



**Effective Innovation**  
Superior Engineering & Design

## Blow-Through Vs. Draw-Through

Blow through and draw through designs are the two basic arrangements available for direct fired heating. In blow-through designs the fan is placed prior to the burner. In draw-through designs, the fan is placed after the burner. This simple difference between the two systems nevertheless leads to some confusion when attempting to compare the two systems.

Heating units are often specified in terms of a burner heating capacity (in BTUH) and a fan volumetric flow rate (in CFM). While a BTU rating can be directly compared across units, a CFM rating obscures the fact that volumetric flow rate cannot be directly compared for units of differing design. The basic BTU to CFM relation is described by the following equation:

$$BTU = 60 * C_p * \rho * CFM * \Delta T$$

Here the CFM of the unit is multiplied by the temperature rise ( $\Delta T$ ), density of air ( $\rho$ ), the specific heat of air ( $C_p$ ), and a time conversion factor of 60. A more commonly encountered form of this equation rolls the specific heat and density of air, along with the minutes to hour conversion, into a convenient constant value of 1.08. This form, while more accessible, is also less accurate.

Despite the straight forward nature of this equation, it is still often misapplied. One source of confusion is that both draw-through and blow-through unit manufacturers specify CFM at the fan. Blow-through manufacturers therefore use a cold air (inlet) CFM while draw-through units use a hot air (outlet) CFM. As colder air has less volume than hotter air, this in turn leads to the misconception that blow-through designs produce more heat with less CFM. A sample calculation for a 2000 CFM blow through unit, assuming 15 degree and 90% RH ambient conditions, finds the following:

$$BTU_{Blow\ Through} = 60 * .24 * .0832 * 2000 * 145 = 347\ MBH$$

In order to properly compare this to a draw through unit, the original inlet CFM must be converted to an expanded air (outlet) CFM. While for estimation it is often acceptable to assume constant volume across a unit, it is actually mass that is conserved in direct fired heating. Therefore, using the conservation of mass principle:

$$CFM_{Expanded\ (Hot)} = CFM_{Unexpanded\ (Cold)} * \frac{\rho_{Cold\ Air}}{\rho_{Hot\ Air}}$$

Applying this conversion and the same ambient conditions allows the draw through BTU to be calculated.

$$BTU_{Draw\ Through} = 60 * .24 * .0637 * 2612 * 145 = 347\ MBH$$

This BTU is equivalent to the figure derived for a draw through unit. The common practice of comparing the inlet CFM of a blow through unit to the outlet CFM of a draw through unit fails to take into account the fact that air expands 25-35% as it crosses the unit's burner. Also note that while the draw through unit will provide the target CFM regardless of seasonality, the blow through unit will not.