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PRODUCT: Terminal Units – Fan Powered Terminal Units
SUBJECT: Efficiency of Fan Powered Air Terminal Units – PART I
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Fan powered air terminal units (ATUs) came into being here in Houston, Texas. John McCabe with the EMDE Company and Charlie Chenault with Chenault Engineering Company designed the first ones in 1973. Their idea was to make office buildings more efficient, an admirable cause while we were suffering from an oil embargo from the Middle East. Mr. Chenault put their sketches on his plans. Dick Graves bought the parts and assembled the first ones in the field. By the third job, the local Honeywell rep was supplying the dampers and actuators, and Magna-Flow Industries was supplying the fans and heaters. Magna-Flow was supplying complete units with the dampers and fans integrated into one casing shortly after this. Initially, these terminal units were parallel arrangements. All controls were pneumatic and pressure dependent. Duct systems were designed for static regain or constant velocity with a large number of reducers in the trunk ducts. Series units came along in the late 1970s. The new devices were very popular and were soon being manufactured by several companies.

In the 1980s, pressure independent pneumatic controls became available. This made duct designs simpler with fewer reducers. Variable volume air handlers were also being used. Dick Graves presented an ASHRAE paper in 1989 claiming that this combination of fan powered terminal units and VAV air handlers was saving about 20% of the building energy at that time. Of course, this was not solely due to the terminal units, but they were definitely instrumental to the system. The fan powered options were energy savers for buildings from the very start.

The parallel ATUs and series ATUs have different operating characteristics. The parallel units run the fan only in the deadband and heating modes. During the cooling mode, they depend on the air handler to drive the cool air down the duct, through the VAV damper in the ATU, through the ATU and down the runout ducts to the occupied space. The fan cycling can be irritating. The series unit places the VAV damper and fan in series, separated by a mixing chamber that is open to the return air plenum or ducted to the occupied space. The fan runs in all modes during all occupied hours. The sound from the fan is background noise and generally not noticed. The air handler only drives the cool air through the VAV damper. Air handler energy requirements is lower for the series unit.

Since the 1980s, a lot has changed. Glass has gotten much better at limiting radiant heat into the occupied space. Thermally broken mullions have been designed limiting much convection heat into the occupied space. It is not unusual today to find new construction with u factors of 0.03 or lower. The

building enclosures are tighter today than in the past. When this tightening first started, we went through the sick building syndrome until we learned to better control the amount of outdoor air needed and supplied into the occupied space. Controls are better with much more capability than in the past. Motor technology is dramatically better. ECMs use significantly less energy and are capable of regulating airflow with digital controls that reset airflow based on the instantaneous demand in the occupied space. Air handlers have changed to smaller units with direct drive fans or banks of fans which can also be controlled based on instantaneous demand in the occupied space and static pressure control. Duct leakage limits have been decreased. Ceiling diffusers have improved with higher induction rates and better throw patterns at low flows. ATUs have also improved with damper assemblies, flow measurement devices and modulating fan motors allowing the entire ATU to regulate the air volume to the occupied spaces based solely on the actual instantaneous demand in the space.

Engineers generally gravitated toward one unit or the other. It was natural as we began to talk about energy use due to rising oil prices again, that there would be differences of opinions about whether a building would be more efficient with one type over the other. The first ASHRAE research started in 2003. It was followed by two more research projects, all of which have generated over 25 ASHRAE research papers describing the process, findings and conclusions.

I was lucky enough to be chosen to chair all three research projects investigating fan powered terminal units: ASHRAE RP 1292, which compared series and parallel fan powered terminal units

(ATUs); The VAV CONSORTIUM AT TEXAS A&M UNIVERSITY, which compared AC induction motors

(PSC) VS. Electronically Commutated Motors (ECMs); and AHRI

RESEARCH PROJECT 8012, which was to rewrite and verify all the equations from the previous 2 projects into heat and mass balance equations to make them fit easier into modeling programs like Energy Plus. I was also chosen as co-chair of the committee to write the new ASHRAE DESIGN GUIDE for Air Terminal Units where much of this research is described and used to evaluate these systems. We will look at more current issues in Part II