



Aeration Systems for Flat-Bottom Round Bins

Carol Jones

Extension Stored Products Engineer

Geetika Dilawari

Research Engineer

Before attempting to select, design, or manage an aeration system one should study the publication Fact Sheet BAE-1101 "Aeration and Cooling of Stored Grain."

Fact sheet BAE-1101 discusses the importance of choosing the right airflow rate to obtain the desired aeration system capabilities. Power requirements, fan selection, control systems, and management suggestions are also presented. BAE-1103 covers the design and selection of aeration system components for cone-bottom round tins. This Fact Sheet, BAE-1102, covers the design or selection of aeration system components for flat-bottom, round grain bins.

Types of Systems

A fully-perforated metal drying floor offers the best air distribution system for flat-bottom grain bins. The totally perforated floor is elevated approximately 18 inches above the concrete floor of the bin. This area serves as a plenum and is a convenient location for the unloading auger. A totally perforated floor is illustrated in Figure 1.

Totally-perforated floors are normally installed in bins for the purpose of grain drying. While they provide the best distribution system for aeration, they are also the most expensive. A foundation ring and floor support system must be installed in addition to the perforated floor.

A partially-perforated floor offers the next best alternative and is illustrated in Figure 2. A square section, with side length equal to $1/2$ to $2/3$ of the bin diameter, is recessed approximately 10 inches at the center of the bin. Concrete blocks and dimensional lumber support sections of perforated floor placed over this area. Air is ducted to this center area, which again serves as a plenum. No foundation ring is needed and the perforated floor section is easily installed. The central recessed area is easily formed in concrete.

Ducts are commonly used as distribution systems for aeration. If the ducts are set below floor level (flush-floor ducts), a sweep auger may be used for complete bin unloading. If ducts are placed above the floor (on-floor ducts), manual labor is required to completely empty the bin.

On-floor ducts are usually round or half-round in cross-section and are illustrated in Figure 3. Flush-floor ducts are usually rectangular in cross-section and are illustrated in Figure 4.

Aeration ducts may be placed in a variety of patterns to obtain more uniform air distribution. Common patterns are illustrated in Figure 5. The system illustrated in 5-B provides

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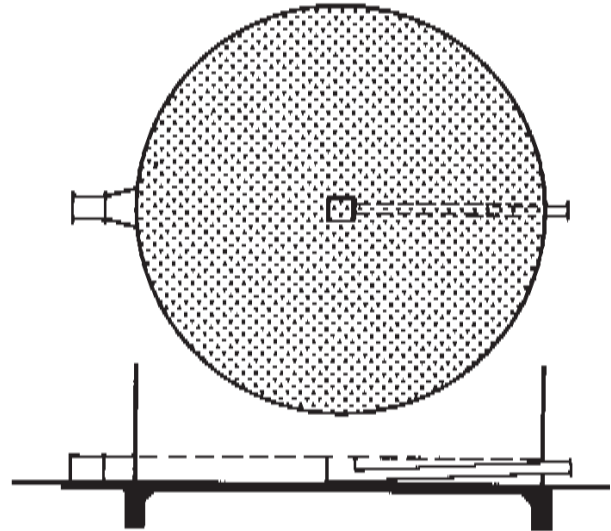


Figure 1. A totally-perforated floor system.

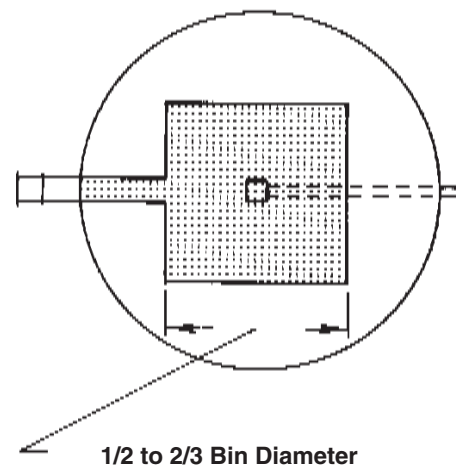


Figure 2. A partially-perforated floor system.

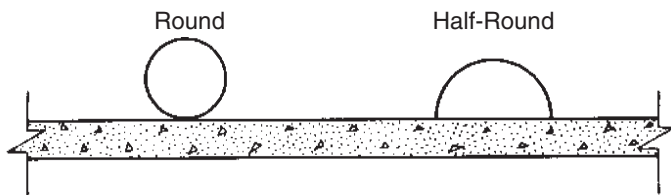


Figure 3. On-floor ducts are usually round or half-round in cross-sections.

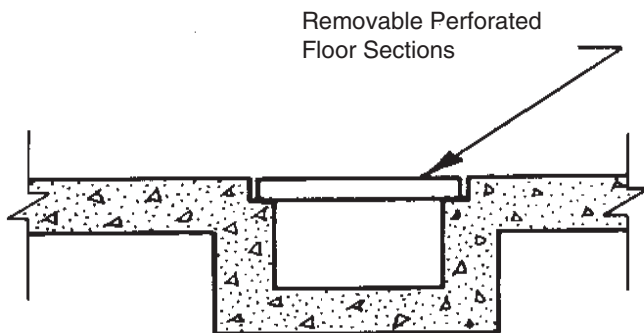


Figure 4. Flush-floor ducts are usually rectangular in cross-section.

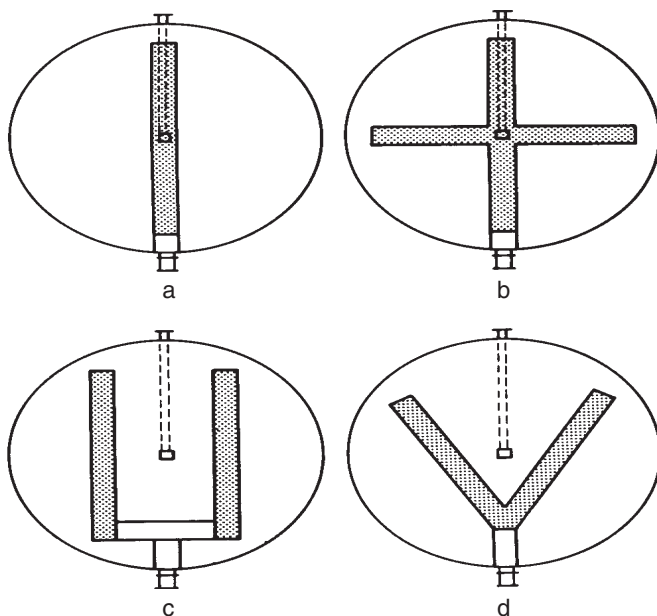


Figure 5. Common patterns for aeration ducts.

the best distribution pattern and gives a higher concentration of airflow at the center, often a trouble spot. This pattern is desirable for bin diameters of 24 to 42 feet.

Description of Terms

The following terms are used in the design procedure:

hp = Horsepower

fpm = feet per minute, air velocity;

CFM = cubic feet of air per minute, air volume;

CFM/bu = cubic feet of air per minute per bushel, airflow rate;

static pressure = the pressure against which the fan must operate, expressed as inches of water.

Design Procedure

The design procedure for aeration systems involves the following steps:

1. Selecting air-flow rate, determining bin capacity, and determining total air volume to be delivered;
2. Selecting ducts on the basis of cross-sectional area and surface area;
3. Determining operating static pressure; and
4. Selecting fans to deliver the required air volume when operating against the expected static pressure.

Determining Air Volume

The required air volume is determined by the chosen airflow rate, in CFM/bu, and the bin capacity in bushels. If the bin diameter, bin sidewall height or grain depth, and desired airflow rate are known, bin capacity and air volume can be determined using Table 1. Bin capacity does not include storage in the roof section. It is assumed the bin will be filled to the eaves making grain depth and bin sidewall height equal.

Example: Bin capacity for a 30 feet diameter and 24 feet sidewall height is 13,625 bu.

The choice of airflow rate is an important decision. Higher aeration airflow rates give greater management flexibility and allow the storage of grain with higher moisture content.

However, higher aeration airflow rates also require larger ducts, involve higher static pressures, and have greater power requirements. For a complete discussion of airflow rates, see Fact Sheet BAE 1101.

Example: For a bin capacity of 13,625 bu and an airflow rate of 1/5 CFM/bu (0.2 CFM/bu), the total air volume would be 2,725 CFM (Table 1).

Determining Required Duct Size

When duct distribution systems are used, two critical design factors must be considered: duct cross-sectional area and duct surface area. Recommended maximum duct velocity is 1,500 fpm. Minimum required duct cross sectional area, in square feet, is the total air volume (CFM) divided by 1,500 fpm. Recommended maximum velocity of air leaving the duct is 25 fpm. Minimum duct surface area, in square feet, is the total air volume (CFM) divided by 25 fpm. Table 1 also gives minimum duct surface area and minimum duct cross-sectional area when the total air volume is determined.

Example: For the air volume of 2,725 CFM, at least 109 square feet of duct surface area and at least 1.82 square feet of duct cross-sectional area should be provided.

The above recommendations apply only to duct systems similar to Figure 5. The duct area requirements do not apply for totally-perforated floor systems. For partially-perforated floor systems, the duct supplying air to the perforated floor must meet the cross-sectional area requirement, but the surface area requirement does not apply. Table 2 is used to determine the required size of flush-floor ducts. Only the flat top of flush-floor ducts may be calculated as surface area.

Example: 22-inch width and 12 inch depth has 1.83 square feet of cross-sectional area and 1.83 square feet of surface area for each foot of length (Table 2). Since 109 square feet of surface area is required, at least 60 feet of 22 inch wide duct must be provided in the bin. (109 divided by 1.83 = 59.6 feet) The duct patterns of Figures 5-B, 5-C, or 5-D would have to be used to provide the required surface area.

Table 1. Bin Capacity, total air volume and minimum duct areas.

Diameter (ft.)	Height (ft.)	Capacity (bu)	Total Air Volume (cfm)					Minimum Duct Surface Area (Sq. ft.)					Minimum Duct Cross-Sectional Area (Sq. ft.)				
			Air Flow Rate (cfm/bu)					Air Flow Rate (cfm/bu)					Air Flow Rate (cfm/bu)				
			1/2	1/3	1/5	1/10	1/20	1/2	1/3	1/5	1/10	1/20	1/2	1/3	1/5	1/10	1/20
15	8	1125	563	375	225	113	56	22.50	15.00	9.00	4.50	2.25	0.38	0.25	0.15	0.08	0.04
	13	1850	925	617	370	185	93	37.00	24.67	14.80	7.40	3.70	0.62	0.41	0.25	0.12	0.06
	16	2275	1138	758	455	228	114	45.50	30.33	18.20	9.10	4.55	0.76	0.51	0.30	0.15	0.08
18	11	2250	1125	750	450	225	113	45.00	30.00	18.00	9.00	4.50	0.75	0.50	0.30	0.15	0.08
	13	2650	1325	883	530	265	133	53.00	35.33	21.20	10.60	5.30	0.88	0.59	0.35	0.18	0.09
	16	3275	1638	1092	655	328	164	65.50	43.67	26.20	13.10	6.55	1.09	0.73	0.44	0.22	0.11
21	21	4300	2150	1433	860	430	215	86.00	57.33	34.40	17.20	8.60	1.43	0.96	0.57	0.29	0.14
	13	3625	1813	1208	725	363	181	72.50	48.33	29.00	14.50	7.25	1.21	0.81	0.48	0.24	0.12
	16	4450	2225	1483	890	445	223	89.00	59.33	35.60	17.80	8.90	1.48	0.99	0.59	0.30	0.15
	24	6675	3338	2225	1335	668	334	133.50	89.00	53.40	26.70	13.35	2.23	1.48	0.89	0.45	0.22
24	16	5825	2913	1942	1165	583	291	116.50	77.67	46.60	23.30	11.65	1.94	1.29	0.78	0.39	0.19
	19	6900	3450	2300	1380	690	345	138.00	92.00	55.20	27.60	13.80	2.30	1.53	0.92	0.46	0.23
	24	8725	4363	2908	1745	873	436	174.50	116.33	69.80	34.90	17.45	2.91	1.94	1.16	0.58	0.29
32	32	11625	5813	3875	2325	1163	581	232.50	155.00	93.00	46.50	23.25	3.88	2.58	1.55	0.78	0.39
	19	8750	4375	2917	1750	875	438	175.00	116.67	70.00	35.00	17.50	2.92	1.94	1.17	0.58	0.29
	24	11025	5513	3675	2205	1103	551	220.50	147.00	88.20	44.10	22.05	3.68	2.45	1.47	0.74	0.37
	32	14725	7363	4908	2945	1473	736	294.50	196.33	117.80	58.90	29.45	4.91	3.27	1.96	0.98	0.49
30	19	10775	5388	3592	2155	1078	539	215.50	143.67	86.20	43.10	21.55	3.59	2.39	1.44	0.72	0.36
	24	13625	6813	4542	2725	1363	681	272.50	181.67	109.00	54.50	27.25	4.54	3.03	1.82	0.91	0.45
	32	18175	9088	6058	3635	1818	909	363.50	242.33	145.40	72.70	36.35	6.06	4.04	2.42	1.21	0.61
33	24	16475	8238	5492	3295	1648	824	329.50	219.67	131.80	65.90	32.95	5.49	3.66	2.20	1.10	0.55
	27	18550	9275	6183	3710	1855	928	371.00	247.33	148.40	74.20	37.10	6.18	4.12	2.47	1.24	0.62
	32	21975	10988	7325	4395	2198	1099	439.50	293.00	175.80	87.90	43.95	7.33	4.88	2.93	1.47	0.73
36	24	19625	9813	6542	3925	1963	981	392.50	261.67	157.00	78.50	39.25	6.54	4.36	2.62	1.31	0.65
	27	22075	11038	7358	4415	2208	1104	441.50	294.33	176.60	88.30	44.15	7.36	4.91	2.94	1.47	0.74
	32	26150	13075	8717	5230	2615	1308	523.00	348.67	209.20	104.60	52.30	8.72	5.81	3.49	1.74	0.87
	40	32700	16350	10900	6540	3270	1635	654.00	436.00	261.60	130.80	65.40	10.90	7.27	4.36	2.18	1.09
42	27	30050	15025	10017	6010	3005	1503	601.00	400.67	240.40	120.20	60.10	10.02	6.68	4.01	2.00	1.00
	32	35600	17800	11867	7120	3560	1780	712.00	474.67	284.80	142.40	71.20	11.87	7.91	4.75	2.37	1.19
	40	44500	22250	14833	8900	4450	2225	890.00	593.33	356.00	178.00	89.00	14.83	9.89	5.93	2.97	1.48
	48	53425	26713	17808	10685	5343	2671	1068.50	712.33	427.40	213.70	106.85	17.81	11.87	7.12	3.56	1.78
48	27	39250	19625	13083	7850	3925	1963	785.00	523.33	314.00	157.00	78.50	13.08	8.72	5.23	2.62	1.31
	32	46500	23250	15500	9300	4650	2325	930.00	620.00	372.00	186.00	93.00	15.50	10.33	6.20	3.10	1.55
	40	58150	29075	19383	11630	5815	2908	1163.00	775.33	465.20	232.60	116.30	19.38	12.92	7.75	3.88	1.94
	48	69775	34888	23258	13955	6978	3489	1395.50	930.33	558.20	279.10	139.55	23.26	15.51	9.30	4.65	2.33

Table 2. Areas of Flush-Floor Ducts.

Width (inches)	Surface Area (Sq. ft./ft. of length)	Depth of Duct (Inches)					
		Cross-sectional Area (Sq. ft.)					
		6	8	10	12	15	18
6	0.50	0.25	0.33	0.42	0.50	0.63	0.75
8	0.67	0.33	0.44	0.56	0.67	0.83	1.00
10	0.83	0.42	0.56	0.69	0.80	1.04	1.25
12	1.00	0.50	0.67	0.83	1.00	1.25	1.50
14	1.17	0.58	0.78	0.97	1.17	1.46	1.75
16	1.33	0.67	0.89	1.11	1.33	1.67	2.00
18	1.50	0.75	1.00	1.25	1.50	1.88	2.25
20	1.66	0.83	1.11	1.39	1.60	2.08	2.50
22	1.83	0.92	1.22	1.53	1.83	2.29	2.75
24	2.00	1.00	1.33	1.67	2.00	2.50	3.00

Table 3 is used to determine the required size of on-floor ducts. For round on-floor ducts the surface area is calculated at 80 percent effective to account for the portion of the duct in contact with the floor. For half-round, on-floor ducts, only the rounded portion of the duct is exposed to grain and can be calculated as surface area.

Examples: A 20-inch diameter, round duct has 2.2 square feet of cross-sectional area and 4.2 square feet of surface area for each foot of length (Table 3). Since 109 square feet of surface area is required in the example, 26 feet of 20-inch diameter, round duct will meet the minimum area requirements. (109 divided by 4.2 = 25.6 feet)

A 30-inch diameter, half-round duct has 2.45 square feet of cross-sectional area and 3.93 square feet of surface area for each foot of length (Table 3). Again, since 109 square feet of surface area is required in the example, 28 feet of 30-inch diameter, half round duct will meet the minimum area requirements (109 divided by 3.93 = 27.8 ft).

Duct sizes are also selected to provide a convenient duct pattern. Often the duct is selected with cross-sectional

Table 3. Areas of On-Floor Ducts.

Diameter (inches)	Round		Half Round	
	Cross-Sectional Area (Sq. ft.)	Surface Area (Sq. ft./ft. of length)	Cross-Sectional Area (Sq. ft.)	Surface Area (Sq. ft./ft. of length)
6	0.2	1.26	0.1	0.79
8	0.35	1.68	0.17	1.05
10	0.55	2.09	0.27	1.31
12	0.79	2.51	0.39	1.57
15	1.23	3.14	0.61	1.96
18	1.77	3.77	0.88	2.36
20	2.18	4.19	1.09	2.62
24	3.14	5.03	1.57	3.14
30	4.91	6.28	2.45	3.93
36	7.07	7.54	3.53	4.71

area larger than required in order to reduce the length of duct necessary to meet the surface area requirement.

Determining Operating Pressure

Tables 4, 5, 6, 7 and 8 are used to determine the expected operating static pressure for various crop types. Table 4 is used when shelled corn is the grain to be aerated, Table 5 is used for barley and oats, Table 6 for soybeans and confectionary sunflowers, Table 7 for oil-type sunflowers and Table 8 for wheat and sorghum. The static pressure of canola is two to three times of wheat. Therefore, if an existing aeration system designed for wheat is used for canola, check the velocity and pressure ratings of the system to ensure adequate airflow. Fact Sheet BAE-1110 covers the methods for storing Oklahoma winter canola. When the system will be used for more than one grain, design for the grain that gives the highest operating pressure.

Table 4. Expected Static Pressure for shelled corn

Values in the table have been multiplied by 1.5 to account for fines and packing in the bin. (If corn is stirred, which tends to decrease airflow resistance, divide table values by 1.5.) Add 0.5 in. water to the table values if air is distributed through a duct system.

Grain depth (ft)	Airflow (cfm/bu)								
	0.05	0.1	0.25	0.5	0.75	1	1.25	1.5	2
	Expected static pressure (inches of water)								
2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
6	0.1	0.1	0.1	0.1	0.2	0.3	0.3	0.4	0.6
8	0.1	0.1	0.1	0.2	0.3	0.5	0.6	0.8	1.2
10	0.1	0.1	0.2	0.3	0.5	0.8	1.1	1.4	2
12	0.1	0.1	0.2	0.5	0.8	1.2	1.6	2.1	3.2
14	0.1	0.1	0.3	0.7	1.2	1.7	2.3	3	4.6
16	0.1	0.1	0.4	0.9	1.6	2.4	3.2	4.2	6.4
18	0.1	0.2	0.5	1.2	2.1	3.1	4.3	5.6	8.7
20	0.1	0.2	0.7	1.6	2.7	4	5.6	7.3	11.3
25	0.2	0.4	1.1	2.6	4.6	7	9.7	12.8	19.9
30	0.3	0.5	1.6	4.1	7.2	11	15.3	20.3	31.9
40	0.5	1	3.1	8.1	14.6	22.6	31.9	42.5	*
50	0.7	1.6	5.3	14	25.6	39.9	*	*	*

* Static pressure is excessive--greater than 50 in. water.

Table 5. Expected Static Pressure for barley and oats.

Values in the table have been multiplied by 1.5 to account for fines and packing in the bin. Add 0.5 in. water to the table values if air is distributed through a duct system.

Grain depth (ft)	Airflow (cfm/bu)								
	0.05	0.1	0.25	0.5	0.75	1	1.25	1.5	2
	<i>Expected static pressure (inches of water)</i>								
2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
4	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.5
6	0.1	0.1	0.1	0.2	0.4	0.5	0.7	0.8	1.1
8	0.1	0.1	0.2	0.4	0.7	0.9	1.2	1.5	2.1
10	0.1	0.1	0.3	0.7	1.1	1.5	2	2.5	3.6
12	0.1	0.2	0.5	1	1.6	2.3	3	3.7	5.4
14	0.1	0.3	0.7	1.4	2.2	3.2	4.2	5.3	7.8
16	0.2	0.3	0.9	1.9	3	4.3	5.7	7.2	10.6
18	0.2	0.4	1.1	2.4	3.9	5.6	7.5	9.5	14.1
20	0.3	0.5	1.4	3	4.9	7.1	9.5	12.2	18.1
25	0.4	0.8	2.2	4.9	8.2	11.9	16.1	20.7	31.1
30	0.6	1.2	3.2	7.4	12.4	18.3	24.8	32.1	48.7
40	1	2.1	6	14.2	24.4	36.2	49.8	*	*
50	1.6	3.4	9.9	23.8	41.4	*	*	*	*

* Static pressure is excessive--greater than 50 in. water.

Table 6. Expected Static Pressure for soybeans and confectionary sunflowers.

Values in the table have been multiplied by 1.5 to account for fines and packing in the bin. Add 0.5 in. water to the table values if air is distributed through a duct system.

Grain depth (ft)	Airflow (cfm/bu)								
	0.05	0.1	0.25	0.5	0.75	1	1.25	1.5	2
	<i>Expected static pressure (inches of water)</i>								
2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
6	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.5
8	0.1	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.9
10	0.1	0.1	0.1	0.3	0.4	0.6	0.8	1	1.5
12	0.1	0.1	0.2	0.4	0.7	0.9	1.2	1.6	2.3
14	0.1	0.1	0.3	0.6	0.9	1.3	1.7	2.2	3.3
16	0.1	0.1	0.3	0.8	1.2	1.8	2.4	3	4.5
18	0.1	0.2	0.4	1	1.6	2.3	3.1	4	6
20	0.1	0.2	0.6	1.2	2	3	4	5.1	7.7
25	0.2	0.3	0.9	2	3.4	5	6.8	8.8	13.4
30	0.2	0.5	1.3	3.1	5.2	7.7	10.6	13.7	21
40	0.4	0.9	2.5	5.9	10.3	15.4	21.4	28	43.4
50	0.6	1.4	4.1	10	17.6	26.7	37.2	49.1	*

* Static pressure is excessive--greater than 50 in. water.

Selecting Fans

Fans are selected from the manufacturer's rating curves or tables to deliver the required air volume when operating against the expected static pressure. Axial fans (propeller-type) are commonly used for aeration since they produce high air volumes at low static pressures. However, air volumes delivered by axial fans fall off rapidly as static pressures increase through the 3.5 to 5.0-inch range. Above this range, centrifugal fans with backward-inclined blades must be used.

In special designs, centrifugal fans will operate efficiently at static pressures of 20 inches or more. Centrifugal fans operate with less noise than axial fans and should be used whenever fan noise may be a nuisance to neighbors. Centrifugal fans of 3 Hp or less cost 2 to 3 times as much as axial fans of the

same Hp rating. Above 5 Hp, centrifugal fans cost 1.5 to 2 times as much as axial fans of the same Hp rating.

The lowest priced fan which will deliver the required air volume when operating at the expected static pressure is the most economical fan to buy. However, the most economical fan to operate is the fan with the lowest power consumption, measured in watts, while delivering the required air volume at the expected static pressure. Nominal horsepower rating is not a good measure of power consumption.

While final fan selection must be made from manufacturer's data, an estimate of the power requirement may be helpful for planning purposes. Equation 1 is used to estimate the power requirement. When selecting fans, consult the data from several manufacturers. Tables 9 and 10 present typical

Table 7. Expected Static Pressure for oil-type sunflowers.

Values in the table have been multiplied by 1.5 to account for fines and packing in the bin. Add 0.5 in. water to the table values if air is distributed through a duct system.

Grain depth (ft)	Airflow (cfm/bu)								
	0.05	0.1	0.25	0.5	0.75	1	1.25	1.5	2
	<i>Expected static pressure (inches of water)</i>								
2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
4	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3
6	0.1	0.1	0.1	0.1	0.2	0.3	0.4	0.5	0.6
8	0.1	0.1	0.1	0.3	0.5	0.7	0.9	1.1	1.7
10	0.1	0.1	0.2	0.5	0.8	1.1	1.5	1.9	2.8
12	0.1	0.1	0.3	0.7	1.2	1.7	2.3	2.9	4.4
14	0.1	0.2	0.5	1	1.7	2.4	3.3	4.2	6.4
16	0.1	0.2	0.6	1.4	2.3	3.3	4.5	5.8	8.8
18	0.1	0.3	0.8	1.8	3	4.4	6	7.8	11.8
20	0.2	0.3	1	2.3	3.8	5.6	7.7	10	15.3
25	0.3	0.6	1.6	3.7	6.5	9.7	13.3	17.4	26.9
30	0.4	0.8	2.4	5.7	10	15.1	20.9	27.5	42.7
40	0.7	1.5	4.5	11.3	20.1	30.7	43	*	*
50	1.1	2.4	7.5	19.3	34.8	*	*	*	*

* Static pressure is excessive--greater than 50 in. water.

Table 8. Expected Static Pressure for wheat and sorghum.

Values in the table have been multiplied by 1.3 for wheat and 1.5 for sorghum to account for fines and packing in the bin. (If corn is stirred, which tends to decrease airflow resistance, divide table values by 1.5.) Add 0.5 in. water to the table values if air is distributed through a duct system.

Grain depth (ft)	Airflow (cfm/bu)								
	0.05	0.1	0.25	0.5	0.75	1	1.25	1.5	2
	<i>Expected static pressure (inches of water)</i>								
2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
4	0.1	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.7
6	0.1	0.1	0.2	0.4	0.6	0.8	1	1.2	1.7
8	0.1	0.1	0.3	0.7	1.1	1.5	1.9	2.3	3.2
10	0.1	0.2	0.5	1.1	1.7	2.3	3	3.7	5.3
12	0.1	0.3	0.8	1.6	2.5	3.4	4.5	5.6	7.9
14	0.2	0.4	1	2.2	3.4	4.8	6.3	7.8	11.3
16	0.3	0.5	1.4	2.9	4.6	6.4	8.4	10.6	15.3
18	0.3	0.7	1.7	3.7	5.9	8.3	11	13.8	20
20	0.4	0.8	2.2	4.7	7.5	10.5	13.9	17.6	25.6
25	0.6	1.3	3.4	7.5	12.2	17.4	23.1	29.4	43.3
30	0.9	1.9	5.1	11.2	18.3	26.3	35.3	45	*
40	1.7	3.4	9.3	21.1	35.1	*	*	*	*
50	2.6	5.4	15	34.8	*	*	*	*	*

* Static pressure is excessive--greater than 50 in. water.

performance data for axial and centrifugal fans, respectively. One manufacturer's 3 Hp fan may be well matched to one's needs while another's 3 Hp fan may not. Fan performance data should be certified in accordance with standard test codes adopted by the Air Moving and Conditioning Association Inc. and bear the AMCA seal.

$$hp = \frac{(cfm \times Ps)}{63.46 \times efficiency} \quad \text{equation 1}$$

where:

cfm = airflow in cfm

Ps= static pressure in inches of water

efficiency = fan efficiency in % form (example: use 50 instead of 0.50 for 50%)

If actual fan efficiency is not known, 50% efficiency can be assumed for design purposes. The fan motor horsepower rating should be equal or exceed the computed horsepower or the fan motor may overload.

Further Examples

A round, on-floor duct distribution system is desired for a 24-foot diameter bin with 16-foot sidewalls storing wheat. An airflow rate of 1/5 (0.2) CFM/bu. is desired.

Table 1 gives the following values: 5,828 bu. bin capacity, 1165 CFM air volume; 47 square feet minimum duct surface area and 0.78 square feet minimum duct cross-sectional area.

Consulting Table 3 shows any round duct with diameter of at least 12 inches will meet the cross-sectional area requirement. A 12-inch diameter round duct must be 19 feet long (47/2.51) to meet the surface area requirement.

Table 8 gives an expected static pressure of 1.9 inches (1.4 for 16 feet depth at 0.25 cfm/bu + 0.5 feet for air distributed through a duct system).

Using equation 1, the approximate power requirement for 1,165 CFM at a static pressure of 1.9 inches is about 0.7 Hp. (Select a 1 Hp motor)

As a final example, suppose a farmer wishes to provide 1/2 (.5) CFM/bu for quick cooling of damp grain sorghum during harvest. The bin is 27 feet in diameter, has 19-foot sidewalls, and is equipped with a totally- perforated floor.

Table 1 shows a bin capacity of 8,750 bushels and an air volume of 4,375 CFM. Since a totally perforated floor will be used, duct area requirements do not apply.

Table 8 gives 4.2 inches of static pressure for .5 CFM/bu, through 19 feet of grain sorghum using a perforated floor. (Calculate the static pressure at 19 feet by assuming the value is half way between 18 feet and 20 feet static pressure values.)

Using equation 1, the approximate power requirement for 4,375 CFM at a static pressure of 4.2 inches is about 5.8 Hp. (Select a 7.5 Hp motor.)

Table 9. Typical Performance Data for Axial Fans.

HP	RPM	Static Pressure (Inches of water)					
		0.5	1.0	1.5	2.0	3.0	4.0
CFM							
1	3450	2880	2635	2360	1935	810	455
3	3450	7000	6400	5700	5200	3700	2200
5	3450	9700	9100	8600	8000	6500	4600
7.5	3450	12800	12300	11600	11000	9800	7400

Table 10. Typical Performance Data for Centrifugal Fan*

CFM	Static Pressure (inches of water)													
	2		4		6		8		10		12		14	
	RPM	HP	RPM	HP	RPM	HP	RPM	HP	RPM	HP	RPM	HP	RPM	HP
1013	1224	0.068	1638	1.25	1968	1.87	2252	2.54	2505	3.27	2737	4.03	2951	4.63
1520	1364	1.15	1753	1.96	2064	2.77	2332	3.6	2574	4.47	2794	5.37	3000	6.3
2026	1527	1.81	1894	2.89	2190	3.94	2446	4.99	2679	6.05	2891	7.14	3090	8.25
2532	1708	2.72	2050	4.07	2334	5.4	2584	6.71	2805	8.01	3010	9.3	3204	10.6

*This table is abbreviated. Intermediate static pressures and a much larger range of CFM values are available from pump manufacturers.

Other Considerations

Aeration systems can operate as pressure systems pushing air upward through the grain or as suction systems pulling air downward through the grain. For a complete discussion of the advantages and disadvantages of each type of system, see fact sheet BAE 1101. There must be sufficient roof openings to allow the air to escape or to enter. The required air escape area, in square feet, is determined by dividing the total volume by 1,500 fpm. If the bin roof is mounted off the sidewall, the slot under the eaves serves as air escape or inlet area. When additional area is required, roof vents should be installed until the air escape or inlet area requirement is met.

When aeration systems are operating, the unloading auger tube should be sealed to prevent the escape of air. Smooth transitions should be used to connect fan outlets with duct inlets. Sudden expansions and reductions should be avoided. Some recently constructed grain systems utilize two axial fans of the same model, size and type installed in series (bolted end-to-end). This practice allows axial fans to be used at static pressures which would normally require centrifugal fans. Two fans installed in series will deliver the same volume of air as a single fan at a static pressure 1.8 to 2.0 times that of the single fan.

Notes to Engineers

All static pressures are projected as Shedd's data x 1.0. Field measurements of operating static pressure confirm the validity of this assumption. Special cases of compaction or fine foreign material may necessitate an increase in projected operating pressure. A ducting pressure loss of 0.5 inches is assumed in all cases. In addition, static pressure loss due to duct distribution is estimated at 0.5 inches for corn or soybeans and at 1.0 inches for wheat, grain sorghum, oats, barley, or rye. These values are appropriate when duct exit velocity is limited to 25 fpm.

All example systems in this Fact Sheet are assumed to be pressure systems which force air upward through the grain. Since duct velocity is limited to 1,500 fpm, static regain is assumed to equal friction loss in the duct. Very rough ducts may produce friction losses in excess of static regain.

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