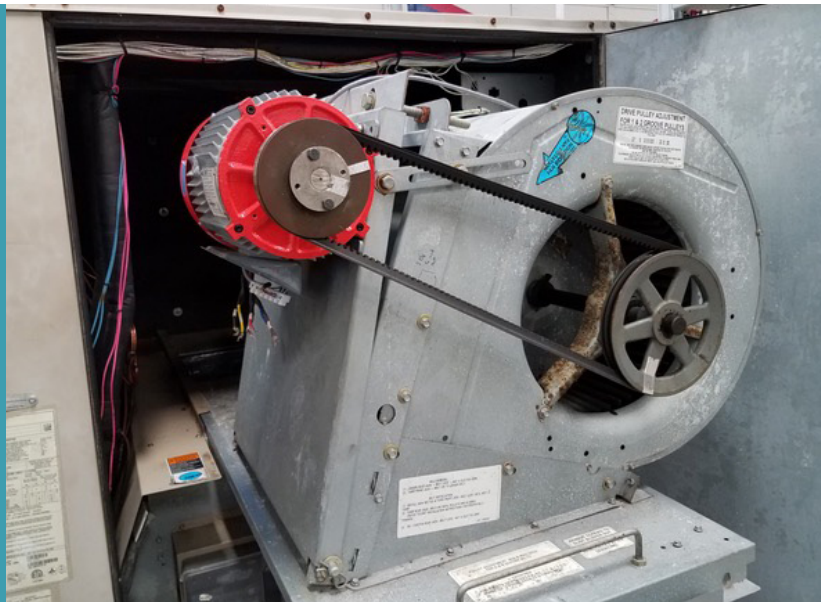
UCDAVIS
Western Cooling Efficiency Center

CASE STUDY
January 2019

LABORATORY TESTING OF SOFTWARE-CONTROLLED SWITCHED RELUCTANCE MOTORS



"High rotor pole switched reluctance motors with software-controlled inverters can save energy and reduce electrical demand."

PROBLEM

Packaged heating, ventilation and air conditioning (HVAC) rooftop units (RTUs) provide an estimated 75 percent of the cooling to commercial buildings in California and can account for more than 50 percent of peak electrical demand. RTUs typically use induction motors to drive the indoor fan. To increase energy savings, it is becoming common for manufacturers to add variable frequency drives (VFDs) to the indoor fan system, which can reduce an RTU's indoor fan speed when only ventilation is needed. However, using a VFD to reduce the speed of an induction motor reduces the efficiency of the system, making it harder to achieve the full energy-savings potential.

SOLUTION

The Western Cooling Efficiency Center (WCEC) evaluated the potential of an emerging technology — a high rotor pole switched reluctance motor (SRM) driven by a software-controlled inverter — to save energy in HVAC systems. Researchers conducted benchtop dynamometer tests and laboratory RTU tests to measure the performance of the emerging technology in comparison with a VFD-controlled induction motor. The results show that the emerging technology outperformed the baseline technology by operating at a higher efficiency, which saves energy and reduces electrical demand in RTUs.

TECHNOLOGIES TESTED

Researchers tested two technologies:

- **Baseline Technology**
  Nominal 3 Horsepower (HP), three phase induction motor controlled by a VFD
- **Emerging Technology**
  Nominal 3 HP, high rotor pole SRM driven by a software-controlled inverter

TEST METHODOLOGY

Researchers used a facility in Sunnyvale, CA to conduct benchtop dynamometer and laboratory RTU tests to measure the performance of the baseline and emerging technology.

The benchtop dynamometer measured the steady-state motor/drive performance of the two technologies across six speeds, each with seven load conditions, for a total of 49 test points.

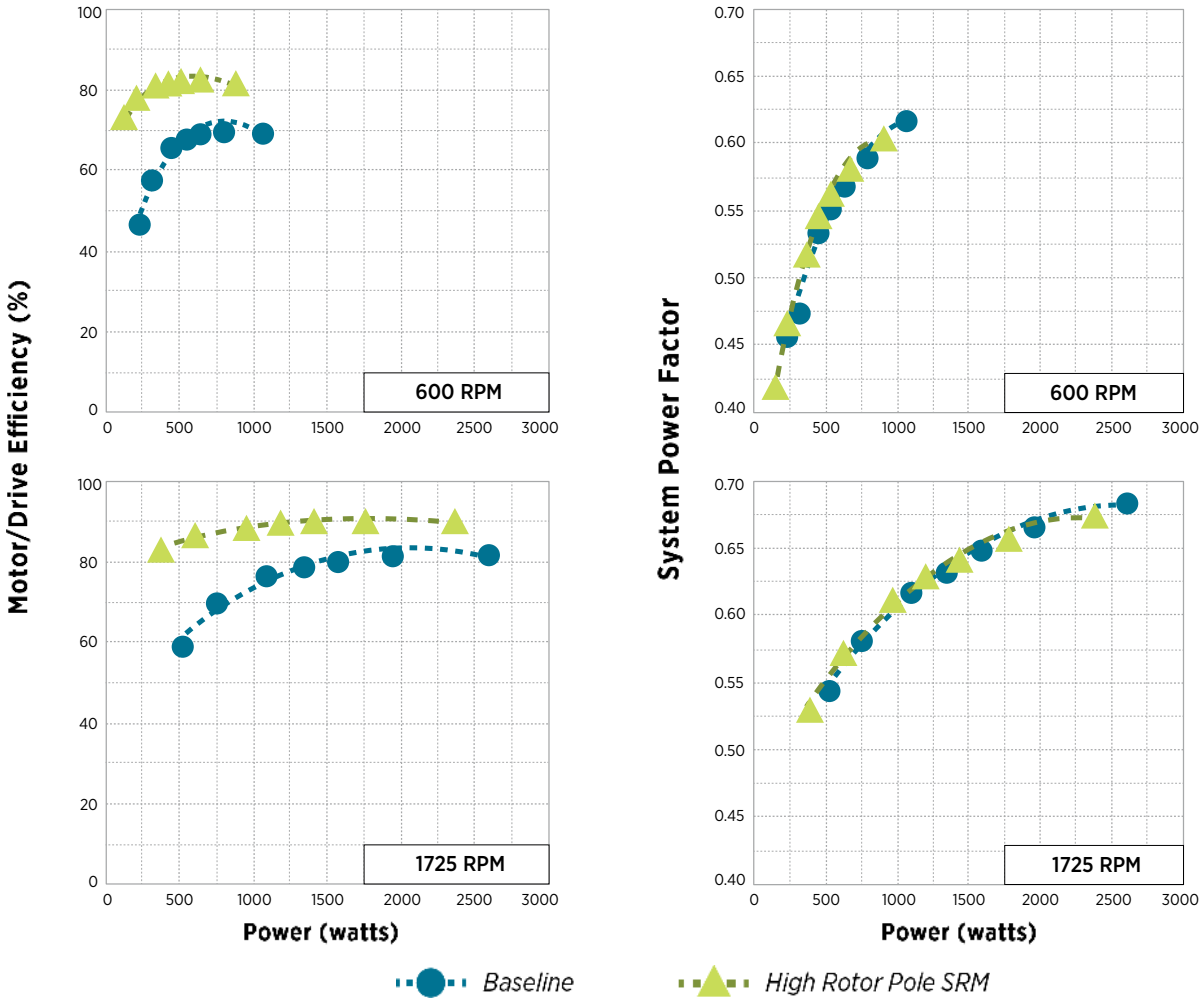
A 10-ton commercial Lennox Strategos RTU with a multi-stage air volume supply fan option and a custom-built plenum-duct apparatus was used to measure the steady-state combined fan/motor/drive performance of the two technologies when driving the RTU's indoor fan. Testing was conducted at three fixed airflow resistance configurations, each with seven different fan speeds, for a total of 21 test points.

RESULTS

Benchtop Dynamometer Testing

- **Motor/Drive Efficiency** – The emerging technology had a motor/drive efficiency between 10% and 57% higher than the baseline.
- **Power Factor** – The baseline and emerging technology had similar power factors.

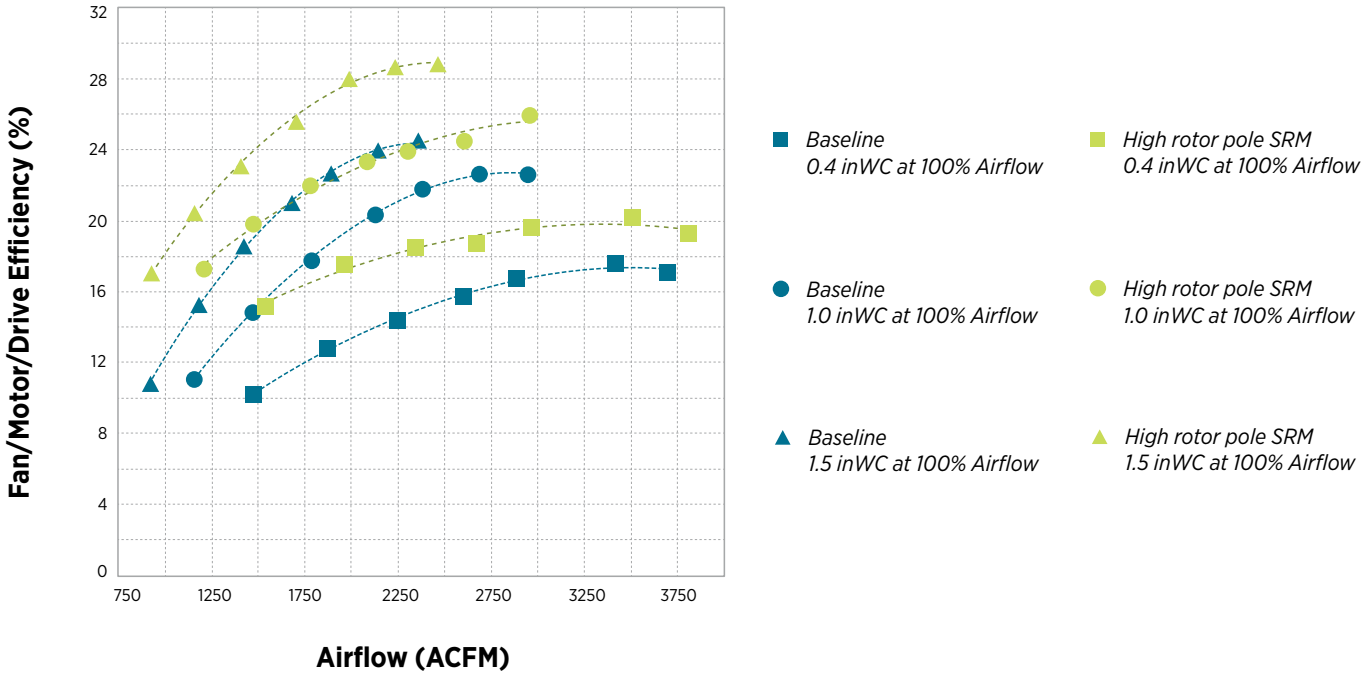
Figure 1 – Power vs. Motor/Drive Efficiency and System Power Factor at 600 and 1725 RPM



Laboratory RTU Testing

The emerging technology had a higher fan/motor/drive efficiency across all static pressures and airflow rates. The average increase in efficiency was between 23% and 28% across all airflow resistance tests.

Figure 2 – Airflow vs. Fan/Motor/Drive Efficiency for the lab RTU testing



CONCLUSION

These laboratory tests show the emerging technology operated at a higher efficiency than the baseline technology over the tested range of load and speed conditions. Therefore, the emerging technology can save energy and reduce electrical demand in RTUs.

NEXT STEPS

WCEC researchers are conducting field tests with the high rotor pole SRM with software-controlled inverter to better understand the performance of this emerging technology and potential barriers to widespread market adoption. WCEC researchers are also interested in exploring additional applications beyond RTUs.

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