Can you REALLY Save 16% for $50? Laboratory Evaluation and Modeling of Latent Recovery Strategies for Mitigating Air Conditioner Energy Use

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The California Investor Owned Utilities (IOUs) actively support the California Energy Commission in developing the state's building energy efficiency standard (Title 24) through their Codes and Standards (C&S) program. The joint intent of the IOUs and CEC is to achieve significant energy savings through the development of reasonable, responsible, and cost-effective code change proposals. Through Codes and Standards Enhancement (CASE) Studies, the IOU C&S Program provides standards and code-setting bodies with the technical and cost-effectiveness information required to make informed judgments on proposed regulations for promising energy efficiency design practices and technologies.

The following items were investigated under this CASE study:

- Testing a potential winter charge testing procedure.
- Adjusting the limits of acceptability for subcooling.
- Determining the efficiency effect of non-condensables in the refrigerant.
- Improving the test method that rates the cycling efficiency of units, particularly in dry climates.
- Testing Charge Indicator Devices

This poster summarizes the tests and subsequent modeling of latent recovery in cycling air conditioners. The purpose was to determine how to provide high net sensible EER (defined as sensible capacity with fan heat/power with fan watt draw) at high outdoor temperatures, normal dry climate indoor conditions, and typical installation (typical duct system restriction).

Laboratory Tests

Two nominal 2.5 ton air conditioners were tested in the Intertek psychrometric rooms in Plano, Texas.

The Cycling tests consisted of adjusting the rooms' conditions until all the parameters were maintained within the limits set for certification testing. Once the conditions were stabilized, the parameters were continuously recorded for the duration of the tests. The cycles alternated 6 minutes of compressor running with 24 minutes of the compressor off for five full cycles. The five cycles had increasingly longer fan off delays beginning with 0 seconds and ending with 610 seconds.

Fan off Delays

Fan off delays are designed to recover the air conditioner capacity stored as water on the evaporator coil and in the drain pan as sensible capacity at the end of the compressor cycle as shown in Figure 1.

Results

Testing showed the changes in sensible EER under different airflows and lengths of time delay. Figure 2 displays the effect of fan airflow rates on the sensible EERs accumulated over the length of the cycle.

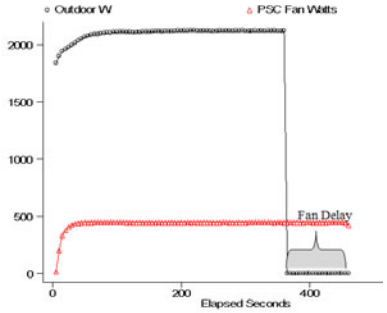

Figure 1 Fan Off Delay

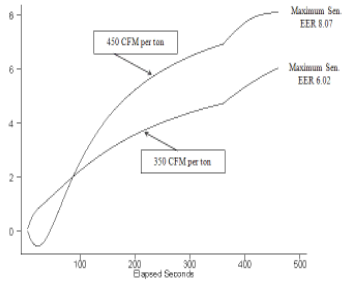

Figure 2 Effect of Airflow On Sensible EER with PSC Motor

Figure 3 displays the changes in sensible EER with a Brushless Permanent Magnet motor.

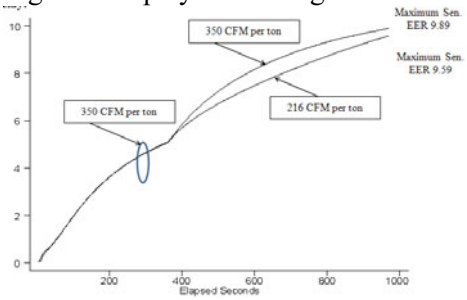

Figure 3 Sensible EER with a BPM Motor

Discussion and Modeling

While the laboratory tests show sensible EER improvements of more than 50% with a BPM motor, the situation in a home and the situation in a laboratory are different. For the BPM motor the lab tests indicate that a long fan delay and lower airflow would be advantageous to produce higher Sensible EERs at the unit. This appearance may be correct for units that have no duct system or have very high distribution efficiencies. However, real ducted systems have conduction and leakage losses. These losses are important to take into account in determining the airflow range and fan delay length.

The laboratory test results were analyzed for connection to a duct system that had a 20% capacity loss at full capacity. The results for a BPM motor are shown in Figure 4. The upper curves are the efficiency measured at the air conditioner while the lower curves include duct losses.

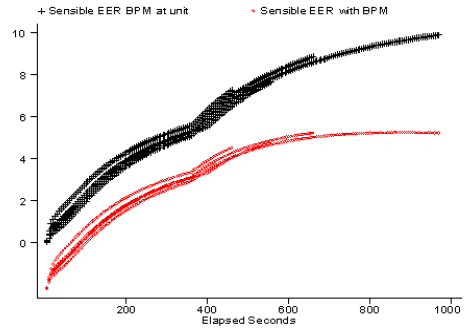

Figure 4 Sensible EER with and without duct losses

Conclusions

Testing at Intertek showed that commonly used certification laboratories can run valid cycling test at conditions more representative than the current SEER cycling test.

The revised test can produce metrics of significant meaning and usefulness for both dry climates and moist climates by differentiating between high Sensible EER and high Latent or Total EER.

When the improved cycling test procedure is used the following practical implications are made apparent:

- At common conditions of 350 CFM per ton and 20% duct losses, the addition of a 5 minute fan delay increases a PSC unit Sensible EER from 2.45 to 3.89, a potential savings of 37%.
- At common conditions of 350 CFM per ton and 20% duct losses, the addition of a 10 minute fan delay increases a BPM Sensible EER from 3.07 to 5.23, a potential savings of 41%.