S589: Upper Air Influences Take-home Exercise

Byram's Convection Number

At-home Exercise (1/6)

Fuel type:	**C3**	**FFMC:**	**93**
ISI:	**18**	**BUI:**	**55**
CFB:	**1.0**	**CFL:**	**1.15 kg/m^2**
Surface wind:	**20 km/h**		
Surface temp:	**18 ^{o}C**		

1. Calculate the value of N_c for the above conditions.

2. A helicopter sounding determines that the wind at 300 m above the fire is 35 km/h. Calculate the convection number at this level.

Byram's Convection Number

At-home Exercise (2/6)

$$N_c = P_f / P_w = 2gI / \rho C_p T(v-R)^3$$

I	**Fire intensity (kW/m)**
g	**Acceleration of gravity (~9.81 m/s^2)**
ρ	**Air density (kg/m^3) at calculation level**
P	**Atmospheric pressure**
R_d	**Gas constant for dry air (287.0 J/kgK)**
C_p	**Heat capacity of dry air (~1003.5 J/kgK)**
T	**Air temp (^{o}C) at the elevation of the fire**
v	**Wind speed (m/s) at some height above the fire**
R	**Rate of spread (m/s) = ROS(m/min)/60**

N_c should be calculated at the surface and at several other levels.

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At-home Exercise (3/6)

$$N_c = P_f / P_w = 2gI / \rho C_p T(v-R)^3$$

Units (dimensionless):

$$\frac{\frac{m}{s^2} * \frac{kgm^2}{ms^3}}{\frac{kgm^2}{s^2 kgK} * \frac{kgK}{m^3} * \frac{m^3}{s^3}}$$

$\rho = P/R_d T$ If P is unknown, P=101,325 Pa

$$N_c = 2gI / 1.2\, C_p T(v-R)^3$$

Heat of combustion H and converting m/min to m/s (18000/60) = 300:

$$I = Hwr = 300 \times TFC \times ROS = 300 \times (CFC + SFC) \times ROS$$

$$= 19.6(300(CFC+SFC)ROS) / 1.2T[(v/3.6) - (R/60.)]^3$$

$$ROS = a\left[1 - e^{-b \times ISI}\right]^c \qquad R = ROS/60$$

$$CFC = CFB \times CFL \text{ and } SFC = 5\left[1.0 - e^{-.0164BUI}\right]^{2.24}$$

$$= \frac{19.6\,(300((CFB \times CFL) + 5\left[1.0 - e^{-.0164BUI}\right]^{2.24})\, a\left[1 - e^{-b \times ISI}\right]^c)}{1.2(T+273.16)[(v/3.6) - R]^3}$$

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At-home Exercise

- **Use the last equation on the previous slide and the given values on the previous 2 slides to complete the calculations for:**
  - **Ground level**
  - **300m above ground level**

Contact information

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