

Energy Balancing & Heat Exchange Devices

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Increasingly, engineers are writing specification requiring “energy balancing.” This specification requires the TAB technicians to read and record entering and leaving dry bulb temperatures for air and water (dry bulb and wet bulb air temperatures for cooling coils), and air CFM and water GPM across each heat exchanger. For electric resistance heater coils, volts and amps are to be read and recorded with entering and leaving air temperatures. These devices are the primary design applications for HVAC systems. Steam to air, steam to water heat exchangers are also a standard design application, but steam applications will not be discussed here.

During the construction phase, it would be helpful for the TBE to review the submittal data on all coils, valves, flow control devices and piping to verify that design capacities can be met with systems being installed. Too many times, we have found piping to be too small to carry the water flow required, or the Cv of the control valves to be incorrect for linear flow control and circuit setters or auto-flow devices sized incorrectly or installed in the wrong location. Periodic inspections and review during the construction phase will save time and money when it comes to TAB and commissioning the systems.

Regardless of what effort we place on design review, the most productive part of system balancing takes place during the actual process. We train our technicians to take the necessary readings, make adjustments and then double-check their work. When the technician has proven to himself or herself that the readings they took are as true and verifiable as possible, then, the information given to the engineer can efficiently be checked and accepted.

Energy balancing requires that both heating and cooling systems be tested under as close to design conditions as possible. This is called opposite season balancing and is specified in most engineers’ specs. It is easier to test the heating system in the cooling season than it is to test the cooling system in the heating season.

BTU input and output at the AHU coil or terminal device can be checked and proven very quickly:

Cooling BTU output formula for air: $\text{BTU/Hr} = \text{CFM} \times 4.5 \times (\text{H1} - \text{H2 from psych chart})$

Cooling BTU input formula for water: $\text{BTU/Hr} = \text{GPM} \times 500 \times (\text{Tin} - \text{Tout})$

These two [preceding?] calculations should be close if all the readings are accurate.

Heating output BTU formula for air: $\text{BTU/Hr} = \text{CFM} \times 1.085 \times (\text{Tin} - \text{Tout})$

Heating input BTU formula for water: $\text{BTU/Hr} = \text{GPM} \times 500 \times (\text{Tin} - \text{Tout})$

Heating input BTU formula for 3 –Phase Electric heat: $\text{BTU/Hr} = (\text{V} \cdot \text{I} \cdot 1,732 / 1000) \cdot 3,413$ (single phase- omit 1.732 in the formula)

Steam heating input BTU can be calculated by using the steam tables in the TRANE Air Conditioning manual, and A.S.H.R.A.E Fundamentals manual. The input BTU and output BTU should be close if all the readings are accurate.

Achieving design heating or cooling loads may be difficult if the balancing is performed in the spring or fall seasons. The technician will not be able to test at reasonable design loads if the water temperatures are not at design conditions. Just reading and setting water flows will not achieve the proper energy balance required. This is why the technician should calculate the total BTU input and output at each device to verify if or when the two values are equal.

When electric reheat coils are used, the technician must remember that not all the airflow will be flowing directly through the heating elements. Therefore, he should take temperature readings at least 2.5 duct diameters downstream and both sides of the duct. Reading the discharge air temperature close to the electric coil, the technician will have higher or lower readings that will not be a good mixture. This will cause an error in the BTU calculation.

As we have seen, BTUs are the common denominator for checking and verifying heat exchange devices. Using Total System Balance per the AABC National Standards, checking and verifying the heat exchange devices and their proper installation is a critical part of our TAB process. If these devices do not meet the design criteria, the entire balancing will be a failure. Energy balancing requires that these devices meet the engineer's design intent for the most efficient energy usage.