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Re: Version 5.0 Energy Star CAC/ASHP

Dear Abigail,

Per your encouragement in your July 1, 2013 memo, Bristol Compressors International, Inc. would like to provide comments relative to the Version 5.0 specification revisions. We appreciate the opportunity to take part in the important work the EPA is doing in revising this specification.

There is much literature published in regard to system factors and the effect on energy efficiency, power usage, and peak power demand and there are many problems in trying to use a simple metric like SEER to predict real world power consumption. Significant system and installation factors such as equipment sizing errors, refrigerant charging errors, duct design, filter condition, etc. have "real world" impact on the actual power consumption and it has been rightly proposed that the installation contractor and homeowner has the most control over these factors.

Diagnostic features as part of the system control could help alert the homeowner of issues or aid the installer in better optimizing charge, air flow, etc., and training programs and certifications for installers are certainly good practice. However, these things will not insure a good installation or proper maintenance and thereby will not necessarily result in the desired outcome.

But the issues are real. Most researchers agree that CAC systems are frequently oversized, charge levels are frequently in error, and air flow problems exist for a wide variety of reasons. In one of these sources it is estimated that up to 53% of CAC systems are oversized by more than one ton of capacity. It is estimated in another reference that the standard practice of using Manual J (ACCA) results in oversizing systems by 155% to 185% . Even with the best training and diagnostics, these systems will still be typically oversized because installers do not want to err on the low side of the building load.

Oversized systems result in a variety of problems. The design efficiency is not reached until approximately 10 minutes into the cycle according to references including EPA. An oversized system will typically run 5 minutes before satisfying the demand except for perhaps the very hottest days. Most of the time the system is short cycling and running less efficiently. Oversizing by 50%, which would seem to be common practice, can result in 9% loss in efficiency. In the worst of cases, it could be as much as 30% degraded. Also, when the system is short cycling it is not running long enough to remove moisture from the air effectively, perhaps causing the homeowner to feel warmer and adjust the thermostat farther down to

compensate. Both the total energy usage for the season and the peak load power usage is higher than it would be with a properly sized system.

Improper air flow is another major issue due to factors like filter type, lack of proper maintenance, poor duct design, duct cleanliness issues, and duct leakage, etc. Even if the installer does a good job with the design and installation, he cannot control the homeowner's actions or the changes the homeowner may make to the building load later by installing better insulation, better windows, getting better shading through tree growth, etc. Improving the house building load through improvements to insulation, etc. only exacerbates the oversize problem by making the building load smaller and causing inefficiencies in the HVAC system.

All of these things contribute to the degradation of system efficiency and increased peak power demand and energy usage. One source estimates that the potential cumulative effect on air conditioning SEER of inadequate airflow, improper charge, duct leaks, and oversizing can be as much as 43% degradation. That's a 14 SEER system running at 8 SEER levels. Implementing higher SEER ratings, requiring diagnostics, and fully communicating systems will not necessarily solve the problem and create a better more efficient system with the Energy Star rating. What is needed is a system solution that will resolve these issues automatically and compensate for the problems.

Studies done at Lawrence Berkeley Laboratory show that in an oversized system, simple two-stage capacity modulation or simply right sizing the system does not resolve the issue entirely. While the two stage system resulted in significant reductions in seasonal energy use, it had no effect on peak demand. The "right-sized" unit had insignificant effect on seasonal energy use but lowered peak demand.

The only real solution for both of these problems is "load matching". Systems using variable refrigerant mass flow and blowers more closely match the building load, not only at its "design point" but throughout the wide range of variation seen over time. These systems use indoor blowers that are capable of automatically compensating for changes in duct systems and maintaining the air flow needed but doing it at a much reduced power consumption.

By matching the refrigerant mass flow and air flow to the building load, along with a variable flow expansion device (TXV, EEV), the typical problems associated with oversizing, inadequate air flow, and refrigerant charge errors can be compensated for automatically while maintain high efficiency and reducing peak load. Load shedding becomes possible in combination with utilities programs to reduce peak loading. Cooling can be reduced, rather than eliminated, to balance grids and avoid blackout periods while also eliminating the power surge when systems come back on.

In order to effectively raise the bar for Energy Star rating, increased SEER is not necessary, although it will be a natural result of load matching.   Diagnostics and complicated fully communicating thermostats are not necessary although they certainly could be a part of high end systems. Variable mass flow systems include many different technologies and the proper incentives to designers and manufacturers create much potential for further innovation. Diagnostics and communicating thermostats do not improve power consumption and variable refrigerant mass flow systems can be controlled without the use of complicated communicating

thermostats. Bristol Compressors believes that these systems do not have to be expensive or complicated to be very effective in reducing overall power consumption, reducing peak loading, and improving overall comfort through better humidity control in the home. Basic HVAC platforms can easily become modulated capacity "load matching" Energy Star systems by adding variable capacity constant cfm indoor blowers and multiple capacity compression. With the volumes driven by the Energy Star rating, electronics cost would be significantly lower than in systems using these methods today. Simple TXVs can be used as long as the mass flow isn't reduced more than around 50% which is sufficient for reasonable load matching and efficiency improvement. We believe the most basic of these systems could be produced at very marginal cost add to the standard 14 SEER single stage system especially since many 14 SEER systems already use TXVs and high efficiency constant cfm indoor blowers.

Bristol Compressors International is proposing an Energy Star revision that would require load matching of both air and refrigerant flow. The standard variable speed SEER rating method as defined in ARI 210/240, or something similar that requires rating at multiple points, could be used for efficiency rating. The Energy Star rating could use efficiency minimums equivalent to the DOE 2015 Regional Standards, or better yet just specify 14 SEER Minimum but with features insuring adequate load matching such as ability to match the actual building load curve at multiple points (more than two), control indoor air cfm to match the refrigerant capacity and automatically compensate for duct problems, etc. . These precedents have already been set with examples such as the requirement of the use of TXV's in California and the recent change in the Ontario building code requiring all furnaces installed in new construction to be equipped with an electronically commutated motor (ECM).

Requirements such as these are common sense approaches to address real field issues with physical design features representative of the Energy Star rating that effect real change and improvement. This type of requirement opens up the field for innovation and incentivizes manufacturers to implement these technologies in cost effective ways. The approaches based on training, expecting homeowners or installers to alter behavior based on diagnostic inputs, etc. are not reasonable approaches to Energy Star rating in our opinion as this merely pushes responsibility for energy efficiency to the end user instead of manufacturers. Energy Star equipment should insure reductions in energy usage and only more efficient systems can do this.

Our conclusion… Variable Capacity systems are the solution to oversizing inefficiencies and peak load power consumption.

Sincerely,

Scott Hix

Scott Hix

References

1. ACHR News, Jen Anesi, June 10, 2013, "Ontario Mandates ECMS In Furnaces– Is US Next?
2. Florida Solar Energy Center, FSEC-PF-328-97, Reference Document: James, P., J.E. Cummings, J. Sonne, R. Vieira, J. Klongerbo, "The Effect of Residential Equipment Capacity on Energy Use, Demand, and Run-Time," ASHRAE Transactions 1997, Vol 103, Pt. 2., American Society of Heating, Refrigerating, and Air- Conditioning Engineers, Inc., Atlanta, GA.
3. EPA, "Right-Sized Air Conditioners, Mechanical Equipment Improvements" http://www.energystar.gov/ia/home_improvement/home_sealing/RightSized_AirCondFS_2005.pdf
4. Advanced Energy (Applied Building Science), "Get the Facts about SEER and Deliver Better Customer Value" http://www.advancedenergy.org/buildings/knowledge_library/heating_and_cooling/seer_facts_bulletin.pdf
5. ACHR News, http://www.achrnews.com/articles/comparing-motor-technologies, Brian Michael, December 14, 2009. "Comparing Motor Technologies"
6. Levin, P., Rice, C., Baxter, V., "Modeled and Measured Effects of Compressor Downsizing in an Existing Air Conditioner/Heat Pump in the Cooling Mode.", 1996 ASHRAE Summer Meeting, June 1996
7. Home Energy Magazine Online March/April 1998, "Efficient Cooling: Making It Happen", Sherman, C., Hilderbrandt, E.
8. Home Energy Magazine Online May/June 1995, "Bigger Is Not Better: Sizing Air Conditioners Properly", Proctor, J., Katsnelson, Z., Wilson, B.
9. Rhodes, J., Stephens, B., Webber, M., "Energy Audit Analysis of Residential Air Conditioning Systems in Austin, Texas.,
10. Lawrence Berkeley Laboratory, Burke, T., Modera, M., "Peak Demand impacts of Residential Air-Conditioning Conservation Measures"
11. Florida Solar Energy Center, FSEC-CR-1761-08, Reference Document: University of Central Florida / Florida Solar Energy Center, Shirey, D., Vieira, R., Contract Report, "Investigate the Feasibility of a Hot-and-Humid Climate Regional Efficiency Rating for Air Conditioner and Heat Pump Systems"
12. Home Energy, http://www.homeenergy.org/index/index/nav/buildingamerica/id/715, May/June 2010, Ueno, K., "ECM Efficiency Better (and Worse) Than You Think"