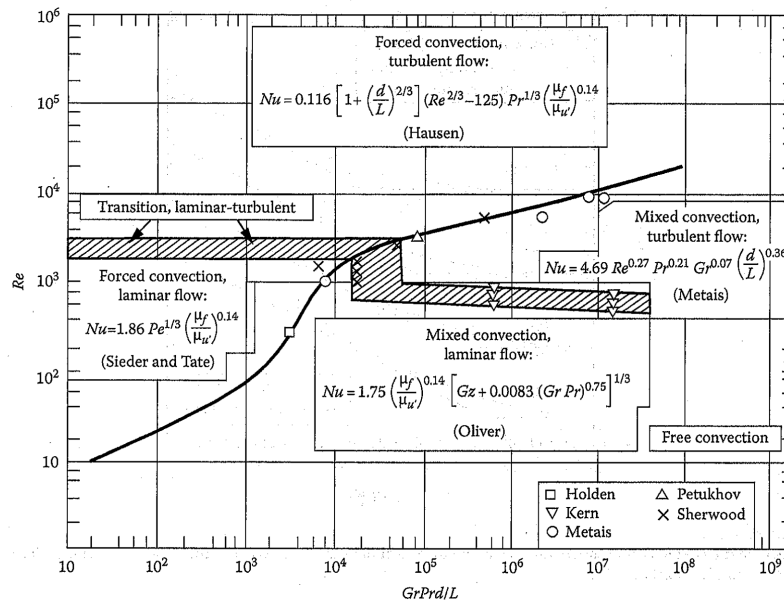


Air at atmospheric pressure and 20°C is forced through a horizontal 1 in. diameter tube at an average velocity of 0.3 m/s. Tube wall is maintained at a constant temperature of 140°C. Calculate the heat-transfer coefficient for this situation if tube is 12 in. long. (For correlations refer below)



```
In[*]:= SetDirectory[NotebookDirectory[]];
airProps = Import["../air_props.csv"];
airProps[[2 ;;, 5]] = airProps[[2 ;;, 5]] 10^-3;
airProps[[2 ;;, 6]] = airProps[[2 ;;, 6]] 10^-5;
airProps[[2 ;;, 7]] = airProps[[2 ;;, 7]] 10^-6;
airProps[[2 ;;, 8]] = airProps[[2 ;;, 8]] 10^-6;
vI = Interpolation[airProps[[2 ;;, {1, 7}]]];
βI = Interpolation[airProps[[2 ;;, {1, 5}]]];
PrI = Interpolation[airProps[[2 ;;, {1, 9}]]];
αI = Interpolation[airProps[[2 ;;, {1, 8}]]];
κI = Interpolation[airProps[[2 ;;, {1, 4}]]];
μI = Interpolation[airProps[[2 ;;, {1, 6}]]];
```

$$\text{In[*]} := \text{Re}_d = \frac{U d}{\nu}; \quad \text{Gr}_d = \frac{g \beta (T_w - T_\infty) d^3}{\nu^2}; \quad \text{Gz} = \text{Re}_d \text{Pr} \frac{d}{L};$$

$$\text{TFilm} = \frac{T_w + T_\infty}{2};$$

```
propertyVals = {ν → νI[TFilm], α → αI[TFilm], β → βI[TFilm],
```

```
Pr → PrI[TFilm], κ → κI[TFilm], g → 9.81, μ_w → μI[T_w], μ → μI[TFilm]};
```

```
problem = {U → 0.3, d → 0.0254, L → 12 × 0.0254, T_w → 140, T_∞ → 20};
```

```
solverRule = Join[propertyVals /. problem, problem];
```

```
In[*]:= Re_d /. solverRule
```

```
Out[*]=
```

363.897

```
In[*]:=  $\frac{Gr_d Pr d}{L}$  /. solverRule
```

```
Out[*]= 7345.76
```

```
In[*]:= Gz /. solverRule
```

```
Out[*]= 21.4699
```

```
In[*]:=  $Nu_d = 1.75 \left( \frac{\mu}{\mu_w} \right)^{0.14} (Gz + 0.0083 (Gr_d Pr)^{0.75})^{1/3};$ 
```

```
 $h = Nu_d \frac{\kappa}{d};$ 
```

```
In[*]:= h /. solverRule
```

```
Out[*]= 8.1085
```

Say, the flow is completely forced convection

```
In[*]:=  $Nu_{forced} = 1.86 \left( Re_d Pr \frac{d}{L} \right)^{1/3} \left( \frac{\mu}{\mu_w} \right)^{0.14};$   $h_{forced} = Nu_{forced} \frac{\kappa}{d};$ 
```

```
In[*]:= hforced /. solverRule
```

```
Out[*]= 5.99039
```