Performance Testing and Results

Maximum® chimneys for natural ventilated systems

Project conducted for:
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Natural ventilation systems are an interesting and practical way of ventilating livestock shelters. Nevertheless, these systems depend on the natural forces of wind and convective airflow created by temperature differences. Several factors influence the performance of the chimneys used for natural ventilation systems, and installed in the roof of the shelters.

The Maximum chimney is a new concept in chimney design for natural ventilation systems. The test conducted for the manufacturer consisted in comparing their performance to the conventional chimney such as those recommended by Agriculture and Agro-food Canada.

Objective

The test consisted in comparing the performance of the Maximum chimney to that of the conventional chimney. To compare performance, the airflow at the chimney inside the building was measured under various outside temperature conditions.

Method

The test was conducted at the piggery of the Macdonald Campus farm of McGill University. The piggery has a naturally ventilated room measuring 50ft in length by 30ft in width and housing some 96 grower hogs. The walls have panels sliding vertically. These panels have a height of 24" and cover the full length of the building. A thermostat controls their position. The room has a cathedral ceiling with two chimney offering a cross sectional area of 24" x 24". The room has a North-South orientation and is located more than 300ft away from any obstacles. It is therefore fully exposed to the prevailing winds.

For the tests conducted in April and Mai 2002, the Northern conventional chimney was replaced by a Maximum chimney also offering a cross sectional area of 24" x 24". For the tests conducted in December 2002, the Southern conventional chimney was replaced by a Maximum chimney, also of 24" x 24" in cross sectional area. Changing the position of the chimneys demonstrated that differences in chimney performances were do to the chimney and not the position.

Once the chimney was installed, the air flow across its inside surface area was measured using an anemometer and a grid (16 positions or 4 x 4 positions). The measurements were taken from inside the building. The grid method respected that recommended by the

American Society of Heating, Refrigeration and Air Conditioning Engineering (1993) page 13.14.

This testing procedure was repeated 6 times in April and Mai 2002 and 4 times in December 2002. In April and Mai, the outside temperature varied between 50 and 90°F, while in December, the temperature varied between 30 and 12°F. During every testing session, the inside and outside temperatures were measured, as well as the wind velocity and direction. The wind velocity was measured at a height of 5ft and at 100ft away from any obstacles.

Results

The attached table summarizes the airflow performance measured for both the Maximum and conventional chimney.

The Maximum chimney offered a more stable airflow than that of the conventional chimney. No matter what the outside temperature and wind velocity were, the Maximum chimney tended to give an average air velocity at its cross sectional area of 1.6 to 2.3 ft/s, (380 to 550 cfm) except for the reading on April 17th, when the air flow was reversed and came into the building. The conventional chimney gave an average air velocity at its cross section, which varied between –2.2 to +3.5 ft/s (-530 to + 840 cfm) and this depending on the prevailing wind speed, the degree of sidewall opening and the temperature differences. A negative velocity means an airflow coming into the building rather than going out, at the chimney level. Airflow was often negative with the conventional chimney. The Maximum chimney gave a negative airflow only once, and because under high West wind speeds with the East panel more widely open than that of the West. Thus, the East wall panel was creating more airflow suction than the West wall panel could provide and to compensate, the air came in by both the conventional and Maximum chimneys.

Even under cold temperatures and low wind velocities, the Maximum chimney gave an air velocity of 2.1ft/s, which corresponds to airflow of 510 cfm. Under the same conditions, the conventional chimney gave almost no airflow.

Conclusion

The Maximum chimney gave a relatively constant airflow of 2.0 ft/s or 480 cfm, under a wide variety of exterior wind and temperature conditions. Also, it consistently allowed air out while the conventional chimney often allowed air to come in, which causes cold air drafts onto the animals. The Maximum chimney allowed air in under a very specific condition where one of the wall panels was letting too much air out for that being let in by the other wall panel. A good balance between wall openings is important because as one allows air in, the other allows air out.

The Maximum chimney is therefore a new concept, which can improve the performance of natural ventilation systems.

Suzelle Barrington, Eng. Agr.
Professor.

December 20th, 2002.

Performance of the Maximum chimney versus the natural chimney
Piggery with natural ventilation (50ft in length by 30 ft in width)

Date	Ext. Temp.	Int. Temp.	Wind speed	Wind Direction	Average chimney air velocity*		Temperature at chimney		Wall panel opening		Chimney air flow	
					Maximum	Conventional	Maximum	Conventional	West	East	Maximum	Conventional
	F	F	mph		ft/s	ft/s	F	F	%	%	cfm	cfm
Maximum chimney on North end												
April 10	53,6	66,2	6,8	West	2,89	-1,67			0	0	693	-401
April 17	82,94	84,56	11,2	West	-1,97	-2,20			66	100	-472	-527
April 25	56,66		9,8	West	2,17	3,49			25	25	521	837
May 1	56,3	66,56	7,2	West	2,26	1,50			0	25	543	361
May 9	53,6	59,54	5,8	West	2,25	2,15			75	0	540	516
May 16	59,36	67,1	4,6	West	1,61	1,47			25	75	386	354
Maximum chimney on South end												
Dec 17	30,2	65,3	6,5	West	2,16	0,43	69,44	66,92	0	10	520	102
Dec 17	15,8	57,2	2,6	East	2,13	0,89	69,08	69,44	0	10	512	213
Dec 18	24,8	65,3	3,3	South East	2,13	-0,43	65,84	66,74	0	10	512	-102
Dec 18	17,6	57,2	0,5	East	2,13	1,21	62,6	62,6	0	10	512	291

* a negative value means air in coming into the building through the chimney