

## 80-2-ISD Leakage Control for Energy Conservation

Leakage of supply air in sheet metal air distribution ducts varies from 5% to 25% of the supply air quantity depending on the quality of workmanship and degree of sealing applied to joints and seams. According to SMACNA's HVAC Duct System Design Guide, low pressure duct systems, such as those typically found in residential and small commercial installations, will have an average leakage equal to 15% of the total supply cfm.

For ducts located outside of the conditioned space, supply air leakage results in a net reduction of the HVAC system to perform to its total capacity. Therefore, in order to obtain the desired comfort in the conditioned space, an allowance for leakage is made and the equipment is selected accordingly. The following calculation shows how fiber glass duct systems, because of their closure system, could save the homeowner as much as 86% of the cost of energy loss due to 15% air supply leakage in a sheet metal duct.

### Energy Loss by Sheet Metal Duct Due to Leakage

For a 1500 sq. ft. house with ducts going through the attic or crawl space and 1200 cfm rate in volume of air handled by the furnace, the energy loss for a 15% leakage can be calculated in the following manner.

1. Determine the supply air loss due to leakage.

At 15% leakage and 1200 cfm supply air volume, the volume of air loss is 180 cfm.

2. Estimate the temperature differences in the air across the furnace.

At a return air temperature of 70°F and a bonnet air temperature of 135°F,  $t$  is equal to 65°F.

3. Determine the rate of energy loss due to leakage.

$$\begin{aligned}
 Q_L &= \text{cfm (1.1) (t)} \\
 &= 180 (1.1) (65) \\
 &= 12,870 \text{ Btu/h}
 \end{aligned}$$

1.1 = Unit conversion constant combining the air density, heat capacity of the supply air, and minutes to hours (Btu/hr/cfm/°F)

4. Determine the energy loss during the heating season due to leakage.

$$E_L = \left( \frac{Q_L \times DD \times 24}{\Delta t \times \eta \times V} \right) (C_D) (C_F) \quad (\text{ASHRAE Systems Handbook})$$

$$Q_L = \text{Heat loss (Btu/h)}$$

$$DD = \text{Number of degree days}$$

$$\Delta t = \text{Design temperature difference (°F)}$$

$$\eta = \text{Rated full load efficiency (expressed as a decimal)}$$

- V = Heating value of fuel
- C<sub>D</sub> = Interim correction factor for heating effect vs. degree days
- C<sub>F</sub> = Interim part load correction factor for fueled system only

For the house in question, the following assumptions were made:

- Q<sub>L</sub> = 12,870 Btu/h as calculated
- DD = 5000 degree days
- Δt = 70°F
- η = 0.80 ( i.e. 80% of rated full load efficiency)
- V = 1000 Btu/cu. ft of gas
- C<sub>D</sub> = 0.71 as on Table 2, Chapter 43, ASHRAE Systems Guide
- C<sub>F</sub> = 1.56 as on Table 3, Chapter 43, ASHRAE Systems Guide
- E<sub>L</sub> =  $\left( \frac{12,870 \times 5000 \times 24}{70 \times 0.80 \times 1000} \right) (0.71) (1.56)$
- = 30,546.02 cu. ft. of gas
- = 305.46 therms

5. Determine the cost to the owner.

- Cost = E<sub>L</sub> x P
- = Therms x \$/therm
- 1 therm = 100,000 Btu = 100 cu. ft. of gas
- P = Price of fuel or energy
- = \$.347 per therm (National Bureau of Standards)
- Cost = 305.46 x .347
- = \$105.99

### Energy Loss Due to Leakage in Fiber Glass Duct System

Fiber glass Mat-Faced Micro-Aire® Duct Board systems, when fabricated and installed to Johns Manville recommendations, will have a leakage of approximately 2% of the total supply air. The procedure for energy loss due to leakage is repeated for the house in question using fiber glass Mat-Faced Micro-Aire Duct Board.

1. Supply air loss due to leakage.

At 2% leakage and 1200 cfm supply air volume of air loss is 24 cfm.

2. Estimate the temperature difference in the air across the furnace.

At a return air temperature of 70°F and a bonnet air temperature of 135°F,  
 $\Delta t$  is equal to 65°F.

3. 
$$\begin{aligned} Q &= \text{cfm (1.1) (t)} \\ &= 24 (1.1) (65) \\ &= 1716 \text{ Btu/h} \end{aligned}$$

4. Determine the energy loss during the heating season due to leakage.

$$Q_L = 1716 \text{ Btu/h as calculated}$$

$$DD = 5000 \text{ degree days}$$

$$\Delta t = 70^\circ\text{F}$$

$$\eta = 0.80 \text{ ( i.e. 80\% of rated full load efficiency)}$$

$$V = 1000 \text{ Btu/cu. ft of gas}$$

$$C_D = 0.71 \text{ as on Table 2, Chapter 43, ASHRAE System Guide}$$

$$C_F = 1.56 \text{ as on Table 3, Chapter 43, ASHRAE System Guide.}$$

$$E_L = \left( \frac{1716 \times 5000 \times 24}{70 \times 0.80 \times 1000} \right) (0.71) (1.56)$$

$$= 4072.80 \text{ cu. ft. of gas}$$

$$= 40.72 \text{ therms}$$

5. Determine the cost to the owner.

$$\text{Cost} = E_L \times P$$

$$= 40.72 \times .347$$

$$= \$14.13$$

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## Engineering & Technical Bulletin

### Energy Conservation and Savings to Homeowner

The difference in lost energy, sheet metal duct verses fiber glass, for the heating season is:

$$\begin{aligned} E_L &= 305.46 - 40.72 \\ &= 264.7 \text{ therms} \end{aligned}$$

which represents a potential savings to the owner of:

$$\begin{aligned} \text{Savings} &= E_L \times P \\ &= 264.7 \times .347 \\ \text{Savings} &= \$91.86 \end{aligned}$$

The actual savings for any particular house would vary according to its location, actual cfm flow, temperature rise across the furnace, and percent of air leakage to unconditioned space. While adding insulation to sheet metal ducts will reduce the energy loss due to heat transfer, it will not reduce leakage.

The above calculations are based on leakage to an unconditioned space. For ducts located inside of the conditioned space, such as those going through a return air plenum, leakage of supply air is not considered energy loss. However, leakage will reduce the system efficiency to provide comfort since the system will not deliver the proper air distribution to the occupied space.



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