Average Heat Transfer Coefficient for Mixed Boundary Layer Flow

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```
syms K L U v x Re Pr              % Identify Variables
```

Integration of hx,Laminar & hx,Turbulent

```
lam = (1/(x^0.5));
turb = (1/(x^(1/5)));
int1 = int((lam),[0 x])   % Integration of hx,laminar
```

int1 = $2\sqrt{x}$

```
int2 = int((turb),[x L]) % Integration of hx,turbulent
```

int2 =

$$\frac{5\,L^{4/5}}{4} - \frac{5\,x^{4/5}}{4}$$

Computation of Average Nu Coefficient

```
x_value = (4*10^5)*(v/U)        % Xcr approximated at 4*10^5
```

x_value =

$$\frac{400000\,v}{U}$$

```
lam_int = subs(int1,x,x_value)
```

lam_int =

$$2\sqrt{\frac{400000\,v}{U}}$$

```
turb_int = subs(int2,x,x_value)
```

turb_int =

$$\frac{5\,L^{4/5}}{4} - \frac{5\left(\frac{400000\,v}{U}\right)^{4/5}}{4}$$

```
hL_lam = 0.332*((U/v)^(0.5))*lam_int
```

hL_lam =

$$\frac{83\sqrt{\frac{U}{v}}\sqrt{\frac{400000\,v}{U}}}{125}$$

```
hL_turb = 0.0296*((U/v)^(4/5))*turb_int
```

hL_turb =

$$\frac{37\left(\frac{U}{v}\right)^{4/5}\left(\frac{5\,L^{4/5}}{4}-\frac{5\left(\frac{400000\,v}{U}\right)^{4/5}}{4}\right)}{1250}$$

```
lam_value = simplify(hL_lam,'IgnoreAnalyticConstraints',true)
```

lam_value =

$$\frac{664\sqrt{10}}{5}$$

```
turb_simplify = simplifyFraction(hL_turb)
```

turb_simplify =

$$\frac{37\left(L^{4/5}-\left(\frac{400000\,v}{U}\right)^{4/5}\right)\left(\frac{U}{v}\right)^{4/5}}{1000}$$

```
turb_value = expand(turb_simplify,'IgnoreAnalyticConstraints',true)
```

turb_value =

$$\frac{37\,L^{4/5}U^{4/5}}{1000\,v^{4/5}}-\frac{37\,400000^{4/5}}{1000}$$

```
Re_subs = subs(turb_value,{L,U,v},{Re Re Re}) % Subsititute as Re
```

Re_subs =

$$\frac{37\,\mathrm{Re}^{4/5}}{1000}-\frac{37\,400000^{4/5}}{1000}$$

Results

```
Nu_ave = vpa(((lam_value) + (Re_subs))*Pr^(1/3)*K/L,3)
```

Nu_ave =

$$\frac{K\,\mathrm{Pr}^{1/3}\,(0.037\,\mathrm{Re}^{4/5}-702.0)}{L}$$