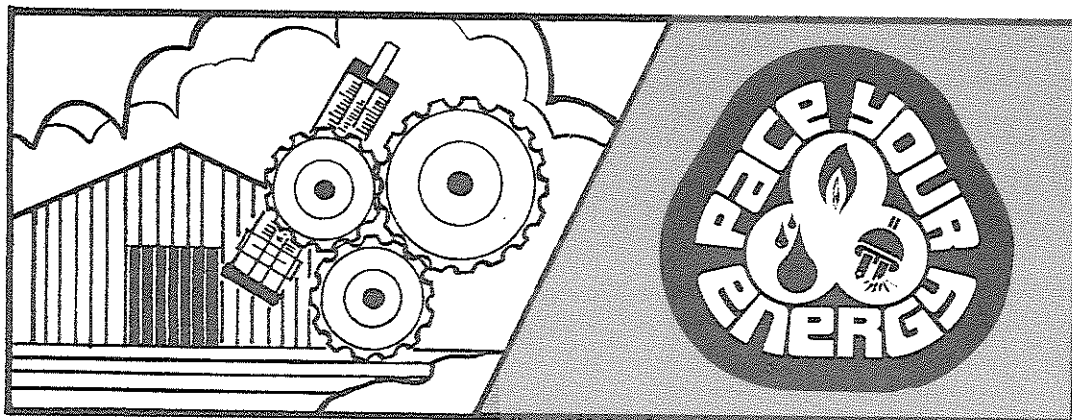


ENERGY IN AGRICULTURE

Fan Performance on Grain Drying Bins

by Otto J. Loewer, Tom C. Bridges, G. M. White, Robert L. Fehr and Larry W. Turner



UNIVERSITY of KENTUCKY
COLLEGE of AGRICULTURE
DEPT. of AGRIC. ENGINEERING
COOPERATIVE EXTENSION SERVICE

in
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KENTUCKY
DEPARTMENT
of
ENERGY

FAN PERFORMANCE ON GRAIN DRYING BINS

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One of the keys to successful in-bin grain drying and aeration is the matching of a drying or aeration fan to the drying or storage bin. A properly designed system will be more efficient in terms of both drying and energy utilization. The quantity of air that may be delivered through the grain depends upon grain type, bin size, fan type, fan horsepower, depth of grain, percent of foreign material and the extent to which the grain is packed. If you wish to evaluate the performance of a fan on a grain bin in terms of air flow and energy efficiency, complete the following form and return it to:

Dr. Otto J. Loewer
Associate Extension Professor
Agricultural Engineering Department
University of Kentucky
Lexington, Kentucky 40506

You will receive a computer analysis of your drying system free of charge, and the input form will be returned to you. However, you must provide answers to all the input questions.

1.

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NAME

2.

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ADDRESS

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3.

A	C																		
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PHONE NUMBER

4.

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FAN IDENTIFICATION
(Use any name or number you desire)

5.

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BIN DIAMETER, FT.

6.

STATIC PRESSURE (inches of water)	AIR FLOW CUBIC FEET per minute
0.0	
1.0	
1.5	
2.0	
2.5	
3.0	
3.5	
4.0	
4.5	
5.0	
5.5	
6.0	
6.5	
7.0	
7.5	
8.0	
8.5	
9.0	
9.5	
10.0	

FAN PERFORMANCE DATA:

Refer to the fan literature provided by the manufacturer. Supply as much of the information as possible concerning the cubic feet of air per minute (CFM) delivered by the fan for each level of static pressure (inches of water). The fan literature may not contain all values requested on this form. However, provide as much information as possible. A minimum of three values is required. For more than one identical fan per bin, total the CFM values for the same static pressure.

7.

HORSEPOWER OF FAN MOTOR

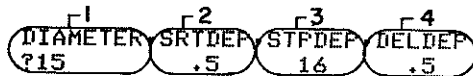
8.

TYPE OF GRAIN
(select either corn, milo, wheat or soybeans.)

9.

MAXIMUM DEPTH OF GRAIN IN THE BIN, FT.

The information you receive will be similar to that shown below. Each term is defined below the sample output.



FAN ID XL370-7		0										
SP	0.0	0.50	1.00	1.50	2.00	2.50	6					
CFM	24530.	24530.	22420.	19900.	16200.	13300.	7					
DEPTH	9	BU	10	SP	11	CFM	12	FFM	CFM/BU	HPUSED	EFF	17
CORN	8											PF=1.50
0.50	71.	1.85	17284.4	97.8	244.52	5.05	50.48					
1.00	141.	2.44	13670.6	77.4	96.70	5.25	52.48					
1.50	212.	2.58	11247.7	63.6	53.04	4.57	45.68					
2.00	283.	2.64	9619.1	54.4	34.02	4.00	39.99					
2.50	353.	2.68	8449.9	47.8	23.91	3.57	35.72					
3.00	424.	2.71	7593.4	43.0	17.90	3.25	32.48					
3.50	495.	2.74	6933.1	39.2	14.01	2.99	29.93					
4.00	565.	2.76	6405.0	36.2	11.33	2.78	27.85					
4.50	636.	2.78	5970.9	33.8	9.39	2.61	26.11					
5.00	707.	2.79	5606.4	31.7	7.93	2.46	24.64					
5.50	778.	2.80	5294.9	30.0	6.81	2.34	23.37					
6.00	848.	2.81	5025.1	28.4	5.92	2.23	22.26					
6.50	919.	2.82	4788.5	27.1	5.21	2.13	21.28					
7.00	990.	2.83	4579.0	25.9	4.63	2.04	20.40					
7.50	1060.	2.83	4391.9	24.9	4.14	1.96	19.62					
8.00	1131.	2.84	4223.6	23.9	3.73	1.89	18.91					
8.50	1202.	2.85	4071.2	23.0	3.39	1.83	18.26					
9.00	1272.	2.85	3936.5	22.3	3.09	1.77	17.69					
9.50	1343.	2.86	3805.6	21.5	2.83	1.71	17.13					
10.00	1414.	2.86	3676.9	20.8	2.60	1.66	16.58					
10.50	1484.	2.87	3551.6	20.1	2.39	1.60	16.04					
11.00	1555.	2.87	3436.9	19.4	2.21	1.55	15.55					
11.50	1626.	2.87	3332.0	18.9	2.05	1.51	15.09					
12.00	1696.	2.88	3234.4	18.3	1.91	1.47	14.67					
12.50	1767.	2.88	3143.5	17.8	1.78	1.43	14.27					
13.00	1838.	2.89	3058.4	17.3	1.66	1.39	13.90					
13.50	1909.	2.89	2978.7	16.9	1.56	1.36	13.56					
14.00	1979.	2.89	2903.8	16.4	1.47	1.32	13.23					
14.50	2050.	2.89	2833.2	16.0	1.38	1.29	12.92					
15.00	2121.	2.90	2766.7	15.7	1.30	1.26	12.63					
15.50	2191.	2.90	2703.7	15.3	1.23	1.23	12.35					
16.00	2262.	2.90	2644.1	15.0	1.17	1.21	12.09					

- DIAMETER—Refers to the diameter of the grain bin.
- SRTDEP—The grain depth at which the fan evaluation begins (ft).
- STPDEP—The final grain depth to be considered (ft.) Corresponds to the answer given in Question 8.
- DELDEP—Grain depth increment between each analysis (ft).
- FAN ID—The identification given in Question 4.
- SP—The static pressure values provided in Question 5.
- CFM—The cubic feet per minute (CFM) values corresponding to static pressures given in Question 5.
- CORN—The grain type considered, Question 7.
- DEPTH—The 1st column is the depth of grain in the bin (ft).
- BU—The 2nd column is the bushels of grain that correspond to the grain depth.
- SP—The 3rd column is the static pressure in inches of water that correspond to the grain depth.

12. CFM—The 4th column is the total cubic feet per minute of air delivered by the fan corresponding to the grain depth.
13. FPM—The 5th column is the velocity of the air in the bin in ft per minute that correspond to the grain depth.
14. CFM/BU—The 6th column is the cubic feet of air per minute delivered to each bushel in the bin corresponding to the grain depth.
15. HPUSED—The 7th column is the horsepower used in actually moving the air through the grain corresponding to the grain depth.
16. EFF—The 8th column is the ratio of the actual horsepower used in moving the air to the total horsepower available.
17. PF—The “packing factor” multiplier; that is, clean loosely filled grain has a value of 1.0. This term serves as a safety factor in fan design.

ESTIMATING DRYING TIME:

The CFM per bushel term is one of several items required to estimate drying time. This value may be easily obtained from the computer output chart (Item 14). For example, if a layer or low-temperature system is being used, the example fan would deliver 1.17 CFM/BU at a grain depth of 16 ft. However, if the grain depth were only 4 ft. such as is typical of batch-in-bin drying, the example fan would deliver 11.33 CFM/BU. Using a computed air flow rate, you may estimate drying time by using one of the available programs listed below (No. 6-8).

ESTIMATING ENERGY USAGE:

An estimate of energy usage may be found with the following equation:

$$\text{Energy used in KW-hr} \approx \left(\frac{\text{hours of fan}}{\text{operation}} \right) \times \left(\frac{\text{horsepower}}{\text{used}} \right) \times 100.0 / (\text{Efficiency Factor})$$

assuming 1 hp-hr = 1000 watts allowing for a motor efficiency of 75%. The efficiency factor is equal to 50.0 or the value given in Column 8, whichever is smaller. The hours of operation may be estimated using the drying programs that are available.

AVAILABLE PROGRAMS:

1. BNDZN: Computer analysis of economics, energy consumption and engineering design of a grain storage system.
2. CHASE: Computer model that evaluates and compares costs of selected methods of harvesting, handling, drying and storage of corn for an individual farmstead. Energy consumption is also estimated.
3. CACHE: Computer model for economic analysis of farm drying and processing systems.
4. SQUASH: Computer simulation of the harvesting-delivery-drying system used to determine bottlenecks in the system.
5. *ESTIMATING FAN SIZES FOR GRAIN DRYING SYSTEMS.
6. *GRAIN DRYING PERFORMANCE EVALUATION
7. *DRYERATION PERFORMANCE EVALUATION
8. *NATURAL AIR—LOW TEMPERATURE DRYING PERFORMANCE EVALUATION
9. *FAN PERFORMANCE ON GRAIN DRYING BINS

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*These programs were developed by:

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University of Nebraska
Lincoln, Nebraska

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