technical bulletin 014

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Voltage and Current Ratings

Voltage

Voltage ratings are determined by the thickness of primary plastic insulation. The published dielectric strength for FEP and PTFE are as high as 500 & 350 volts/mil under ideal laboratory conditions. The Voltage Rating used for oil field cables is a conservative 50 Volts DC /mil of insulation As an example, Camesa cable 1N22PP has 24.5 mils of insulation.
At 50 Volts/mil this would indicate a rating of 1,250 Volts DC. The actual catalog rating is rounded off at 1,200VDC.

The sixty cycle AC RMS voltage rating of a cable is less than the DC rating. The peak voltage of the sine wave AC voltage is 1.4 times the RMS value, so this would make the AC voltage rating of the Camesa cable 1N22PP only 700VAC.

With AC voltages there is always the threat of corona discharge that can deteriorate the plastic insulation. A complete treatment of corona problems is very complex and includes effects of temperature, pressure, conductor size, frequency as well as insulation thickness. A simplified conservative formula, (NTIS), for calculating the volts per mil for the onset of corona for this cable is:

E =0. 868 / d [log(D / d)]
Where: E – Volts / mil for the onset of corona
d – diameter of conductor – inches
D – Diameter over insulation – inches
E =0. 868 / 0.059 [log(0.108 / 0.059)] = 56 Volts / mil, is where corona could start to be a problem.
By rating Camesa cables at 50 Volts/mil, corona should never be a problem.

Current

The maximum current in a cable is determined by the allowable voltage drop and the heat generated by the current in the cable that is on the drum. Unless the maximum current is on continuously for several hours, the maximum current will normally be limited by the maximum voltage.

Using a 25,000 ft. 1N22PP cable as an example, the maximum allowable current can be calculated using the values of resistance and voltage rating listed in the catalog.

- Ld = cable length on drum (kft)
- Lh = cable length in bore hole (kft)
- The conductor resistance, of the cable on the drum is: (4.0 x Ld) Ohms (from Camesa Catalog)
- The armor of the cable on the drum has no resistance as it is all shorted on itself and the drum
- The conductor resistance, of the cable in the hole is (4.0 x Lh) Ohms
- The armor resistance, Ohms, of cable in the hole is (4.4 x Lh) Ohms (from Camesa Catalog)

Example #1:

Length of cable in the hole is 20,000 feet; therefore, Lh = 20;
Length of cable on the drum is 5,000 feet; therefore, Ld = 5;
The Voltage required at the tool Vb = 700;
The cable voltage rating Vmax= 1200, (from Camesa Catalog)

- Total cable loop resistance, Rc = (4.0 x 5) + (4.0 x 20) +
- (4.4 x 20) = 188 Ohms
- Total allowable Voltage drop, Vd = Vmax – Vb = 1200 – 700 = 500 Volts
- Current = Voltage /Resistance
- Maximum current that can be supplied is Imax = Vd / Rc = 500 / 188 = 2.6 amps.

Now consider the heating effect of the cable on the drum.
Power = (Current)^2 x Resistance = Current x Current x Resistance
Power (watts) dissipated in drum cable, Pd = (Imax x Imax) x (4.0 x Ld) = (2.6 x 2.6) x (4.0 x 5) = 135 Watts. In this example the heat from 135 watts, a typical light bulb, dissipated in the 500 pounds of cable on the drum plus the steel drum will have little effect on the cable temperature.

Example #2:

Lh =5; Ld = 20; Vb = 700; Vmax = 1200; Calculate Imax
Rc = (4.0 x 20) + (4.0 x 5) + (4.4 x 5) = 122 Ohms
Vd = 1200 – 700 = 500 Volts
Imax = 500 / 122 = 4.1 amps

Now consider the heating effect of the cable on the drum.
Pd = (Imax x Imax) x Rd
Rd = 4.0 x Ld
Pd = (4.1 x 4.1) x (4.0 x 20) = (16.8 x 80) = 1,344 watts.

This is nearly 10 times the wattage of the other example but still not a serious problem for short periods. 1,344 Watts is about the power of a kitchen “hot plate”. It would take a very long time to heat up a 2,000 pound cable on the drum plus a steel drum with a kitchen hot plate. This example does however, illustrate that the problem of maximum current becomes more serious when most of the cable is on the drum. There are too many variables to calculate the maximum allowable time limit, including: ambient temperature, layers of cable on the drum, air circulation, spooling tensions, etc. Experience has indicated that cable on the drum can tolerate, without damage, 1/10 watt per foot for periods of 24 hours. In this example that would be 1,250 watts.