AVI AIR

Heat Exchangers

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Greenhouse gases reduction summery with Avi35 air to air heat exchanger installed in Canadian broiler farms.

Study #1 Data gathered and analysed by LEMAY & CHOINIÈRE engineering consultants.

Study #2 Data gathered and analysed by NGTC, gas technology development centre

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The Avi-Air heat exchangers are installed all across Canada in broiler barns. There is great interest in evaluating the gains in fuel gas savings and the reduction of CO_2 emission for chicken farmers following the installation of heat exchanger units. Two different study were conducted by two independent organisations to evaluate the potential reduction of greenhouse gas emissions.

The first study was performed by Lemay and Choinière engineering consultants, where the energy consumption of several poultry farm sites are analyzed over a full year of measurements after the installation of heat recovery units. Conditions vary greatly from one barn to another, and from one breeding year to another. Consequently, the consumption measurements for a specific year are adjusted using energy modeling software to mimic average monthly outdoor ambient conditions obtained during measurement period and coincidences of outdoor versus normalized indoor temperatures. This method proves more accurate for comparing energy consumptions obtained for a building without heat recovery units with those measured following the addition of heat exchangers. The results are presented in table 1. You can compare different sites with and without heat exchangers.

Table 1 – Energy consumption of several poultry farm sites

General conditions by site						
Description	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**
Number of buildings	6	1	2	2	1	1
Number of storey by building	2	2	2	2	2	3
Average width of buildings	38'-0" (11,58 m)	40'-0" (12,19 m)	40'-0" (12,19 m)	42'-0" (12,80 m)	46'-0" (14,02 m)	40'-0" (12,19 m)
Type of fuel used for heating	Propane	Propane	Propane	Propane	Propane	Propane

Annual fuel and electricity consumption without heat recovery units						
Description	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**
Fuel (L or m^3)	170 615	23 520	38 737	101 256	39 243	43 150
Fuel (L/bird or m^3/bird)	1.529	1.049	0.894	1.369	1.379	1.447
Fuel (MJ/kg bird produced)	2.526	1.515	1.587	2.256	2.267	2.98
Fuel (J/DJC/kg Bird produced)	435	269	358	539	456	674
Electricity (kWh)	221 361	47 353	74 040	94 570	45 682	34 960
Electricity (kWh/bird)	1.983	2.112	1.709	1.279	1.605	1.172

Details on heat recovery units installed						
Description	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Number of Avi35 air exchangers installed	44	6	12	24	8	12
Number of bird/recovery units	2 536	3 738	3 611	3 081	3 558	2 486

Annual fuel and electricity consumption with heat recovery units						
Description	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Fuel (L or m^3)	91 344	10 595	16 180	52 035	19 299	22 386
Fuel (L/bird or m^3/bird)	0.818	0.472	0.373	0.704	0.678	0.751
Fuel (MJ/kg bird produced)	1.352	0.683	0.663	1.159	1.115	1.546
Fuel (J/DJC/kg Bird produced)	233	121	150	277	224	349
Electricity (kWh)	325 986	62 297	97 994	124 139	59 459	50 066
Electricity (kWh/bird)	2.921	2.778	2.261	1.679	2.089	1.678

Energy report by site						
Description	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
% of fuel consumption reduction	46%	55%	58%	49%	51%	48%
% of electricity consumption reduction	-47%	-32%	-32%	-31%	-30%	-43%
Reduction of greenhouse gases emission (GHG) (T CO2e/year)	121.466	19.809	34.576	75.493	30.586	31.842
Reduction of greenhouse gases emission (GHG) (T CO2e/year/recovery units)	2.761	3.302	2.881	3.146	3.823	2.654

Clearly, energy consumption and its reduction following the addition of heat recovery units can vary from one site to another, from one building to another and even from one year to another. Nevertheless, the results presented show that the addition of heat recovery units significantly reduced the fossil fuel consumption required to heat the 13 livestock buildings studied in six different projects.

The second study was performed by NGTC in one broiler site with two identical and isolated pens, where one was equipped with 2 Avi-Air heat exchangers and the other was using conventional ventilation. In the latter study, 6000 chicks were placed in each pen on the same day and were sent to market on the same day as well. This way, outside and inside temperature are the same for both pens. The study lasted for three consecutive flock cycles in winter of 2019. A natural gas meter and a power meter were installed in both pens. Outside and inside relative humidity and temperature were also measured and analysed. The gas and electricity consumption of both pens were analyzed and presented on a weekly basis of a 37 days production cycle. The natural gas consumption reduction from the Avi-Air heat exchanger pen is summarised in table 2.

Table 2

Semaine d'élevage (Journées)	**Économies d'énergie (gaz naturel) (%)**			
	Cycle 1	**Cycle 2**	**Cycle 3**	**Moyenne par semaine ou cycle**
1 J[1 – 7]	nd	8,28 ±0,03 %	19,32 ±0,03 %	**13,80 ±0,02 %**
2 J]7 – 14]	25,49 ±0,03 %	26,89 ±0,03 %	43,16 ±0,04 %	**31,85 ±0,02 %**
3 J]14 – 21]	56,91 ±0,03 %	40,13 ±0,04 %	49,71 ±0,05 %	**48,92 ±0,02 %**
4 J]21 – 28]	46,70 ±0,04 %	60,91 ±0,03 %	59,81 ±0,06 %	**55,81 ±0,03 %**
5 J]28 – 37]	69,67 ±0,03 %	68,77 ±0,07 %	nd	**69,22 ±0,04 %**
Moyenne par cycle	**54,67 ±0,02 %**	**41,32 ±0,02 %**	**43,00 ±0,02 %**	**47,87 ±0,01 %**

On average, over three cycles of production, the pen using the heat exchangers used 48 % less natural gas as oppose to the conventional pen.

The global energy reduction must account for the increase in electricity, since each exchanger operates with two ventilators (exhaust and intake fans) as oppose to a conventional single fan. To compare electricity and gas consumption on the same basis, NGTC converted the electric consumption to cubic feet natural gas at a ratio of 1KWh 3,41 cubic feet of gas. The global energy reduction is decreased by 8 % when the rise of electrical power is added. Table 3 presents the total energy reduction, gas and electricity.

Table 3

Semaine d'élevage (Journées)	**Économies d'énergie totale (gaz naturel et électricité) (%)**			
	Cycle 1	**Cycle 2**	**Cycle 3**	**Moyenne par semaine ou cycle**
1 J[1 – 7]	nd	7,27 ±0,03 %	17,62 ±0,03 %	**12,44 ±0,02 %**
2 J]7 – 14]	24,15 ±0,03 %	24,81 ±0,03 %	38,52 ±0,04 %	**29,16 ±0,02 %**
3 J]14 – 21]	52,71 ±0,03 %	35,02 ±0,04 %	26,97 ±0,04 %	**38,23 ±0,02 %**
4 J]21 – 28]	39,91 ±0,03 %	54,42 ±0,03 %	35,53 ±0,03 %	**43,28 ±0,02 %**
5 J]28 – 37]	59,19 ±0,03 %	59,72 ±0,06 %	nd	**59,45 ±0,03 %**
Moyenne par cycle	**48,22 ±0,02 %**	**39,66 ±0,02 %**	**29,66 ±0,02 %**	**39,18 ±0,01 %**

In conclusion, in an effort to reduce greenhouse gas emissions, the Avi-Air heat exchanger has been proven to be an efficient tool for the Canadian farmers. Both studies, performed with different approaches, showed a significant decrease in gas emissions. In the six sites study, where some barns are equipped with heat exchangers and others are using conventional ventilation, an averaged a 51 % reduction of propane consumption over one year is measured. Similarly, the NGTC measured a 48 % reduction in natural gas consumption in the heat exchanger equipped pen compared to the control pen, from a site where the pen size and external relative humidity and temperature were identical.