
Pyfas Documentation

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Pyfas is a python toolbox for flow assurance engineers.

1.1 Wrappers

At this moment in time the toolbox contains wrappers for:

- OLGA
- Unisim Design
- Gap (not yet available)
- Pipesim (via OpenLink, for all the versions ≤ 2012.4)
- SFC

Olga is the standard de facto for the dynamic simulations of multiphase systems (single pipelines or complex network) in the oil and gas industry. The simulator has text input and output files; with pyfas you can expose Olga results to python (both trends and profiles) or dump all the results to excel/csv for your post-processing.

UnisimDesign is mainly a process simulator but can be used also to simulate pipelines or networks in particular providing some external components. Differently from Olga Unisim (unfortunately) does not use text input or output files, the only way to communicate with the software is via a COM interface using pywin32. Pyfas does not pretend to exposes all the possible functionalities of Unisim, only a very limited subset is available at the moment.

PipeSim is a steady state simulator for both single branches or networks

1.2 Utilities

- Surge volume calculation
- PIRead functionality

Tab files are look-up tables with specific thermodynamic properties at given pressure and temperature intervals used for flash calculations by dynamic simulators. These files are generated by thermodynamic simulators (like PVTsim) and it is good practice to have a look on this information *before* a dynamic simulation. With pyfas it is possible to generate 3d plots of all the properties and examine more in detail critical ones.

The **surge volume calculation** utility returns the surge volume given a drain rate and a liquid flowrate time series. Not more than a simple discrete integration.

With **PIRead** it is possible to retrieve PI values from a PI server.

A live demo should be available here below (no installation required)

CHAPTER 2

Installation

```
pip install pyfas
```

```
[ ]:
```

```
[1]: import pyfas as fa
import pandas as pd
import matplotlib.pyplot as plt
```

OLGA tpl files, examples and howto

For an tpl file the following methods are available:

- `filter_data` - return a filtered subset of trends
- `extract` - extract a single trend variable
- `to_excel` - dump all the data to an excel file

The usual workflow should be:

1. Load the correct tpl
2. Select the desired variable(s)
3. Extract the results or dump all the variables to an excel file
4. Post-process your data in Excel or in the notebook itself

3.1 Tpl loading

To load a specific tpl file the correct path and filename have to be provided:

```
[2]: tpl_path = '../..pyfas/test/test_files/'  
     fname = '11_2022_BD.tpl'  
     tpl = fa.Tpl(tpl_path+fname)
```

3.1.1 Trend selection

A tpl file may contain hundreds of trends, in particular for complex networks. For this reason a filtering method is quite useful. A trend can be specified in an OLGA input files in different ways, the identification of a single trend may be not trivial.

The easiest way is to filter all the trends using patters, the command `tpl.filter_trends("PT")` filters all the pressure trends (or better, all the trends with “PT” in the description, if you have defined a temperature trend in the position “PTTOPSIDE”, for example, this trend will be selected too). The resulting python dictionary will have a unique index for each filtered trend that can be used to identify the interesting trend(s). In case of an empty pattern all the available trends will be reported.

```
[3]: tpl.filter_data('PT')
```

```
[3]: {9: "PT 'POSITION:' 'EXIT' '(PA)' 'Pressure'\n",
37: "PT 'POSITION:' 'BOTTOMHOLE' '(PA)' 'Pressure'\n",
38: "PT 'POSITION:' 'TUBINGHEAD' '(PA)' 'Pressure'\n",
39: "PT 'POSITION:' 'DC6' '(PA)' 'Pressure'\n",
40: "PT 'POSITION:' 'DC7' '(PA)' 'Pressure'\n",
41: "PT 'POSITION:' 'DC8' '(PA)' 'Pressure'\n",
42: "PT 'POSITION:' 'DC9' '(PA)' 'Pressure'\n",
43: "PT 'POSITION:' 'RBM' '(PA)' 'Pressure'\n",
44: "PT 'POSITION:' 'EXIT' '(PA)' 'Pressure'\n"}
```

or

```
[4]: tpl.filter_data("'POSITION:' 'EXIT'")
```

```
[4]: {3: "GLT 'POSITION:' 'EXIT' '(KG/S)' 'Total liquid mass flow'\n",
4: "GLTHL 'POSITION:' 'EXIT' '(KG/S)' 'Mass flow rate of oil'\n",
5: "GLTWT 'POSITION:' 'EXIT' '(KG/S)' 'Mass flow rate of water excluding vapour'\n",
6: "GLWVT 'POSITION:' 'EXIT' '(KG/S)' 'Total mass flow rate of water including Vapour
↪ '\n",
7: "GT 'POSITION:' 'EXIT' '(KG/S)' 'Total mass flow'\n",
8: "HOL 'POSITION:' 'EXIT' '(-)' 'Holdup (liquid volume fraction)'\n",
9: "PT 'POSITION:' 'EXIT' '(PA)' 'Pressure'\n",
10: "QLT 'POSITION:' 'EXIT' '(M3/S)' 'Total liquid volume flow'\n",
11: "TM 'POSITION:' 'EXIT' '(C)' 'Fluid temperature'\n",
12: "UL 'POSITION:' 'EXIT' '(M/S)' 'Average liquid film velocity'\n",
20: "HOL 'POSITION:' 'EXIT' '(-)' 'Holdup (liquid volume fraction)'\n",
28: "HOLWT 'POSITION:' 'EXIT' '(-)' 'Water volume fraction'\n",
36: "ID 'POSITION:' 'EXIT' '(-)' 'Flow regime: 1=Stratified, 2=Annular, 3=Slug,
↪ 4=Bubble.\n",
44: "PT 'POSITION:' 'EXIT' '(PA)' 'Pressure'\n",
52: "Q2 'POSITION:' 'EXIT' '(W/M2-C)' 'Overall heat transfer coefficient'\n",
60: "TM 'POSITION:' 'EXIT' '(C)' 'Fluid temperature'\n",
68: "TU 'POSITION:' 'EXIT' '(C)' 'Ambient temperature'\n",
76: "TWS 'POSITION:' 'EXIT' '(C)' 'Inner wall surface temperature'\n",
84: "QGST 'POSITION:' 'EXIT' '(SM3/S)' 'Gas volume flow at standard conditions'\n",
92: "QOST 'POSITION:' 'EXIT' '(SM3/S)' 'Oil volume flow at standard conditions'\n",
100: "QWST 'POSITION:' 'EXIT' '(SM3/S)' 'Water volume flow at standard conditions'\n
↪ ",
108: "AL 'POSITION:' 'EXIT' '(-)' 'Void (gas volume fraction)'\n",
116: "GG 'POSITION:' 'EXIT' '(KG/S)' 'Gas mass flow'\n",
124: "GLT 'POSITION:' 'EXIT' '(KG/S)' 'Total liquid mass flow'\n",
132: "GT 'POSITION:' 'EXIT' '(KG/S)' 'Total mass flow'\n",
140: "DTHYD 'POSITION:' 'EXIT' '(C)' 'Difference between hydrate and section
↪ temperature'\n"}
```

The same output can be reported as a pandas dataframe:

```
[5]: pd.DataFrame(tpl.filter_data('PT'), index=("Trends",)).T
```

```
[5]:
9          PT 'POSITION:' 'EXIT' '(PA)' 'Pressure'\n
37 PT 'POSITION:' 'BOTTOMHOLE' '(PA)' 'Pressure'\n
38 PT 'POSITION:' 'TUBINGHEAD' '(PA)' 'Pressure'\n
39      PT 'POSITION:' 'DC6' '(PA)' 'Pressure'\n
40      PT 'POSITION:' 'DC7' '(PA)' 'Pressure'\n
41      PT 'POSITION:' 'DC8' '(PA)' 'Pressure'\n
42      PT 'POSITION:' 'DC9' '(PA)' 'Pressure'\n
43      PT 'POSITION:' 'RBM' '(PA)' 'Pressure'\n
44      PT 'POSITION:' 'EXIT' '(PA)' 'Pressure'\n
```

The `view_trends` method provides the same info better arranged:

```
[18]: tpl.view_trends('PT')
```

```
[18]:
      Index Variable      Position Unit Description
Filter: PT
0          37      PT  POSITION - BOTTOMHOLE  PA  Pressure
1          38      PT  POSITION - TUBINGHEAD  PA  Pressure
2          39      PT      POSITION - DC6    PA  Pressure
3          40      PT      POSITION - DC7    PA  Pressure
4           9      PT  POSITION - EXIT      PA  Pressure
5          41      PT      POSITION - DC8    PA  Pressure
6          43      PT      POSITION - RBM    PA  Pressure
7          44      PT  POSITION - EXIT      PA  Pressure
8          42      PT      POSITION - DC9    PA  Pressure
```

3.1.2 Dump to excel

To dump all the variables in an excel file use `tpl.to_excel()`. If no path is provided an excel file with the same name of the `tpl` file is generated in the working folder. Depending on the `tpl` size this may take a while.

3.1.3 Extract a specific variable

Once you know the variable(s) index you are interested in (see the filtering paragraph above for more info) you can extract it (or them) and use the data directly in python.

Let's assume you are interested in the inlet pressure and the outlet temperature:

```
[17]: tpl.view_trends('TM')
```

```
[17]:
      Index Variable      Position Unit      Description
Filter: TM
0          59      TM      POSITION - RBM    C  Fluid temperature
1          53      TM  POSITION - BOTTOMHOLE  C  Fluid temperature
2          54      TM  POSITION - TUBINGHEAD  C  Fluid temperature
3          55      TM      POSITION - DC6    C  Fluid temperature
4          56      TM      POSITION - DC7    C  Fluid temperature
5          57      TM      POSITION - DC8    C  Fluid temperature
6          58      TM      POSITION - DC9    C  Fluid temperature
7          11      TM  POSITION - EXIT      C  Fluid temperature
8          60      TM  POSITION - EXIT      C  Fluid temperature
```

```
[14]: tpl.view_trends('PT')
```

```
[14]:
```

	Index	Variable	Position	Unit	Description
Filter: PT					
0	37	PT	POSITION - BOTTOMHOLE	PA	Pressure
1	38	PT	POSITION - TUBINGHEAD	PA	Pressure
2	39	PT	POSITION - DC6	PA	Pressure
3	40	PT	POSITION - DC7	PA	Pressure
4	9	PT	POSITION - EXIT	PA	Pressure
5	41	PT	POSITION - DC8	PA	Pressure
6	43	PT	POSITION - RBM	PA	Pressure
7	44	PT	POSITION - EXIT	PA	Pressure
8	42	PT	POSITION - DC9	PA	Pressure

Our targets are:

variable 11 - TM 'POSITION:' 'EXIT' '(C)' 'Fluid temperature'

and

variable 38 - PT 'POSITION:' 'TUBINGHEAD' '(PA)' 'Pressure'

Now we can proceed with the data extraction:

```
[8]: # single trend extraction
tpl.extract(11)
tpl.extract(38)

# multiple trends extraction
tpl.extract(12, 37)
```

The `tpl` object now has the four trends available in the `data` attribute:

```
[11]: tpl.data.keys()
[11]: dict_keys([11, 12, 37, 38])
```

while the `label` attribute stores the variable type as a dictionary:

```
[15]: tpl.label
[15]: {11: 'TM POSITION: EXIT (C) Fluid temperature',
      12: 'UL POSITION: EXIT (M/S) Average liquid film velocity',
      37: 'PT POSITION: BOTTOMHOLE (PA) Pressure',
      38: 'PT POSITION: TUBINGHEAD (PA) Pressure'}
```

3.1.4 Data processing

The results available in the `data` attribute are numpy arrays and can be easily manipulated and plotted:

```
[49]: %matplotlib inline

pt_inlet = tpl.data[38]
tm_outlet = tpl.data[11]

fig, ax1 = plt.subplots(figsize=(12, 7));
ax1.grid(True)
p0, = ax1.plot(tpl.time/3600, tm_outlet)
```

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```

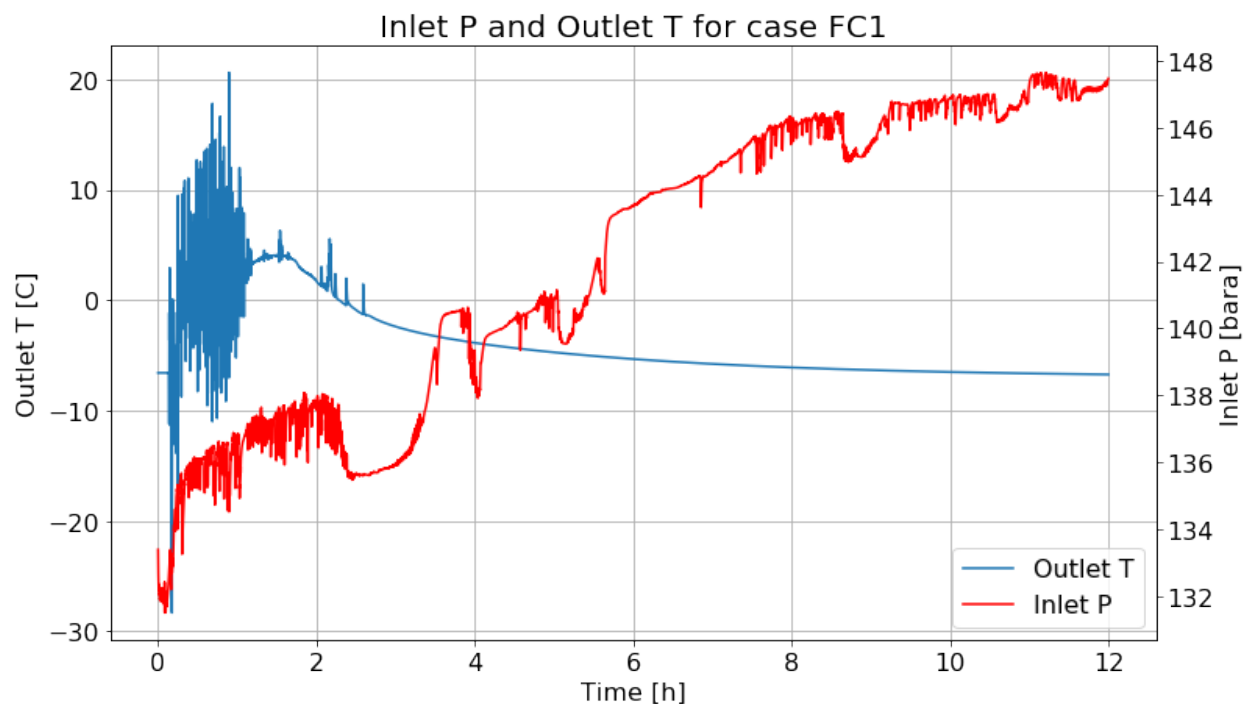
ax1.set_ylabel("Outlet T [C]", fontsize=16)
ax1.set_xlabel("Time [h]", fontsize=16)

ax2 = ax1.twinx()
p1, = ax2.plot(tpl.time/3600, pt_inlet/1e5, 'r')
ax2.grid(False)
ax2.set_ylabel("Inlet P [bara]", fontsize=16)

ax1.tick_params(axis="both", labelsize=16)
ax2.tick_params(axis="both", labelsize=16)

plt.legend((p0, p1), ("Outlet T", "Inlet P"), loc=4, fontsize=16)
plt.title("Inlet P and Outlet T for case FC1", size=20);

```



3.1.5 Advanced data processing

An example of advanced data processing for Python enthusiasts and professional flow assurance. Script below extracts variable trends at given positions. Usage instructions: - For unit conversion multiplication factors for every variable can be provided. - Only few global variables and lists have to be defined (allMul, allVar, allPos, and myTPLFile), there is no need to edit functions, unless you understand what you are doing. - Extracted trends are written in to a CSV file "OLGA_Simulation.tpl.csv", where "OLGA_Simulation.tpl" is the simulation file. - The script does not perform error checks, make sure that all variables and positions are present in the simulation file.

```

[ ]: import os
import sys
import time
import pyfas as fa

```

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```

def getVarsInds(tpl, emptyLst):

    for _, pos in enumerate(allPos):

        lst = []

        # dictionary of the following kind:
        # {3: "GLT 'POSITION:' 'EXIT' '(KG/S)' 'Total liquid mass flow'\n",
        #  4: "GLTHL 'POSITION:' 'EXIT' '(KG/S)' 'Mass flow rate of oil'\n"}
        myDic = tpl.filter_trends("POSITION:' '{0}'".format(pos))

        for _, var in enumerate(allVar):

            for _, (k, v) in enumerate(myDic.items()):

                lstStr = v.split(" ")

                if lstStr[0] == var:

                    lst.append(int(k))

        emptyLst.append(lst)

def getData(tplFileName, fullLst):

    myFlag = False

    fout = open("{0}.csv".format(tplFileName), 'w')

    # write header
    outLine = ""
    for _, pos in enumerate(allPos):
        for _, var in enumerate(allVar):
            outLine += "{0},{1} {2},".format("Time [H]", pos, var )

    fout.writelines("{0}\n".format(outLine))

    # write data
    with open(tplFileName) as infile:
        for line in infile:

            if myFlag:

                myValList = line.split()

                myTime = float(myValList[0]) / 3600.0 # in hours

                outLine = ""

                for i in range(len(allPos)):
                    for j in range(len(allVar)):
                        outLine += "{0},{1},".format(myTime,
→float(myValList[fullLst[i][j]]) * allMul[j] )

                fout.write("{0}\n".format(outLine))

```

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```

        else:

            if line.find("TIME SERIES") > -1: myFlag = True

    fout.close()

def main():

    print( "{0} initialization".format(time.strftime("%H:%M:%S", time.localtime())) )
    fname = myTPLFile
    tpl = fa.Tpl(fname)

    # list of indices for vars at every position (separate list for every position in
    ↪order)
    varIndLst = []

    getVarsInds(tpl, varIndLst)

    print( "{0} extraction".format(time.strftime("%H:%M:%S", time.localtime())) )
    getData(fname, varIndLst)
    print( "{0} done".format(time.strftime("%H:%M:%S", time.localtime())) )

    # multiplication factors and variables
    allMul = [1.0, 1.0, 1.0e-5, 1.0]
    allVar = ["ROL", "ROG", "PT", "TM"]

    # positions
    allPos = ["FLOWLINE_1KM", "FLOWLINE_2KM", "FLOWLINE_3KM", "FLOWLINE_4KM", "FLOWLINE_
    ↪5KM"]

    myTPLFile = "OLGA_Simulation.tpl"

    main()

```

```

[4]: import pyfas as fa
import pandas as pd
import matplotlib.pyplot as plt
pd.options.display.max_colwidth = 120

```

OLGA ppl files, examples and howto

For an tpl file the following methods are available:

- `filter_data` - return a filtered subset of trends
- `extract` - extract a single trend variable
- `to_excel` - dump all the data to an excel file

The usual workflow should be:

1. Load the correct tpl
2. Select the desired variable(s)
3. Extract the results or dump all the variables to an excel file
4. Post-process your data in Excel or in the notebook itself

4.1 Ppl loading

To load a specific tpl file the correct path and filename have to be provided:

```
[5]: ppl_path = '../..pyfas/test/test_files/'  
     fname = 'FC1_rev01.ppl'  
     ppl = fa.Ppl(ppl_path+fname)
```

4.1.1 Profile selection

As for tpl files, a ppl file may contain hundreds of profiles, in particular for complex networks. For this reason a filtering method is quite useful.

The easiest way is to filter on all the profiles using patterns, the command `ppl.filter_trends("PT")` filters all the pressure profiles (or better, all the profiles with “PT” in the description, if you have defined a temperature profile in the position “PTTOPSIDE”, for example, this profile will be selected too). The resulting python dictionary will

have a unique index for each filtered profile that can be used to identify the interesting profile(s). In case of an empty pattern all the available profiles will be reported.

```
[6]: ppl.filter_data('PT')
[6]: {4: "PT 'SECTION:' 'BRANCH:' 'old_offshore' '(PA)' 'Pressure'\n",
      12: "PT 'SECTION:' 'BRANCH:' 'riser' '(PA)' 'Pressure'\n",
      20: "PT 'SECTION:' 'BRANCH:' 'new_offshore' '(PA)' 'Pressure'\n",
      28: "PT 'SECTION:' 'BRANCH:' 'to_vent' '(PA)' 'Pressure'\n",
      36: "PT 'SECTION:' 'BRANCH:' 'dry' '(PA)' 'Pressure'\n",
      44: "PT 'SECTION:' 'BRANCH:' 'tiein_spool' '(PA)' 'Pressure'\n"}
```

The same output can be reported as a pandas dataframe:

```
[7]: pd.DataFrame(ppl.filter_data('PT'), index=("Profiles",)).T
[7]:
```

	Profiles
4	PT 'SECTION:' 'BRANCH:' 'old_offshore' '(PA)' 'Pressure'\n
12	PT 'SECTION:' 'BRANCH:' 'riser' '(PA)' 'Pressure'\n
20	PT 'SECTION:' 'BRANCH:' 'new_offshore' '(PA)' 'Pressure'\n
28	PT 'SECTION:' 'BRANCH:' 'to_vent' '(PA)' 'Pressure'\n
36	PT 'SECTION:' 'BRANCH:' 'dry' '(PA)' 'Pressure'\n
44	PT 'SECTION:' 'BRANCH:' 'tiein_spool' '(PA)' 'Pressure'\n

4.1.2 Dump to excel

To dump all the variables in an excel file use `ppl.to_excel()` If no path is provided an excel file with the same name of the tpl file is generated in the working folder. Depending on the tpl size this may take a while.

4.1.3 Extract a specific variable

Once you know the variable(s) index you are interested in (see the filtering paragraph above for more info) you can extract it (or them) and use the data directly in python.

Let's assume you are interested in the pressure and the temperature profile of the branch riser:

```
[8]: pd.DataFrame(ppl.filter_data("TM"), index=("Profiles",)).T
[8]:
```

	Profiles
5	TM 'SECTION:' 'BRANCH:' 'old_offshore' '(C)' 'Fluid temperature'\n
13	TM 'SECTION:' 'BRANCH:' 'riser' '(C)' 'Fluid temperature'\n
21	TM 'SECTION:' 'BRANCH:' 'new_offshore' '(C)' 'Fluid temperature'\n
29	TM 'SECTION:' 'BRANCH:' 'to_vent' '(C)' 'Fluid temperature'\n
37	TM 'SECTION:' 'BRANCH:' 'dry' '(C)' 'Fluid temperature'\n
45	TM 'SECTION:' 'BRANCH:' 'tiein_spool' '(C)' 'Fluid temperature'\n

```
[9]: pd.DataFrame(ppl.filter_data("PT"), index=("Profiles",)).T
[9]:
```

	Profiles
4	PT 'SECTION:' 'BRANCH:' 'old_offshore' '(PA)' 'Pressure'\n
12	PT 'SECTION:' 'BRANCH:' 'riser' '(PA)' 'Pressure'\n
20	PT 'SECTION:' 'BRANCH:' 'new_offshore' '(PA)' 'Pressure'\n
28	PT 'SECTION:' 'BRANCH:' 'to_vent' '(PA)' 'Pressure'\n

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```

36         PT 'SECTION:' 'BRANCH:' 'dry' ' (PA)' 'Pressure'\n
44     PT 'SECTION:' 'BRANCH:' 'tiein_spool' ' (PA)' 'Pressure'\n

```

Our targets are:

variable 13 for the temperature

and

variable 12 for the pressure

Now we can proceed with the data extraction:

```

[10]: ppl.extract(13)
      ppl.extract(12)

```

The ppl object now has the two profiles available in the data attribute:

```

[11]: ppl.data.keys()
[11]: dict_keys([12, 13])

```

while the *label* attribute stores the variable type:

```

[12]: ppl.label[13]
[12]: "TM 'SECTION:' 'BRANCH:' 'riser' '(C)' 'Fluid temperature'"

```

4.1.4 Ppl data structure

The ppl data structure at the moment contains:

- the geometry profile of the branch as `ppl.data[variable_index][0]`
- the selected profile at the timestep 0 as `ppl.data[variable_index][1][0]`
- the selected profile at the last timestep as `ppl.data[variable_index][1][-1]`

In other words the first index is the variable, the second is 0 for the geometry and 1 for the data, the last one identifies the timestep.

4.1.5 Data processing

The results available in the data attribute are numpy arrays and can be easily manipulated and plotted:

```

[13]: %matplotlib inline

geometry = ppl.data[12][0]
pt_riser = ppl.data[12][1]
tm_riser = ppl.data[13][1]

def ppl_plot(geo, v0, v1, ts):
    fig, ax0 = plt.subplots(figsize=(12, 7));
    ax0.grid(True)
    p0, = ax0.plot(geo, v0[ts])
    ax0.set_ylabel("[C]", fontsize=16)
    ax0.set_xlabel("[m]", fontsize=16)

```

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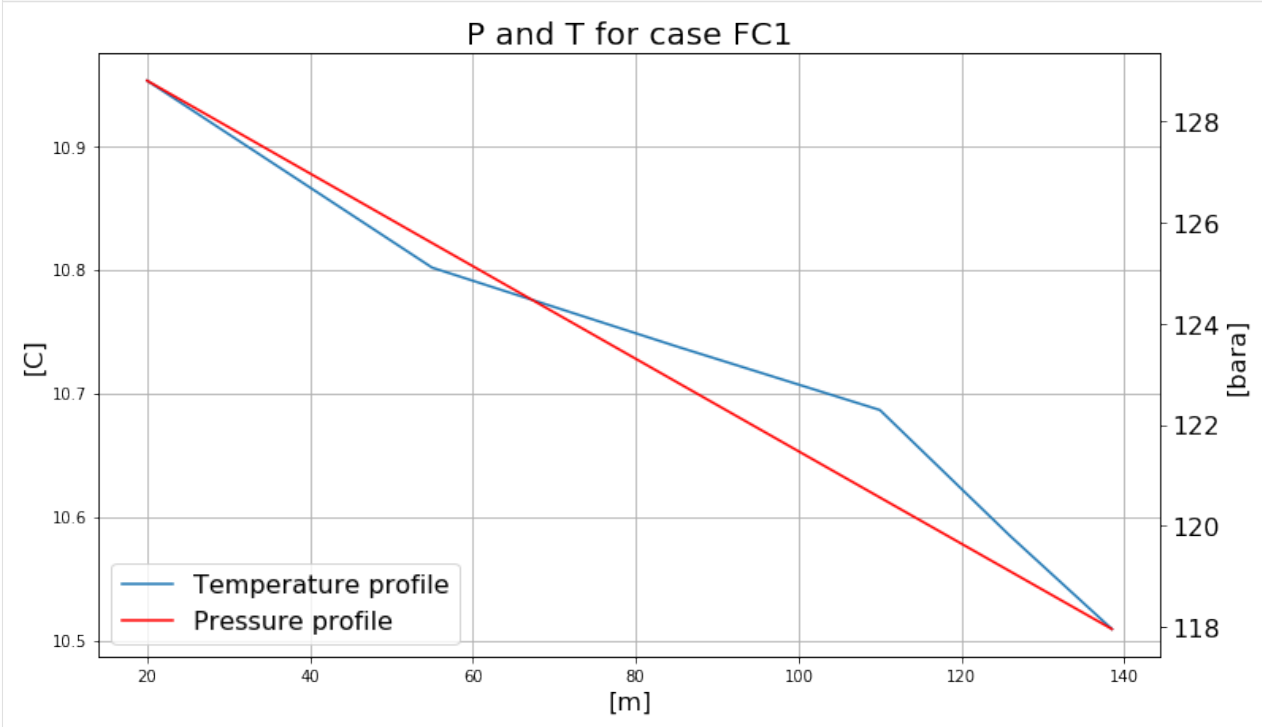
```

ax1 = ax0.twinx()
p1, = ax1.plot(geo, v1[ts]/1e5, 'r')
ax1.grid(False)
ax1.set_ylabel("[bara]", fontsize=16)
ax1.tick_params(axis="both", labelsize=16)
ax1.tick_params(axis="both", labelsize=16)
plt.legend((p0, p1), ("Temperature profile", "Pressure profile"), loc=3,
↪ fontsize=16)
plt.title("P and T for case FC1", size=20);

```

To plot the last timestep:

```
[14]: ppl_plot(geometry, tm_riser, pt_riser, -1)
```



The time can also be used as parameter:

```

[15]: import ipywidgets.widgets as widgets
from ipywidgets import interact

timesteps=len(tm_riser)-1

@interact
def ppl_plot(ts=widgets.IntSlider(min=0, max=timesteps)):
    fig, ax0 = plt.subplots(figsize=(12, 7));
    ax0.grid(True)
    p0, = ax0.plot(geometry, tm_riser[ts])
    ax0.set_ylabel("[C]", fontsize=16)
    ax0.set_xlabel("[m]", fontsize=16)
    ax0.set_ylim(10, 12)
    ax1 = ax0.twinx()
    ax1.set_ylim(90, 130)
    p1, = ax1.plot(geometry, pt_riser[ts]/1e5, 'r')

```

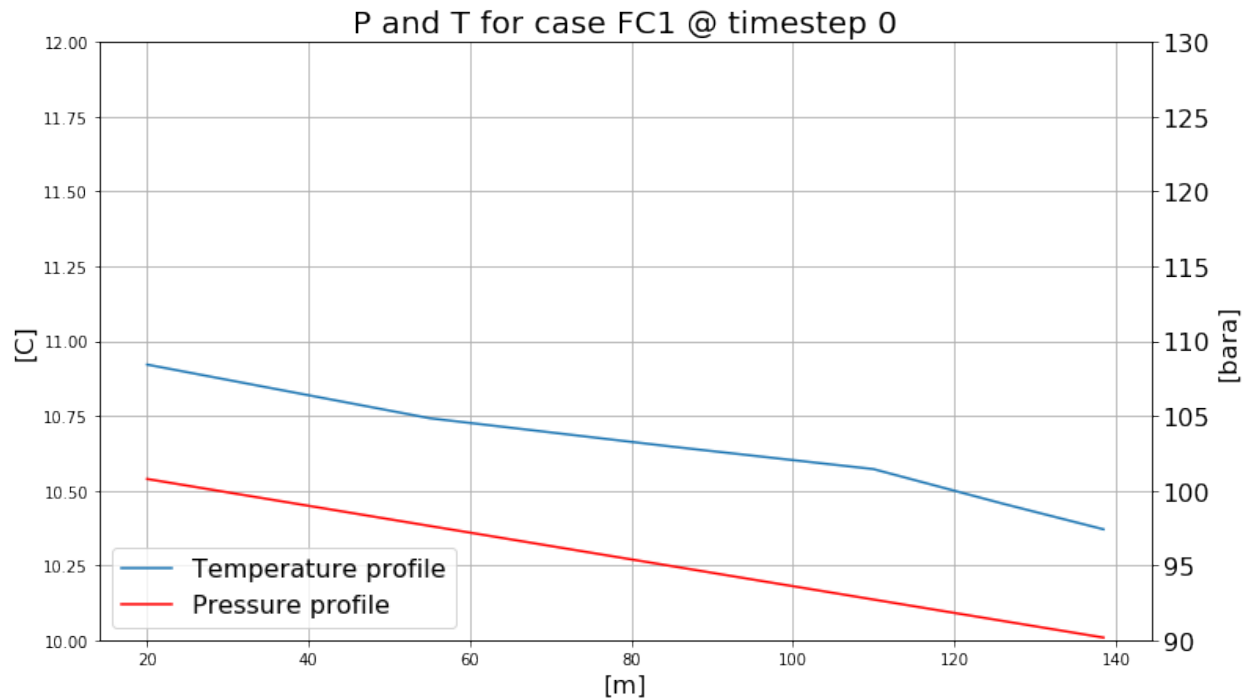
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```

ax1.grid(False)
ax1.set_ylabel("[bara]", fontsize=16)
ax1.tick_params(axis="both", labelsize=16)
ax1.tick_params(axis="both", labelsize=16)
plt.legend((p0, p1), ("Temperature profile", "Pressure profile"), loc=3,
↪ fontsize=16)
plt.title("P and T for case FC1 @ timestep {}".format(ts), size=20);

```



The above plot has an interactive widget if executed

4.1.6 Advanced data processing

An example of advanced data processing for Python enthusiasts and professional flow assurance. Script below extracts variable profiles along given branches at given time steps. Usage instructions: - Consecutive branches are joined together and extracted profiles are written into a CSV file. - For unit conversion multiplication factors for every variable can be given. - Global variables can be redefined before every call of main(), which allows for multiple extractions in a single script run. No need to modify the functions, unless you know what you are doing. - Only few global variables and lists have to be defined, see below main(), there is no need to edit the functions. - The script does not perform error checks, make sure that all variables, branches and times (time steps) are present in the simulation file.

```

[ ]: import os
import sys
import time
import pyfas as fa

def getVarsInds(ppl, emptyLst):

    for _, var in enumerate(allVar):

```

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```

lst = []

# dictionary of the following kind:
# {4: "PT 'SECTION:' 'BRANCH:' 'old_offshore' '(PA)' 'Pressure'\n",
# 12: "PT 'SECTION:' 'BRANCH:' 'riser' '(PA)' 'Pressure'\n"}
myDic = ppl.filter_data(var)

for _, pos in enumerate(allPos):

    for _, (k, v) in enumerate(myDic.items()):

        lstStr = v.split(" ' ")
        lstStr1 = v.split(" ")

        if lstStr1[0] == var and lstStr[2] == pos: # my var and_
↳branch

            lst.append( int(k) )
            break

emptyLst.append(lst)

def getData(ppl, pplFileName, fullLst):

    filterTimesLstLoc = filterTimesLst
    if filterTime and (not filterTimesLstLoc):
        filterTimesLstLoc = [round( ppl.time[myTS-1] / 3600.0, 3 ) for myTS in_
↳filterTimesInd]

    for i, _ in enumerate(allVar):
        for j, _ in enumerate(allPos): ppl.extract( fullLst[i][j] )

    fout = open("{0}.csv".format(pplFileName), 'w')

    # write header
    outLine = ""
    for i, _ in enumerate(allVar):
        for ts in range( len(ppl.time) ):
            outStr = "Pipe L [km],{0},".format( allNam[i] )
            if filterTime:
                if round(ppl.time[ts] / 3600.0, 3) in filterTimesLstLoc:
↳outLine += outStr
            else: outLine += outStr
        fout.write("{0}\n".format(outLine))

    outLine = ""
    for i, _ in enumerate(allVar):
        for ts in range( len(ppl.time) ):
            outStr = "Time [hr],{0},".format( float(ppl.time[ts]) / 3600.0 )
            if filterTime:
                if round(ppl.time[ts] / 3600.0, 3) in filterTimesLstLoc:
↳outLine += outStr
            else: outLine += outStr
        fout.write("{0}\n".format(outLine))

```

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```

# write profiles
lastGeomPoint = 0.0
for j, _ in enumerate(allPos):

    geomPrfl = ppl.data[ fullLst[0][j] ][ 0 ] + lastGeomPoint # geometry_
    profile

    for p in range( len( ppl.data[ fullLst[0][j] ][ 1 ][ 0 ] ) ): # for p in_
    range( len(geomPrfl) ): # loop over profile points

        outLine = ""

        for i, _ in enumerate(allVar):

            for ts in range( len(ppl.time) ): # loop over timesteps

                varPrfl = ppl.data[ fullLst[i][j] ][ 1 ][ ts ] #_
                var profile at the timestep ts

                outStr = "{0},{1},".format( float(geomPrfl[p]) /_
                1000.0, float(varPrfl[p]) * allMul[i] )

                if filterTime:
                    if round(ppl.time[ts] / 3600.0, 3) in_
                filterTimesLstLoc: outLine += outStr
                else:
                    outLine += outStr

            fout.write("{0}\n".format(outLine))

        if doSpecialGeomJoin:
            lastGeomPoint = geomPrfl[0] - lastGeomPoint + geomPrfl[-1] #_
            check it for the genral case with more than two sections!!!
        else:
            lastGeomPoint = geomPrfl[-1]

    fout.close()

def main():

    print( "{0} initialization".format(time.strftime("%H:%M:%S", time.localtime())) )
    fname = myPPLFile
    ppl = fa.Ppl(fname)

    varIndLst = [] # separate list for every var in order (all postions/branches for_
    every var)
    getVarsInds(ppl, varIndLst)

    print( "{0} extraction".format(time.strftime("%H:%M:%S", time.localtime())) )

    getData(ppl, fname, varIndLst)

    print( "{0} done".format(time.strftime("%H:%M:%S", time.localtime())) )

# global variables

```

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```
allMul = [1.0, 1.0e-5, 1.0]
allVar = ["TM", "PT", "ROF"]
allNam = ["Temperature, degC", "Pressure, bara", "Mixture Density, kg/m3"]

doSpecialGeomJoin = False

myPPLFile = "OLGA_Simulation.ppl"

filterTime = True
filterTimesLst = [] # as an option (if the list is not empty), time in hours rounded_
→to three decimal points

# extract data (i)
filterTimesInd = [1, 2, 3, 4, 5, 10, 50, 100] # the first time step is one (not zero!)
allPos = ["E_RISER", "E_FLOWLINE"]
main()
os.rename( "{0}.csv".format(myPPLFile), "{0}_East.csv".format(myPPLFile) )

# extract data (ii)
filterTimesInd = [1, 2, 3, 4, 5, 10, 50, 100] # the first time step is one (not zero!)
allPos = ["W_RISER", "W_FLOWLINE"]
main()
os.rename( "{0}.csv".format(myPPLFile), "{0}_West.csv".format(myPPLFile) )
```

Unisim usc files

Unisim Design provides some old-fashion API via a COM interface to handle usc files. This interface works only on Windows and more info can be found [here](#) (a free registration is required). The Usc class of pyfas exposes in python a minimal subset of API.

The available methods are:

- `extract_profiles`
- `extract_stripchart`
- `run_until`
- `close`
- `save`

Warning: Save and close any Unisim instance before using this class!

5.1 Usc loading

To load a specific usc file the correct path and filename have to be provided:

```
usc_path = '../..pyfas/test/test_files/'  
fname = 'test_case.usc'  
usc = fa.Usc(usc_path+fname)
```

5.1.1 Extract Profiles

Profiles can be extracted with the `extract_profiles` method: the pipeline name is required

5.1.2 Extract stripchart

Stripcharts can be extracted with the `extract_stripchart` method: the default stripchart name is `overall`

5.1.3 Run until

With `run_until` the simulation is started until the specified endtime (in minures) is reached.

```
[2]: import pandas as pd
import pyfas as fa
```

A tab file contains thermodynamic properties pre-calculated by a thermodynamic simulator like PVTsim. It is good practice to analyze these text files *before* using them. Unfortunately there are several file layouts (key, fixed, with just a fluid, etc.). The Tab class handles some (most?) of the possible cases but not necessarily all the combinations. The only public method is `extract_all` and returns a pandas dataframe with the thermodynamic properties. At this moment in time the dataframe obtained is not unique, it depends on the tab format and on the number of fluids in the original tab file. Room to improve here.

6.1 Tab file loading

```
[14]: tab_path = '../pyfas/test/test_files/'
      fname = '3P_single-fluid_key.tab'
      tab = fa.Tab(tab_path+fname)
```

6.1.1 Extraction

```
[15]: tab.export_all()
```

```
[16]: tab.data
```

```
[16]:
          "1"
CPG      [1898.12, 1905.92, 1913.71, 1921.51, 1929.3, 1...
CPHL     [1610.0, 1617.06, 1623.76, 1630.02, 1635.79, 1...
CPWT     [3454.74, 3458.93, 3463.33, 3467.94, 3472.76, ...
DROGDP   [8.4946e-06, 8.42111e-06, 8.34888e-06, 8.27788...
DROGDT   [-0.000323057, -0.000317492, -0.00031207, -0.0...
DROHLDP  [4.47091e-07, 4.5376e-07, 4.60533e-07, 4.67363...
DROHLDT  [-0.694011, -0.693068, -0.691885, -0.69043, -0...
DROWTDP  [5.24381e-07, 5.22483e-07, 5.1907e-07, 5.14565...
DROWTDT  [0.158913, 0.142489, 0.120409, 0.0942844, 0.06...
```

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```

HG      [-19279.3, -14920.5, -10543.9, -6149.34, -1736...
HHL     [-317877.0, -313080.0, -308335.0, -303637.0, -...
HWT     [-1395510.0, -1387580.0, -1379650.0, -1371710...
PT      [10000.0, 10000.0, 10000.0, 10000.0, 10000.0, ...
ROG     [0.0849146, 0.0841808, 0.0834595, 0.0827506, 0...
ROHL    [899.718, 900.424, 901.309, 902.434, 903.838, ...
ROWT    [813.363, 812.66, 811.929, 811.17, 810.382, 80...
RS      [0.999977, 0.999979, 0.99998, 0.999982, 0.9999...
RSW     [0.000692485, 0.000692485, 0.000692484, 0.0006...
SEG     [1185.33, 1201.82, 1218.24, 1234.58, 1250.85, ...
SEHL    [-587.526, -570.743, -554.118, -537.594, -521...
SEWT    [-4115.44, -4085.47, -4055.71, -4026.17, -3996...
SIGGHL  [0.0280944, 0.0280288, 0.0279906, 0.0279847, 0...
SIGGWT  [0.0698809, 0.0690383, 0.0682086, 0.0673915, 0...
SIGHLWT [0.0551154, 0.0550872, 0.0550879, 0.0551306, 0...
TCG     [0.0277744, 0.028032, 0.0282904, 0.0285496, 0...
TCHL    [0.0969043, 0.0960938, 0.0953334, 0.094616, 0...
TCWT    [0.548681, 0.553425, 0.558072, 0.562624, 0.567...
TM      [-10.0, -7.70833, -5.41667, -3.125, -0.833333,...
VISG    [1.01832e-05, 1.02634e-05, 1.03434e-05, 1.0423...
VISHL   [0.220481, 0.227562, 0.234135, 0.240676, 0.247...
VISWT   [0.0010661, 0.00101649, 0.000970794, 0.0009286...

```

Some key info about the tab file are provided as `tab.metadata`

```
[17]: tab.metadata
```

```

[17]: {'fluids': [' "1"'],
      'nfluids': 1,
      'p_array': array([ 1.00000000e+04,  1.01325000e+05,  7.38958000e+05,
                        1.46792000e+06,  2.19688000e+06,  2.92583000e+06,
                        3.65479000e+06,  4.38375000e+06,  5.11271000e+06,
                        5.84167000e+06,  6.57063000e+06,  7.29958000e+06,
                        8.02854000e+06,  8.75750000e+06,  9.48646000e+06,
                        1.02154000e+07,  1.09444000e+07,  1.16733000e+07,
                        1.24023000e+07,  1.31313000e+07,  1.38602000e+07,
                        1.45892000e+07,  1.53181000e+07,  1.60471000e+07,
                        1.67760000e+07,  1.75050000e+07,  1.82340000e+07,
                        1.89629000e+07,  1.96919000e+07,  2.04208000e+07,
                        2.11498000e+07,  2.18788000e+07,  2.26077000e+07,
                        2.33367000e+07,  2.40656000e+07,  2.47946000e+07,
                        2.55235000e+07,  2.62525000e+07,  2.69815000e+07,
                        2.77104000e+07,  2.84394000e+07,  2.91683000e+07,
                        2.98973000e+07,  3.06263000e+07,  3.13552000e+07,
                        3.20842000e+07,  3.28131000e+07,  3.35421000e+07,
                        3.42710000e+07,  3.50000000e+07]),
      'p_points': 50,
      'properties': ['PT',
                    'TM',
                    'ROG',
                    'ROHL',
                    'ROWT',
                    'DROGDP',
                    'DROHLDP',
                    'DROWTDP',
                    'DROGDT',
                    'DROHLDT',

```

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```

'DROWTDT',
'RS',
'RSW',
'VISG',
'VISHL',
'VISWT',
'CPG',
'CPHL',
'CPWT',
'HG',
'HHL',
'HWT',
'TCG',
'TCHL',
'TCWT',
'SIGGHL',
'SIGGWT',
'SIGHLWT',
'SEG',
'SEHL',
'SEWT'],
't_array': array([ -10.          ,  -7.70833 ,  -5.41667 ,  -3.125   ,  -0.833333,
    1.45833 ,   3.75   ,   6.04167 ,   8.33333 ,  10.625   ,
   12.9167 ,  15.2083 ,  15.56   ,  17.5    ,  19.7917 ,
   22.0833 ,  24.375  ,  26.6667 ,  28.9583 ,  31.25   ,
   33.5417 ,  35.8333 ,  38.125   ,  40.4167 ,  42.7083 ,
   45.     ,  47.2917 ,  49.5833 ,  51.875   ,  54.1667 ,
   56.4583 ,  58.75   ,  61.0417 ,  63.3333 ,  65.625   ,
   67.9167 ,  70.2083 ,  72.5    ,  74.7917 ,  77.0833 ,
   79.375   ,  81.6667 ,  83.9583 ,  86.25    ,  88.5417 ,
   90.8333 ,  93.125  ,  95.4167 ,  97.7083 , 100.     ]),
't_points': 50}

```

6.1.2 Plotting

Here under an example of a 3D plot of the liquid hydrocarbon viscosity

```

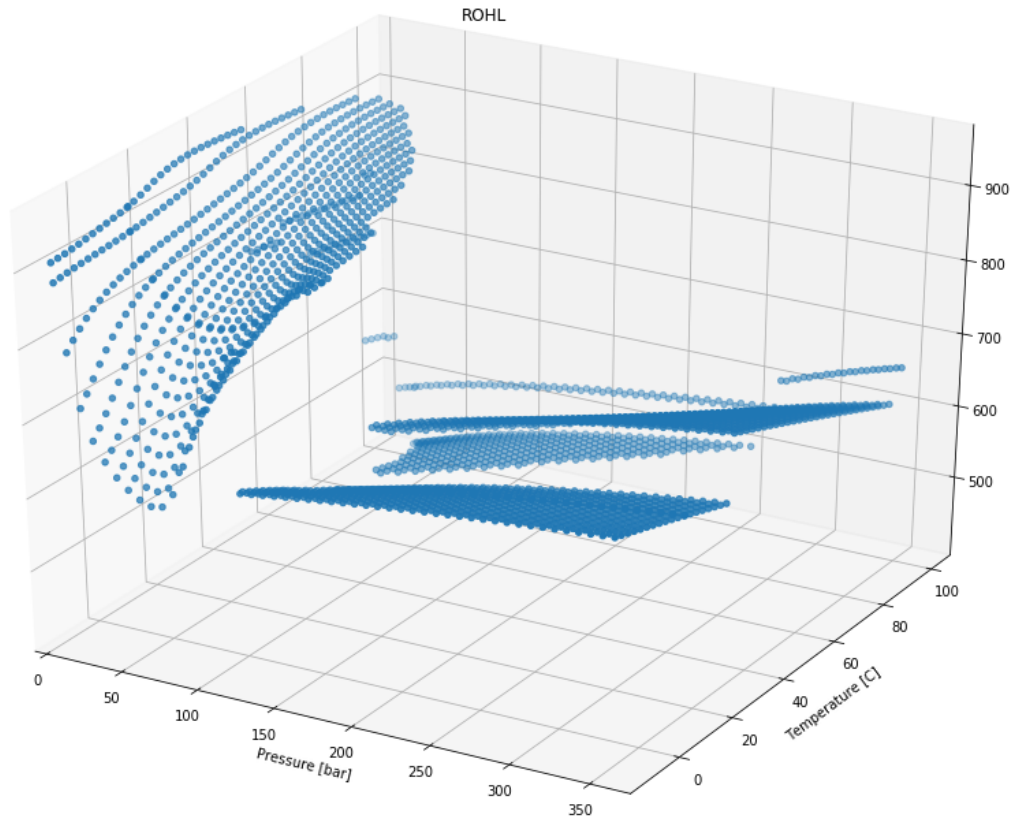
[48]: import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D
import itertools as it

def plot_property_keyword(pressure, temperature, thermo_property):
    fig = plt.figure(figsize=(16, 12))
    ax = fig.add_subplot(111, projection='3d')
    X = []
    Y = []
    for x, y in it.product(pressure, temperature):
        X.append(x/1e5)
        Y.append(y)
    ax.scatter(X, Y, thermo_property)
    ax.set_ylabel('Temperature [C]')
    ax.set_xlabel('Pressure [bar]')
    ax.set_xlim(0, )
    ax.set_title('ROHL')
    return fig

```

```
[49]: plot_property_keyword(tab.metadata['p_array'],  
                             tab.metadata['t_array'],  
                             tab.data.T['ROHL'].values[0])
```

```
[49]:
```



```
[ ]:
```

CHAPTER 7

GAP interface

GAP provides a comfortable set of API via the OpenServer interface. This interface works, of course, only on Windows and provides a CLI access to most of the simulator features. `Pyfas` is not required to use OpenServer.

This example uses `pywin32`, but any package providing a COM interface should work:

```
# Connecting to the open GAP file
from win32com.client import Dispatch
gap = Dispatch('PX32.OpenServer.1')
```

The previous command gives the possibility to interact with an open GAP model (open via the UI). In case more than one model is open, the last one opened is considered.

It is also possible to access to closed models:

```
gap.docommand('GAP.START')
gap.docommand(r'GAP.OpenFile("C:\example\example.gap")')
```

Two basic operations are possible:

- `getvalue`
- `setvalue`

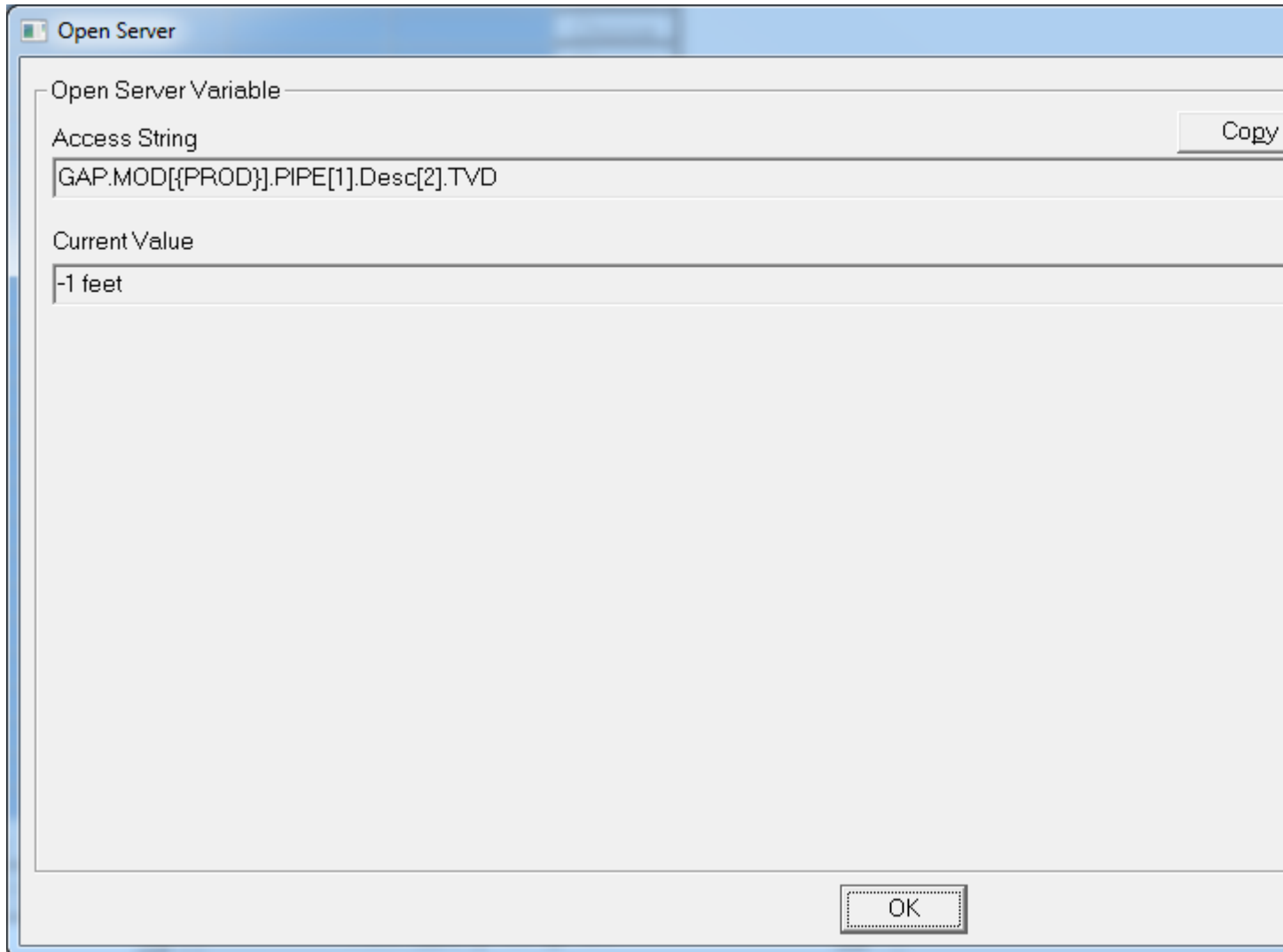
Pretty straightforward, isn't it?

```
# This command shows the flow correlation for the Pipe1 of the model {PROD}
gap.getvalue("GAP.MOD[{PROD}].PIPE[1].PIPECORR")
Out[4]: 'MukerjeeBrill'
```

To set a value instead:

```
# This command sets the flowrate of SOURCE1 to 10 (it uses predefined unit)
gap.setvalue("GAP.MOD[{PROD}].SOURCE[{Source1}].Rate", 10)
```

It looks complicated but a good reference guide is available and, even better, with the right click in the GUI the corresponding OpenServer command can be showed in the OpenServer window:



PipeSim interface (via Openlink)

The OpenLink functionality (available for all the PipeSim versions ≤ 2012.4) provides a COM interface to both single branch and network models.

Like for other COM interfaces the `Dispatch` method of the `pywin32` module can be used to communicate with PipeSim. For example to open the a network model called `base_model.bpn` you can:

```
o = Dispatch("NET32COM.INetModel")
o.OpenModel(path_to/base_model.bpn)
```

Once loaded the model all the the different elements can be checked or modified: `o.GetNameList(i)` returns a 2-elements tuple containing the all the names and the number of elements corresponding to the index `i`. For example:

```
o.GetNameList(2)[0]
```

would return all the names of the sources of the model.

Once the name of the source you want to modify is known it is possilbe to use `o.SetBoundaryFluidrate` to define a new fluid rate:

```
o.SetBoundaryFluidrate(source_name, 0, new_value, 'STB/d')
```

`SetBoundaryFluidrate` as second parameter accepts an integer:

- 0 for liquid flowrate
- 1 for gas flowrate

```
o.SaveModel
```

can be use to save as (it requires as parameter the path and the new name of the model as a string)

8.1 Run a case

To run a case in the background:

```
o.RunNetwork2(False, "-B")
```

and to check if it is still simulating:

```
o.GetIsModelRunning()
```

8.2 Node results

Node results can be extracted using the `Dispatch("PNSREADER.PNSCom")`:

```
results.ReadPnsFile(pns_file_path)
idx = results.GetNodeIndex(interesting_node)
pt = results.GetNodeVariableValue(idx, 'Pressure')
```

CHAPTER 9

SFC interface

Providing you have available the SFC dlls this wrapper allows you to run SFC directly from python.

Here an example (Win platform only):

```
import pyfas as fa
sfc = fa.SFC()
case = sfc.default_input()
df = sfc.run(**case)
dp_fr = df["Frictional pressure gradient (> 0 for dp_f/dx < 0) [N/m3]"]
hol = df["Liquid volume fraction [fraction]"]
```

A pandas dataframe with all the input and potential output is returned.

```
[33]: import pyfas as fa
import pandas as pd
import matplotlib.pyplot as plt
```


CHAPTER 10

Utilities

CHAPTER 11

Indices and tables

- `genindex`
- `modindex`
- `search`