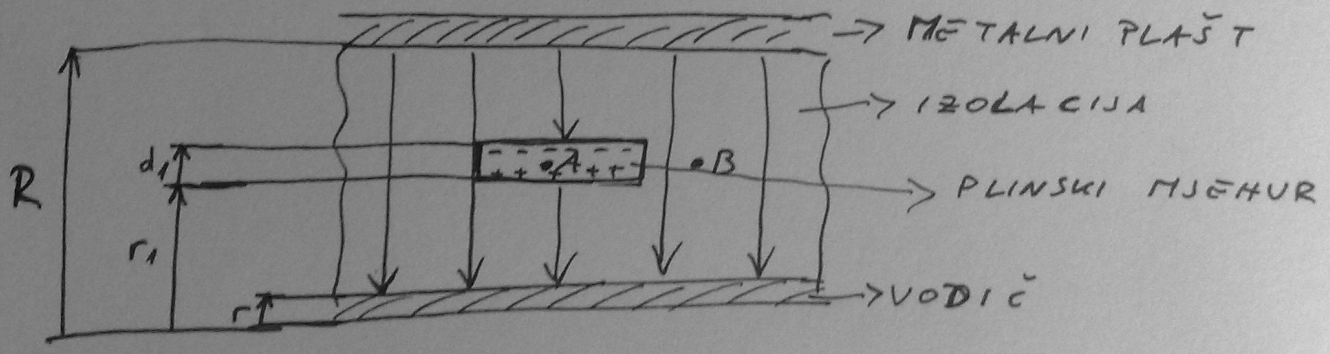
GRUPA A

1. PAPIROM IZOLIRANI VODIČ U KABELU OSTAO JE BEZ ULJA TE SE STVORIO PLINSKI MJEHUR PREMA SLICI.

ε_r PAPIRNE IZOLACIJE JE 2,5, A PLINA U MJEHURU 1.

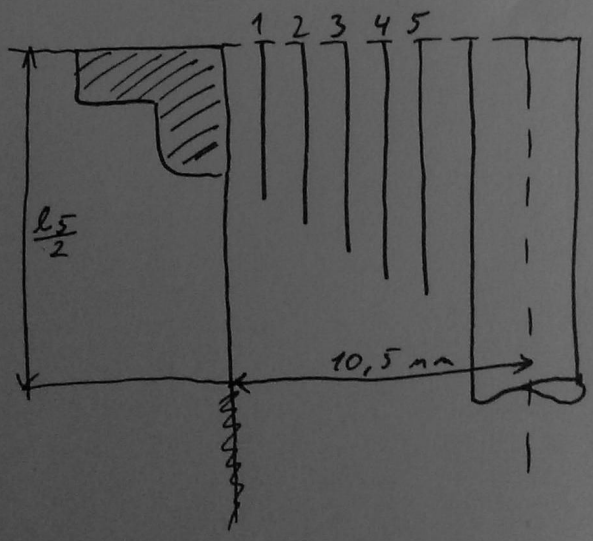
ODREDITE $\frac{E_A}{E_B}$ NA UDALJENOSTI $r_1 + 0{,}5d$ AKO JE VODIČ NA NAPONU U

$r = 12$ mm, $r_1 = 17$ mm, $d = 1$ mm, $R = 25$ mm



2. NA KOJOJ ĆE SE NADMORSKOJ VISINI PRI FAZNOM NAPONU 120kV POJAVITI VIDLJIVA KORONA NA VODIČU PROMJERA 14mm, NA VISINI 26 m. PRETPOSTAVIMO LINEARAN PAD TEMP. S VISINOM TAKO DA NA 0 m TEMP. IZNOSI 20°C, A NA 1800 m IZNOSI 0°C FAKTOR NEPRAVILNOSTI 0,73

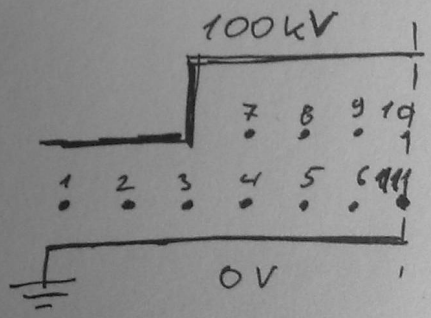
3. ODREDITE DULJINE 5 SUOSNIH CILINDRIČNIH FOLIJA ZANEMARIVE DEBLJINE U PROVODNOM IZOLATORU UKOLIKO SU SVE MEĐUSOBNO UDALJENE 1mm UZ UVJET LINEARIZACIJE (JEDNAKOSTI) NAPONA IZMEĐU SVAKE POJEDINE FOLIJE, FOLIJE I PRIRUBNICE TE FOLIJE I VODIČA. POLUMJER VODIČA JE 4,5 mm, DULJINA PRIRUBNICE 100mm



$l_1, l_2, l_3, l_4, l_5 = ?$

8. ODREDITI l_{10} i l_{11}.

ZADANO $l_6 = 30$kV, $l_9 = 60$kV



TVN – 1. MI 2010./2011. grupa A

① $\varepsilon_r = 2.5$

$\frac{E_A}{E_B} = ?$

$r_1 + \frac{\delta}{2}$

$r = 12$ mm

$r_1 = 17$ mm

$\delta = 1$ mm

$R = 25$ mm

$$E_A = \frac{U}{1\cdot(r_1+0.5d)\left(\frac{1}{\varepsilon_r}\ln\frac{r_1}{r} + \frac{1}{1}\cdot\ln\frac{r_1+d}{r_1} + \frac{1}{\varepsilon_r}\ln\frac{R}{r_1+d}\right)}$$

$$E_B = \frac{U}{(r_1+0.5d)\ln\frac{R}{r}}$$

$$\frac{E_A}{E_B} = \frac{\ln\frac{R}{r}}{\frac{1}{\varepsilon_r}\ln\frac{r_1}{r} + \ln\frac{r_1+d}{r_1} + \frac{1}{\varepsilon_r}\ln\frac{R}{r_1+d}} = \frac{\ln\frac{25}{12}}{\frac{1}{2.5}\ln\frac{17}{12} + \ln\frac{18}{17} + \frac{1}{2.5}\ln\frac{25}{18}} = 2.24$$

② $U = 120$ kV

$r = 7$ mm

$h = 26$ m

0 m → 20°C

1800 m → 0°C

$m_v = 0.73$

$$U_v = 30 m_v \cdot \delta \cdot r\left(1 + \frac{0.3}{\sqrt{\delta r}}\right)\ln\frac{2h}{r}$$

$$U_v = 120\sqrt{2}$$

$$120\sqrt{2} = 30\cdot 0.73\cdot\delta\cdot 0.7\left(1+\frac{0.3}{\sqrt{0.7\delta}}\right)\ln\frac{2\cdot 26}{7\cdot 10^{-3}}$$

$$1.242 = \delta + 0.358\sqrt{\delta}$$

$$\sqrt{\delta} = t;\ \delta = t^2 \Rightarrow t^2 + 0.358t - 1.242 = 0 \Rightarrow t = 0.950$$

$$\delta = 0.902 \quad //$$

$$\delta = \frac{p T_0}{p_0 T} = \frac{1.013 e^{-\frac{z}{7.4}}\cdot 293}{1.013(293 - 11.1z)} \quad \text{jer je } t = -11.1z + 20 \quad z[\text{km}]$$

$$293 e^{-\frac{z}{7.4}} = \delta(293 - 11.1z) \Rightarrow e^{-\frac{z}{7.4}} + 0.034z = 0.902$$

z	
1	0.908
1.2	0.891
1.05	0.903

z	
1.06	0.903
1.07	0.902

Vidljiva korona će se pojaviti na 1070 m nadmorske visine.

③ $\Delta s = 1$ mm

$r = 4.5$ mm

$l_0 = 100$ mm

$$\varphi_1 - \varphi_0 = \varphi_2 - \varphi_1 = \ldots = \varphi_6 - \varphi_5 \Rightarrow C_1 = C_2 = \ldots = C_6$$

$$C_1 = \frac{2\pi\varepsilon l_0}{\ln\frac{9.5}{10.5}};\ C_2 = \frac{2\pi\varepsilon l_1}{\ln\frac{8.5}{9.5}};\ \ldots;\ C_6 = \frac{2\pi\varepsilon l_5}{\ln\frac{4.5}{5.5}}$$

$$\Rightarrow l_1 = l_0\frac{\ln\frac{8.5}{9.5}}{\ln\frac{9.5}{10.5}} = 111.13\text{ mm};\ l_2 = 100\frac{\ln\frac{7.5}{8.5}}{\ln\frac{10.5}{9.5}} = 125.06\text{ mm}$$

$$l_3 = 142.98\text{ mm};\ l_4 = 166.91\text{ mm};\ l_5 = 200.50\text{ mm}$$

⑧ $\varphi_0 = 100$ kV

$\varphi_6 = 30$ kV

$\varphi_9 = 60$ kV

$\varphi_{10} = ?$

$\varphi_{11} = ?$

$$\begin{cases}\varphi_{10} = \frac{\varphi_9 + 100 + \varphi_9 + \varphi_{11}}{4}\\ \varphi_{11} = \frac{\varphi_{10} + \varphi_6 + \varphi_6 + 0}{4}\end{cases}$$

$$\begin{cases}4\cdot\varphi_{10} = 220 + \varphi_{11}\\ 4\cdot\varphi_{11} = 60 + \varphi_{10}\end{cases} \Rightarrow \begin{matrix}\varphi_{11} = 30.67\text{ kV}\\ \varphi_{10} = 62.68\text{ kV}\end{matrix}$$

TVN 1.011 2010./2011. grupa B

① $\varepsilon_r = 2.8$
$r_0 + 0.5d$
$r = 12\,mm$
$r_1 = 18\,mm$
$d = 1\,mm$
$R = 26\,mm$

$$E_A = \frac{U}{1\cdot(r_1+0.5)\left(\frac{1}{\varepsilon_r}\ln\frac{r_1}{r}+\frac{1}{1}\ln\frac{r_1+d}{r_1}+\frac{1}{\varepsilon_r}\ln\frac{R}{r_1+d}\right)}$$

$$E_B = \frac{U}{(r_1+0.5d)\ln\frac{R}{r}}$$

$$\frac{E_A}{E_B} = \frac{\ln\frac{R}{r}}{\frac{1}{2.8}\ln\frac{18}{12}+\ln\frac{19}{18}+\frac{1}{2.8}\ln\frac{26}{19}} = 2.49$$

② $U_r = 118\,kV$
$r = 7\,mm$
$h = 28\,mm$
$0°C \to 1200\,m$
$20°C \to 0\,m$
$m_v = 0.74$

$$U_r = 30\,m_v\,\delta\,r\left(1+\frac{0.3}{\sqrt{\delta r}}\right)\ln\frac{2h}{r}$$

$$118\sqrt{2} = 30\cdot0.74\cdot\delta\cdot0.7\left(1+\frac{0.3}{\sqrt{0.7\delta}}\right)\ln\frac{2\cdot28}{7\cdot10^{-3}}$$

$$1.194 = \delta + 0.359\sqrt{\delta}$$

$\sqrt{\delta} = t \Rightarrow \delta = t^2 \qquad t^2 + 0.359t - 1.194 = 0 \Rightarrow t = 1.856$

$\delta = 0.861$

$$\delta = \frac{p_0}{p_0}\frac{T_0}{T} = \frac{1.013\,e^{-\frac{z}{7.4}}\cdot293}{1.013(293-16.6z)}$$

$$e^{-\frac{z}{7.4}} + 0.049z = 0.861$$

z	
1	0.92
1.5	0.89
→ 2	0.861

Vidljiva korona počinje se javljati na 2000 m n.v.

③ $l_0 = 120\,mm$
$\Delta\Delta = 1\,mm$
$r = 4.5\,mm$

$$\varphi_1 - \varphi_0 = \varphi_2 - \varphi_1 = \ldots = \varphi_6 - \varphi_5 \Rightarrow C_1 = C_2 = \ldots = C_6$$

$$C_1 = \frac{2\pi\varepsilon l_0}{\ln\frac{9.5}{10.5}} = C_2 = \frac{2\pi\varepsilon l_1}{\ln\frac{8.5}{9.5}} \Rightarrow l_1 = 120\,\frac{\ln\frac{8.5}{9.5}}{\ln\frac{9.5}{10.5}} = 133.36\,mm$$

$$l_2 = 120\,\frac{\ln\frac{7.5}{8.5}}{\ln\frac{8.5}{9.5}} = 150.07\,mm$$

$l_3 = 171.58\,mm \qquad l_4 = 200.30\,mm$
$l_5 = 240.60\,mm$

⑧ $\varphi_0 = 120\,kV$
$\varphi_6 = 36\,kV$
$\varphi_9 = 72\,kV$
$\varphi_{10} = ?$
$\varphi_{11} = ?$

$$\begin{cases} \varphi_{10} = \dfrac{\varphi_9 + 120 + \varphi_9 + \varphi_{11}}{4} \\ \varphi_{11} = \dfrac{\varphi_{10} + \varphi_6 + \varphi_6 + 0}{4} \end{cases}$$

$$\begin{cases} 4\varphi_{10} = 264 + \varphi_{11} \\ 4\varphi_{11} = 72 + \varphi_{10} \end{cases} \Rightarrow$$

$264 + \varphi_{11} = 16\varphi_{11} - 4.72$

$\varphi_{11} = 36.8\,kV$

$\varphi_{10} = 75.2\,kV$