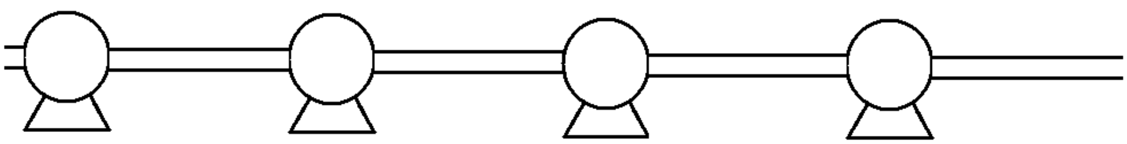
TOPIC
Fluids – Section X – Question 7

QUESTION
The following two questions (7-8) refer to the statement and diagram below.
A 1.2 m diameter pipeline is used to transport 1.3 m^3/s (940,000 bbl/day) of crude oil over a distance of 1200 km. Because the pressures generated would be too high to do this with a single pump, a series of pumping stations are used as shown in the drawing below. Each pumping station is designed to pump the liquid from 200 kPa at the pump inlet to 1300 kPa at the pump exit. The pipe is smooth and may be assumed to be straight with no elevation gain or loss. Pumps operate at 80 % efficiency. The density and viscosity of the crude oil are 850 kg/m^3 and 0.1 kg/m-s, respectively.



QUESTION
The power required at each pumping station in MW is most nearly
(A) 1.0
(B) 1.8
(C) 2.2
(D) 4.3

HINTS
- Consider the relation between head and ΔP
- Use the pump power equation

SOLUTION
The pump power equation is

$$\dot{W} = \frac{Q\rho g h}{\eta}$$

where
Q is the volumetric flow rate,
ρ is the fluid density,
g is the gravitational constant,
h is the pump head, and
η is the pump efficiency.
The pump head is related to the pressure increase ΔP by

$$\Delta P = \rho g h$$

Therefore the power required is

$$\dot{W} = \frac{Q \Delta P}{\eta}$$

$$\dot{W} = \frac{(1.3m^3/s)((1300 - 200)\text{kPa})}{0.8}$$

$$= 1788\text{kPa} \cdot m^3/s$$

$$= 1788\text{kW}$$

$$= 1.788\text{MW}$$

ANSWER

(B)

CONTRIBUTOR

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