MS Excel and VBA for Chemical Engineers

TSEC - Online Certificate Course

QUESTION SET

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1 VBA fundamentals

Type Name	Example
`String`	"Hello world!"
`Integer`	$10, -3, 6$
`Boolean`	`True`, `False`
`Single`	3.1416 (32-bit floating point)
`Double`	3.1416 (64-bit floating point)
`Variant`	Can accept either `String` or `Double`
`Array()`	Collection of elements
`Range`	Collection of elements

Table 1: Basic types in VBA

Operator	Meaning
$+, -, *, /$	Mathematical operations
^	Exponent
$=$	Assignment/ is equal to
$<>$	not equal to
$<, >$	less than, greater than
$<=, >=$	less than or equal to, greater than or equal to
`and`, `or`	Boolean operators
`not`	Negation operator

Table 2: Operators in VBA

2 Theoretical flame temperature

A producer gas (34.7% CO, 65.3% N_2) at 25°C is burnt with 100% excess air (preheated to 250°C). Conversion of CO to CO_2 is 90%. Calculate the theoretical flame temperature.

$$CO + \frac{1}{2}O_2 \rightarrow CO_2 \tag{1}$$

Data:

$$(\Delta H_f)\ CO \text{ at } 25°C = -26.416\ kcal/gmol$$
$$(\Delta H_f)\ CO_2 \text{ at } 25°C = -94.052\ kcal/gmol$$
$$C_{p,O_2} = 6.935 + 0.000677T$$
$$C_{p,N_2} = 6.499 + 0.001413T$$
$$C_{p,CO} = 6.350 + 0.00018T$$
$$C_{p,CO_2} = 9.085 + 0.0048T$$

All C_p units are $cal/mol - K$.

3 1D- Diffusion equation

A fluid is bounded between two parallel plates. The upper plate remains stationary and the lower plate is suddenly accelerated in y-direction at velocity U_0. It is required to find the velocity profile between the plates for the given initial and boundary conditions. For the sake of simplicity in setting up numerical variables, let's assume that the x-axis is pointed in the upward direction and y-axis is pointed along the horizontal direction as shown in the schematic below:

The equation of diffusion is given as follows:

Figure 1: Fluid between parallel plates

$$\frac{\partial u}{\partial t} = \nu \frac{\partial^2 u}{\partial x^2} \tag{2}$$

Initial conditions

$$u(t = 0, 0 < x \le H) = 0 \; m/s \tag{3}$$
$$u(t = 0, x = 0) = 40 \; m/s \tag{4}$$

Boundary conditions

$$u(t \ge 0, x - 0) = 40 \; m/s \tag{5}$$
$$u(t \ge 0, x = H) = 0 \; m/s \tag{6}$$

Using forward in time, central in space method, we have

$$\frac{u_i^{n+1} - u_i^n}{\Delta t} = \nu \frac{u_{i-1}^n - 2u_i^n + u_{i+1}^n}{(\Delta x)^2}$$
$$u_i^{n+1} = u_i^n + \frac{\nu \Delta t}{(\Delta x)^2} \left(u_{i-1}^n - 2u_i^n + u_{i+1}^n \right)$$