

## AE 469/569 - Exam 1

Multiple Choice: 2 pts each  
One 8.5 x 11 sheet (both sides) open

Name \_\_\_\_\_

K. J. B.

1. The suspended overhead floor batch dryer (roof dryer) overcomes this disadvantage of a conventional bin-batch dryer:
  - a) too much moisture variation across grain depth.
  - b) time lost unloading the batch.
  - c) no wet grain holding.
  - d) small batch size.
  
2. Addition of heat to a drying bin will
  - a) not affect the Allowable Storage Time of the grain.
  - b) cannot tell from information given.
  - c) lengthen the Allowable Storage Time of the grain.
  - d) shorten the Allowable Storage Time of the grain.
  
3. Air and grain below the drying zone
  - a) are at the same temperature.
  - b) are at the same enthalpy.
  - c) have not begun to come to equilibrium.
  
4. Centrifugal fans are generally better for static pressures above what level?
  - a) 2 inches
  - b) 3 inches
  - c) 4 inches
  - d) 5 inches
  - e) 8 inches
  
5. Increasing bin diameter for a constant depth of grain and the same fan will have what effect on total CFM delivered by that fan?
  - a) increase
  - b) decrease
  - c) no effect
  - d) cannot determine from this information.

6. Preservation of grain can:
- slow deterioration.
  - stop deterioration.
  - reverse deterioration.
  - a, b, or c depending on circumstances.
7. In the common types of oil extractors, beans and solvent move in this mode:
- counter flow
  - cross flow
  - concurrent flow
8. As air picks up water
- T db stays constant, T wb decreases.
  - T db decreases, T wb stays constant.
  - T db decreases, T wb increases.
  - T wb increases, T db decreases.
  - T db decreases, T wb decreases.
9. In grain drying situations, the addition of heat will
- increase absolute humidity slightly with increase in temperature
  - increase absolute humidity rapidly with increase in temperature
  - absolute humidity does not increase
  - cannot tell from information given
10. A 10 lb. sample of grain has a wet basis moisture content of 30%. The dry basis moisture content is
- 30%.
  - 80%.
  - 42.8%.
  - 70%.
  - none of the above

$$\begin{array}{r}
 100 \text{ lb} \\
 \frac{30 \text{ lb water}}{70 \text{ lb DM}} \\
 \frac{30}{70} = 42.8
 \end{array}$$

11. The test weight of corn
- is the weight of corn in one bushel for grain trade computations.
  - is used as an indicator of grain quality
  - both of the above
12. If a bushel of corn is defined as 56 lb at 15.5% MC, this weight of corn is required to make a bushel at 30% MC.
- 61.5 lb
  - 70.5 lb
  - 67.6 lb
  - 76.3 lb
  - 64.1 lb

$$\frac{W}{47.32 + W} = .30$$

$$W = .30(47.32) + .30W$$

$$\begin{array}{r}
 20.28 \\
 47.32 \\
 \hline
 67.60
 \end{array}$$

$$.3(47.32) = .7W$$

$$W = \frac{.3(47.32)}{.7} = 20.28$$

13. This is not a source of hexane loss:
- a) soybean oil
  - b) soybean meal
  - c) soybean hulls
  - d) leaks in plumbing fittings
14. Soybeans are cracked prior to flaking by use of a
- a) hammer mill
  - b) burr mill
  - c) roller mill
  - d) aspirator
15. In a grain bin, superficial air velocity is
- a) the velocity of air as it finds its way up through the airspace between kernels
  - b) the velocity that the air would be moving if there was no grain in the bin.
  - c) a ballpark guess of air velocity as you feel air as it leaves the top surface of a grain mass.
  - d) air velocity calculated from unreliable data supplied by fan manufacturers.

(8)

16. A soybean processor asks you how much crude soybean oil (in lbs) can be extracted from a bushel (60 lbs) of average Iowa soybeans. What answer should you give in response?

*Assume 13% moisture*

Assumptions:

- The average protein and oil content of soybeans grown in Iowa last year was 34.4% protein and 19.6% oil on a 13% moisture basis.
- The soybeans enter the plant at 13% moisture.
- In the processor's plant, there is no de-hulling.
- There is no moisture in crude soybean oil.
- The meal has a residual oil content of 1.0% and a moisture content of 12%.

ASSUME BEANS @ 13%

$$(60 \text{ LB}) (.196) = 11.76 \text{ LB OIL (WATER FREE)}$$

$$(60)(.13) = 7.8 \text{ LB water}$$

$$\begin{array}{r}
 60 \\
 - 7.80 \\
 - 11.76 \\
 \hline
 40.44 \text{ LB MEAL (DM)}
 \end{array}$$

$$\begin{array}{r}
 40.44 \text{ dry meal} \\
 7.8 \text{ water} \\
 11.76 \text{ oil} \\
 \hline
 60.00
 \end{array}$$

$$\frac{W}{40.44 + W} = .13$$

$$W = (40.44)(.13) + .13W$$

$$\text{water} + \text{OIL} = W = \frac{40.44(.13)}{.87} = 6.04$$

40.44

6.04

46.48 WT OF MEAL

$$46.48(.01) = .4648 \text{ LB OIL}$$

$$\begin{array}{r}
 11.7600 \\
 - .4648 \\
 \hline
 11.2952
 \end{array}$$

4 LB OIL

(21) 17. Air at 80° db and 60° wb is heated 5° and then moved through corn at 16% moisture. The corn initially weighs 100,000 lb.

4

a) To what moisture can this dryer dry the corn?

$$\left. \begin{array}{l} 85^\circ \\ 26\% \end{array} \right\} - 7.3\%$$

3

b) At what temperature is the 16% moisture corn stored at?

$$65.5^\circ$$

3

c) What is the allowable storage time of the 16% moisture corn?

$$110 \text{ days}$$

8

d) If the fan delivers 200 cfm, how many days will it take to dry the corn?

$$\begin{array}{r} .84(100,000) = .927(100,000 - W) \\ W = 9385 \end{array} \quad \begin{array}{r} .0112 \\ .0067 \\ \hline .0045 \end{array}$$

$$DR = \frac{200 \text{ FT}^3 \text{ MIN} \cdot 60 \text{ MIN} \cdot \text{LBDA} \cdot .0045 \text{ LBW}}{13.8 \text{ FT}^3 \cdot \text{LBDA}} = 3.91 \frac{\text{LB}}{\text{h}} = 93.9 \frac{\text{LB}}{\text{DAY}}$$

$$\frac{9385}{93.9} = 99.9 \text{ day}$$

3

e) Is this fast enough to avoid corn spoilage? (explain)

110 > 99.9 COMPLETES DRYING IN LESS THAN ALLOWABLE STORAGE TIME

- (21) 18. A Sukup 24-in, 5-7 hp axial fan is mounted on a 30-ft diameter bin containing wet, thrower-spreader-placed corn. The static pressure in the plenum is 2.3 in H<sub>2</sub>O. How deep is the corn in the bin?

$$2.3 \text{ in} \rightarrow 9600 \text{ CFM} \quad \text{FAN CURVE}$$

$$\pi(15)^2 = 225(\pi) = 706.9 \text{ FT}^2$$

$$\frac{9600}{706.9} = 13.58 \frac{\text{CFM}}{\text{FT}^2} \rightarrow .12 \frac{\text{IN}}{\text{FT CORN}} \text{ (SHEDD)}$$

$$(.12)(1.68) = 0.202 \frac{\text{IN}}{\text{FT}} \frac{2.3 \text{ IN FT}}{.202} = \boxed{11.4 \text{ FT}}$$

- (20) 19. A 10,000-lb bin of corn at 24% moisture has undergone an increase in moisture to 26%. There has been no water transfer into or out of the bin, so the moisture increase is completely due to fungal activity.

a) What % dry matter loss has occurred?

$$.74(10,000) = .76(10,000 - W)$$
$$W = 263.16 \text{ LB WATER}$$

15

$$263.16 \left( \frac{180}{108} \right) = 438.6 \text{ LB DM LOSS}$$

$$.74(10,000) = 7400 \text{ LB ORIGINAL DM}$$

$$\frac{438.6}{7400} = 0.0592$$
$$= 5.9\%$$

b) Describe the general quality of this corn.

5

BADLY DETERIORATED

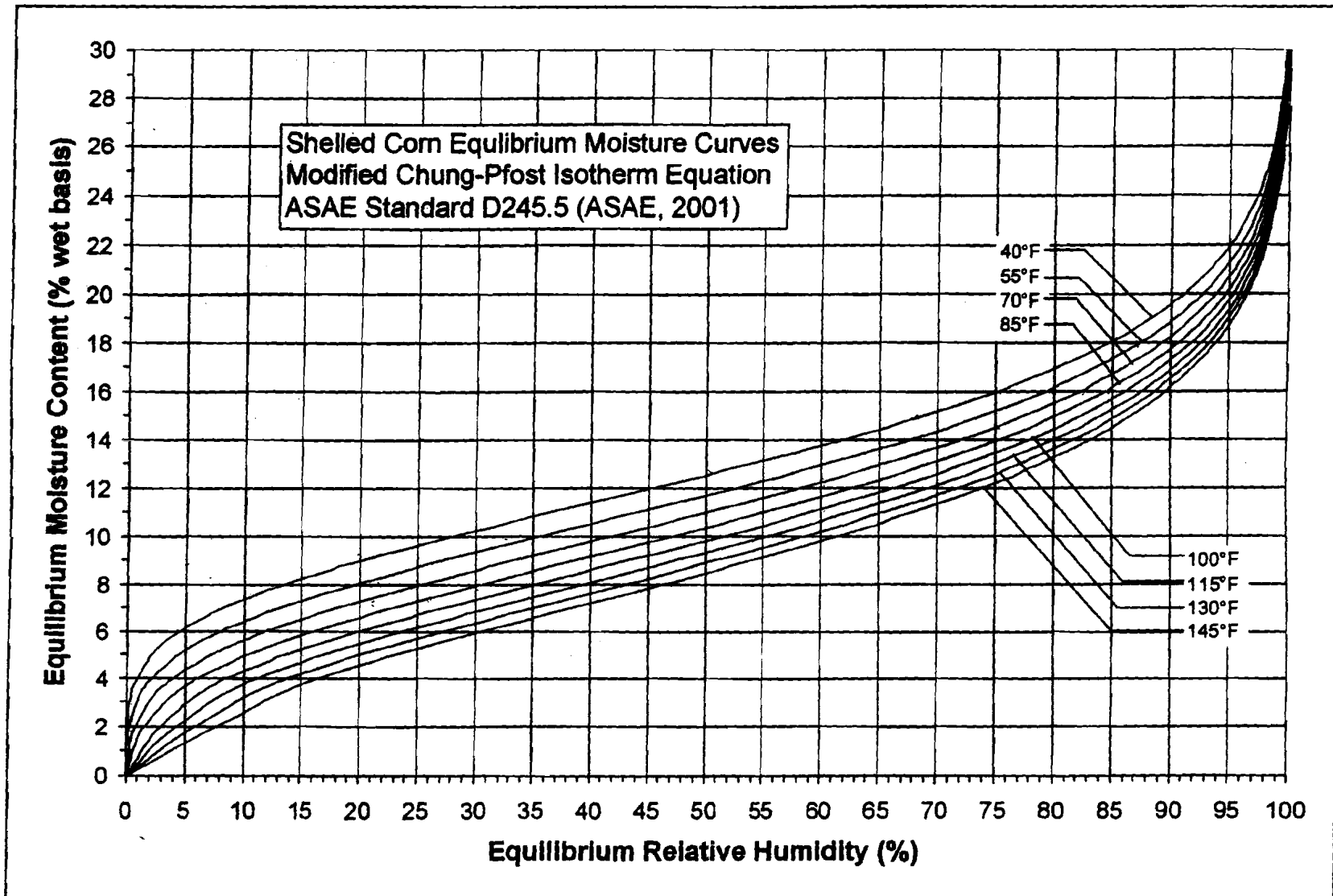
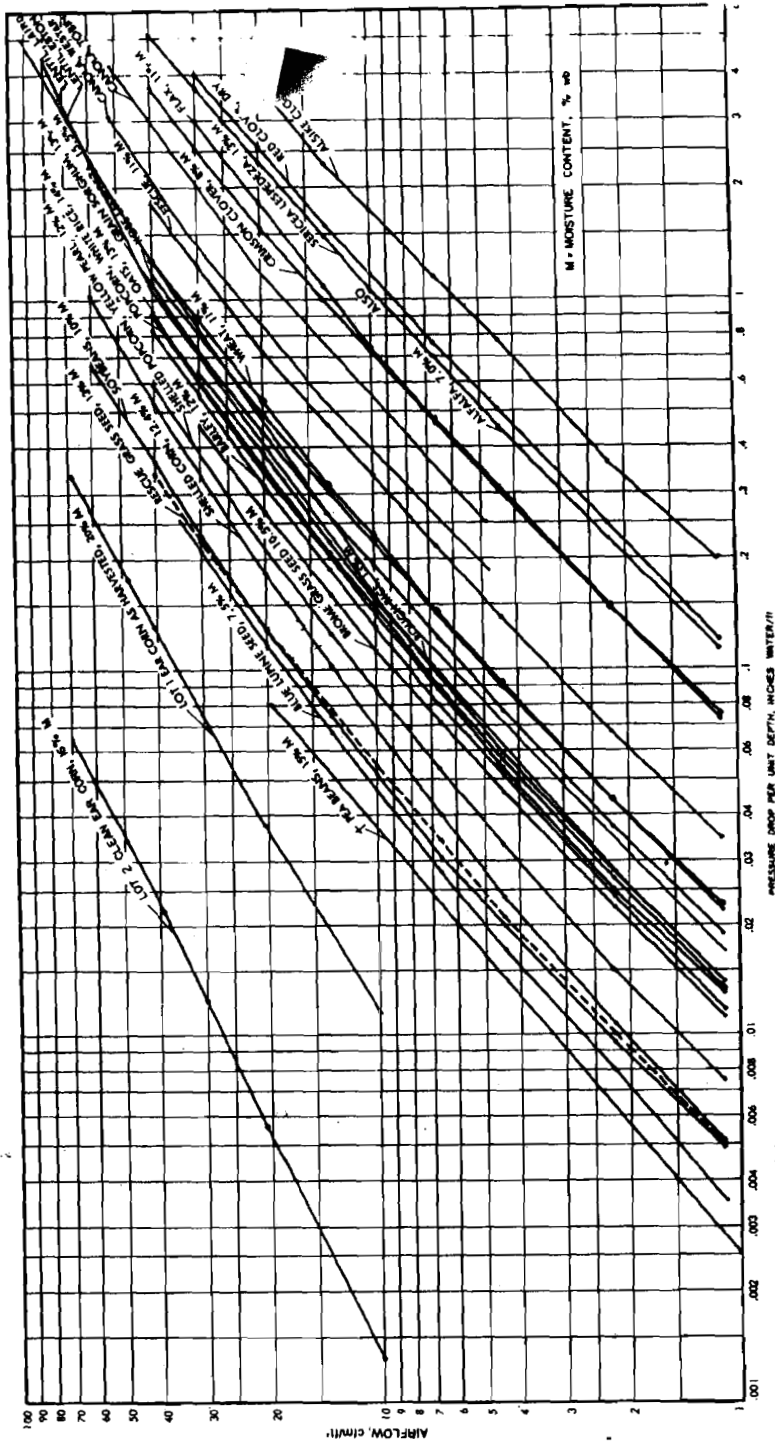


Figure 2-3. Equilibrium moisture content for corn.



NOTE - This chart gives values for a loose fill (not packed) of clean, relatively dry grain. For a loose fill of clean grain having high moisture content (in equilibrium with relative humidities exceeding 85%), use only 80% of the indicated pressure drop for a given rule of air flow. Packing of the grain in a bin may cause 50% higher resistance to air flow than the values shown.

When foreign material is mixed with grain no specific correction can be recommended. However, it should be noted that resistance to air flow is increased if the foreign material is finer than the grain, and resistance to air flow is decreased if the foreign material is coarser than the grain.

The pressure drop for airflow through bulk grain in the horizontal direction has been measured for wheat and barley (Kumar and Muir, 1986); canola (Jayas et al., 1987); corn (Key et al., 1989); alfalfa pellets (Sokransanj et al., 1990); flaxseed (Jayas et al., 1991); and bird's foot trefoil, canary seed, fababeans, lentils, meadow fescue, oats, timothy, and tara peas (Alagusundaram et al., 1992). The pressure drop in the horizontal direction may be 60% to 70% of the pressure drop for airflow in the vertical direction. For some seeds, however, the difference between the pressure drops for the horizontal and vertical airflows may be nonexistent.

Figure 2 - Resistance to airflow of grains and seeds (Inch-pound units) (Shedd's data)

of beds  
if metal  
design  
cultural  
range



ASHRAE PSYCHROMETRIC CHART NO. 1

NORMAL TEMPERATURE

BAROMETRIC PRESSURE 29.921 INCHES OF MERCURY

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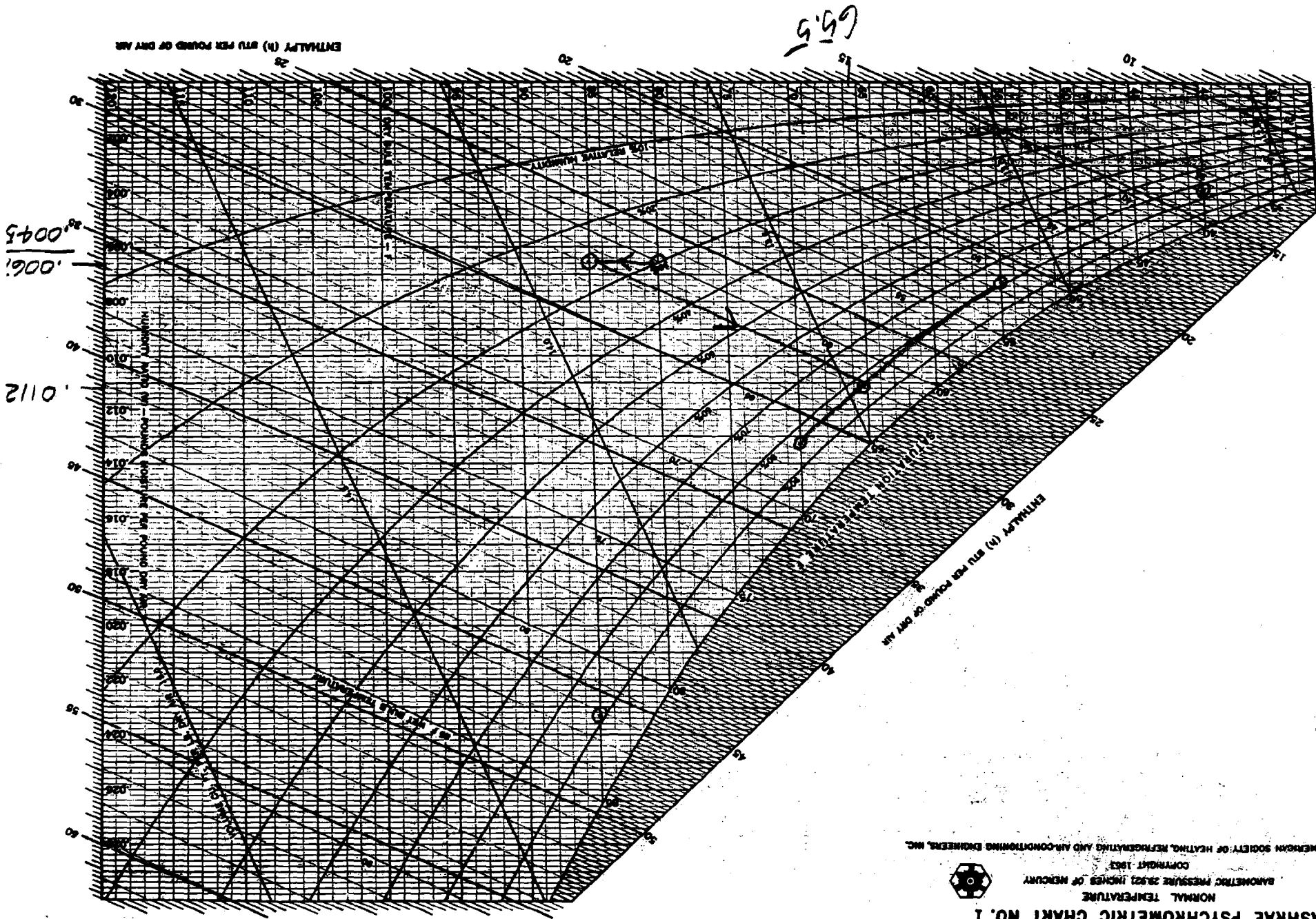


Table 5-1. Shelled Corn Storage Time (SCST) in days.

Corn Temp	Corn Moisture, % wet-basis																																					
°C	°F	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49		
0	32	2702	1458	866	557	381	276	208	163	132	110	93	81	71	64	58	53	48	45	42	40	37																
1	34	2298	1240	737	473	324	234	177	139	112	93	79	69	61	54	49	45	41	38	35	34	32																
2	36	1954	1055	627	403	276	199	150	118	95	79	67	57	50	44	39	35	32	30	28	26	24	23															
3	38	1662	897	533	342	235	169	128	100	81	67	57	49	42	37	33	30	27	25	24	22	21	20															
4	40	1413	763	453	291	199	144	109	85	69	57	49	41	36	32	28	26	23	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	
6	42	1202	649	385	248	170	123	93	73	59	49	41	36	32	28	26	23	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	
7	44	1022	552	328	211	144	104	79	62	50	41	35	31	27	24	22	20	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0		
8	46	869	469	279	179	123	89	67	52	42	35	30	26	23	20	19	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	0	0		
9	48	739	399	237	152	104	75	57	45	36	30	26	22	19	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	0	0	0	0		
10	50	629	339	202	130	89	64	48	38	31	26	22	19	17	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	0	0	0	0	0	0		
11	52	535	289	171	110	75	55	41	32	26	22	18	16	14	13	11	10	9	8	7	6	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0		
12	54	455	245	146	94	64	46	35	27	22	18	16	14	12	11	10	9	8	7	6	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	
13	56	387	209	124	80	55	39	30	23	19	16	14	12	11	10	9	8	7	6	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
14	58	329	177	105	68	46	34	25	20	16	13	11	10	9	8	7	6	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
16	60	280	151	90	58	39	29	22	17	14	11	10	8	7	6	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
17	62	249	134	80	51	35	25	19	15	12	10	9	8	7	6	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
18	64	222	120	71	46	31	23	17	14	11	9	8	7	6	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
19	66	197	107	63	41	28	20	16	12	10	8	7	6	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
20	68	176	95	56	36	25	18	14	11	9	8	7	6	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
21	70	157	85	50	32	22	16	13	10	8	7	6	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
22	72	139	75	45	29	20	15	11	9	7	6	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
23	74	124	67	40	26	18	13	10	8	7	6	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
24	76	111	60	35	23	16	12	9	7	6	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
26	78	98	53	32	20	14	10	8	7	6	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
27	80	88	47	28	18	12	9	7	6	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
28	82	78	42	25	16	11	8	7	6	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
29	84	70	38	22	14	10	7	6	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
30	86	62	33	20	13	9	7	6	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
31	88	55	30	18	11	8	6	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
32	90	49	26	16	10	7	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
33	92	44	24	14	9	6	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
34	94	39	21	12	8	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
36	96	35	19	11	7	5	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
37	98	31	17	10	6	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
38	100	27	15	9	6	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
39	102	24	13	8	5	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
40	104	22	12	7	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
41	106	19	10	6	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
42	108	17	9	6	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
43	110	15	8	5	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
44	112	14	7	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
46	114	12	7	4	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
47	116	11	6	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
48	118	10	5	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
49	120	9	5	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

120  
-107  
107