The JETS Challenge

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Challenge 68 — The Alaskan Pipeline Challenge

Problem:

The Alaska pipeline runs 800 miles (1,300 km) from Prudhoe Bay on the north coastline to Valdez, the northern most ice-free port in the world. There the oil is loaded onto super tankers for transfer to refineries in the continental United States. Assume the system is designed to operate continuously (24/7/365) and to move two million barrels of oil per day at a velocity of 4 miles per hour. A barrel of oil equals 42 gallons, and a cubic foot of oil equals 7.48 gallons. The equation $Q = V \bullet A$ relates the flow rate (Q in cubic feet per second) to the product of the velocity (V in feet per second) and pipe cross-sectional area (A in square feet).

What is the diameter of the Alaska pipeline to the nearest inch?

See page 2 for solution.

Solution:

2 million barrels = 84,000,000 gallons

$$x \text{ ft}^3 = 84,000,000 \text{ gal} \times \frac{1 \text{ ft}^3}{7.48 \text{ gal}} = 11,229,946.5241 \text{ ft}^3$$

$$\frac{x \text{ ft}}{\text{sec}} = \frac{4 \text{ miles}}{1 \text{ hr}} \times \frac{1 \text{ hr}}{60 \text{ min}} \times \frac{1 \text{ min}}{60 \text{ sec}} \times \frac{5,280 \text{ ft}}{1 \text{ mile}} = 5.86\overline{6} \text{ ft/sec} = \text{V}$$

$$\text{Q} = \frac{x \text{ ft}^3}{1 \text{ sec}} = \frac{11,229,946.5241 \text{ ft}^3}{1 \text{ day}} \times \frac{1 \text{ day}}{24 \text{ hr}} \times \frac{1 \text{ hr}}{60 \text{ min}} \times \frac{1 \text{ min}}{60 \text{ sec}}$$

$$Q = 129.9762 \text{ ft}^3 / \text{sec}$$

$$Q = VA$$

$$A = \frac{Q}{V} = \frac{129.9762 \text{ ft}^3 / \text{sec}}{5.86\overline{6} \text{ ft/sec}} = 22.15755 \text{ ft}^2$$

$$A = \pi r^2$$

$$r^2 = 7.0529$$

$$r = \sqrt{7.0529} = 2.6557$$

$$d = 2r = 2.6557 \times 2 = 5.3114593 \text{ ft} \times \frac{12 \text{ in}}{1 \text{ ft}} = 63.7575 \text{ in}$$

=64 in