ENGINEERING WHITE PAPER

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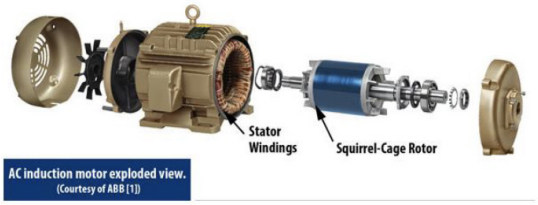
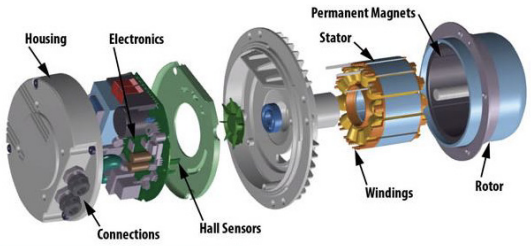
Comparison between EC Driven and VFD Driven Fan Application

ECM (electronically commutated motor) applications are becoming more prevalent as the motor abilities increase in size and application. VFD (variable frequency drive) motors are applied most typically when varying the speed of an induction motor. The question often heard currently is "which technology is better"? This topic can expand to subjects of motor loss differences, switching frequencies, and power factor correction to name a few. This document will address the questions from a further distance as we examine a common Fanwall application and look at overall costs and efficiencies.

An ECM is a "brushless" DC motor using permanent magnet rotors. ECMs use multiple poles around a motor stator to attract and rotate through DC pulses provided through the commutator. Most applications using ECMs are achieved with internal built in commutators essentially providing a motor and controller in a single package. VFDs utilize an alternating current (AC) motor and vary the frequency of applied power to control the speed of the rotor. Traditional DC motors require brushes to provide power to the motor rotor. The VFD is coupled in combination with a separate AC motor (image below) to operate as a system.



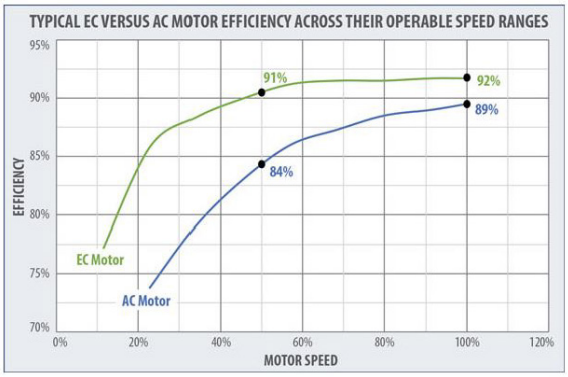
AC induction motor exploded view.
(Courtesy of ABB [1])

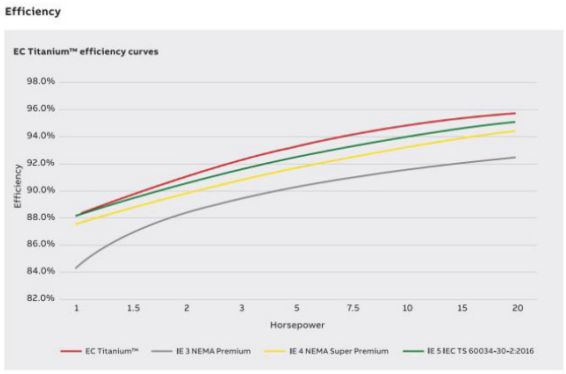


EC permanent magnet motor exploded view.
(Courtesy of Rosenberg [3])

Energy Efficiency

The power law theory states the power consummed by the impellor is proportional to the cube of the change in speed. Therefore reducing the the impellor speed by 50% reduces the power input to 12.5%. This is true in theory for both EC and VFD systems. EC fan systems are constructed with the rotor on the exterior surface and directly attached to the fan wheel. VFD systems often control a direct drive AC motor with the rotor internal and connected through a shaft to the fan wheel. EC motors have efficiencies of above 90%. The AC motor of a VFD system has a lower motor efficiency. The addition of the VFD to complete the system can also decrease the overall efficiency by 5-7%. At first glance the ECM application has the best overall efficiency.





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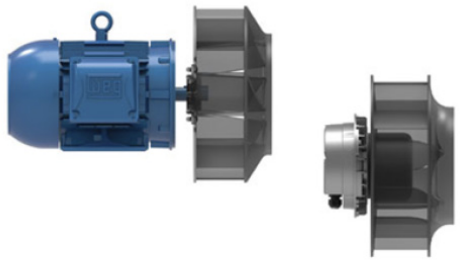
Physical Size

ECM applications have the motor, commutator, controllert, and fan wheel close coupled into a compact package. They occupy less space in the direction of airflow compared to direct drive AC motor systems.



Internal rotor motor (left), versus a comparable external rotor motor (right).

Design Flexibility

As a result of this packaged approach, ECM applications have less flexibility in design. VFD applications can control multiple fans motors from a single, redundant, or individual drive package. VFDs can be replaced or serviced independently from the motor of fan assembly. Many ECM manufacturers do not permit the system to be repaired in part but rather replace the entire assembly. VFDs also have a more advanced programming capability (hand-mode operation, time-stamped faults, Firemans override, PID control, end switch control, etc.) without use of additional external gateways. ABB has built a DC bus choke into the VFD providing 5% impedance for harmonic mitigation. ECM application would require external filtration.

Horsepower Ranges

ECM applications are still limited by horsepower with most manufacturers supplying up to 15HP. The static pressure capability has increased up to 9" TSP. However, the dominant use of fan arrays in large airflow air handlers has maintained an individual motor size of 10HP or less making this less of a concern.

Life Expectancy

ABB ACH550 advertised Mean Time Between Failure (MTBF) is 30.4 years. The most widely used motor manufacturers are in the range of 8-10 years. EBM and Ziehl-Abegg have listed a 4.5-year MTBF.

Cost Comparison:

Fanwall with VFD Driven Motors	
CFM	56750
Design Static	3"
Maximum Static	4.30"
Nominal HP (each)	5.5
Application HP (each)	4.39
Fan Wheel Size	22"
Backdraft Dampers	Yes
Airflow Monitoring	Yes
Quantity of Cells	9
Coplaner Silencer	Yes
Fanwall Market Price	$49,200
VFD Panel Market Price	$9,800
Total Application Price	**$59,000**
Programming and Start-Up	$1,400
Life Expectancy	10-15 years
Lead Time	4-6 Weeks

Fanwall with EC Driven Motors	
CFM	56750
Design Static	3"
Maximum Static	4.96"
Nominal kW (each)	6
Approximate HP	8
Application kW (each)	4.43
Approximate HP	5.9
Fan Wheel Size	22"
Backdraft Dampers	Yes
Airflow Monitoring	Yes
Quantity of Cells	9
Coplaner Silencer	Yes
Fanwall Market Price	$57,000
Total Application Price	**$57,000**
Programming and Start-Up	$1,000
Life Expectancy	10-15 years
Lead Time	4-6 Weeks

Conclusions

Energy efficiency comparisons between the two systems is impossible considering the construction methods. ECM applications are a packaged system with a controller, commutator, motor, and fan in an assembly all close coupled. VFDs have the flexibility of a multitude of design applications and combinations. There are benefits to each system. Cost, fit, energy, and programmability all play a role in the overall decision. Coming soon watch for ABBs release of the EC Titanium motor (page 1) which will have the benefits of the EC motor plus the harmonics, flexibility, life of the VFD applied systems, and at a higher efficiency model.

If there are any questions or concerns, please feel free to contact the engineering department.

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