# Python in the VE

VE Scripts – Infiltration scaled off wind speed

**What?** In this article we look at a script that creates data in a CSV file that we can import into the VE as a freeform profile. The freeform profile will replace the 'continuously on' profile typically utilised with an infiltration air exchange

**Why?** Users typically have a infiltration target or standard; this is usually represented in a VE model as a mean air change rate and a 'continuously on' profile

As building standards tighten infiltration is of increasing importance

In this example we improve the resolution of a model by scheduling infiltration off wind pressure derived from the model weather file selection

The script uses a user entered mean target air change rate to derive data for a freeform profile based on wind pressure. When assigning the imported free form profile to the air exchange the user must also set the infiltration air exchange max flow to the value produced by this script in the VE Scripts output pane

The script outputs a CSV file. To create/import a freeform profile use the VE Scripts > iesutils > FFD_create.py script to create an FFD in the current project from the CSV, then assign to the required infiltration air exchange

```
"""
====================================
Infiltration scaled by wind pressure
====================================

Module description
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Creates a CSV file containing input data for the creation of a MOD
FFD infiltration profile scaled off wind pressure from the selected
aps (weather) file. Enter the ach required annual mean on line 64.

Once the CSV is created use VE Scripts > iesutils > FFD_create.py to
create an FFD in the current project from the CSV, then assign to the
required infiltration air exchange.

IMPORTANT: when assigning the FFD to an infiltration air exchange make
sure the ACH value is revised to the max_ach value that is reported in
the output pane when this script is run.

Background & method:

Typical VE practice is to use an infiltration air exchange with a
CONTINOUSLY ON profile. This is an annual mean ACH value which is
```

Readme comments

```
import os
import iesve
import numpy as np
import pandas as pd
from statistics import mean
from ies_file_picker import IesFilePicker
from datetime import datetime, timedelta


# Enter mean infiltration ACH from CIBSE A 2006 tables A4.13 to 4.21
ach = 0.25
csv_filename = 'Infiltration_' + str(ach)
profile_type = 'Modulating'
units_type = 'Metric'

# Get aps file
aps_file = IesFilePicker.pick_aps_file()

# Open aps and get weather file and get wind speed data
with iesve.ResultsReader.open(aps_file) as results:
    assert results is not None, "Error opening results file"
    wind_speeds = results.get_all_weather_results('Wind speed', 1, 365)

# Check timestep
number_of_ordinates = len(wind_speeds['Wind speed'])
if number_of_ordinates == 8760:
    timestep = 60
else:
    print('Not hourly aps data')
    quit()

# Process annual wind speed data
avg_wind_speed =  np.average(wind_speeds['Wind speed'])
max_wind_speed = np.max(wind_speeds['Wind speed'])

avg_wind_pressure = 0.6 * avg_wind_speed**2
max_wind_pressure = 0.6 * max_wind_speed**2

print('avg_wind_speed', avg_wind_speed,'max_wind_speed', max_wind_speed )
print('avg_wind_pressure', avg_wind_pressure, 'max_wind_pressure',max_wind_pressure)

# Calculate max ACH
max_ach = ach * (max_wind_pressure/avg_wind_pressure)**0.65
print('max_ach - enter on air exchange', max_ach)

# Calculate hourly ach data
data = []
for ws in wind_speeds['Wind speed']:
    ws_pressure = 0.6 * ws**2
    ws_ach = max_ach * (ws_pressure/max_wind_pressure)**0.65
    # convert to a proportion of max_ach i.e. MOD
    data.append(ws_ach/max_ach)

# Checks mean ach should be = ach (ish)
print('mean ach', mean(data) * max_ach)
#for speed, air_change in zip(wind_speeds['Wind speed'], data):
#    print(speed, air_change)

# Get the current VE project
project = iesve.VEProject.get_current_project()
folder = os.path.join(project.path, 'ffd_data')

# If the ffd_data folder doesn't exist, create it
if not os.path.exists(folder):
    os.mkdir(folder)

filename = os.path.join(folder, csv_filename)
if not filename.lower().endswith('.csv'):
    filename += '.csv'

# Create date & value nested list
output = []
year = 2018 # arbitrary non-leap year
cur_date = datetime(year, 1, 1, 0, 0, 0)
next_year = datetime(year + 1, 1, 1, 0, 0, 0)
offset = timedelta(minutes=timestep)
count = 0
while cur_date < next_year:
    output.append([cur_date.month, cur_date.day, cur_date.hour, cur_date.minute, data[count]])
    cur_date += offset
    count+= 1
# Create the final row at the end of the year
output.append([12, 31, 24, 0, data[count-1]])

# Make dataframe, encode the profile and units type in the value column, and save
value_column = 'value|{}'.format(profile_type.lower())
df = pd.DataFrame(output, columns=['month', 'day', 'hour', 'min', value_column])
df.to_csv(filename, encoding='utf-8', index=False)
print('CSV file created; now run - iesutils > FFD_create.py')
```

Import modules

Enter target mean infiltration rate in air changes per hour

Create and assign variables that will be used in the data export

Open results file and get associated weather file wind speed data

Outside of the with … section the aps file is automatically closed

Check APS reporting is hourly as we want hourly output (as the weather data is hourly)

Use Numpy functions on the wind speed to determine average and max values

Calculate the associated wind pressure at average and max wind speed

Calculate the max air change rate based on the ratio of max to average wind pressure. Print this value as this will need the user to input this on the VE air exchange

Create an empty list

For each timestep (hour) calculate the air change rate based on the ratio of timestep wind pressure to max wind pressure

Calculate the ratio as a proportion (MOD profile value) and add this to the data list

Check the mean of the list multiplied by the max ACH is the same the user input value

Get the current project folder path and create a string URL for the ffd folder where the CSV will be saved

Check to see if the ffd folder exists; if not create it

Generate a URL for the CSV file using the csv_filename variable. Make sure it ends with the .csv filetype suffix

Create an empty output list

The ffd input file has a specific format Set up variables using the datetime module to allow this to be generated

While Loop: whilst the current date is less than next year add a list of data to the list in the required format. Increment the loop by the timestep

Add an extra final row – this is a copy of the last row

Create a string of the profile type for use as a column header

Create a Pandas dataframe with the data and the column labels as parameters

Export the Pandas dataframe to CSV

Sample CSV output format …

Infiltration_0.25.csv

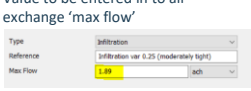
```
month,day,hour,min,value|modulating
1,1,0,0,0.4349648105721534
1,1,1,0,0.4455634925404326
1,1,2,0,0.4588941065591365
1,1,3,0,0.44025679131806444
1,1,4,0,0.42705457586000434
1,1,5,0,0.42705457586000434
1,1,6,0,0.4139458896099365
1,1,7,0,0.42705457586000434
1,1,8,0,0.3854438959024328
1,1,9,0,0.372645480840858
1,1,10,0,0.388015505967814
1,1,11,0,0.388015505967814
1,1,12,0,0.40093231619112657
1,1,13,0,0.4139458896099365
1,1,14,0,0.42705457586000434
1,1,15,0,0.42705457586000434
1,1,16,0,0.42705457586000434
1,1,17,0,0.44025679131806444
1,1,18,0,0.4804096923112069
1,1,19,0,0.49397138376287253
1,1,20,0,0.5379437891023882
```

CSV output file opened in a text editor

Sample VE scripts output pane …

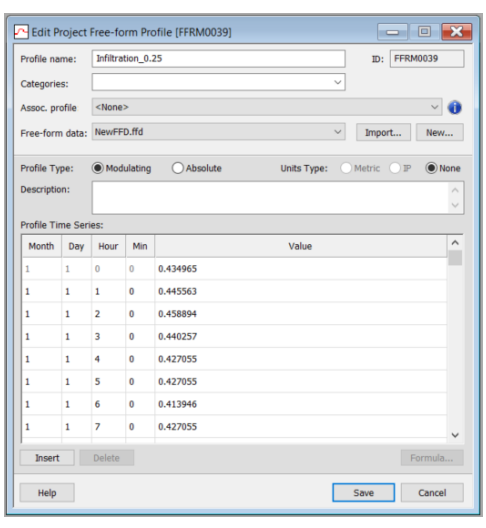
```
  >>> Run start, Wed Feb 14 09:46:20 2024
avg_wind_speed 4.2801423 max_wind_speed 20.3
avg_wind_pressure 10.991770902348572 max_wind_pressure 247.25398141479525
max_ach - enter on air exchange 1.8914251753771087
mean ach 0.2689490074208193
CSV file created; now run - iesutils > FFD_create.py
  >>> Runtime: 3.00 seconds
```

Value to be entered in to air exchange 'max flow'




Reminder of the what you need to do to import the data as a freeform profile in to your model

Sample after import & simulation …




Freeform profile after import (in ApPro)

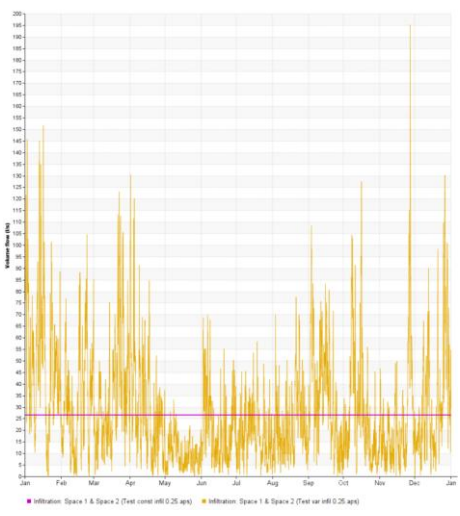


Chart of infiltration from APS test files:

0.25 ACH continuously ON

0.25 ACH mean freeform using wind pressure


Chart of infiltration gain from APS test files for two weeks in February:

0.25 ACH continuously ON

0.25 ACH mean freeform using wind pressure

Wind speed