6.11

n-Octane spills on a hot pavement during a summer day. The pavement is at 40C and heats the octane to this temperature. the wind temperature is at 33 C and the pressure is 1 atm. Use Table 6.1.

$Tb := 125.6 + 273 \quad Tb = 398.6 \qquad Tinf := 33 + 273 \qquad TL := 40 + 273 \quad TL = 313$

$xl := 0.0095 \qquad xu := .032 \qquad hfg := 0.305 \cdot 1000$

$Rgas := 8.314 \qquad M1 := 12 \cdot 8 + 18 \qquad M1 = 114$

$cpl := 2.2 \qquad cpv := 1.67 \qquad \rho l := 705$

(a) If the octane interface is really at 40 C then it is simple to find

$$xlc := \exp\left[\left(\frac{-hfg \cdot M1}{Rgas}\right)\cdot\left(\frac{1}{TL} - \frac{1}{Tb}\right)\right] \qquad xlc = 0.057$$

$$Plc := xlc \cdot 101 \qquad Conc := \frac{Plc}{Rgas \cdot Tinf} \qquad Conc = 2.252 \times 10^{-3}\ \frac{kmole}{m^3}$$

No spark, too rich

$$yu := 4 \cdot \left(1 - \frac{xu}{xlc}\right) \qquad yu = 1.744$$

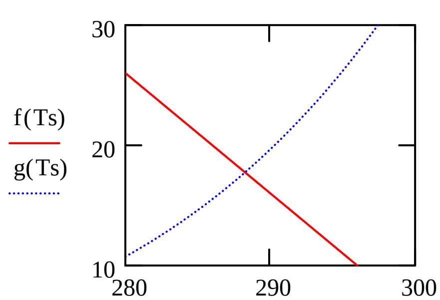
$$yl := 4 \cdot \left(1 - \frac{xl}{xlc}\right) \qquad yl = 3.33$$

But a more accurate solution is required. We assume a heat transfer coefficient

$hinf := 5$

$Te := Tinf \qquad he := hinf \qquad Mair := 29 \qquad cg := 1$

$$f(Ts) := Te - Ts \qquad g(Ts) := \frac{M1}{Mair \cdot cg} \cdot \exp\left[-hfg \cdot \frac{M1}{Rgas} \cdot \left(\frac{1}{Ts} - \frac{1}{Tb}\right)\right] \cdot [\, hfg - cpl(TL - Ts)\,]$$



$f(280) = 26 \qquad g(280) = 10.732$

$f(300) = 6 \qquad g(300) = 34.549$

$f(290) = 16 \qquad g(290) = 19.663$

$f(288) = 18 \qquad g(288) = 17.482$

$Ts1 := 288$

Ts, Ts

$$Ys := \frac{M1}{Mair} \cdot \exp\left[-hfg \cdot \frac{M1}{Rgas} \cdot \left(\frac{1}{Ts1} - \frac{1}{Tb}\right)\right] \qquad Ys = 0.07 \qquad Xs := \frac{Ys \cdot Mair}{M1}$$

$$xlc := \exp\left[\left(\frac{-hfg \cdot M1}{Rgas}\right) \cdot \left(\frac{1}{Ts1} - \frac{1}{Tb}\right)\right] \qquad xlc = 0.018 \qquad Xs = 0.018$$

$$Plc := xlc \cdot 101 \qquad Conc := \frac{Plc}{Rgas \cdot Tinf} \qquad Conc = 7.062 \times 10^{-4} \ \frac{kmole}{m^3}$$

(b) surface falls in flammable range

$$yu := 4 \cdot \left(1 - \frac{xu}{xlc}\right) \qquad yu = -3.196$$

$$yl := 4 \cdot \left(1 - \frac{xl}{xlc}\right) \qquad yl = 1.864$$

c Assume a linear distribution of fuel vapor over a 4 cm thick boundary layer. Determine the vertical region over which the mixture is flammable?

if the surface is a x=0.018 (1.8%) and this mole fraction decays to zero over the 4 cm thickness of the boundary layer, we are asked to find the height that the mixture goes below 0.0095

$$z := \frac{xl - xlc}{-xlc} \cdot 4 \qquad z = 1.864 \quad cm$$

it is no longer flammable above 1.86 cm.