ABSTRACT FOR CYCLONE

Description:

This abstract is for the code written for Cyclone. Function of this program is to evaluate the amount of dirt separated by cyclones and also finding efficiency of cyclone for specified ranges of particle diameter, given the dimension of cyclone.

Assumption:
1) Only one component is specified as dirt particle

The number of revolutions gas particle make inside cyclone can be approximated by the formula:

$$N = \frac{1}{H}\left(L_b + \frac{L_c}{2}\right)$$

where, N is the number of revolutions,
L_b is the length of cyclone body in m,
H is the height of inlet duct in m
L_c is the length of cyclone cone in m

The feed velocity is calculated as:

$$V_i = \frac{Q}{WH}$$

where V_i is the feed velocity inside duct with which it enters cyclone in m/s
Q is the volumetric flow in m^3/s
W is the width of inlet duct in m
H is height of duct in m

The diameter of particle with 50% efficiency is calculated by formula:

$$d_{pc} = \sqrt{\frac{9}{2\pi}\frac{\mu W}{NV_i(\rho_p - \rho_a)}}$$

where, d_{pc} is diameter of particles collected with 50% efficiency
μ is the viscosity of feed fluid in Pa.s
ρ_p is particle density in Kg/m^3
ρ_a is fluid density in Kg/m^3

Efficiency for particle with diameter d_{pj} is calculated using:

$$\eta_j = \frac{1}{1 + (d_{pc}/d_{pj})^2}$$

where, η_j is the efficiency of removal of particle with diameter d_{pj}

Overall efficiency is then, calculated by weighing of efficiency with mass distribution of particles as:

$$\eta = \frac{\Sigma \eta_j m_j}{M}$$

where m_j is the mass of particle of diameter d_{pj} in Kg
M is the total mass of particles in Kg

Reference: http://www.dartmouth.edu/~cushman/courses/engs37/Cyclones.pdf

Examples:

Q1)

(The example question given in slide 10 of reference) The cyclone is of conventional type with standard proportions. Diameter = 1m. Flowrate = Q = 150 m^3/min. Particle denisty = 1600 Kg/m^3. Particle distribution is as follows:

Particle size (d_p)	% mass in that size (m/M)
0-2 μm	1.0%
2-4 μm	9.0%
4-6 μm	10.0%
6-10 μm	30.0%
10-18 μm	30.0%
18-30 μm	14.0%
30-50 μm	5.0%
50-100 μm	1.0%
	100%

Calculate the collection efficiency

A1) The efficiency given in answer is tabulated below:

Size range (in μm)	Average size d_p (in μm)	Collection efficiency η	Mass fraction m/M	Contribution to performance $\eta \times m/M$
0 – 2	1	2.9%	0.01	0.029%
2 – 4	3	21.1%	0.09	1.903%
4 – 6	5	42.7%	0.10	4.268%
6 – 10	8	65.6%	0.30	19.678%
10 – 18	14	85.4%	0.30	25.613%
18 – 30	24	94.5%	0.14	11.953%
30 – 50	40	97.9%	0.05	4.897%
50 - 100	75	99.4%	0.01	0.994%
			1.00	70.6%

The efficiency calculated in custom model is given below:

Diameter Range in (μm)	Collection efficiency in %
0-2	2.9
2-4	21
4-6	42.5
6-10	65.5
10-18	85.3

18-30	94.5
30-50	97.9
50-100	99.4

The total efficiency is calculated to be 70.5% which is in accordance with the given result.