Second Semester Examination
Academic Session 2020/2021

July/August 2021

EAF526 – Fire Behaviour

Duration : 2 hours

Please ensure that this examination paper contains **SEVEN (7)** printed pages before you begin the examination.

Instructions: This paper contains **THREE (3)** questions. Answer **ALL** questions.

All questions **MUST BE** answered on a new page.

(1). (a). **Figure 1** illustrates a fire plume in an atrium. Based on your knowledge on *Ideal Plume*, *Heskestad*, and *McCaffrey* plume models, **justify** suitable plume model(s) that can accurately predict the temperatures at positions [1] and [2].

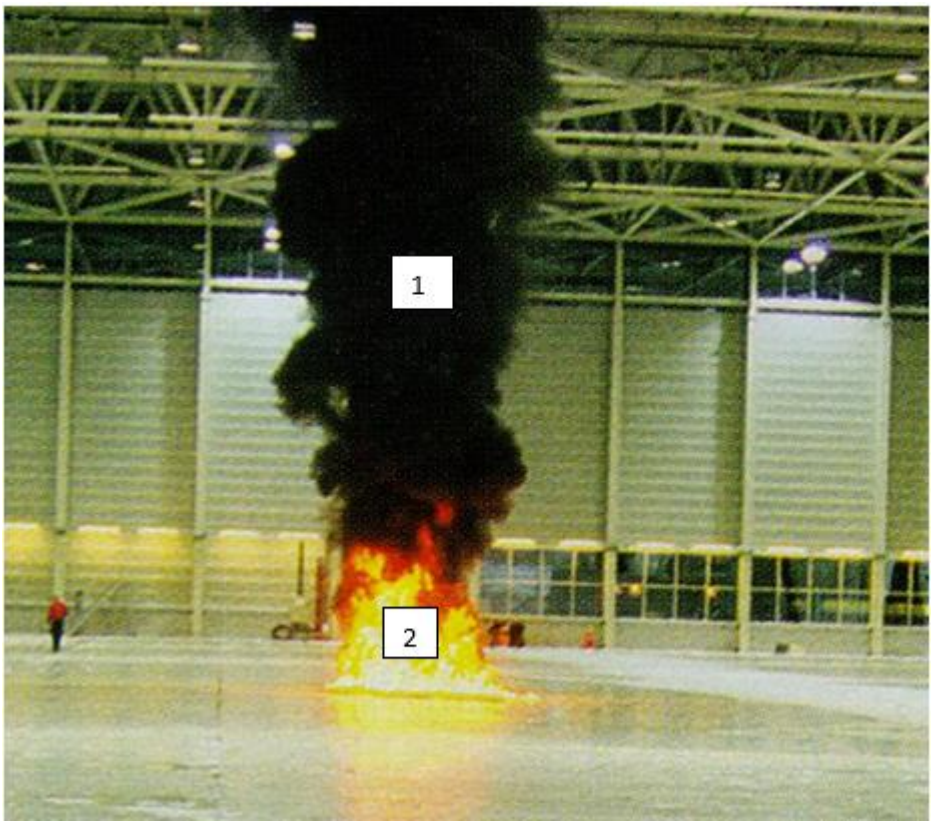

Figure 1

[10 marks]

(b). An industrial building is to be designed. The building will be equipped with detection devices that will activate when the temperature of the smoke is greater or equal to 45ºC. Assume that a fire will occur at the central point of the building and the devices will be placed at 3 locations (L1, L2, L3) as depicted in **Figure 2**. By choosing **a suitable design height between 9.0 m ≤ H ≤ 15.0 m**,

(i). Outline the strategies to predict the locations of L2 and L3, respectively.

[5 marks]

(ii). Predict the locations of L2 and L3 by assuming that Tmax2 = 0.5 Tmax1, Tmax3 = 0.25 Tmax1, respectively.

[20 marks]

Data:

i. Fire: 6 m^2 diesel oil pool
ii. Ambient temperature (T_∞= 27ºC)
iii. Use equation of circle for the diameter (if required)
iv. Other data such heat capacity, etc can be assumed (if required)

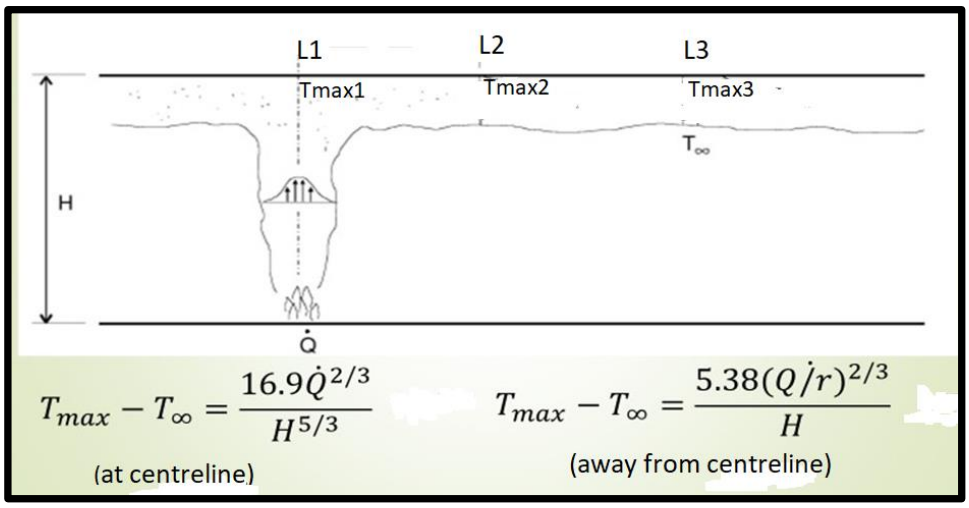

Figure 2

2). (a). **"The temperature of the hot gases during a compartment fire is important to practitioners of fire protection engineering"**

-James G. Quintiere, University of Maryland, College Park

Discuss several points why the prediction of the temperatures of hot gases in a compartment fire is important based on the perspective of fire protection engineering

[10 marks]

(b). A fire occurs in a room of 5 m wide, 5 m long and 3 m high with 2 openings. The dimensions of the openings are 2 m high and 0.6 m wide (2.0 m x 0.6 m) and 0.5 m high and 1.5 m wide (0.5 m x 1.5 m), respectively. Determine the average gas temperature at 10 minutes. Use the following data and information.

i. Ambient temperature of 25°C
ii. Select any preferred suitable construction material for building
iii. Use a preferred material thickness between 125 mm – 175 mm
iv. Heat release rate (**Figure 3**).

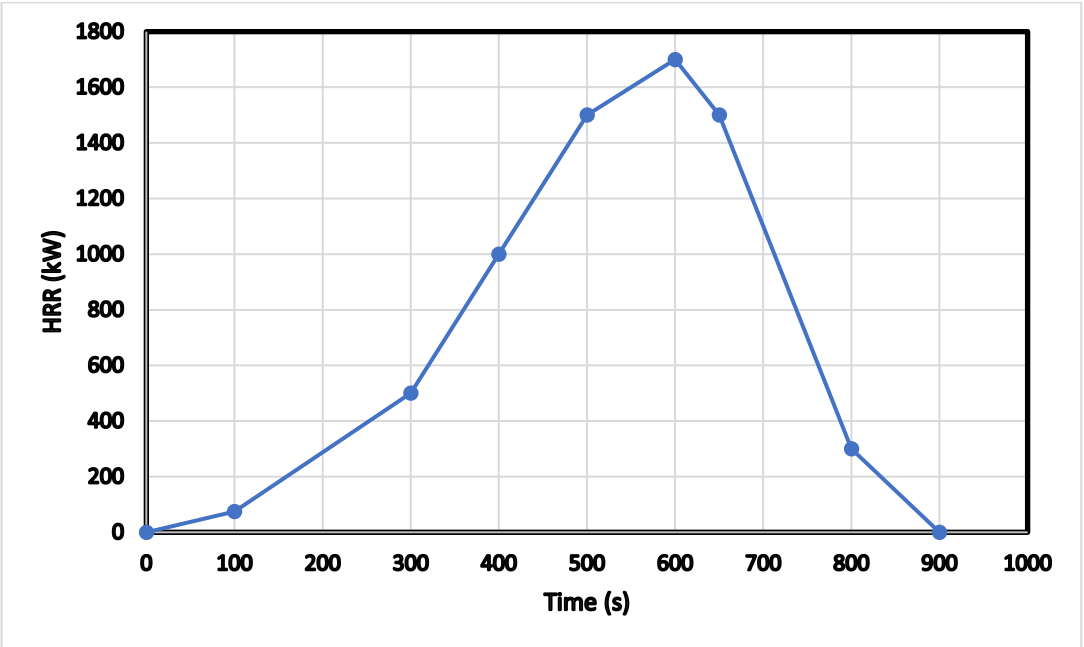

Figure 3

[25 marks]

(3). (a). **Figure 4** and **Figure 5** show fire incidents occurring at two liquid storage tanks. Differentiate the nature of the two fire incidents.

Figure 4

Figure 5

[5 marks]

(b). The assessment of radiant heat flux received by a person from any fire incident is very crucial in devising firefighting strategies as well as designing the plant layout. **Table 1** depicts various impacts of radiation intensities. You are required to perform a fire risk assessment on a storage tank that contains highly flammable liquid. Assume the fire occurs at the top of the storage tank 5 m above the ground.

(i). Determine the mass burning rate of the flammable liquid.

[5 marks]

(ii). Determine the height of the flame.

[5 marks]

(iii). Determine the radiation heat flux received by a worker standing 20 m from the edge of the storage tank.

[15 marks]

Data:

Diameter of storage tank	30 m
Heat of combustion of the liquid	50000 kJ/kg
Heat of vaporization of the liquid	400 kJ/kg
Boiling point of the liquid	370 K
Ambient temperature	298 K
Heat capacity of liquid	3.5 kJ/kgK
Ambient density	1.2 kg/m^3
Radiation intensity (η)	0.4
Relative humidity	70%

Table 1

Radiation Intensity (kW/m^2)	Observed Effect
37.5	Sufficient to cause damage to process equipment
25	Minimum energy required to ignite wood at indefinitely long exposures (no piloted)
12.5	Minimum energy required for piloted ignition of wood, melting of plastic tubing
9.5	Pain threshold reached after 8 sec; second degree burns after 20 sec
4	Sufficient to cause pain to personnel if unable to reach cover within 20 sec, however blistering of the skin (second degree burns) is likely; 0% lethality
1.6	Will cause no discomfort for long exposure

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