Nguyen Xuan Binh 887799 Round 5 Problem 2

To test aerodynamics of a new prototype automobile, scale model is tested in wind tunnel

Dynamic similarity: $Re_{proto} = Re_{model}$. Scale of prototype - model: 1 : 10.

Both prototype and model exposed to standard air pressure, what's better for wind tunnel air to be cooler or hotter than standard sea-level air temperature of 15°C ?

Reynold's number are similar between prototype and ~~mobile~~ model

$$\Rightarrow \frac{V_m \ell_m}{\nu_m} = \frac{V\ell}{\nu} \quad (\nu_m, \nu: \text{kinematic viscosity})$$

$$\Rightarrow V_m = \frac{\nu_m}{\nu} \cdot \frac{\ell}{\ell_m} V = \frac{\nu_m}{\nu} 10V \quad (\text{Scale is } 1:10)$$

V is prototype automobile's velocity. We know that cars are fast and 10 times the velocity of cars is hard to replicate in the model. To be realistic, V_m should be $< 10V$

$\Rightarrow$ To reduce 10V magnitude, $\frac{\nu_m}{\nu}$ should be smaller than 1

$\Rightarrow \nu_m < \nu \Rightarrow \nu_m < 1.47 \times 10^{-5}$ according to table B.4

Since temperature is proportional to kinematic viscosity $\Rightarrow T_m < T$

$\Rightarrow$ It's better for wind tunnel air to be colder than standard air temperature of 15°C (Ans)