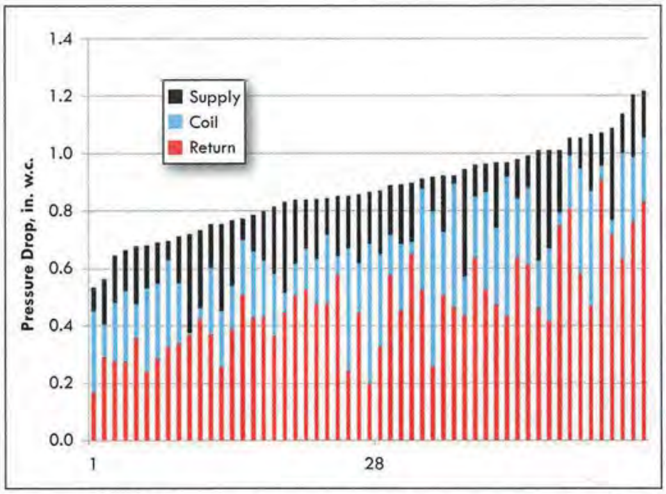

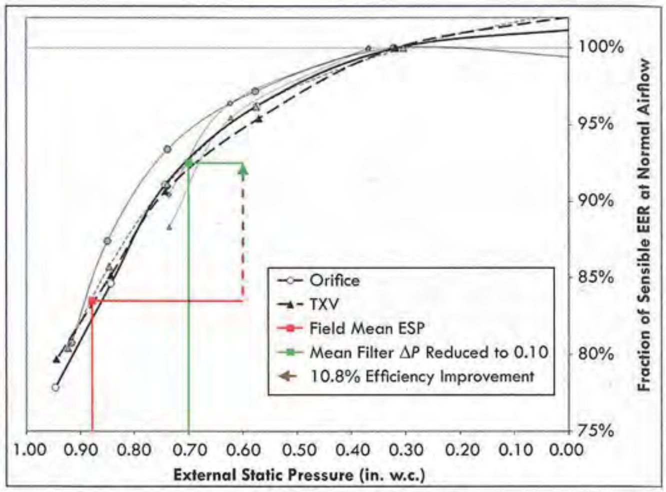

Figure 1 (left): Return, coil, and supply pressure drop for 53 ducted systems. **Figure 2 (right):** Potential 10.8% increase in sensible EER if the mean filter pressure drop was reduced from 0.28 in. w.c. to 0.1 in. w.c. (70 Pa to 25 Pa).

Residential AC Filters

By John Proctor, P.E., Member ASHRAE

This column was inspired by a presentation at the 2012 ASHRAE Annual Conference in San Antonio.

Field research in California residences has found that the trend for homeowners to replace lower arrestance filters (assumed by HVAC manufacturers) with higher arrestance filters (encouraged by concerns for IAQ) results in lower airflows, which means lower efficiencies of the furnaces, heat pumps, and air conditioners.* Therefore, homeowners need a way to select an air filter with high arrestance that ensures it will not significantly reduce the efficiency of the air conditioner.

The California Energy Commission and California's investor-owned utilities sponsored field research that included an investigation of the actual filtration found in two-year old California homes. The most common replacement filter used is a 1 in. (25 mm) pleated filter.[2] While the Air Conditioning Contractors of America manuals assume the pressure drop through the system filter is approximately 0.10 in. w.c. (25 Pa), field installations showed filter pressure drops far in excess of 0.10 in. w.c. (25 Pa) (*Table 1*).

Another metric of interest in forced-air systems is the external static pressure, which is the increase in pressure from the return side to the supply side. The common total external static pressure residential furnace rating point is 0.50 in. w.c. (125 Pa). None of the systems had an external static pressure of 0.50 in. w.c. (125 Pa) or less.

Statistically, 57% of the variation in the total external static pressure in these systems is explained by the combination of the filter and return system pressure drop. The most common airflow problem with these systems is on the return side.

The close correlation of return static pressure to the total static pressure is shown in *Figure 1.* The data are arranged from the lowest to the highest external static pressure. Note that the return static pressures generally rise from left to right while the coil and supply static pressures are more random from left to right. Although individual coils (particularly dirty ones) and individual supply systems can

Metric	Filter Pressure Drop	Return Static Pressure	Total External Static Pressure
Mean in. w.c.	0.282	–0.417	0.887
Range in. w.c.	0.075 to 0.792	–0.143 to –0.928	0.533 to 1.21

Table 1: Static pressures for 34 split air conditioners with furnaces.

be restrictive, the dominant cause of high statics in these homes is the return system.

The effect of increased static pressure is lower evaporator airflow, which lowers the total EER and the sensible EER of the machine. This is most detrimental in dry climates where the sensible EER is of greater importance. In moist climates lower airflow increases dehumidification. Any reduction in static pressure is helpful. *Figure 2* shows the tested relationship between external static pressure and sensible EER at standard conditions (outside 95°F [35°C], inside 80°F [27°C] dry bulb, 67°F [19°C] wet bulb) for two thermal expansion valve (TXV) units and two fixed orifice units.[3]

Figure 2 also illustrates the potential 10.8% increase in sensible EER if the mean filter pressure drop was reduced from 0.28 in. w.c. to 0.1 in. w.c. (70 Pa to 25 Pa).

Filter pressure drops can be reduced substantially even if high arrestance filters are used. The face areas and filter location depths will have to be increased to allow the use of these filters without harming the airflows through the furnace, air conditioner, or heat pump.

Figure 3 illustrates the types and sizes of filters needed to accomplish a clean filter pressure drop of only 0.05 in. w.c. (12 Pa) for one manufacturer's line of filters.

Fortunately, higher arrestance filters can be compatible with maintaining proper airflow and static pressure on residential systems. But, consumers need a way to properly choose a filter, so if they continue to use higher arrestance filters (partially at the urging of ASHRAE standards such as Standard 62.2)** then:

- Changes need to be made in HVAC design and installation standard practice, such as sizing the filter racks for the higher arrestance filters;
- There needs to be filter labeling such as AHRI Standard 680 (*Table 2*); and
- There needs to be a consumer label at filter locations indicating the allowable maximum resistance at the airflow rate closest to the design airflow for that section of the return system. An example of a filter location label for a return section designed for 500 cfm at 0.05 in. w.c. (236 L/s at 12 Pa) is shown in *Table 3*. Note that the standard airflow values are in 400 cfm (189 L/s) steps. The pressure specifications need to be translated to those standard test points.

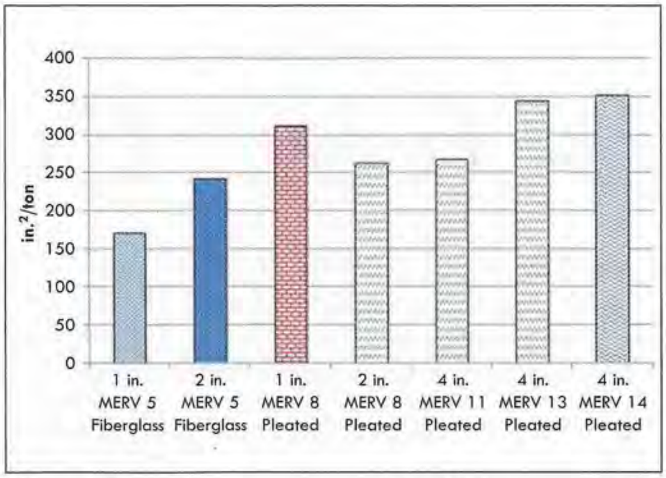

Figure 3: Filter face area required for 0.05 in. w.c. (12 Pa) pressure drop at 400 cfm/ton (189 L/s per kW).

AHRI 680 Standard Rating						
Airflow Rate (cfm)	Initial Resistance (in. w.c.)	Final Resistance** (in. w.c.)	Dust Holding Capacity** (g)	Particle Size Efficiency** (0.30 to 1.0 μm)%	Particle Size Efficiency** (1.0 to 3.0 μm)%	Particle Size Efficiency** (3.0 to 10 μm)%
400	0.05					
800	0.10					
1,200	0.17					
1,600	0.25					
2,000*	0.32	0.50	45	17	53	87

* Maximum rated airflow rate as published by the manufacturer.

** Standard rating requires that these shall be tested at maximum rated airflow rate as published by manufacturer.

Table 2: Example of format for published rating.

AHRI 680 Standard Rating		Maintenance Instructions
Airflow Rate (cfm)	Initial Resistance (in. w.c.)	Use Only Replacement Filters With an Initial Resistance Less Than 0.032 in. w.c. at 400 cfm Airflow Rate
400	0.03	

Table 3: Return location label.

References

1. Stevens, B., J. Siegel, A. Novoselac. 2010. "Energy implications of filtration in residential and light-commercial buildings." *ASHRAE Transactions* 116(1):346–357.

2. Proctor, J., R. Chitwood, B. Wilcox. 2011. "Efficiency Characteristics and Opportunities for New California Homes." California Energy Commission.

3. Davis, R. 2001. "Influence of Evaporator Coil Airflow in Relation to the Type of Expansion Device on the Performance of a Residential Split-System Air Conditioner." Pacific Gas and Electric Company Performance Testing and Analysis Unit, Technical and Ecological Services.

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*For an opposing view of the relationship between filters, efficiency, and energy usage see a discussion of the results of ASHRAE RP-1299.[1]

**ASHRAE SSPC 62.2 is considering whether to increase the currently specified MERV 6 filter or equivalent.