task_underseacable

Student Group

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Sure, here's the answer with the values and formulas in LaTeX notation:

Given:

- Distance between two coastal cities = $d = 400~{\rm km}$
- Depth of the cable below the ocean's surface = $h = 1000~{\rm m}$
- Resistance of the cable per unit length = $R = 0.1~{\rm \Omega/km}$
- Voltage at the source end of the cable = $V_s = 500~{\rm kV}$
- Power factor of the cable = $\cos \phi = 0.8$
- Load at the destination end of the cable = $P = 800~{\rm MW}$

The total resistance of the cable is:

\begin{align*} R_{\rm total} &= R \times L \ &= 0.1~{\rm \Omega/km} \times 400~{\rm km} \ &= 40~{\rm \Omega} \end{align*}

The current flowing through the cable is:

\begin{align*} I &= \frac{V_s}{R_{\rm total}} \ &= \frac{500~{\rm kV}}{40.01~{\rm \Omega}} \ &= 12.5 ~{\rm kA} \end{align*}

The real power being transmitted through the cable is:

\begin{align*} P &= V_s \times I \times \cos \phi \ &= 500~{\rm kV} \times 12.5~{\rm kA} \times 0.8 \ &= 5,000~{\rm MW} \end{align*}

The reactive power being transmitted through the cable is:

\begin{align*} Q &= V_s \times I \times \sqrt{1 - \cos^2 \phi} \ &= 500~{\rm kV} \times 12.5~{\rm kA} \times \sqrt{1 - 0.8^2} \ &= 2,500~{\rm MVAr} \end{align*}

The total power that the cable can handle is:

\begin{align*} S &= \sqrt{P^2 + Q^2} \ &= \sqrt{(5,000~{\rm MW})^2 + (2,500~{\rm MVAr})^2} \ &= 5,590.17~{\rm MVA} \end{align*}

Therefore, the maximum capacity of the cable is $S = 5,590.17~{\rm MW}$, which is greater than the required power of $P = 800~{\rm MW}$.