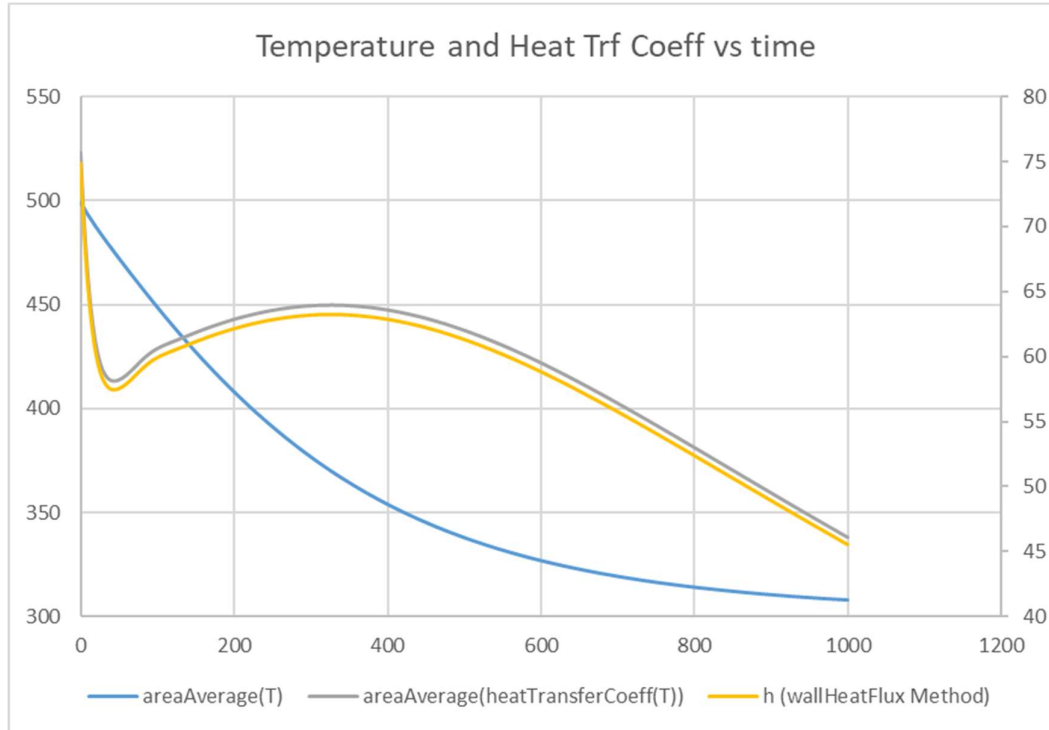


Hot Sphere in Oil Coarse Mesh Case

$$\int q dA = hA(T_f - T_s)$$

$$h = \frac{\int q dA}{A(T_f - T_s)}$$



Nusselt Number (Tf=300K)

$$Nu = \frac{hD}{k}$$

$$k_{fluid} = 0.1856 - 0.0002 * 300 = 0.1376 \frac{W}{m \cdot K}$$

$$D_{sp} = \frac{3}{100} m$$

Prandtl Number (Tf=300K)

$$Pr = \frac{\mu c_p}{k}$$

$$k_{fluid} = 0.1856 - 0.0002 * 300 = 0.1376 \frac{W}{m \cdot K}$$

Dynamic viscosity (300K)

	Dynamic Viscosity		T(K)
	Coefficient	T^n	300
first term	4.57E-17	7.29E+14	
second term	-1.42E-13	2.43E+12	
third term	1.83E-10	8100000000	
fourth term	-1.24E-07	27000000	
fifth term	4.71E-05	90000	
sixth term	-9.47E-03	300	
seventh term	7.89E-01	1	
dynamic viscosity	0.003756412		

$$\mu(300K) = 0.003756 \text{ Pa s}$$

Cp (300K)

	cp		T(K)
	Coefficient	T^n	300
first term	3.22E-08	8100000000	
second term	-5.51E-05	27000000	
third term	3.44E-02	90000	
fourth term	-6.49E+00	300	
fifth term	1.67E+03	1	
Cp (J/kgK)	1591.1103		

$$C_p = 1591.1103 \frac{J}{kg \cdot K}$$

Grasshof Number

$$Gr = \frac{g\beta(T_s - T_f)D^3}{\nu^2} = \frac{g\beta(T_s - T_f)D^3\rho^2}{\mu^2}$$

$$g = 9.81 \frac{m}{s^2}$$

$$\beta = -\frac{1}{\rho} \left(\frac{\partial \rho}{\partial T} \right)_p$$

$$D = \frac{3}{100} m$$

Density Data (300K)

	density		T(K)
	Coefficient	T^n	300
T^6	0.00E+00	7.29E+14	
T^5	0.00E+00	2.43E+12	
T^4	0.00E+00	8100000000	
T^3	-1.74E-06	27000000	
T^2	1.73E-03	90000	
T	-1.39E+00	300	
constant	1.36E+03	1	
density	1054.258887		

$$\rho = 1054.2588$$

	d(rho)/dT		T(K)
	Coefficient	T^n	300
T^6	0.00E+00	7.29E+14	
T^5	0.00E+00	2.43E+12	
T^4	0.00E+00	8100000000	
T^3	0.00E+00	27000000	
T^2	-5.22E-06	90000	
T	3.47E-03	300	
constant	-1.39E+00	1	
d(rho)/dT	-0.82281423		
beta	0.000780467		

$$\left(\frac{\partial \rho}{\partial T}\right)_p = -0.8228$$

$$\beta = -\frac{1}{\rho} \left(\frac{\partial \rho}{\partial T}\right)_p = 0.000780467$$

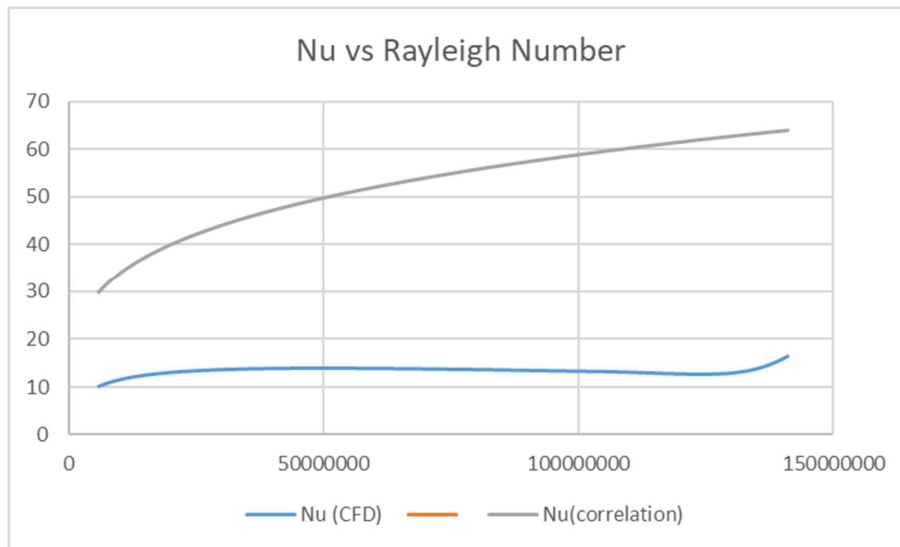
Largest Rayleigh Number

$$Ra = Gr \cdot Pr = 1.411E+08$$

This is below our threshold ($3e8$) for liquids!

Laminar simulation is correct!

Comparison vs correlation



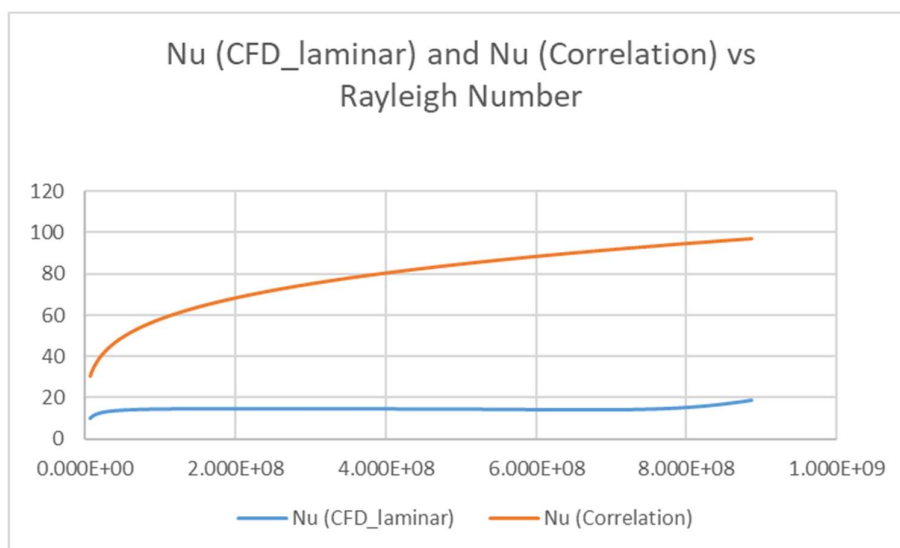
Round one doesn't seem convincing!

Why the mismatch?

- Mesh is too coarse
- The correlation developed is for steady state and the experiment was transient
- β changes with temperature??, don't use bulk fluid temperatures for β
 - o [redacted]'s input: film temperature instead of bulk temperature

http://courses.washington.edu/mengr331/lab/ME331_Transient_Lab_Sample_Report.pdf

After we include temperature variation using film temperature, the discrepancy grows (for turbulent) and remains for laminar.



Need to account for turbulence!

