

Appendix B

Raw Data of Drying Experiment

Condition 1

1. Superheated Steam Drying

Date of work	: January 22, 2003
Condition	: Temperature 110°C, Pressure 1 atm
Dimension of sample	: 1 in.thick × 3 in.wide × 83 cm long
Moisture content initial	: 89.7% (d.b.)
final	: 19.8% (d.b.)

Results

Table B-1 Moisture content of sample after drying with superheated steam at various time.

Time (hr)	Weight (g)	Moisture Content (% d.b.)	Note
0	2085.33	89.7	*Sample cracked
6	1899.08	72.8	after drying for 6 hr.
12	1815.48	65.2	
17	1720.11	56.5	
24	1447.27	31.7	
30	1406.32	25.6	
36	1380.59	19.8	

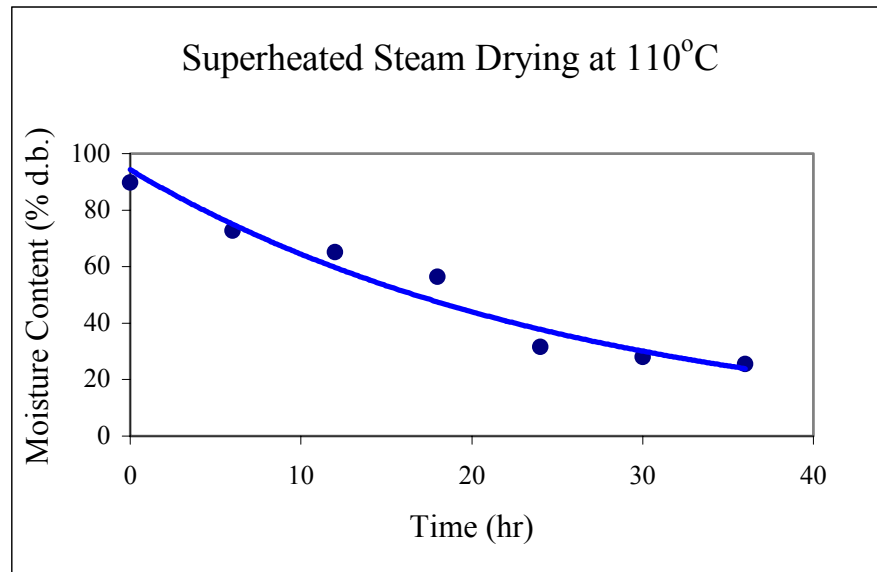


Figure B-1 Drying curve of superheated steam drying at 110°C.

Physical properties after superheated steam drying



Figure B-2 After drying with superheated steam at 110°C for 36 hours, showing wood warp that develops during drying.



Figure B-3 Showing the end check after drying, end checks occurred in the wood rays, but on end-grain surfaces. End checks occur because moisture moves much faster in the longitudinal direction than in either transverse direction. There, the ends of boards dry faster than the middle and stresses develop at the ends (Simpson et al., 1991).



Figure B-4 The coffee-brown stains that develop during the superheated steam drying.

Condition 2**2. Superheated Steam Drying for 6 hr and Follow by Hot Air for 1 hr**

- 2.1. Date of work : January 29, 2003
 Condition : Temperature 110°C, Pressure 1 atm
 Dimension of sample : 1 in.thick × 3 in.wide × 102 cm long
 Moisture content initial : 96.2% (d.b.)
 final : 15.7% (d.b.)

Results

Table B-2-1 Moisture content of sample after drying with superheated steam combine with hot air (Steam: Air = 6: 1) at various time.

Time (hr)	Weight (g)	Moisture Content (% d.b.)	Note
0	3196.36	96.2	
7	2708.18	66.2	
14	2392.15	46.8	
21	2152.31	32.1	
28	1928.25	18.3	
35	1885.79	15.7	

- 2.2. Date of work : February 13, 2003
 Condition : Temperature 110°C, Pressure 1 atm
 Dimension of sample : 1 in.thick × 3 in.wide × 89.5 cm long
 Moisture content initial : 56.3% (d.b.)
 final : 18.1% (d.b.)

Results

Table B-2-2 Moisture content of sample after drying with superheated steam combine with hot air (Steam: Air = 6: 1) at various time.

Time (hr)	Weight (g)	Moisture Content (% d.b.)	Note
0	2493.31	56.3	
7	2228.68	39.7	
14	2102.15	31.7	
21	2067.65	29.6	
28	1988.92	24.6	
35	1884.84	18.1	

- 2.3. Date of work : February 20, 2003
 Condition : Temperature 110°C, Pressure 1 atm
 Dimension of sample : 1 in.thick × 3 in.wide × 85 cm long
 Moisture content initial : 92.3% (d.b.)
 final : 18.9% (d.b.)

Results

Table B-2-3 Moisture content of sample after drying with superheated steam combine with hot air (Steam: Air = 6: 1) at various time.

Time (hr)	Weight (g)	Moisture Content (% d.b.)	Note
0	2490.29	92.3	*Sample cracked
7	2147.58	65.8	after drying for 7
14	1898.05	46.6	hr.
21	1717.5	32.6	
28	1579.99	22.0	
35	1539.05	18.9	

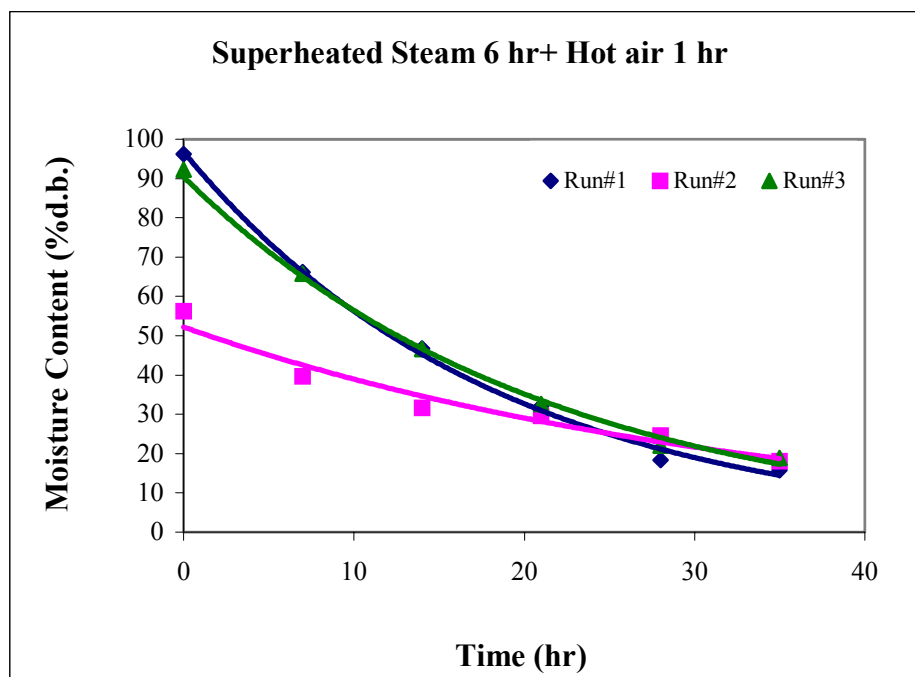


Figure B-5 Drying curve of superheated steam drying for 6 hr and followed by hot air for 1 hr.

Physical properties after drying



Figure 6: Showing wood warp that develops during drying.



Figure B-7: The coffee-brown stains that develop during the drying.

Condition 3**3. Superheated Steam Drying for 4 hr and Follow by Hot Air for 1 hr**

- 3.1. Date of work : February28, 2003
 Condition : Temperature 110°C, Pressure 1 atm
 Dimension of sample : 1 in.thick × 3 in.wide × 88 cm long
 Moisture content initial : 79.8% (d.b.)
 final : 15.7% (d.b.)

Results

Table B-3-1 Moisture content of sample after drying with superheated steam combine with hot air (Steam: Air = 4: 1) at various time. (Run#1)

Time (hr)	Weight (g)	Moisture Content (% d.b.)	Note
0	2402.64	79.8	
5	2086.19	56.2	
10	1892.77	41.7	
15	1807.91	35.3	
20	1718.28	28.6	
25	1605.60	20.2	
30	1545.84	15.7	

- 3.2. Date of work : March15, 2003
 Condition : Temperature 110°C, Pressure 1 atm
 Dimension of sample : 1 in.thick × 3 in.wide × 88 cm long
 Moisture content initial : 58.2% (d.b.)
 final : 19.1% (d.b.)

Results

Table B-3-2 Moisture content of sample after drying with superheated steam combine with hot air (Steam: Air = 4: 1) at various time. (Run#2)

Time (hr)	Weight (g)	Moisture Content (% d.b.)	Note
0	2238.29	58.2	
5	2069.28	46.3	
10	1924.89	36.1	
15	1832.20	26.5	
20	1777.43	25.7	
25	1748.60	23.6	
30	1684.99	19.1	

- 3.3. Date of work : March 19, 2003
 Condition : Temperature 110°C, Pressure 1 atm
 Dimension of sample : 1 in.thick × 3 in.wide × 97 cm long
 Moisture content initial : 80.0% (d.b.)
 final : 15.2% (d.b.)

Results

Table B-3-3 Moisture content of sample after drying with superheated steam combine with hot air (Steam: Air = 4: 1) at various time. (Run#3)

Time (hr)	Weight (g)	Moisture Content (%d.b.)	Note
0	3042.14	80.0	*Sample
5	2630.15	55.7	cracked after
10	2379.44	40.8	drying for 5
15	2207.63	30.7	hr.
20	2083.03	23.3	
25	2003.62	18.6	
30	1947.30	15.2	

3.4.	Date of work	:	September8, 2003
	Condition	:	Temperature 110°C, Pressure 1 atm
	Dimension of sample	:	1 in.thick × 3 in.wide × 90 cm long
	Moisture content	initial	: 87.9% (d.b.)
		final	: 16.3% (d.b.)

Results

Table B-3-4 Moisture content of sample after drying with superheated steam combine with hot air (Steam: Air = 4: 1) at various time. (Run#4)

Time (hr)	Weight (g)	Moisture Content (% d.b.)	Note
0	2637.28	87.9	*Sample cracked
5	2222.94	58.3	at the end of
10	1875.67	33.6	wood after
15	1719.71	22.5	drying for 5 hr.
20	1640.31	16.8	
25	1632.33	16.3	

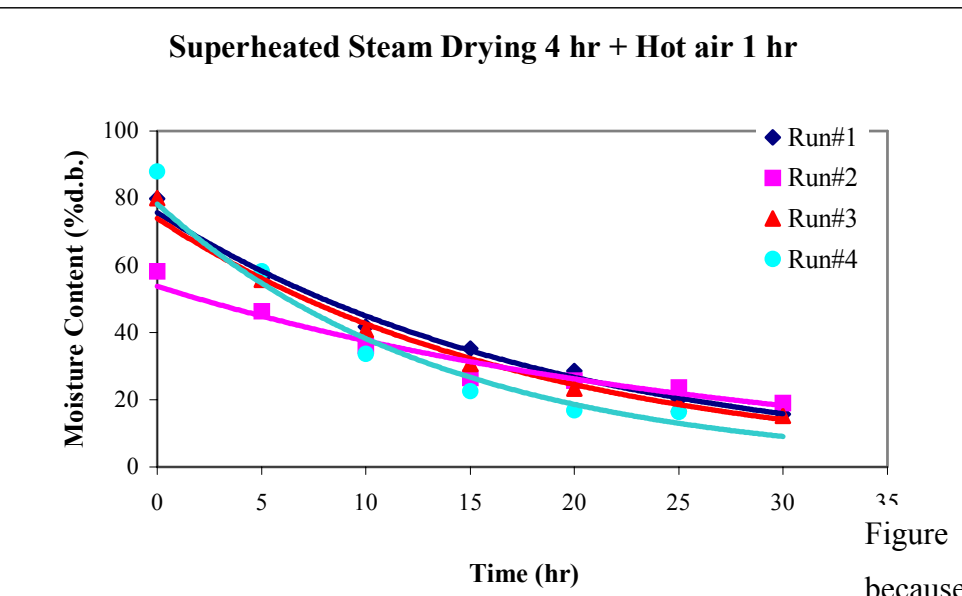


Figure B-8 Drying curve of superheated steam drying for 4 hr and followed by hot air for 1 hr.

Physical properties after drying

Figure B-9 Showing the straight wood after drying because wood was placed on the clamped rack support inside the chamber.





Figure B-10 Prong test showing unacceptable piece of wood with excessive stress buildup. Shows one way to cut stress sections and illustrates the reaction of sections that are casehardened. When the sections have stress, the two outer prongs pinch in because the tension stress in the core is released by the saw cut. Thus, the inner faces of the prongs shorten because of the release of stresses (Simpson, W.T., ed., 1991).

Condition 4

4. Superheated Steam Drying for 1 hr and Follow by Hot Air for 6 hr

Date of work	:	February 7, 2003
Condition	:	Temperature 80°C, Pressure 1 atm
Dimension of sample	:	1 in.thick × 3 in.wide × 86 cm long
Moisture content	initial	: 62.8% (d.b.)
	final	: 15.3% (d.b.)

Results

Table B-4 Moisture content of sample after drying with superheated steam combine with hot air (Steam: Air = 1: 6) at various time.

Time (hr)	Weight (g)	Moisture Content (%d.b.)	Note
0	2366.36	62.8	*Sample cracked
7	2083.38	43.3	after drying for 7
14	1902.21	30.9	hr.
21	1806.39	24.3	
28	1743.57	19.9	
35	1675.84	15.3	

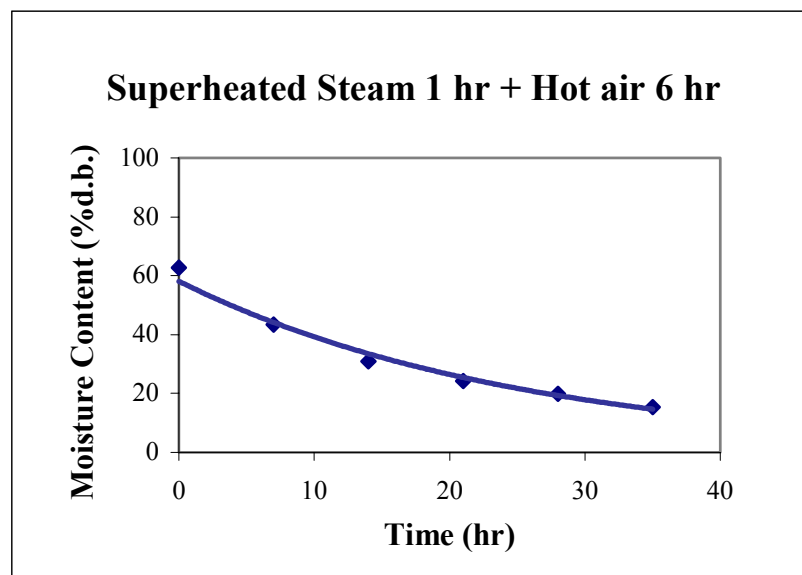


Figure B-11 Drying curve of superheated steam drying for 1 hr and hot air for 6 hr.

Physical properties after drying



Figure B-12 Showing wood warp that develops during drying.



Figure B-13 The end check after drying.

Condition 5

5. Air Drying

Date of work	: June20, 2003
Condition	: Temperature 80°C, Pressure 1 atm
Dimension of Sample	: 1 in.thick × 3 in.wide × 90 cm long
Moisture content initial	: 76.71% (d.b.)
final	: 7.45 % (d.b.)

Results

Table B-5 Moisture content of sample after drying with hot air at 80°C

Time (hr)	Weight (g)	Moisture Content (% d.b.)	Note
0	2490.38	76.71	
6	2146.80	52.33	
12	1894.40	34.42	
17	1748.73	24.02	
24	1649.48	17.04	
30	1575.02	11.76	
36	1514.35	7.45	

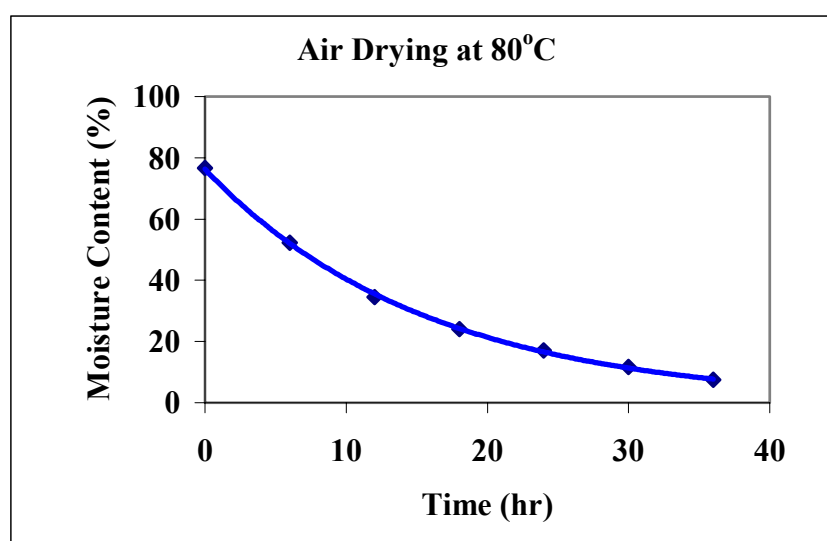


Figure B-
Drying

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curve of hot air drying at 80°C

Condition 6**6. Optimum Drying**

Date of work		: October 20, 2003
Condition		: Temperature 110°C, Pressure 1 atm
Dimension of sample		: 1 in.thick × 3 in.wide × 81.5cm long
Moisture content	initial	: 91.9% (d.b.)
	final	: 15.6% (d.b.)

Methods

1. Spray steam at temperature inside the chamber 100°C for 4 hours, after that heat up temperature inside the chamber to 105°C for 3 hours and weigh the sample.
2. Dry at temperature inside 105°C for 6 hours and follow by hot air for 1 hour.
3. Dry with superheated steam 110°C for 6 hours and follow by hot air 1 hour.
4. Dry with superheated steam 110°C for 4 hours and follow by hot air 1 hour.
5. Dry with superheated steam 110°C for 4 hours and follow by hot air 1 hour.
6. Spray steam for 1 hour before dry with hot air at 80°C for 3 hours and weigh sample.
7. Spray steam for 1 hour before dry with hot air at 80°C for 5 hours and weigh sample.

Results

Table B-6 Moisture content of sample after drying with superheated steam combine with hot air at various time.

Time (hr)	Weight (g)	Moisture Content (%d.b.)	Note
0	2456.61	91.6	*Sample cracked
7	2259.07	76.2	at the end check
14	1854.44	44.6	after drying for 21
21	1661.60	29.6	hr.
26	1585.23	23.6	
31	1575.89	22.9	
35	1543.30	20.4	
41	1482.25	15.6	

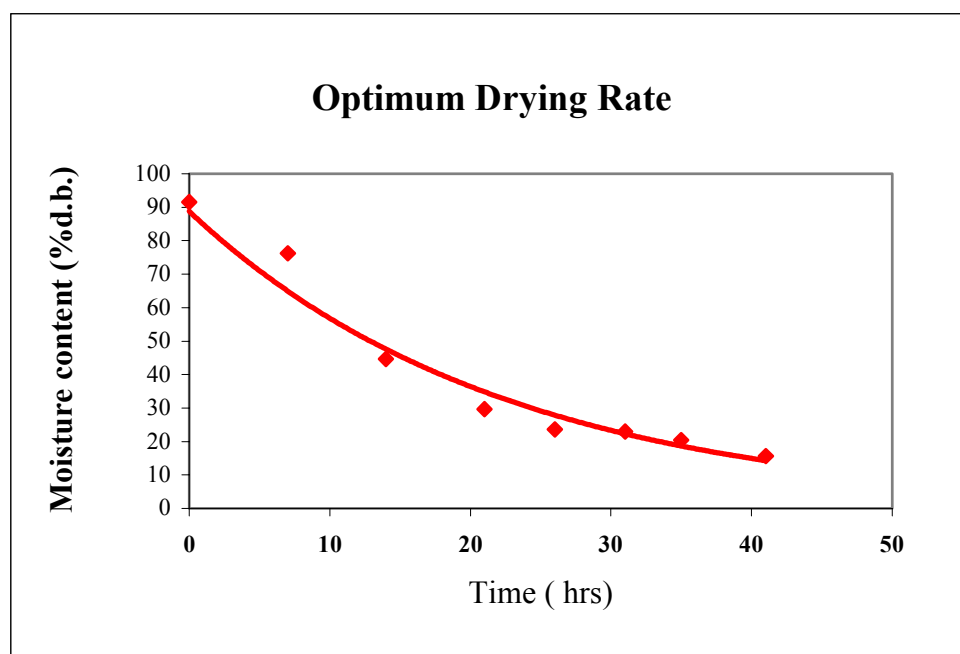


Figure B-15 Drying curve of optimum drying.

Physical properties after drying



Figure B-16 Showing the straight wood after drying because wood was placed on the clamped rack support inside the chamber.

Figure B-17 Prong test showing acceptable piece of wood.

