

## Gap / Primary Losses and Surge Impedance

Mark S. Rzeszutarski, Ph.D.  
Cleveland, Ohio, U.S.A.

## Primary Current

- $I_p = V_{p-p} / Z_p$
- $V_{p-p}$  = peak voltage where spark gap fires
- $Z_p$  = primary impedance

## Primary Impedance $Z_p$

- $Z_p = Z_{\text{surge}} + R_{\text{gap}} + R_{\text{pri.}} + R_{\text{diel.}} + Z_m$
- $Z_{\text{surge}}$  = surge impedance =  $\sqrt{L_p / C_p}$   
(limits max current but is not a loss factor)
- $R_{\text{gap}}$  = spark gap resistance (1-10 ohms)
- $R_{\text{primary}}$  = tubing resistance (0.2-1 ohm)
- $R_{\text{diel.}}$  = capacitor dielectric losses (<1 ohm)
- $Z_m$  = coupled impedance from secondary

## Spark Gap Resistance

- Follows Toepler's equation:  
 $R_{\text{gap}} = (0.8 \times 10^{-3} \times d \times p) / (C_p \times V_{p-p})$
- $d$  = total gap distance in cm
- $p$  = pressure in atmospheres (air)
- $C_p$  = primary capacitance in Farads
- $V_{p-p}$  = peak to peak spark gap firing voltage

