Summary of Field and Laboratory Tests of the ADSIL Coating

ADSIL has developed an inorganic coating for application on air-cooled condensers of air conditioners and chillers. The ADSIL coating process improves condenser heat transfer performance and increases cooling efficiency. The process of cleaning and coating the coil also appears to stabilize the performance improvement by minimizing the chance of further corrosion, fouling, or heat transfer degradation. Some of the heat transfer improvement may result from the coating's ability to penetrate and fill voids between the fin and tube that naturally form as the condenser coil degrades with time.

The savings achieved with the ADSIL coating process has been determined through both laboratory and field measurements. The Florida Solar Energy Center (FSEC) has measured the impact of the Adsil coating by completing pre and post coating tests on several air conditioner (AC) units in their laboratory facilities in Cocoa, Florida. CDH Energy Corp. has also analyzed pre-post field data collected from several AC units that were monitored at Mayport Naval Air Station and MacDill Air Force Base.

FSEC Laboratory Testing

A series of new and used residential split system air conditioners have been tested in psychrometric chambers at FSEC's Appliance Laboratory (ALT). For each AC split system, the condensing unit was placed in the outdoor chamber and AC evaporator section was located in the indoor chamber. The chambers were maintained at standard test conditions (i.e., 95°F outdoors, 80°F & 51% rh indoors). The sensible and latent cooling capacity of the indoor coil was determined by measuring the temperature and humidity entering and leaving the unit along with the supply air flow rate (i.e., the air-enthalpy method, as per ASHRAE Standard 37).

For each test unit, the system was first tested "as is". Then, the outdoor coil was "pre-cleaned" using industry-standard maintenance techniques (i.e., a garden hose with a brush) and the unit was retested. Then, the ADSIL cleaning and coating process was completed and system efficiency was tested again for a third time. Table 1 summarizes the impact that the ADSIL process had on the efficiency of the tested units. The coating process had no impact – either positive or negative – on new AC units. However, older units that had suffered more condenser degradation did show a statistically significant increase in efficiency, ranging from 10-12% for systems more than half way through their useful life. The initial "pre-cleaning" of each unit (before the ADSIL coating) increased efficiency by an additional 5-7%.

Table 1. Summary of Laboratory "Pre-Post" Test Results at FSEC

Test Unit	Test Unit Description	Est. Unit Age (% of Expected Life)	Impact of ADSIL Cleaning/Coating on Efficiency
A1	Bryant 5-ton split system	75%	9.7%
A2	Carrier 2.5-ton spilt system	0%	no impact
A3	Trane 5-ton split system	85%	11.8%
A4	Rheem 5-ton split system	67%	9.5%
A5	Lennox 5-ton	40%	1.8%
A6	Carrier 5-ton	0%	No impact

Another test at FSEC compared the long-term performance of two identical AC units exposed to a salt spray for more 248 days. One AC unit had the ADSIL coating applied while the other untreated unit served as the control. Both units were subjected to the salt spray and the efficiency of both units were measured until the base unit was estimated have reached 75% of its useful life.

Figure 1 summarizes the measured efficiency degradation trends for both the ADSIL-treated and control units over the their expected life. The ADSIL coating visibly reduced corrosion and significantly reduced rate of efficiency degradation. When the control unit reached 50% of its useful life, the ADSIL-coated unit was from 5-20% more efficient than the control unit.

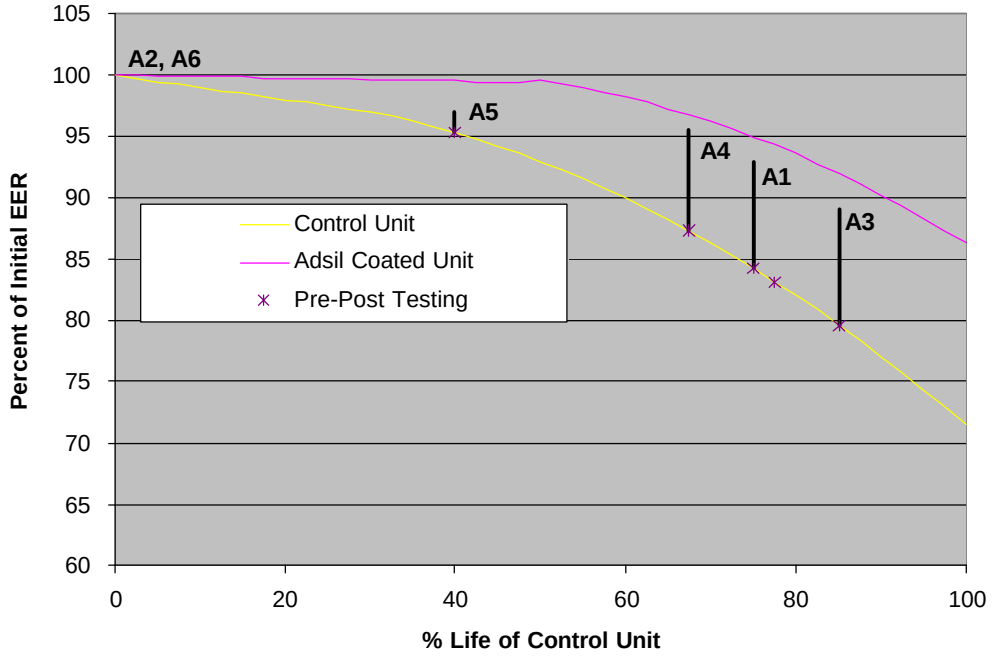

Figure 1. Results of Salt-Spray "Life" Testing of AC Units at FSEC

The results of the pre-post tests in Table 1 are also shown on Figure 1 as vertical bars. Applying the ADSIL coating to a degraded unit (as was done in tests A1 to A6) appears to bring the system back to nearly the same performance level that would be expected for an AC unit that was coated when new.

Field Testing at Mayport and MacDill

Detailed testing of several air-cooled DX units and chillers in the field demonstrated a similar impact when applying the ADSIL coating. Several AC units at Mayport Naval Base and MacDill AFB were cleaned and coated in the Fall 2000 and Spring 2001. Dataloggers and instrumentation were installed on each unit to collect performance and energy use data at 5-minute intervals across the monitoring period. The efficiency of these units was monitored both before and after the ADSIL coating was applied. In most cases, the AC units and chillers were initially cleaned and checked prior to the monitoring period to eliminate these confounding effects.

The pre- and post-coating data were statistically analyzed to quantify the impact of the ADSIL process. The first step was to find data in the pre and post period where the system operated at approximately the same conditions and operating state. Multi-linear regression analysis was used to discern the impact of the ADSIL coating while accounting for variations in operating conditions. The regression analysis also provided a quantitative estimate of the statistical uncertainty associated with the savings. Table 2 summarizes the estimated savings for each system at both locations. For Mayport, the average increase in unit efficiency for the 10 systems was 5.7%. The average increase for each unit ranged from 0.6 to 11.1%. For 6 of the 10 systems,

the impact was found to be statistically significant at the 95% confidence level. The average efficiency increase for these units was 6.2%.

Table 2. EER Improvement Attributable to the ADSIL Coating

Mayport Units	**Average Efficiency Impact**
Bldg 436 (5 ton DX)	3.3%
Bldg 36 (15 ton DX)	1.8%
Bldg 1966 (7.5 ton DX)	0.6%*
Bldg 1966 (5 ton DX)	8.2%
Bldg 1380 (DX)	11.1%*
Bldg 1343 (1 ton window)	2.6%*
Bldg 1343 (chiller)	9.9%
Bldg 117 (25 ton chiller)	6.4%
Bldg 116 (50 ton chiller)	5.6%*
Bldg 24 (3.5 ton DX)	7.4%
Mayport Average (6 units w/ statistically significant savings)	**6.2%**

MacDill Units	**Average Efficiency Impact**
Gym Chiller (50 ton)	2.0%*
Building 312 Chiller (25 ton)	13.2%
Building 299 Chiller (70 ton)	10.3%
Building 926 Chiller (30 ton)	-0.3%*
Officers Club Chiller #2 (100 ton)	12.9%
Building 926 Split System (10 ton)	5.3%
Hanger 3 Unitary System (7.5 ton)	10.1%
Hanger 3 Split System (7.5 ton)	5.4%
McDill Average (6 units w/ statistically significant savings)	**9.5%**

Note: * - results were not statistically significant

The overall average efficiency increase for the eight ADSIL-coated units at MacDill was 7.4%. The efficiency impact on each unit ranged from 0.3% to 13.3%. Six of the eight coated units showed an increase in efficiency that was statistically significant at the 95% confidence level. The average increase in efficiency for these six units was 9.5%.

Summary

The laboratory test results showed efficiency improvements of 10-12% for older units with significant condenser degradation. No improvement was observed for nearly new units with a clean condenser (as would be expected with a pristine coil). Unlike organic coatings, the ADSIL coating was demonstrated to have no negative impact on condenser heat transfer. The sample of different AC units in the field showed efficiency improvements ranging from 0% to 13%. The average efficiency increase at the statistically significant field test sites was 8%.

For all these laboratory and field tests, care was taken to pre-clean the condensers before the ADSIL coating was applied. If credit is also taken for the efficiency improvement due to this initial cleaning, then the laboratory test show that an additional energy savings of 5-7% can be credited to the overall ADSIL process. Thus, comprehensive programs that both clean and coat AC condensers would be expected to provide overall energy savings of 13 to 15%.