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BPL_TEST2_PID_Fedbatch_reg6 script with FMPy

The key library FMPy is installed.

After the installation a small application BPL_TEST2_PID_Fedbatch_reg6 is loaded and run.

You can continue with this example if you like.

In [1]:
```
!lsb_release -a # Actual VM Ubuntu version used by Google
```

```
No LSB modules are available.
Distributor ID: Ubuntu
Description:    Ubuntu 22.04.4 LTS
Release:        22.04
Codename:       jammy
```

In [2]:
```
!python --version
```

```
Python 3.11.11
```

In [3]:
```
!pip install fmpy
```

```
Collecting fmpy
  Downloading FMPy-0.3.22-py3-none-any.whl.metadata (1.9 kB)
Requirement already satisfied: attrs in /usr/local/lib/python3.11/dist-packages (fro
m fmpy) (25.3.0)
Requirement already satisfied: Jinja2 in /usr/local/lib/python3.11/dist-packages (fr
om fmpy) (3.1.6)
Collecting lark (from fmpy)
  Downloading lark-1.2.2-py3-none-any.whl.metadata (1.8 kB)
Requirement already satisfied: lxml in /usr/local/lib/python3.11/dist-packages (from
fmpy) (5.3.1)
Requirement already satisfied: msgpack in /usr/local/lib/python3.11/dist-packages (f
rom fmpy) (1.1.0)
Requirement already satisfied: numpy in /usr/local/lib/python3.11/dist-packages (fro
m fmpy) (2.0.2)
Requirement already satisfied: MarkupSafe>=2.0 in /usr/local/lib/python3.11/dist-pac
kages (from Jinja2->fmpy) (3.0.2)
Downloading FMPy-0.3.22-py3-none-any.whl (4.9 MB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 4.9/4.9 MB 36.9 MB/s eta 0:00:00
Downloading lark-1.2.2-py3-none-any.whl (111 kB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 111.0/111.0 kB 6.5 MB/s eta 0:00:00
Installing collected packages: lark, fmpy
Successfully installed fmpy-0.3.22 lark-1.2.2
```

BPL_TEST2_Fedbatch setup

Now specific installation and the run simulations. Start with connecting to Github. Then upload the two files:

- FMU - BPL_TEST2_Fedbatch_linux_om_me.fmu
- Setup-file - BPL_TEST2_Fedbatch_fmpy_explore.py

In [4]:
```
%%bash
git clone https://github.com/janpeter19/CONF_2023_10_MODELICA15
```

```
Cloning into 'CONF_2023_10_MODELICA15'...
```

In [5]:
```
%cd CONF_2023_10_MODELICA15
```

```
/content/CONF_2023_10_MODELICA15
```

In [6]:
```
run -i BPL_TEST2_PID_Fedbatch_reg6_fmpy_explore.py
```

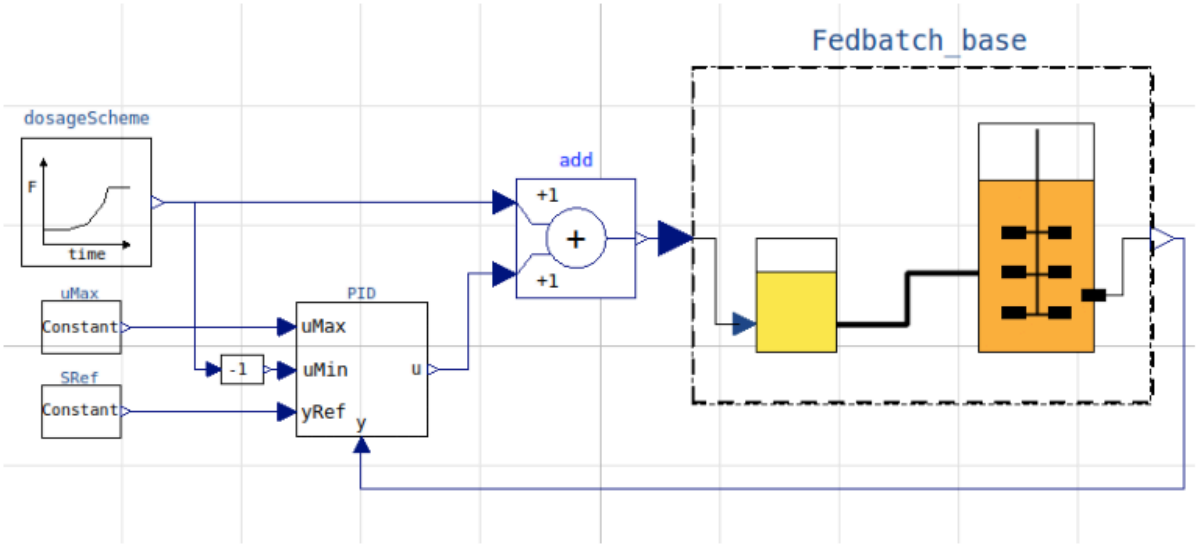
```
Linux - run FMU pre-compiled OpenModelica

Model for the process has been setup. Key commands:
 - par()       - change of parameters and initial values
 - init()      - change initial values only
 - simu()      - simulate and plot
 - newplot()   - make a new plot
 - show()      - show plot from previous simulation
 - disp()      - display parameters and initial values from the last simulation
 - describe()  - describe culture, broth, parameters, variables with values/units

Note that both disp() and describe() takes values from the last simulation
and the command process_diagram() brings up the main configuration

Brief information about a command by help(), eg help(simu)
Key system information is listed with the command system_info()
```

In [7]:
```
%matplotlib inline
plt.rcParams['figure.figsize'] = [25/2.54, 20/2.54]
```

In [8]:
```
import warnings
warnings.filterwarnings("ignore")
```

BPL_TEST2_Fedbatch - demo

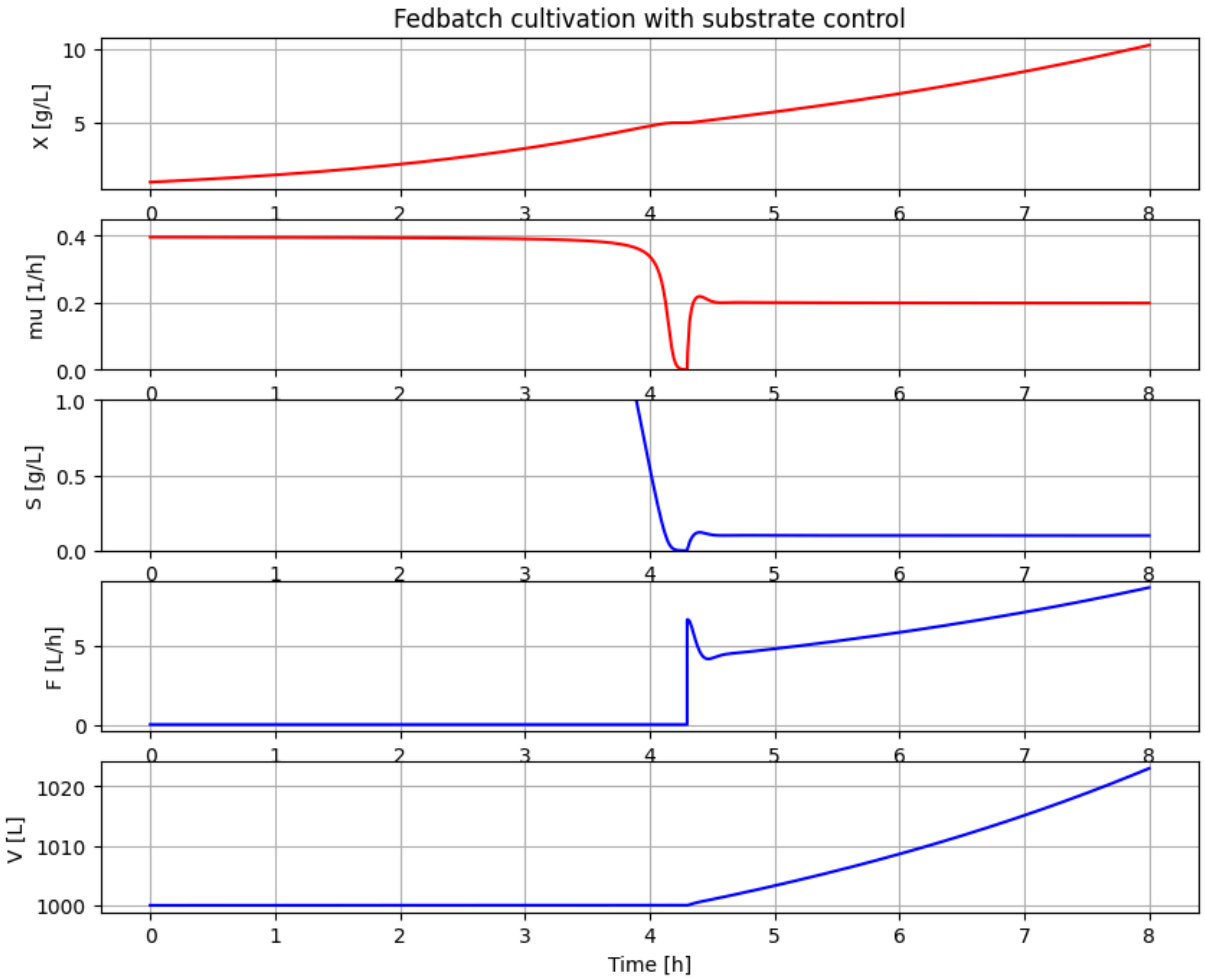
In [9]:
```
process_diagram()
```



In [10]:
```
describe('culture'); print(); #describe('liquidphase')
```

```
Simplified text book mode - only substrate S and cell concentration X
```

In [11]:
```
par(Y=0.40, qSmax=1.0, Ks=0.1)
init(V_0=1e3, VX_0=1e3, VS_0=10*1e3)
# Culture parameters
# Process initialization
par(S_in=600)
par(t_start=4.3, F_start=4, mu_feed=0.2, F_max=35)
par(S_ref=0.1) # Substrate controller
par(t_regStart=4.3)
par(uMax=50)

newplot()
ax2.set_ylim([0, 0.45]); ax3.set_ylim([0, 1])
setLines(['-']);
par(K=30, Ti=0.5)
simu(8)
```



In [12]:
```
disp(mode='long')
```

```
bioreactor.V_0 : V_0 : 1000.0
bioreactor.m_0[1] : VX_0 : 1000.0
bioreactor.m_0[2] : VS_0 : 10000.0
bioreactor.culture.Y : Y : 0.4
bioreactor.culture.qSmax : qSmax : 1.0
bioreactor.culture.Ks : Ks : 0.1
feedtank.V_0 : feedtank_V_0 : 10.0
feedtank.c_in[2] : S_in : 600
dosagescheme.mu_feed : mu_feed : 0.2
dosagescheme.F_0 : F_0 : 0.0
dosagescheme.t_start : t_start : 4.3
dosagescheme.F_start : F_start : 4
dosagescheme.F_max : F_max : 35
substrateSensor.x_0 : Sensor_x_0 : 0
substrateRef.k : S_ref : 0.1
t_regStart : t_regStart : 4.3
PIDreg.K : K : 30
PIDreg.Ti : Ti : 0.5
PIDreg.I_0 : I_0 : 0
uMax : uMax : 50
```

In [13]:
```
describe('mu')
```

```
Cell specific growth rate variable : 0.199 [ 1/h ]
```

In [14]:
```
describe('parts')
```

```
['bioreactor', 'bioreactor.culture', 'dosagescheme', 'feedtank', 'PIDreg', 'substrat
eRef', 'substrateSensor', 't_regStart', 'uMax']
```

In [15]:
```
describe('MSL')
```

```
MSL: 3.2.3 - used components: RealInput, RealOutput
```

In [16]:
```
system_info()
```

```
System information
 -OS: Linux
 -Python: 3.11.11
 -Scipy: not installed in the notebook
 -FMPy: 0.3.22
 -FMU by: OpenModelica Compiler OpenModelica 1.21.0
 -FMI: 2.0
 -Type: ME
 -Name: BPL_TEST2_PID.Fedbatch_reg6
 -Generated: 2023-08-22T10:54:51Z
 -MSL: 3.2.3
 -Description: Bioprocess Library version 2.1.1
 -Interaction: FMU-explore for FMPy version 0.9.8
```

In [16]: