Package ‘AeroSampleR’

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Type Package

Title Estimate Aerosol Particle Collection Through Sample Lines

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Description Estimate ideal efficiencies of aerosol sampling through sample lines. Functions were developed consistent with the approach described in Hogue, Mark; Thompson, Martha; Farfan, Eduardo; Hadlock, Dennis, (2014), "Hand Calculations for Transport of Radioactive Aerosols through Sampling Systems" Health Phys 106, 5, S78-S87, <doi:10.1097/HP.000000000000092>.

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AeroSampleR

Estimate Aerosol Particle Collection Through Sample Lines

Description

This package provides a method to estimate sampling efficiency of sampling systems drawing aerosol particles through tubing.

Details

Functions were developed consistent with the approach described in Hogue, Mark; Thompson, Martha; Farfan, Eduardo; Hadlock, Dennis, (2014), "Hand Calculations for Transport of Radioactive Aerosols through Sampling Systems" Health Phys 106, 5, S78-S87. <doi:10.1097/HP.0000000000000092>. To learn how to use AeroSampleR, start with the vignette: ‘browseVignettes(package = "AeroSampleR")’

bend_eff

bend efficiency

Description

In order to run this function, first produce a particle distribution with the ‘particle_dist’ function, then produce a parameter set with the ‘set_params’ function. Both of these results must be stored as per examples described in the help set with each.

Usage

bend_eff(df, params, method, bend_angle, bend_radius, elnum)

Arguments

df is the particle data set (data frame) established with the ‘particle_dist’ function

params is the parameter data set for parameters that are not particle size-dependent

method choice of models: Pui, McFarland, or Zhang

bend_angle bend angle in degrees

bend_radius bend radius in m

elnum element number to provide unique column names
dat_for_plots

Value
data frame containing original particle distribution with added data for this element

References


Examples

```r
df <- particle_dist() # set up particle distribution
params <- set_params_1("D_tube" = 2.54, "Q_lpm" = 100,  
"T_C" = 25, "P_kPa" = 101.325) #example system parameters
df <- set_params_2(df, params) #particle size-dependent parameters
df <- probe_eff(df, params, orient = 'h') #probe orientation - horizontal
df <- bend_eff(df, params, method='Zhang', bend_angle=90, 
bend_radius=0.1, elnum=3)
head(df)
```

dat_for_plots Data from readme file for use in plot examples

Description
This data was created by running the readme script. It is needed for simple plot examples.

Usage
dat_for_plots

Format
A data.frame

D_p particle diameter in micrometers
dens probability density
dist either log_norm or discrete
C_c Cunningham slip correction factor
v_ts particle terminal velocity
Re_p Reynold’s number for particle
Description

Needed as a first step in estimating system efficiency. Make the data frame that will be used to estimate efficiency of variously sized aerosol particles’ transport through the sampling system. To create your data, save this data to the global environment as shown in the examples.

Usage

```r
particle_dist(
  AMAD = 5,
  log_norm_sd = 2.5,
  log_norm_min = 5e-04,
  log_norm_max = 100,
  discrete_vals = c(1, 5, 10)
)
```

Arguments

- **AMAD** default is 5 based on ICRP 66
- **log_norm_sd** default is 2.5 based on ICRP 66
- **log_norm_min** default is 0.0005 based on ICRP 66
- **log_norm_max** default is 100 based on ICRP 66
- **discrete_vals** default is c(1, 5, 10)

Details

All inputs are in micron AMAD, meaning: the aerodynamic diameter of a particle is the diameter of a standard density (1000 kg/m\(^3\)) sphere that has the same gravitational settling velocity as the particle in question.

Value

a data frame containing a lognormally distributed set of particles and discrete particle sizes
### Examples

```r
df <- particle_dist() # default
df <- particle_dist(AMAD = 4.4,
                    log_norm_sd = 1.8)
head(df)
```

---

### probe_eff

**Probe efficiency**

### Description

In order to run this function, first produce a particle distribution with the ‘particle_dist’ function, then produce a parameter set with the ‘set_params’ function. Both of these results must be stored as per examples described in the help set with each.

### Usage

```r
probe_eff(df, params, orient = "u", method = "blunt pipe")
```

### Arguments

- `df`: is the particle data set (data frame) established with the ‘particle_dist’ function
- `params`: is the parameter data set for parameters that are not particle size-dependent
- `orient`: orientation of the probe. Options are 'u' for up, 'd' for down, and 'h' for horizontal

### Value

data frame containing original particle distribution with added data for this element

### Examples

```r
df <- particle_dist() # set up particle distribution
params <- set_params_1("D_tube" = 2.54, "Q_lpm" = 100, "T_C" = 25, "P_kPa" = 101.325) #example system parameters
df <- set_params_2(df, params) #particle size-dependent parameters
df <- probe_eff(df, params, orient = "u") #probe orientation - draws upward
head(df)
```
**Description**

In order to run a report, first produce a model of each individual element. Start with producing a particle distribution with the ‘particle_dist’ function, then produce a parameter set with the ‘set_params’ function. Both of these results must be stored as per examples described in the help set with each. Next, add elements in the sample system until all are complete.

**Usage**

```r
report_basic(df, params, dist)
```

**Arguments**

- `df` is the particle data set (data frame) established with the ‘particle_dist’ function.
- `params` is the parameter data set for parameters that are not particle size-dependent.
- `dist` selects the distribution for the report. Options are ‘discrete’ for discrete particle sizes or ‘log’ for the log-normal distribution of particles that were started with the ‘particle_dist’ function.

**Value**

report of system efficiency

**Examples**

```r
df <- particle_dist() # set up particle distribution
params <- set_params_1("D_tube" = 2.54, "Q_lpm" = 100,
"T_C" = 25, "P_kPa" = 101.325) #example system parameters
df <- set_params_2(df, params) #particle size-dependent parameters
df <- probe_eff(df, params, orient = 'h') #probe orientation - horizontal
df <- bend_eff(df, params, method='Zhang', bend_angle=90,
bend_radius=0.1, elnum=3)
df <- tube_eff(df, params, L = 100,
angle_to_horiz = 90, elnum = 3)
report_basic(df, params, dist = 'discrete')
```
Description

In order to run a report, first produce a model of each individual element. Start with producing a particle distribution with the `particle_dist` function, then produce a parameter set with the `set_params` function. Both of these results must be stored as per examples described in the help set with each. Next, add elements in the sample system until all are complete.

Usage

```
report_cum_plots(df, micron)
```

Arguments

- `df` is the particle data set - after transport analysis by element
- `micron` selects the particle size (aerodynamic mass activity diameter in micrometers). This must be selected from the original distribution of particles that were started with the `particle_dist` function.

Value

A plot of cumulative transport efficiencies is generated in a plot window

Examples

```
report_cum_plots(dat_for_plots, micron = 10)
```

---

Description

This function shows the entire table of results by particle diameter.

Usage

```
report_log_mass(df)
```

Arguments

- `df` is the particle data set - after transport analysis by element
Value

data frame containing mass-based particle fractions in ambient location and in distribution delivered through the system.

Examples

df <- particle_dist() # set up particle distribution
params <- set_params_1("D_tube" = 2.54, "Q_lpm" = 100,
  "T_C" = 25, "P_kPa" = 101.325) #example system parameters
df <- set_params_2(df, params) #particle size-dependent parameters
df <- probe_eff(df, params, orient = 'h') #probe orientation - horizontal
df <- bend_eff(df, params, method='Zhang', bend_angle=90,
  bend_radius=0.1, elnum=3)
df <- tube_eff(df, params, L = 100,
  angle_to_horiz = 90, elnum = 3)
report_log_mass(df)

report_plots(df, dist)

Arguments

df is the particle data set - after transport analysis by element
dist selects the distribution for the report. Options are 'discrete' for discrete particle sizes or 'log' for the log-normal distribution of particles that were started with the 'particle_dist' function.

Value

A plot of transport efficiencies is generated in a plot window

Examples

report_plots(dat_for_plots, dist = 'discrete')
**set_params_1**  
*Set parameters (not particle size specific)*

**Description**
Make a set of parameters that will be used throughout this package. 'set_params_1' sets all single parameters. 'set_params_2' adds particle-size-dependent parameters to the particle distribution.

**Usage**
```
set_params_1(D_tube_cm, Q_lpm, T_C = 20, P_kPa = 101.325)
```

**Arguments**
- **D_tube_cm**  
  Inside diameter of tubing in cm, no default
- **Q_lpm**  
  System flow in lpm, no default
- **T_C**  
  System temperature in Celsius
- **P_kPa**  
  System pressure in kPa (Pa is the MKS unit)

**Details**
All parameters are to be in MKS units, except as noted.

**Value**
a data frame with singular parameters
```
examples params <- set_params_1("D_tube" = 2.54, "Q_lpm" = 100, "T_C" = 25, "P_kPa" = 101.325) t(params)
```

**set_params_2**  
*Make a set of particle-size-dependent parameters*

**Description**
This set of parameters will be used for evaluation of transport efficiency for particle-size-dependent parameters.

**Usage**
```
set_params_2(df, params)
```

**Arguments**
- **df**  
  is the particle data set (data frame) established with the 'particle_dist' function
- **params**  
  is the parameter data set for parameters that are not particle size-dependent
Details

No user-selected arguments are needed. Parameters are used in efficiency functions. For each particle diameter, an entry is made in the data frame for the Cunningham slip correction factor, the particle terminal velocity, the particle Reynold’s number, and the Stokes factor.

‘set_params_1’ sets all single parameters. ‘set_params_2’ adds particle size-dependent parameters to the particle distribution

Value

a data frame starting with the submitted particle distribution with additional columns for particle-size-dependent parameters

Examples

df <- particle_dist()
params <- set_params_1("D_tube" = 2.54, "Q_lpm" = 100, "T_C" = 25, "P_kPa" = 101.325)
df <- set_params_2(df, params)
head(df)

tube_eff

Tube efficiency

Description

Computation is consistent with the approach described in Hogue, Mark; Thompson, Martha; Farfan, Eduardo; Hadlock, Dennis, (2014), "Hand Calculations for Transport of Radioactive Aerosols through Sampling Systems" Health Phys 106, 5, S78-S87, <doi:10.1097/HP.0000000000000092>, with the exception that the diffusion deposition mechanism is included.

Usage

tube_eff(df, params, L_cm, angle_to_horiz, elnum)

Arguments

df is the particle data set (data frame) established with the 'particle_dist' function
params is the parameter data set for parameters that are not particle size-dependent
L_cm tube length, cm
angle_to_horiz angle to horizontal in degrees
elnum element number to provide unique column names

Details

In order to run this function, first produce a particle distribution with the ‘particle_dist’ function, then produce a parameter set with the ‘set_params’ function. Both of these results must be stored as per examples described in the help set with each.
Value
data frame containing original particle distribution with added data for this element

Examples

# Example output is a sample of the full particle data set.

# laminar flow (Reynolds number < 2100)

df <- particle_dist() # distribution
params <- set_params_1("D_tube" = 2.54, "Q_lpm" = 20,
"T_C" = 25, "P_kPa" = 101.325) #example system parameters
df <- set_params_2(df, params) #particle size-dependent parameters
df <- probe_eff(df, params, orient = 'h') #probe orientation - horizontal
df <- tube_eff(df, params, L_cm = 100,
angle_to_horiz = 90, elnum = 2)
(df[sort(sample(1:1000, 10)), ])

# turbulent flow (Reynolds number > 4000)

df <- particle_dist() # distribution
params <- set_params_1("D_tube" = 2.54, "Q_lpm" = 100,
"T_C" = 25, "P_kPa" = 101.325) #example system parameters
df <- set_params_2(df, params) #particle size-dependent parameters
df <- probe_eff(df, params, orient = 'h') #probe orientation - horizontal
df <- tube_eff(df, params, L_cm = 100,
angle_to_horiz = 90, elnum = 2)
(df[sort(sample(1:1000, 10)), ])

# midrange flow (Reynolds number > 2100 and < 4000)

df <- particle_dist() # distribution
params <- set_params_1("D_tube" = 2.54, "Q_lpm" = 60,
"T_C" = 25, "P_kPa" = 101.325) #example system parameters
df <- set_params_2(df, params) #particle size-dependent parameters
df <- probe_eff(df, params, orient = 'h') #probe orientation - horizontal
df <- tube_eff(df, params, L_cm = 100,
angle_to_horiz = 90, elnum = 2)
(df[sort(sample(1:1000, 10)), ])
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