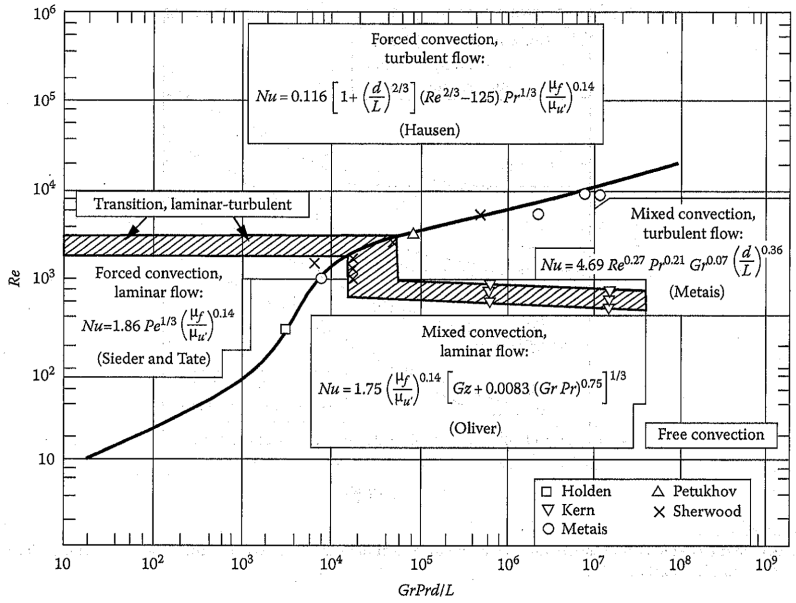
Air at atmospheric pressure and 20°C is forced through a horizontal 1 in. diameter tube at an average velocity at 0.3 m/s. Tube wall is maintained at a constant temperature of 140°C. Calculate the heat-transfer coefficient for this situation if tube is 12 in. long. (For correlations refer below)




```
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;
νI = 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}]]];
```

```
In[•]:= Re_d = U d / ν ; Gr_d = g β (T_w - T_∞) d^3 / ν^2 ; Gz = Re_d Pr d / L ;
TFilm = (T_w + T_∞) / 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[•]:= $Nu_d = 1.75 \left(\frac{\mu}{\mu_w}\right)^{0.14} \left(Gz + 0.0083\, (Gr_d\, Pr)^{0.75}\right)^{1/3};$

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

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[•]:= h_{forced} /. solverRule

Out[•]=

5.99039

In[1]:= 1 - 5.99 / 8.11

Out[1]= 0.261406