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DUAL TUBE COUNTER FLOW HEAT EXCHANGER
Final Report

Work Performed Under Contract No. FG01-82CE15148

Wilhelm Engineering Company, Inc.
Ashland, Wisconsin

Technical Information Center
Office of Scientific and Technical Information
United States Department of Energy

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DUAL TUBE COUNTER FLOW
HEAT EXCHANGER

FINAL REPORT

JULY 1984

DOE #DE-FG01-82CE15148

WEC PROJECT #513

WILHELM ENGINEERING CO., INC.
CONSULTING ENGINEERS

707 SECOND STREET WEST ASHLAND, WISCONSIN 54806

MASTER

PHASE I - Mobilization Fact Gathering

On October of 1982 mobilization and fact gathering stage of this project was started. Information was gathered on prices and materials needed on the project such as thin wall plastic tubes, fans, blowers, relative humidity measuring recording equipment, temperature measuring recording equipment, fastening devices, etc.

A meeting was held with the cooperator Frank Gessell and Dr. Mattson at the site. We're unable to obtain a cooperator to volunteer two similar buildings, therefore, sections of a single building were used.

The barns were physically measured and heat loss estimates were made. Since the barn was a set of two buildings were heated from the same central heating plan, and separate energy usage had not been previously collected for each building, and individual building energy use was unavailable.

In-house staff meetings were held to assign project tasks and to go over the results of the field trip.

PHASE II - Design

Engineering staff of Wilhelm Engineering researched various types of materials and material suppliers. After some study it seemed most appropriate to use materials currently being supplied by poultry industry suppliers. The largest center for poultry equipment is in the Wilmar, Minnesota area. Traveled to Wilmar and talked to several Ag equipment suppliers there and selected various components from shelf stock equipment. Tubes are typically stocked with perforations and we had to order unperforated tubes. This is the only material which was custom ordered. We designed a test model to be tested in the basement of Wilhelm Engineering office. Because of limited space a 40 foot long section was designed at approximately one-fourth the capacity anticipated for the full scale proto-type.

Supporting system was developed. No exchange of heat was anticipated in the test model, therefore, no drain system was developed.

The development of the proposal program was anticipated at two side by side buildings. However, a cooperator was not available with this type of building. The cooperator was agreeable to the project and allowed us to use a split section within a single barn. We feel this did not compromise the objective but some of the work anticipated for the heating system and insulation was no longer appropriate.

PHASE III - Monitoring Systems

Monitoring systems consisted of manual and automatic monitoring. Central boiler was monitored for furnace efficiencies. Stack temperatures were monitored. Based on this information the recommendations were given to the cooperator to improve thermal efficiencies. This was done prior to beginning the heat exchanger monitoring. Ventilation system volumes were checked at various speeds with manual equipment. Differential between the test section and the outside of the building were determined to be 0.1 inch of water.

Initial readings were taken on gas (LP) supply lines and hour meter readings on circulating pumps.

Automatic recording including both temperature and relative humidity. Automatic recording was established to record outside air temperature. Pressure intake duct and temperature entry to exhaust duct. Intake air outlet duct, room temperature near ceiling of test section, room air temperature 18 inches above floor and 6 sensors inside the tubes measuring the inside duct and outside duct temperature at three locations. Inside relative humidity is measured. Intake air to furnace temperatures were not measured because it was in a separate boiler room and impractical to run thermo-couple wires outside the test building. Ventilation fan running times could not be obtained because the number of ventilating fans.

The recording mechanism was set up and calibrated against hand held equipment.

The automatic recording equipment was bought utilizing Minneapolis, Honeywell, Brown Instrument Company. No problem was encountered in interfacing various equipment.

PHASE IV - Test Section

We constructed a 40 foot long working model utilizing 12 inch diameter inside tubes and 18 inch diameter outside tubes. Fans were mounted on the intake end and exhaust end. System was pressurized to determine the strength of tubes. Outside air was not connected to the system. There was no attempt to exchange heat in the working model. We discovered problems with collapse of the inside tubes and swaying of the entire unit after it had been running awhile. Information was useful in designing the final version as the problems discovered in the test model could be eliminated.

PHASE V

Wilhelm Engineering prepared working drawings for a full scale proto-type installation. Plans were reviewed by Dr. Mattson, DVM, regarding environmental health. A copy of the plans have been forwarded to the DOE under separate cover.

PHASE VI - Construction

This section was accomplished by forces from Wilhelm Engineering and local electrical and plumbing contractor. Initial construction was completed in December of '82 and January of '83.

PHASE VII - Evaluation of Monitoring Modifications of the System

Engineers from Wilhelm Engineering supervised the start up and initial readings of all monitoring systems. Installation was inspected by Dr. Mattson after construction and initial start up. Dr. Mattson inspected the poultry for diseases and stresses. There's difficulty in having the cooperators employees obtain the readings due to their total infamiliarity with the equipment and rotating work assignments. Decision was made to go to the automatic recording equipment instead. The automatic recording equipment did not arrive until spring of '83. Further, winter of '83 was unusually mild and reliable data was not obtained during the cold weather season.

Because of these problems an extension of time was requested and granted. Wilhelm Engineering staff regularly checked the monitoring equipment, picked up data charts. During these inspections meetings were held with the cooperator and the farm manager to obtain their input on the heat exchanger.

A recirculation duct was installed in February of 1984.

CONCLUSIONS

The heat exchanger was successful in exchanging heat. It's performance was almost directly proportional to temperature differential between inside barn temperature and outside ambient air. In extremely cold weather some icing problems occurred. We feel that it can be managed in further installations by the recirculating system and also by different location for the intake screens.

CONCLUSION - Continued

The heat exchanger recordings have shown as much as 60 degrees increase in temperature from outside air being run through the heat exchanger. It should be noted that this is an extreme during very cold subzero weather. However, it does point out the ability of the heat exchanger to greatly temper outside air with simply using air which would otherwise be exhausted and with no additional heat being added to this system. A 2 hour period of heat exchanger results is shown in Appendix A of this report. A letter from Dr. Mattson is included as Appendix B.

Payback period for the heat exchanger is estimated to be less than one year. The heat exchanger has no adverse affect on bird health. In fact, it created a healthier environment for the birds as is noted in Dr. Mattson's final comments in Appendix B.

APPENDIX A

SUMMARY OF DATA ANALYSIS

CASE 1

DATE 01/09/84

TOTAL ELAPSED TIME = 24 HOURS

OUTDOOR TEMPERATURE

AVERAGE; 12.53 HIGH; 23.00 LOW; -6.00

INDOOR TEMPERATURE

AVERAGE; 86.65 HIGH; 89.00 LOW; 83.00

THERMAL PERFORMANCE

AVERAGE HEAT GAIN; 31.96 AVERAGE BTU/MIN.; 1353 TOTAL BTU'S; 1,948,401

CASE 1

DATE 01/10/84

!-----AIR TEMPERATURES, DEGREES F.-----!-GAIN THRU EXCHANGER-!-MEAN HEAT TRANSFER COEFFICIENT-!

	OUTDOOR	FRESH INTAKE	FRESH EXH.	ROOM INTAKE	ROOM EXH.	INDOOR	HEAT DEG.F.	BTU'S /min.	SECTION 1	SECTION 2	SECTIONS 1&2	
12; 4 AM	-05	-02	41	91	72	86	43	1870	0.000	0.000	0.000	12; 4 AM
12;10 AM	-06	-03	39	90	71	85	42	1833	0.000	0.000	0.000	12;10 AM
12;16 AM	-06	-03	41	90	72	85	44	1916	0.000	0.000	0.000	12;16 AM
12;22 AM	-07	-03	42	90	73	85	45	1957	0.000	0.000	0.000	12;22 AM
12;28 AM	-06	-03	41	91	73	86	44	1916	0.000	0.000	0.000	12;28 AM
12;34 AM	-07	-03	40	89	72	85	43	1875	0.000	0.000	0.000	12;34 AM
12;40 AM	-07	-05	42	91	73	86	47	2049	0.000	0.000	0.000	12;40 AM
12;46 AM	-08	-05	42	91	73	86	47	2049	0.000	0.000	0.000	12;46 AM
12;52 AM	-07	-05	42	91	73	86	47	2049	0.000	0.000	0.000	12;52 AM
12;58 AM	-08	-05	41	90	72	85	46	2008	0.000	0.000	0.000	12;58 AM
1; 4 AM	-08	-05	43	91	73	86	48	2090	0.000	0.000	0.000	1; 4 AM
1;10 AM	-09	-06	42	90	73	87	48	2095	0.000	0.000	0.000	1;10 AM
1;16 AM	-09	-05	41	91	73	85	46	2008	0.000	0.000	0.000	1;16 AM
1;22 AM	-10	-06	41	89	72	85	47	2054	0.000	0.000	0.000	1;22 AM
1;28 AM	-09	-06	41	90	72	85	47	2054	0.000	0.000	0.000	1;28 AM
1;34 AM	-10	-06	41	90	72	85	47	2054	0.000	0.000	0.000	1;34 AM
1;40 AM	-10	-07	41	90	71	84	48	2100	0.000	0.000	0.000	1;40 AM
1;46 AM	-10	-07	40	90	71	85	47	2059	0.000	0.000	0.000	1;46 AM
1;52 AM	-11	-07	43	90	72	87	50	2182	0.000	0.000	0.000	1;52 AM
1;58 AM	-10	-05	41	90	71	87	47	2054	0.000	0.000	0.000	1;58 AM

APPENDIX B

VETCON

W. E. Mattson, D.V.M., Pres.
R.R. 2, Box 458
New London, MN 56273
June 29, 1984

Received by Mr. A.
June 29, 1984
W. E. Mattson, D.V.M.
New London, MN 56273

A.A. Wilhelm
Wilhelm Engineering
Ashland, Wisconsin

Dear Tony,

I have just finished reading the final report on the Dual Tube Counter Flowing Heat Exchanger. There is no question that the system works, but the most striking information to be gained from the experiment was the reduction in incidence of pericarditis, which accounted for most of the mortality in this particular barn. The reduction of humidity is probably a cause of decrease in pericarditis incidence. Dust removal is also a beneficial factor.

The removal of moisture, other than by the exhaust fan, would result in an economic reduction in mortality and an increase in final weights and grades. To date there has been no satisfactory system to remove moisture, that is available to the industry. The Dual Tube Counter Flowing Heat Exchanger fulfills this need.

Sincerely,

W.E. Mattson DVM

W.E. Mattson, DVM

Enclosure
WEM:klm

APPENDIX C

KEY PERSONS

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