Improving Energy Efficiency in Alabama Broiler Housing with Closed Cell Polyurethane Spray Systems

Summary Report - 10/1/05 Through 3/31/07

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Project Overview

Many growers are exploring a number of technological and management innovations in an effort to reduce rapidly escalating propane expenses encountered in recent years. Better broiler house tightness and improved insulation have played key roles in helping reduce propane usage on many newly constructed broiler farms. However, in older broiler houses the high cost of traditional insulation technology and the high labor requirements associated with proper sealing have been barriers. A new, sprayable, closed cell polyurethane foam (AG-Tite $_{TM}$) was introduced in recent years, which appears to have great potential for providing growers with a cost-effective method of simultaneously tightening and insulating older curtain-sided broiler houses. AG-Tite seals whatever surface it touches, it dries and hardens within 15 seconds, and it has an insulation value of R-7 per inch of thickness. It is fireproof and waterproof. With only a small amount of preparatory work, AG-Tite can be sprayed throughout the curtain opening in an older broiler house to seal, insulate, and provide a vapor barrier. Treating both sidewalls and endwalls on a typical 40 foot wide by 500 foot long takes only a few hours. A one-inch thick application of this product to the side and end walls seals the entire surface from air leakage and provides a continuous vapor barrier, in addition to increasing insulation by R-7. AG-Tite also provides an airtight seal between sidewall and endwall boards, as well as around equipment openings. Applying AG-Tite to existing surfaces, such as board lumber or OSB, increases the insulation of that surface by a value of R-7 per inch of thickness. House tightness, measured with a term referred to as static pressure, improves substantially. Thus, AG-Tite jointly provides sealing and insulting capabilities which promotes increased energy efficiency and more efficient ventilation. Experimental tests have shown that a properly treated older house should experience a reduction in annual fuel usage and cost of approximately 30 percent.

Location

This project was implemented on a 12 house broiler farm near Susan Moore in Blount County, AL. The grower who operates this farm agreed to maintain accurate energy use and production records, and agreed to accommodate visits by groups for educational purposes during and following the demonstration period, provided that all visitors adhered to normal biosecutity procedures recommended by the State Veterinarian. The company for which he grows, Tyson Foods, agreed to maintain separate production records for the two sets of houses during the demonstration period whenever possible. All 12 houses were originally constructed in 1989 and are virtually identical. Each of the 40' X 500' houses is structurally sound, and has been retrofitted over time with tunnel ventilation, evaporative cooling, sidewall inlets, and electronic controllers. Emergency generators and transfer switches have also been installed. The 12 houses are paired, as shared feed bins service each pair. Thus, for this project, three pairs of houses were treated with AG-Tite and 3 pairs of houses were left untreated. This facilitated a direct comparison between 6 treated (test) houses and 6 untreated (control) houses. For 5 of the 7 flocks studied in this project, 3.80 pound target weight birds were grown. The 6th flock had a target weight of 5.00 pounds and the 7th flock had a target weight of 5.40 pounds. These 7 flocks represent one annual cycle.

In addition to closely monitoring fuel usage, this project also monitored electrical usage. Separate electrical meters are extremely uncommon on most farms. However, this farm has a separate electric meter for each of three groups of four houses. Thus, direct electrical consumption comparisons were made for four of the AG-Tite treated houses against four of the untreated houses, and an average annual electrical cost per house was determined. Propane usage and electricity usage constitute total utility costs.

This poultry farm served as an ideal demonstration site for this technology, as the houses are located in close proximity to several hundred growers representing several companies, the houses are very typical of the "average" curtain sided broiler house in Alabama, the ability to monitor separate houses is in place, the producer is very progressive and maintains excellent production and financial records, and the company management is very cooperative. This project sought to demonstrate the improved energy efficiency and profitability of sealing and insulating conventional curtain-sided broiler houses in a cost effective manner. Feed conversion (where possible), propane consumption & cost, electricity consumption & cost, and pounds of liveweight produced were recorded and compared for each flock, and totaled for the annual period.

Implementation

Application of Ag-Tite and initiation of the project began in October, 2005 when the first time-between-flock period occurred. Prior to site preparation and treatment, each house had a static pressure reading taken to provide a baseline value of house tightness. Site preparation consisted of removal of litter from the treatment area, standard interior wall wash-down procedures, permanently closing large doors on the fan end of each house, and nailing the existing curtain to the sidewalls. The actual foam treatment of the 6 houses occurred during late October, 2005, with AG-Tite being sprayed onto all interior sidewalls and endwalls of the 6 test houses from the ceiling line down to the dirt floor pad. Additionally, a sealer was sprayed on the bottom 2 feet of all interior walls to reduce potential damage from birds pecking and from darkling beetles burrowing into the foam. In an effort to minimize anticipated damage arising from darkling beetles, an insecticide treatment, graciously provided by Ivesco, was performed in each house, followed by strip treating beneath all feed lines and along all sidewalls and endwalls with boric acid. Insecticide and boric acid treatment occurred prior to each flock placement. Excellent darkling beetle control results have been observed throughout the project.

Upon completion of the AG-Tite treatment, static pressure readings were taken in each house and compared to the readings obtained prior to treatment. These tests were performed with all inlets and doors closed and one 48-inch fan running. The following table shows the difference in readings:

House No.	Pre-Treatment	Post-Treatment
1	0.12	0.27
2	0.12	0.26
3	0.12	0.27
4	0.13	0.29
5	0.12	0.28
6	0.12	0.26

The test houses (#1-6) were all not quite as tight initially as the control houses (#7-12). Control houses ranged from 0.13 to 0.17. Thus, the 6 test houses were selected for treatment because of their greater potential for improvements in tightness. The tightness results were extremely impressive, as static pressure readings more than doubled in each treated house. This greatly improved the farm manager's ability to establish and manage an effective and cost efficient ventilation program.

After a total of 9 flocks (approximately 1 ½ years), static pressure readings were again taken. This was to ascertain if house settling or continuous equipment operation resulted in loss of house tightening. After 9 flocks, static pressures were reduced by an average of 0.10 indicating that houses lost tightness; however, insulation value was not adversely affected. The following table shows static pressure readings after 9 flocks:

House No.	Static Pressure	Difference
1	0.17	0.10
2	0.18	0.08
3	0.17	0.10
4	0.17	0.12
5	0.18	0.10
6	0.16	0.10

Project Summary

Since the completion of the initial application of AG-Tite closed cell polyurethane foam sealant and insulation, nine flocks have now been raised. The farm manager initially had difficulty understanding how the major house changes would increase house ventilation efficiency and alter ventilation performance. Thus, it was decided to begin accumulating data with the second flock placement. Additionally, production data from Flock #7 were not correctly acquired. The Tyson Foods plant which normally processed these flocks burned and this flock had to be processed with another integrator. Birds from the test and control houses were not processed separately for this flock. Consequently, the final data set represents Flock numbers 2-6 and 8-9.

There were negligible fuel savings observed during the first flock, only 10 gallons of propane. Following some detailed ventilation management training of the farm manager, the 2nd flock saved an average of 211 gallons of propane per house, the 3rd flock saved an average of 277 gallons of propane per house, the 4th flock saved an average of 112 gallons of propane per house, the 5th flock saved an average of 38 gallons of propane per house, the 6th flock saved an average of 27 gallons of propane per house, the 7th flock saved an average of 35 gallons of propane per house, the 8th flock saved an average of 424 gallons of propane per house, and the 9th flock saved an average of 557 gallons of propane per house. Annual propane usage was reduced from 5,639 gallons to 3,958 gallons, or by 1,681 total gallons per house. This is a reduction of 30 percent. At $1.50 per gallon of propane, the average cumulative fuel savings amount to $2,521.50 per house. A slight increase in electrical consumption of 1,064 kWH per year, or $79.80 per house ($11.40 per house per flock) has been observed in the test houses. This is because the improved house tightness causes more fresh air to be pulled through the evaporative cooling pads than cracks and leaks. Since pads provide more resistance for incoming air, fans are placed under a slightly heavier electrical load.

Bird performance improved in the Test houses for most flocks, as the in-house environment became more consistent side-to-side and end-to-end. This better, more consistent bird environment led to performance improvements in every category measured. It should be noted that the 3rd, 4th, and 5th flocks had severe hatchery-related chick quality and growout problems which the owner and manager recognized immediately, and took steps to remedy. This led to higher mortality and decreased growth rate. Even so, average flock per house performance was better in the test houses than in the control houses, as shown in the table below:

Performance Item	Test House Improvement
Total Net Weight	10,348
Average Weight	0.0544
Average Daily Gain	0.0017
Percent Livability	0.2470

The test houses averaged producing 10,438 additional pounds per house of liveweight with a value of $558.42, average bird weight increased by 0.0544 pounds, average daily gain improved by 0.0017 pounds per bird per day, and livability improved by 0.2470 percent. From the grower's perspective, the annual net profitability improvement is $3,000.12 per house ($2,521.50 propane - $79.80 electricity + $558.42 production), or $18,000.72 for the 6 AG-Tite treated houses. Assuming an initial treatment cost of $7,500.00 per house financed at 8% interest for 5 years, the conservative estimate of the break-even point for recovering investment cost plus interest occurs in 22 small bird flocks, or slightly more than 3 years. Occasional spot re-treatment of damaged foam areas was quick and inexpensive using aerosol canisters of the AG-Tite touch-up product.

From the Integrator's perspective, the results are excellent. Problems arose with separating feed delivery records from the 4th flock forward, thus separate feed conversion and standard cost calculations are not possible for the last 6 flocks. However, feed conversion was better each of the first three flocks with an average improvement of 5.58 points (0.0558 fewer pounds of feed required per pound of liveweight gain). Standard cost was also better for each of the first three flocks with an average improvement of $0.0089 per pound. The cumulative Integrator's savings was calculated to be approximately $17,000 through three flocks, which includes improved livability, increased production, and decreased feed cost. Extrapolation of results in the absence of actual feed data indicates an estimated annual Integrator savings of approximately $30,000.

Outreach Plan

The extensive outreach component planned for this project was limited as a result of the large number of outbreaks of avian *laryngotracheitis* (referred to simply as LT) in the surrounding area of the farm during the study period. On the advice of the Commissioner, Alabama Department of Agriculture and Industries, the State Veterinarian, and Tyson Foods management, on-site tours of the demonstration facilities and grower meetings have needed to be minimized until there is no further threat of spreading this disease. While several small-scale visits and tours have been held, once the danger of disease spread is no longer deemed a problem by the Alabama Department of Ag and Industries, the State Veterinarian, and Tyson Foods management, additional demonstration tours will be conducted. Several housing coordinators, live production managers, broiler managers, poultry supply companies, legislators, and growers have already been to the farm to learn about this technology, and tentative arrangements are being made to tour the test farm with several Integrator representatives from nearby complexes in North Alabama beginning in the summer of 2007.

Extension and Outreach publications with preliminary findings have been developed and have be published and presented during the duration of this project, as well as posted to www.poultryhouse.com. Invited presentations containing much of the preliminary findings and highlighting advantages of tight, well insulated poultry housing have already been made at the following formal events (estimated attendees):

International Poultry Exposition, Atlanta, GA, January 2006 (225)
American Academy of Agricultural Scientists, St. Louis, MO, February 2006 (100)
AAES/ACES Energy Meeting, E.V. Smith Research Center, February 2006 (125)
Poultry House Construction Short Course, Auburn, AL March 2006 (100)
Getting Ready for Hot Weather, APEA Short Course, Montgomery, May 2006 (100)
Pilgrims Pride Flock Supervisor Seminars, Jasper, TX, May 2006 (75)
Gold Kist Summertime Ventilation Training, Sumter, SC, May 2006 (60)
UGA Tunnel Ventilation Workshop, Athens, GA, May 2006 (100)
Koch Foods Summertime Ventilation Training, Chattanooga, TN May 2006 (25)
Aviagen International Seminar, Huntsville, June 2006 (60)
Aviagen International Seminar, Auburn, June 2006 (50)
Diversified Imports Annual Management Training, New York, NY, June 2006 (100)
The Poultry Federation Annual Seminar, Springdale, Arkansas, October 2006 (250)
USPEA Annual Live Production and Health Conference, Memphis, TN, September 2006 (125)
ALFA State Poultry Committee, Montgomery, AL, September 2006 (25)
APEA Poultry Grower Seminars, Troy, New Brockton, Cullman, and Boaz, AL, October, 2006 (950)
APEA Board of Directors Meeting, Montgomery, AL, December 2006 (40)
National Association of RC&D Councils Annual Meeting, Huntsville, AL, January 2007 (100)
International Poultry Exposition, Atlanta, GA, January 2007 (1,500)
Iner-Agency Waste Management Meeting, Auburn, AL, February 2007 (30)
RC&D CAFO Training Meeting, Oneonta, AL, March 2007 (15)

Conclusions

This project successfully demonstrated that AG-Tite closed cell polyurethane spray foam treatment of older poultry houses is a cost-effective method for tightening, sealing, and insulating structurally sound older poultry houses. Houses retrofitted with this technology can significantly reduce propane consumption, while increasing production and flock performance. Growers with older, loose, uninsulated houses which are structurally sound will financially benefit from treating their house walls and curtain openings with closed cell polyurethane spray foam. Growers who choose to use this retrofit technique must understand that the foam may be severely damaged by darkling beetles, by bird pecking, and by physical equipment damage.

Several growers who have implemented this technique have reported either adding a physical protective barrier to the wall bottoms (plywood, OSB, rolled roofing, etc.) or applying a higher density product to prevent equipment damage and bird pecking damage. Additionally, an effective darkling beetle control program must be implemented, to include insecticide product rotation and proper application coverage.

Selected photographs from the project farm are attached.

ADECA Poultry Energy Efficiency Project – Selected Photographs

Test Farm – Susan Moore, AL – October 2005

Interior Curtain Wall Prior To Treatment – October 2005

Exterior Curtain Wall Prior To Treatment – October 2005

Darkling Beetle Problem Prior To Treatment – October 2005

Exterior Curtain Nailed Down With Treated 1” X 4” Boards – October 2005

Nailed Down Curtain – October 2005

AG-Tite Application Equipment – October 2005

Applying AG-Tite To Curtain Opening And Sidewall – October 2005

AG-Tite Dried On Curtain Opening And Sidewall – October 2005

Completed AG-Tite Curtain Opening And Sidewall – October 2005

Boric Acid Strip Beneath Feed Lines For Darkling Beetles – October 2005

Demonstrating Proper Ventilation Techniques – December 2005