EXECUTIVE SUMMARY

FINAL REPORT ARTI-21CR/611-40050-01
THE ROLE OF FILTRATION
IN MAINTAINING CLEAN HEAT EXCHANGER COILS

The main purpose of the study was to investigate the role of filtration in maintaining clean heat exchanger coils and overall performance. Combinations of 6 different levels of filtration (MERV 14, 11, 8, 6, 4, and no filter) and 4 different coils (an eight-row lanced-fin coil, HX8L), (an eight-row wavy-fin coil, HX8W), (a four-row lanced-fin coil, HX4L) and (a two-row lanced-fin coil, HX2L) were tested at 4 different air velocities (1.52, 2.03, 2.54,3.05 m/s (300, 400, 500, 600 ft/min)). The fouled conditions were obtained after injection of 600 grams of ASHRAE standard dust upstream of the filter/coil combination. This magnitude of dust is representative of a year of normal operation for an air conditioning system. The air-side pressure drops of the coils and filters and air-side heat transfer coefficients of the coils were determined from the measurements under the clean and fouled conditions. Depending upon the filter and coil test, the coil pressure drops increased in the range of 6%-30% for an air velocity at 2.54 m/s (500 ft/min). The impact was significantly greater for tests performed without a filter. The largest relative effect of fouling on pressure drop occurs for coils with fewer rows and having lanced fins. Coils with a greater number of rows can hold more dust so that a fixed amount of dust has a relatively smaller impact. The impact of fouling on air-side heat transfer coefficients was found to be relatively small. In some cases, heat transfer was actually enhanced due to additional turbulence caused by the presence of dust.

The experimental results for pressure drops and heat transfer coefficients were correlated and the correlations were implemented within computer models of prototypical rooftop air conditioners and used to evaluate the impact of fouling on cooling capacity and EER. The equipment cooling capacity is reduced with fouling primarily because of a decrease in air flow due to the increase pressure drop rather than due to changes in heat transfer coefficient. In most cases, the EER was reduced with fouling primarily due to increased fan power. However, the changes in EER were relatively small, in the range of 1%-9%

(10%). For most cases, equipment having low efficiency filters had higher EER after fouling than equipment with high efficiency filters, because the high efficiency filter caused significantly higher pressure drops than the low efficiency filters. The extra filter pressure drop outweighed the reduced coil pressure drop after fouling. The impact of fan efficiency curves was also investigated in the study. The energy penalty associated with high efficiency filters was reduced considerably with higher efficiency fans.

There is an energy penalty associated with the use of high efficiency filtration. However, the primary reason for selecting high efficiency filters for a particular application would be improved air quality. For HX8L, the quantity of dust passing through the coil with a MERV4 filter was approximately 30 times the dust passing the coil with a MERV14 filter. Without an upstream filter, the quantity of dust passing through the coil was approximately 60 times the value for a MERV14 filter.