor efficiency the responsibility of the motor manufacturer. In addition, a motor's efficiency may be

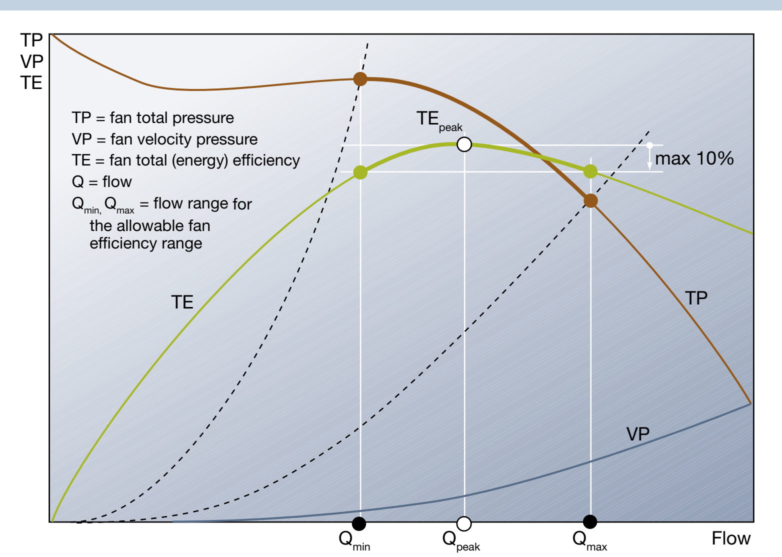


Figure 3: A typical fan performance curve, efficiency curve, and two system curves are shown. The system operating point should fall within a range around the peak efficiency. This figure shows an efficiency range on either side of the peak efficiency, the corresponding point on the fan curve, and the two associated system curves. The system should be designed to operate between these two system curves.

Source for all figures: John Cermak

regulated by another authority. For example, in the United States, public law requires minimum efficiencies for motors with power ratings of 1 hp or greater.

It also was agreed that to achieve the expected energy savings, the fans must have high peak efficiency but also must be operated near peak efficiency. Therefore, two additional measures are proposed.

First, the fan must be selected near peak efficiency for all expected operating points. The fan efficiency at any operating point should not be more than 10% (points) less than the fan peak total efficiency (see Figure 3). This requirement will go a long way toward correcting the tendency to weigh initial cost far more than operating cost.

Second, if the fan is intended to operate only part of the time or has been selected for multiple operating points, possibly at different fan speeds, the overall energy consumption of the fan over one year must be calculated using estimated times of operation for each point. This requirement is important because it opens up the possibility for a regulatory body to make exceptions from application-required FEGs because the overall energy used by the fan is acceptably small. This approach is already a part of the ISO 12759 and the AMCA 205 standards currently under development. The work on both standards may be accomplished by the end of 2009.

CONCLUSIONS

The fan manufacturers within AMCA International, in conjunction with professionals from ASHRAE, have designed a program to allow long-term support for reduction of energy consumption by fans. The program includes labeling fans for their energy efficiency and adds requirements for fan selection and use at high levels of fan peak energy efficiency. It also opens the opportunity for possible exceptions when the fan energy consumption in one year falls below some limit, which could be defined by a regulatory body. The program allows a regulatory body to simply and effectively define fan energy-efficiency requirements for immediate as well as future needs.

This classification system for fan energy efficiency will be a part of the ISO 12759 and AMCA 205 standards currently under development. AMCA International is developing its own standard, AMCA 205, and, through its members and staff, is instrumental in the development of the international standard ISO 12759.