NEW TEMPERATURE CORRECTION FACTORS FOR THE PORTABLE RESISTANCE-TYPE MOISTURE METER

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Portable electric moisture meters are used extensively in the forest products industries to estimate the moisture content (MC) of wood. For lumber, the resistance-type meter with two-pin, insulated electrodes is by far the most commonly used instrument and the preferred choice of lumber inspection agencies.

Proper use of this meter requires that the meter scale readings be corrected for the effects of wood temperature and species, both of which affect conductance and consequently the magnitude of the meter scale reading at a given MC. Species correction factors have been developed and verified for most commercial, North American species, using the "Delmhorst" resistance-type meters (used almost exclusively in the Canadian lumber industry).

To avoid the use of separate corrections for temperature and species, the Forintek laboratories published handbooks of combined temperature-species correction tables (1,2). Following this, it became apparent from industry feedback that the correction tables over-estimated the wood MC by as much as 6 percent MC when measurements were made in lumber at -30°C. Since the species correction factors had been verified, the over-estimation was attributed to inappropriate temperature correction factors for wood temperatures below freezing. Mackay (3) carried out a controlled laboratory investigation and found that the true MC was over-estimated by up to 7 percent MC at -20°C.

METHODS

New relationships between moisture meter scale reading and true MC were established for eight softwood and five hardwood species at wood temperatures of -29°, -23°, -18°, -12°, 4° and 49°C, using the Delmhorst resistance-type meter with 2 pin, insulated electrodes. These relationships, based on 1,050 specimens per species, produced a set of curves (linear) which were statistically interpolated to develop a family of incremental curves for meter scale reading vs. true MC at each 5.56°C (10°F) increment in wood temperature within the range -29° to 49°C. Two additional curves were extrapolated to include -34°C and -40°C. Specimens were conditioned to seven MC levels within the range 10 to 23 percent.

To determine the effect of wood temperature alone, it was necessary to include a temperature baseline at which the temperature correction is "0" (i.e. meter calibration temperature). A temperature of 22.8°C (73°F) was used since this was the temperature used to establish the species correction factors for the eastern Canadian correction factor handbook (23 species). Temperature corrected meter readings at each increment in wood temperature were obtained for each species by solving for the true MC at meter scale readings of 7 to 20 percent, inclusive, and entering the true MC in the 22.8°C baseline equation to obtain the temperature-corrected reading.

From the foregoing procedure, a table was produced giving the average temperature-corrected reading (13 species) for meter scale readings of 7 to 21 and wood temperatures of -40°C to 49°C. At each increment in temperature, the relationship between scale reading and temperature-corrected reading was established in the form of:

$$Y = AX + B \tag{1}$$

Where Y = meter scale reading

X = temperature corrected reading

To obtain the temperature-corrected reading at any wood temperature within the test range, the linear regression coefficients (A) and (B) at each temperature increment were regressed against the corresponding wood temperature in the form of:

$$y = a(b^{x}) \tag{2}$$

$$y' = a + bx + cx^{2} \tag{3}$$

Where: y = coefficient A

y' = coefficient B

x = wood temperature

Thus, for a calibration temperature of 22.8°C (where x = y), the coefficients (A) and (B) at any wood temperature were established as:

$$A = 0.881\ (1.0056)^{x}$$

$$B = -0.567 + 0.0260x - 0.000051x^{2}$$

By substituting in equation (1), the temperature-corrected meter reading at any temperature within the range -40° to 49°C was defined by:

$$x = \frac{Y + 0.567 - 0.0260x + 0.000051x^{2}}{0.881\ (1.0056)^{x}} \tag{4}$$

The results of equation (4) are graphically illustrated in Figure 1 at temperature increments of 5°C.

Given equation (4), a single equation was produced to give the estimated true MC for a given meter scale reading at any temperature within -40°C to 49°C, using the established species correction factor equations. For species correction factor equations developed at 22.8°C the combined equation becomes:

$$x_{o} = \left[\frac{Y + 0.567 - 0.0260x + 0.000051x^{2}}{0.881\ (1.0056)^{x}} - b\right] \div a \tag{5}$$

Where: x_o = estimated true moisture content (%)

Y = meter scale reading at (x)

x = wood temperature (°C)

a,b = regression coefficients from species correction factor equation: ($Y = aX + b$), where Y is meter reading and X is estimated true moisture content.

RESULTS

At a meter scale reading of 11 at -30°C the previously published correction tables given an estimated true MC of 24 percent for Douglas-fir (example). Equation (5) reduces this estimate to 18 percent MC. The difference between the two results decreases as wood temperature increases and as meter scale reading decreases. At temperatures above 10°C the previous corrections and those of equations (5) give effectively the same results. Table 1 illustrates the magnitude of the effect at selected wood temperatures.

CONCLUSIONS

The new temperature correction factors, when combined with the species correction give a more realistic estimate of the true MC when testing frozen lumber with the portable resistance-type moisture meter. Corrections based on the new relationships will minimize the risk of having lumber shipments rejected unjustifiably on the basis of excessive MC, when in fact, oven-test procedures confirm that the MC is within specifications. Alternatively, it will not be necessary to overdry lumber in winter to ensure compliance with grading specifications, as would be the situation if the previous correction tables are applied for inspection purposes.

REFERENCES

1. Bramhall, G. and M. Salamon. 1974. Combined species-temperature correction tables for moisture meters. Dept. of Environment, Can. Forest Serv., Western Forest Prod. Lab., Inform. Rep. VP-X-103 (revised 1978).

2. Cech, M.Y. and F. Pfaff. 1975. Moisture content correction tables for resistance-type moisture meters. Dept. of Environment, Can. Forest Serv., Forestry Tech. Rep. 7.

3. Mackay, J.F.G. 1984. Assessment of accuracy of species-temperature correction tables for resistance-type moisture meters. Forintek Canada Corp., Vancouver, B.C.

Table 1. Comparative estimates of wood moisture content by the portable resistance-type moisture meter — Douglas fir

Wood Temp. (°C)	Meter Scale Reading (%MC)	Moisture Content (%)		
		Previous Correction Tables	New Correction Factors [1]	Difference
-30	15	off scale	25	>6
	10	22	16	6
-10	15	24	21	3
	10	16	14	2
10	15	19	18	1
	10	12	11	1

[1] Based on equation (5) and same species corrections as used for previous correction tables.