However, some plants, particularly with higher voltage ratings in equipment, use another Megger product – the dielectric test set. So, you should be aware of this instrument and its use in insulation resistance measurements.

The dielectric test set can be used to determine insulation resistance by the same test methods as outlined for the Megger instrument; that is, the short-time, time-resistance and step-voltage tests. It is designed for other uses, too, but for insulation testing it provides: (1) an adjustable output voltage and (2) a monitoring of the resultant current in micro-amperes. The Megger DC Dielectric Test Sets are available with voltage outputs ranging from 5 kV up to 160 kV.

The curves of Fig. 5 are plotted as current versus time, as are curves for insulation measurements on typical equipment given near the end of this manual. Megger supplies graph paper which makes it easy to plot megohms of insulation resistance from your voltage and current readings.

TESTS DURING DRYING OUT OF EQUIPMENT

Wet electrical equipment is a common hazard faced by all maintenance engineers. If the equipment is wet from fresh water, you go right ahead drying it out. However, if you've got salt water, you must first wash away the salt with fresh water. Otherwise, you'll leave very corrosive deposits of salt on metal and insulating surfaces as well as in crevices of the insulation. With moisture, such deposits form a very good conductor of electricity. Also, you should remove oil or grease from the insulation, using a suitable solvent.

There are various ways to dry out electrical equipment, depending upon its size and portability. You can use a blast of hot air, an oven, circulation of current through conductors, or a combination of techniques. Local plant conditions and facilities, together with information from the equipment manufacturers, can serve as a guide to the best method for your particular equipment.

In some cases, or with certain equipment, drying out may not be necessary. You can check this by insulation resistance tests, if you have records of previous tests on the apparatus. When drying out is required, such records are also helpful to determine when the insulation is free of moisture.

NOTE:

> **Wet equipment is susceptible to voltage breakdown. Therefore, you should use a low-voltage Megger tester (100 or 250 VDC), at least in the early stages of a drying-out run. If a low-voltage instrument is not readily available, slow cranking of a 500-volt tester may be substituted.**

> **Many testers have an additional test range measuring in kilohms (kW). This measurement is typically made at only a few volts, and is the ideal initial measurement to be made on flooded equipment. This range measures below the Megohm range, and can, therefore, provide an actual measurement to use as a benchmark in monitoring the drying process. If a kilohm measurement is obtained, insulation has been thoroughly saturated, but may be reclaimable. Alternately test and dry, watching the readings rise until they reach the Megohm range, at which time higher voltage tests can be safely employed.**

As an example of how important past readings are, let's look at a 100-hp motor that's been flooded. After a clean-up, a spot reading with the Megger tester shows 1.5 megohms. Offhand, you'd probably say this is ok. What's more, if past records showed the insulation resistance to run between 1 and 2 megohms, you'd be sure.

On the other hand, if past records showed the normal resistance values to run 10 or 20 megohms, then you would know that water was still in the motor windings.

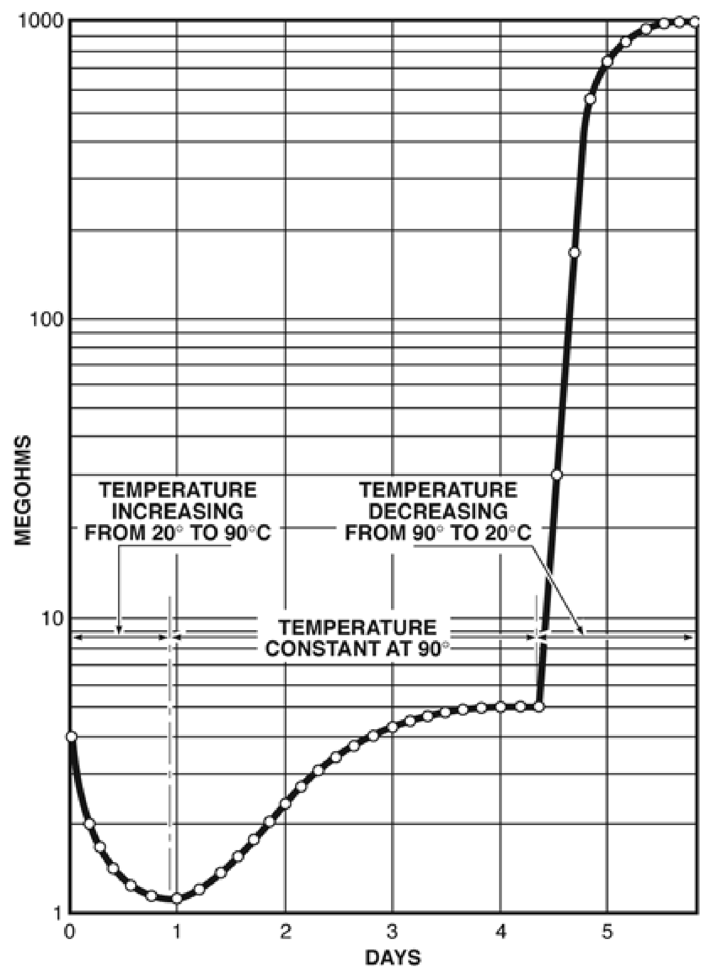


Figure 10-Typical drying curve where one-minute readings of insulation resistance are taken every four hours.

The typical drying-out curve for a DC motor armature (Fig. 10) shows how insulation resistance changes. During the first part of the run, the resistance actually decreases because of the higher temperature. Then it rises at a constant temperature as drying proceeds. Finally, it rises to a high value, as room temperature (20°C) is reached.

Note that if you conduct insulation resistance tests during drying, and you have readings of previous tests on the dry equipment, you'll know when you've reached the safe value for the unit. You may prefer to use a time-resistance test, taken periodically (say, once a shift), using the dielectric absorption ratio or polarization index to follow dry-out progress (no need to correct for temperature).

Effect of Temperature on Insulation Resistance

The resistance of insulating materials decreases markedly with an increase in temperature. As we've seen, however, tests by the time-resistance and step-voltage methods are relatively independent of temperature effects, giving relative values.

If you want to make reliable comparisons between readings, you should correct the readings to a base temperature, such as 20°C, or take all your readings at approximately the same temperature (usually not difficult to do). We will cover some general guides to temperature correction.

One thumb rule is:

For every 10°C increase in temperature, halve the resistance; or, for every 10°C decrease, double the resistance.

For example, a two-megohm resistance at 20°C reduces to 1/2 megohm at 40°C.

Each type of insulating material will have a different degree of resistance change with temperature. Factors have been developed, however, to simplify the correction of resistance values. Table II gives such factors for rotating equipment, transformers and cable. You multiply the readings you get by the factor corresponding to the temperature (which you need to measure).

For example, assume you have a motor with Class A insulation and you get a reading of 2.0 megohms at a temperature (in the windings) of 104°F (40°C). From Table II you read across at 104°F to the next column (for Class A) and obtain the factor 4.80. Your corrected value of resistance is then:

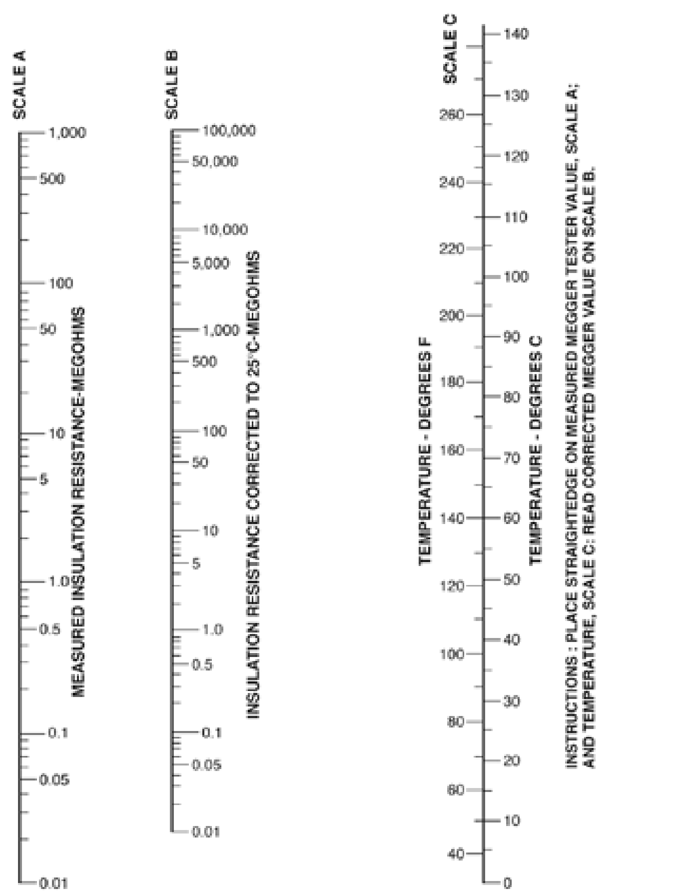
2.0 megohms (reading at 104°F)	x (correction	4.80 = (corrected factor for Class A insulation at 104°F)	9.6 megohms reading for 68°F or 20°C)

Note that the resistance is almost five times greater at 68°F (20°C), as compared to the reading taken at 104°F. The reference temperature for cable is given as 60°F (15.6°C), but the important point is to be consistent and correct to the same base.

TABLE II-Temperature Correction Factors*

TEMP.		ROTATING EQUIP.			CABLES							
ϒC	ϒF	CLASS A	CLASS B	OIL-FILLED TRANSFORMERS	CODE NATURAL	CODE GR-S	PERFORMANCE NATURAL	HEAT RESIST. NATURAL	HEAT RESIST. & PERFORM. GR-S	OZONE RESIST. NATURAL GR-S	VARNISHED CAMBRIC	IMPREGNATED PAPER
0	32	0.21	0.40	0.25	0.25	0.12	0.47	0.42	0.22	0.14	0.10	0.28
5	41	0.31	0.50	0.36	0.40	0.23	0.60	0.56	0.37	0.26	0.20	0.43
10	50	0.45	0.63	0.50	0.61	0.46	0.76	0.73	0.58	0.49	0.43	0.64
15.6	60	0.71	0.81	0.74	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
20	68	1.00	1.00	1.00	1.47	1.83	1.24	1.28	1.53	1.75	1.94	1.43
25	77	1.48	1.25	1.40	2.27	3.67	1.58	1.68	2.48	3.29	4.08	2.17
30	86	2.20	1.58	1.98	3.52	7.32	2.00	2.24	4.03	6.20	8.62	3.20
35	95	3.24	2.00	2.80	5.45	14.60	2.55	2.93	6.53	11.65	18.20	4.77
40	104	4.80	2.50	3.95	8.45	29.20	3.26	3.85	10.70	25.00	38.50	7.15
45	113	7.10	3.15	5.60	13.10	54.00	4.15	5.08	17.10	41.40	81.00	10.70
50	122	10.45	3.98	7.85	20.00	116.00	5.29	6.72	27.85	78.00	170.00	16.00
55	131	15.50	5.00	11.20			6.72	8.83	45.00		345.00	24.00
60	140	22.80	6.30	15.85			8.58	11.62	73.00		775.00	36.00
65	149	34.00	7.90	22.40				15.40	118.00			
70	158	50.00	10.00	31.75				20.30	193.00			
75	167	74.00	12.60	44.70				26.60	313.00			

Corrected to 20ϒ C for rotating equipment and transformers; 15.6ϒ C for cable.



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