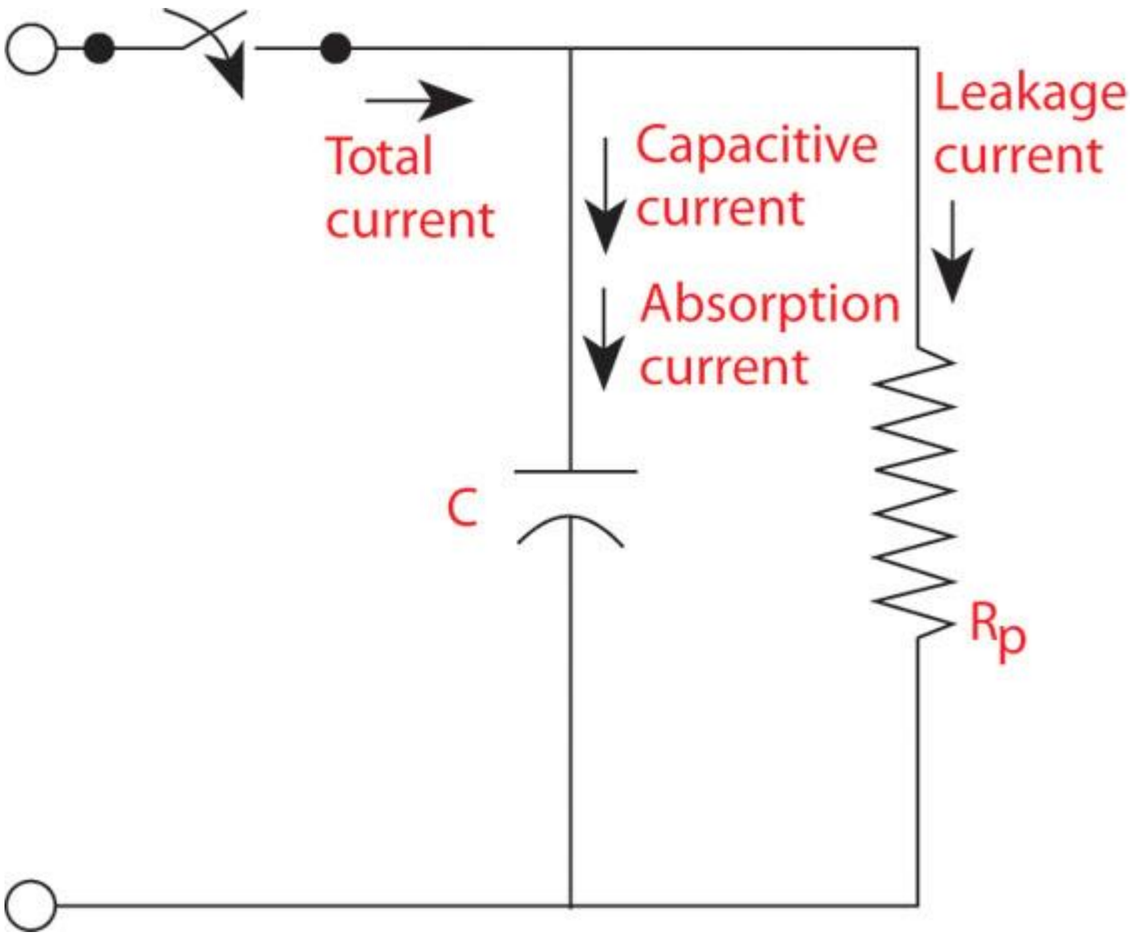
# Understanding Insulation Resistance Testing Part III

***3) Step voltage test***

This test is particularly useful in evaluating aged or damaged insulation not necessarily having moisture or contamination. A dual voltage test instrument is required here. After the connections are made, the IR test is done at a low voltage, say 500V. The test specimen then is discharged and the test is done again, this time at a higher voltage, say 2500V. If more than a 25% difference exists between the two IR readings, age deterioration or damaged insulation should be suspected.

**SIDEBAR: Basic Theory**

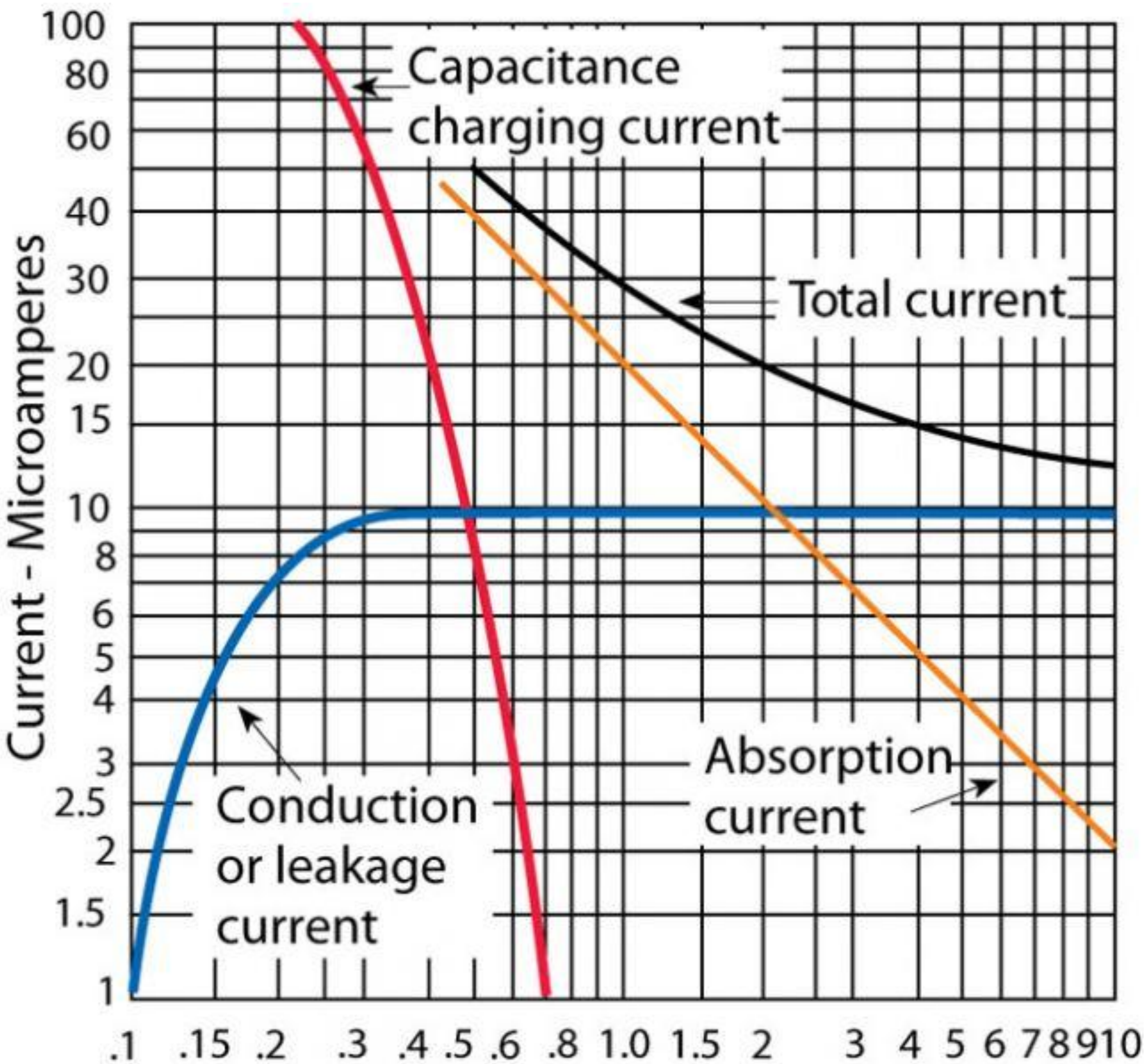



An equivalent circuit for electrical insulation is shown in **Fig. 5** (right). The top terminal might be the center conductor of a power cable, and the bottom terminal, its shield. The current flowing through the cable's insulation would be that current noted as "total current" in the diagram. As you can see, the total current is equal to the sum of the "capacitive current" plus the "absorption current" plus the "leakage current."

Note that the total current is not the load current flowing through the system. Rather, it's the current that flows from the energized conductor *through* the insulation to ground.

Let's provide some basic definitions here.

*Capacitive current*. A capacitor is created when two conductors are separated by an insulator. This is the situation in a power system.




If a DC voltage is suddenly applied (closing the switch in Fig. 5), electrons will rush into the negative plate and be drawn from the positive plate. Initially, this current flow will be very large, but it will gradually reduce to a much smaller value, eventually approaching zero. The current labeled "capacitive charging current" in **Fig. 6** (right) shows how this current varies with time after DC voltage is applied.

***Leakage current.*** No insulation is perfect; even new insulation will have some leakage current, albeit small. This leakage current will increase as the insulation ages. It also will worsen when the insulation is wet or contaminated.

The "conduction or leakage current" shown in Fig. 6 is a graphical representation of leakage current. Notice that it starts at zero, and quickly increases to a final value of 10 microamps. This is the way that good insulation behaves. As insulation ages and deteriorates, however, two changes may occur in leakage current. One change may be that the final value of leakage current may increase and not level off. For example, instead of leveling off at 10 microamps, the final current may increase to 20 microamps. The other change may be that, instead of rising quickly to a final value and the leveling out, the leakage current simply may continue to increase. In this scenario, the insulation eventually will fail.

***Absorption current.*** The charges that form on the plates of the capacitor attract charges of the opposite polarity in the insulation, causing these charges to move and, thus, drawing current. The largest charge motion occurs in the initial moments and then gradually tapers off to near zero. This current is called dielectric absorption, or just absorption current. A time plot of this current, labeled "absorption current," also is shown in Fig. 6.

**Total current.** The total current flowing in the circuit is equal to the sum of the components shown in Fig. 6. The total current flow, when a DC voltage is applied, starts at a relatively high value and then drops, settling at a value just slightly above the leakage current. In bad or deteriorated insulation, the total current will drop slowly, or may even increase.