Air Missile Test Evaluation Report May 2020

Background

Drying grain is a necessary part of any grain operation. Several methods to accomplish this include batch dryers, continuous feed dryers and in-bin aeration. During in-bin aeration, warm dry air is applied to the bottom of the bin to dry the grain. This process pushes moisture up and out the top of the bin to dry the grain. One major problem experienced with this method is the air becomes saturated and cool by the time it reaches the top part of the bin. This saturated, cooler air can no longer carry any more moisture with it and results in a moisture cap forming at the top of the bin that requires extra heat, air and time to remove. The Air Missile was developed to solve this problem.

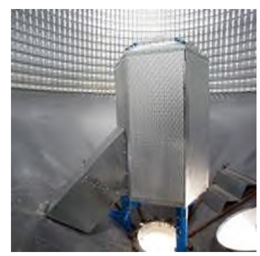
The Air Missile consists of an 8" vertical tube that directs air to the upper portion of the bin where the moisture cap typically forms. This redirected air flow to the top portion of the bin continues to push the moisture up and out of the bin drying the grain faster and more evenly throughout the bin. Preliminary tests using a prototype have shown up to 17% improvement in energy usage compared to a more conventional air distribution system.

Test Setup and Data Collection

The testing site was located at O'Hare Ranching outside Kitscoty, AB. Two identical 4000-bushel bins with hoppers were selected and filled with wheat. These bins both have Bin Sense Cables installed for moisture and temperature readings and each bin was fitted with a 7.5HP HEPAD for heat and aeration.

A leading competitor's "Product X" was installed in Bin 3. This is a 48" aeration system rated for 5000 bushels. This bin was filled with wheat and had an average moisture content of 18.39% at the start of the test.

The Air Missile was installed on a 24" horizontal ducting in Bin 4. The horizontal ducting measures 8' long and is located near the top of the hopper. This bin was filled with wheat and had an average moisture content of 16.37% at the start of the test.



Competitor Product

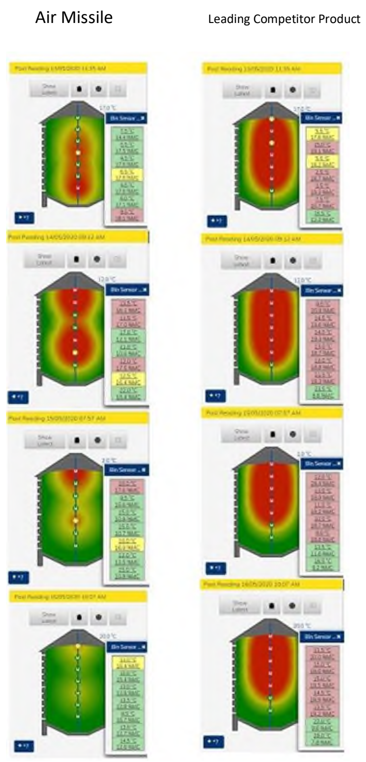
Prior to the test, flow and temperature sensors were installed to measure:

a. air flow supplied by the HEPAD on each bin
b. air flow directed up the Air Missile
c. temperature of air supplied by each HEPAD
d. ambient temperature and humidity

The gas and electricity usage were also metered for each HEPAD during the test. Data was documented daily for the 5-day duration of the test.

Test Results

During the test, it was quickly evident that the Air Missile was outperforming the other leading aeration system. Only 50 hours into the test, the burner on Bin 4 (Air Missile) had to be shut off to avoid over drying the grain. After 76 hours, Bin 4 was sufficiently dried and the HEPAD fan was shut down as well. Drying continued on Bin 3 to the point where the average moisture was unchanging and the grain near the bottom of the bin was over-dried.



Bin 3 was started with a moisture of 18.39%. The final moisture content was 16.64%. On average the grain was dried 1.8% removing 5,038 lbs. of water. This process took 95 hours, used 10.6GJ of natural gas and 737 KWH of electricity. The average air flow over the course of the test was 4602 cfm. Screen shots taken of the bin moisture and temperature sensors show the formation of the moisture cap in Bin 3 preventing efficient drying from occurring.

Bin 4 was started with a moisture of 16.37%. The final moisture content was 13.21%. On average the grain was dried 3.2% removing 8,738 lbs. of water. This process took 76 hours, used 5.5 GJ of natural gas and 563 KWH of electricity. The average air flow over the course of the test was 4728 cfm. Screen shots taken of the bin moisture and temperature sensors shows the effect of the Air Missile in breaking down the moisture cap and moving the moisture out of the bin. This process resulted in complete drying of the grain with no excessive wet or hot spots occurring during drying.

Based on the data collected, costs to dry the grain were calculated as well as the quantity of water removed using the two different aeration products. During this test, we saw an improvement of over 60% in cost to dry per bushel and a 70% reduction in BTU required per lbs. water removed

Bin3 - Rocket	Bushels	MC	Dry Wt (lbs)	H20 Wt (lbs)	Date/Time	
Start	4000	18.39%	195,864	44,136	13/05/2020 10:37	
Finish	3916	16.64%	195,864	39,098	17/05/2020 10:01	
Shrink		84	Bushels		Power Calculations	
Drying Pts		1.8	%		Amp	32.2
Water Removed		5,038	lbs		Hours	95
Power Usage		737.3	KWH		KWH	737.3
Gas Usage		10,000.0	Cubic Feet		$ 0.10	/KWH
		10.6	GJ		$ 4.99	/GJ
		10,000,000	BTU			
BTU/lbs H2O Removed		1985	BTU			
Power 737 KWH x $ 0.1 /KWH		$ 71.34				
Gas 11 GJ x $ 4.99 /GJ		$ 52.61				
Total Cost		**$ 123.95**				
$ / 1000 Bushel / 1 pt Drying		**$ 17.71**				
$ / 1000 lbs H2O Removed		**$ 24.60**				

Conclusion

Although further testing will be done to fully optimize the Air Missile for max height, size, different products and other specifications, it is clearly evident that the Air Missile has easily out-performed the leading competitor's product. The Air Missile will significantly lower the cost per bushel to dry using bin aeration as well as fully drying grain in the bin without turning the grain.

Bin 4 - Air Missile	Bushels	MC	Dry Wt (lbs)	H20 Wt (lbs)	Date/Time	
Start	4000	16.37%	200,712	39,288	13/05/2020 10:37	
Finish	3854	13.21%	200,712	30,550	16/05/2020 14:30	
Shrink		146	Bushels		Power Calculations	
Drying Pts		3.2	%		Amp	30.9
Water Removed		8,738	lbs		Hours	76
Power Usage		562.8	KWH		KWH	562.8
Gas Usage		5,200.0	Cubic Feet		$ 0.10	/KWH
		5.5	GJ		$ 4.99	/GJ
		5,200,000	BTU			
BTU/lbs H2O Removed		595	BTU			
Power 563 KWH x $ 0.1 /KWH		$ 54.46				
Gas 5 GJ x $ 4.99 /GJ		$ 27.36				
Total Cost		**$ 81.81**				
$ / 1000 Bushel / 1 pt Drying		**$ 6.47**				
$ / 1000 lbs H2O Removed		**$ 9.36**				

Calculations of cost to dry grain