



Class 5: Order-of-magnitude estimate 

Normally, it requires only a block flow diagram.

Class 4: Study estimate 

Based on the process flow diagram. Costs from generalized charts.

Class 3: Preliminary estimate

Based on PFD. Includes vessel sketches for major equipment, preliminary plot plan, and elevation diagram.

Class 2: Definitive estimate

Final PFD, vessel sketches, plot plan, and elevation diagrams, utility balances, and a preliminary piping and instrumentation diagram (P&ID).

Class 1: Detailed estimate

Final PFD and P&ID, vessel sketches, utility balances, plot plan and elevation diagrams, and piping isometrics. All diagrams are required to complete the construction of the plant if it is built.

Class	Complete definition	Purpose of estimation	Methodology
5	0-2%	Screening or Feasibility	Stochastic or Judgment
4	1-15%	Concept Study or Feasibility	Primarily Stochastic
3	10-40%	Budget, authorization or Control	Mixed but Primarily Stochastic
2	30-70%	Control or Tender	Primarily Deterministic
1	50-100%	Check Estimate or Tender	Deterministic

Error of class 1: +6% ~ -4%

Error of class 4&5: +40% ~ -25%

Cost Estimation

$$\log_{10} C_P^0 = K_1 + K_2 \log_{10} S_a + K_3 (\log_{10} S_a)^2$$

Equipment cost attribute (size)

↓ Purchased cost at the year in the book (CEPCI=397, 2001)

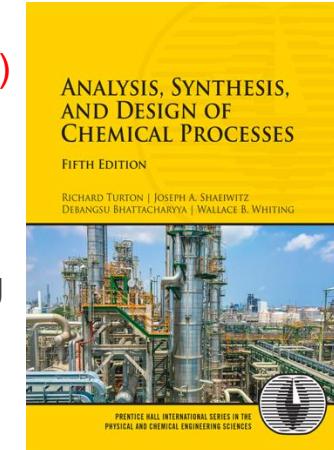
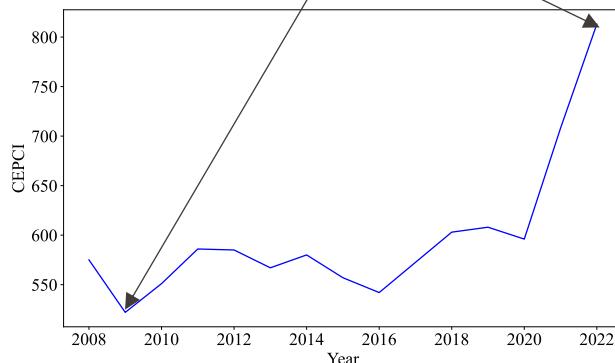
$$\frac{C_{P,a}^0}{C_{P,ref}^0} = \left(\frac{S_a}{S_{ref}} \right)^n \frac{I_{2022}}{I_{2009}}$$

Size exponent, 0.6

Cost index - Chemical Engineering
Plant Cost Index (CEPCI)

$$\frac{I_{2022}}{I_{2009}} = \frac{813}{522} = 1.56$$

When you spend
money is important



Note:

The calculation equation of bare module cost will change according to different types of equipment.
You can find all the information in this book.

$$\text{Bare module cost: } C_{BM} = C_P^0 F_{BM} = C_P^0 (B_1 + B_2 F_M F_P) = C_P^0 F_{BM} F_P F_T$$

Temperature factor



Bare module cost factor



Material factor Pressure factor



Case Study: Compressor

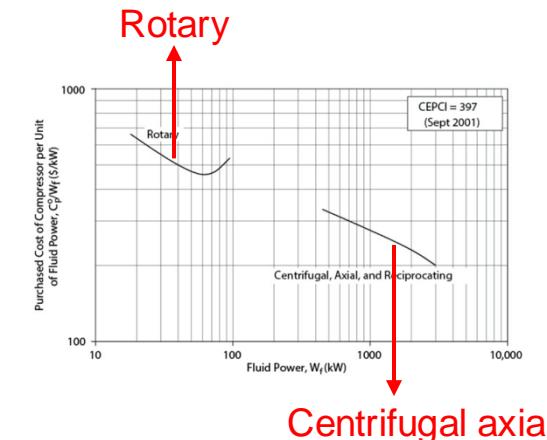
$$\log_{10} C_P^0 = K_1 + K_2 \log_{10} P + K_3 (\log_{10} P)^2 \longrightarrow \text{Equipment cost attribute, fluid power, kW}$$

Achieved in ASPEN.

Purchase cost of the equipment, at ambient operating pressure and using carbon steel construction.

**Table A.1 Equipment Cost Data to Be Used with
Equation (A.1)**

Equipment Type	Equipment Description	K_1	K_2	K_3	Capacity, Units	Min Size	Max Size
Compressors	Centrifugal, axial, and reciprocating	2.2897	1.3604	-0.1027	Fluid power, kW	450	3000
	Rotary	5.0355	-1.8002	0.8253	Fluid power, kW	18	950



Be careful with the range and unit

Pressure factor $\log_{10}F_P = C_1 + C_2\log_{10}P + C_3(\log_{10}P)^2$

Table A.2 Pressure Factors for Process Equipment

Go to page 1297

Equipment Type	Equipment Description	C ₁	C ₂	C ₃	Pressure Range (barg)
Compressors	Centrifugal, axial, rotary,	0	0	0	—
Pumps	Reciprocating	0	0	0	P<10
	Positive displacement	-0.245382	0.259016	-0.01363	10<P<100
	Centrifugal	0	0	0	P<10
		-0.3935	0.3957	-0.00226	10<P<100

Note:

The pressure factor of compressors is 1;

For other equipment, such as pumps, be careful with the pressure range.

Calculation Method

$$C_{BM} = C_P^0 F_{BM} = C_P^0 (B_1 + B_2 F_M F_P)$$

Equations depend on the type of equipment

Table A.4 Constants for Bare Module Factor to Be Used in Equation (A.4)

Equipment Type	Equipment Description	B_1	B_2
Heat exchangers	Double pipe, multiple pipe, scraped wall, and spiral tube	1.74	1.55
	Fixed tube sheet, floating head, U-tube, bayonet, kettle reboiler, and Teflon tube	1.63	1.66
	Air cooler, spiral plate, and flat plate	0.96	1.21
Process vessels	Horizontal	1.49	1.52
	Vertical (including towers)	2.25	1.82
Pumps	Reciprocating	1.89	1.35
	Positive displacement	1.89	1.35

Table A.5 Equations for Bare Module Cost for Equipment Not Covered by Tables A.3 and A.4

Equipment Type	Equation for Bare Module Cost
Compressors and blowers without drives	$C_{BM} = C_P^0 F_{BM}$
Drives for compressors and blowers	$C_{BM} = C_P^0 F_{BM}$
Evaporators and vaporizers	$C_{BM} = C_P^0 F_{BM} F_p$
Fans with electric drives	$C_{BM} = C_P^0 F_{BM} F_p$
Fired heaters and furnaces	$C_{BM} = C_P^0 F_{BM} F_p F_T$

$$C_{BM} = C_P^0 F_{BM} = C_P^0 (B_1 + B_2 F_M F_P)$$

Equations depend on the type of equipment

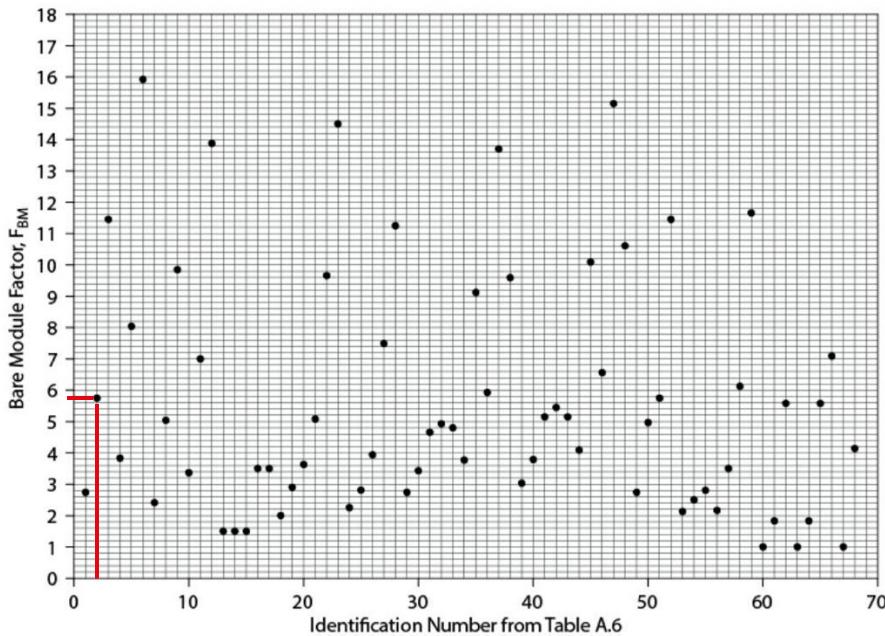


Figure A.19 Bare Module Factors for Equipment in Table

Table A.6 Identification of Material Factors for Equipment Listed in Table A.5 to Be Used with Figure A.19

Identification Number	Equipment Type	Equipment Description	Material of Construction
1	Compressors/blowers	Centrifugal compressor or blower	CS
2	Centrifugal compressor or blower	Centrifugal compressor or blower	SS
3	Centrifugal compressor or blower	Centrifugal compressor or blower	Ni alloy
4	Axial compressor or blower	Axial compressor or blower	CS
5		Axial	SS



Get access to the website: https://ipese-web.epfl.ch/equipement_costs/index.html.

Preface

AUTHOR

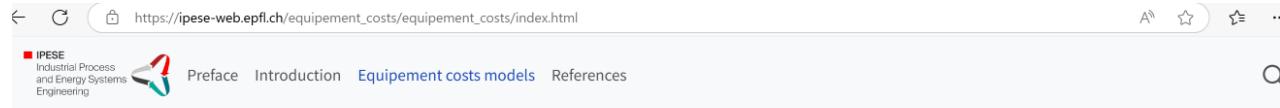
Du Wen, François Maréchal

Edit

This Quarto book will give an introduction of how we connect all resources in FM's lab.

All relevant information of each process unit will be put in one folder with the name of the unit being the name of the folder, such as:

- **index.qmd:** It is the documentation of the process using markdown text.
- **References:** A reference.bib file which includes references of model development and relevant data.
- **./Model:** A folder that includes the model of the unit:
 - Model File can be with different formats:
 - **.asp:** Aspen format
 - **.xls:** Xls format
 - **.lua:** ET.lua format of osmose.lua
 - **Input.csv:** Input of the model with the following format:
 - **“from”:** command that accesses the value in osmose.
 - **“to”:** command that allows to transfer the value to Input.csv.
 - **“unit”:** physical unit of the value transferred.
 - **“Value”:** value transferred.
 - **Output.csv:** Output of the model with the following format:
 - **“from”:** command that accesses the the location in model and extract the value after the model execution.
 - **“to”:** command that allows to transfer the value to Output.csv.
 - **“unit”:** physical unit of the value transferred.
 - **“Value”:** value resulting from the model execution.
 - **Script:** It is a Python script with the following functions:
 - **create index.qmd:** If there is no such a file, create one with a fixed format.
 - **execute ET.lua:** Find the location of the ET file, create a frontend.lua to include ET.lua, execute OSMOSE, read the results in .json.



The screenshot shows a web browser window with the URL https://ipese-web.epfl.ch/equipment_costs/equipment_costs/index.html. The page title is "Equipment costs models". The header includes the IPSE logo (Industrial Process and Energy Systems Engineering) and navigation links for Preface, Introduction, Equipment costs models, and References. On the right, there are "Edit" and "Categories" buttons, and a "Filter" search bar. Below the title, two large gray boxes represent "Industrial sector 1" and "Industrial sector 2", each with a "Process units for industrial sector 1" and "Process units for industrial sector 2" sub-section. A red arrow points upwards from the text "Find the equipment cost library here." to the "Equipment costs models" link in the header.

Equipment costs models

Categories

All (2)

Edit

In each industrial sector, it contains relevant process units.



Filter

Industrial sector 1
Process units for industrial sector 1

Industrial sector 2
Process units for industrial sector 2



Find the equipment cost library here.

https://ipese-web.epfl.ch/equipement_costs/equipement_costs/Sector2/index.html

IPESI
Industrial Process
and Energy Systems
Engineering

Preface Introduction Equipement costs models References

Categories All (144)

Industrial sector 2

Process units for industrial sector 2

cost_O2separator
Add here a description of the equipment, define the reference size, the function of the activity modeled by the process unit and the assumptions.

cost_SteamBoilers
Add here a description of the equipment, define the reference size, the function of the activity modeled by the process unit and the assumptions.

cost_LiquidRadialExpander
S
Add here a description of the equipment, define the reference size, the function of the activity modeled by the process unit and the assumptions.

cost_FuelCell_SOFC

cost_PelsterCompressor_a

cost_PlanarSOFC_leni

Filter

We put the underlying code here. You can look at the documentation, inputs, and outputs.

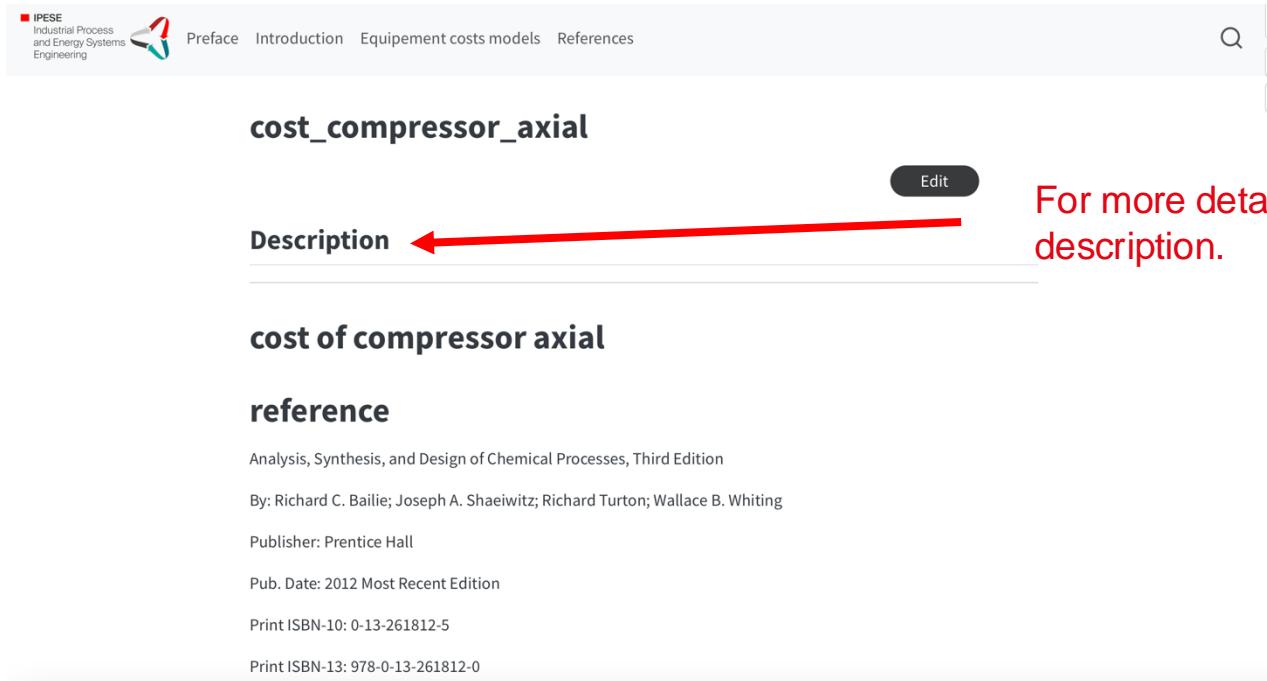
Website – Equipment Cost Library

The screenshot shows a web browser displaying the 'Equipment costs' section of the EPFL website. The URL is https://ipese-web.epfl.ch/equipement_costs/equipement_costs/Sector2/index.html. The page features a search bar at the top with the word 'compressor' typed into it. A red arrow points from this search term to the search bar. To the right of the search bar, there is a 'Categories' section with a link 'All (144)'. Below the search bar, there are several equipment subcategory cards. A red arrow points from the text 'The equipment subcategory is shown in the name.' to the name of the first card, 'cost_compressor_axial'. The cards are as follows:

- cost_PelsterCompressor_axial
- cost_compressor_reciprocating
- cost_compressor_centrifugal
- cost_compressor_rotary
- cost_FuelCompressor_axial
- cost_compressor_axial

You can search for the equipment.

The equipment subcategory is shown in the name.



IPESI
Industrial Process
and Energy Systems
Engineering

Preface Introduction Equipement costs models References

cost_compressor_axial

Description Edit

cost of compressor axial

reference

Analysis, Synthesis, and Design of Chemical Processes, Third Edition
By: Richard C. Bailie; Joseph A. Shaeiwitz; Richard Turton; Wallace B. Whiting
Publisher: Prentice Hall
Pub. Date: 2012 Most Recent Edition
Print ISBN-10: 0-13-261812-5
Print ISBN-13: 978-0-13-261812-0

For more details, you can check the description.

Maziar Kermani

Versioning

2017-07-24 V1: update based on latest data from the reference

Input parameters

cost_compressor_axial(shaftpower, material='CS')



Required inputs

Code

▼ Show/hide code for vertical vessel

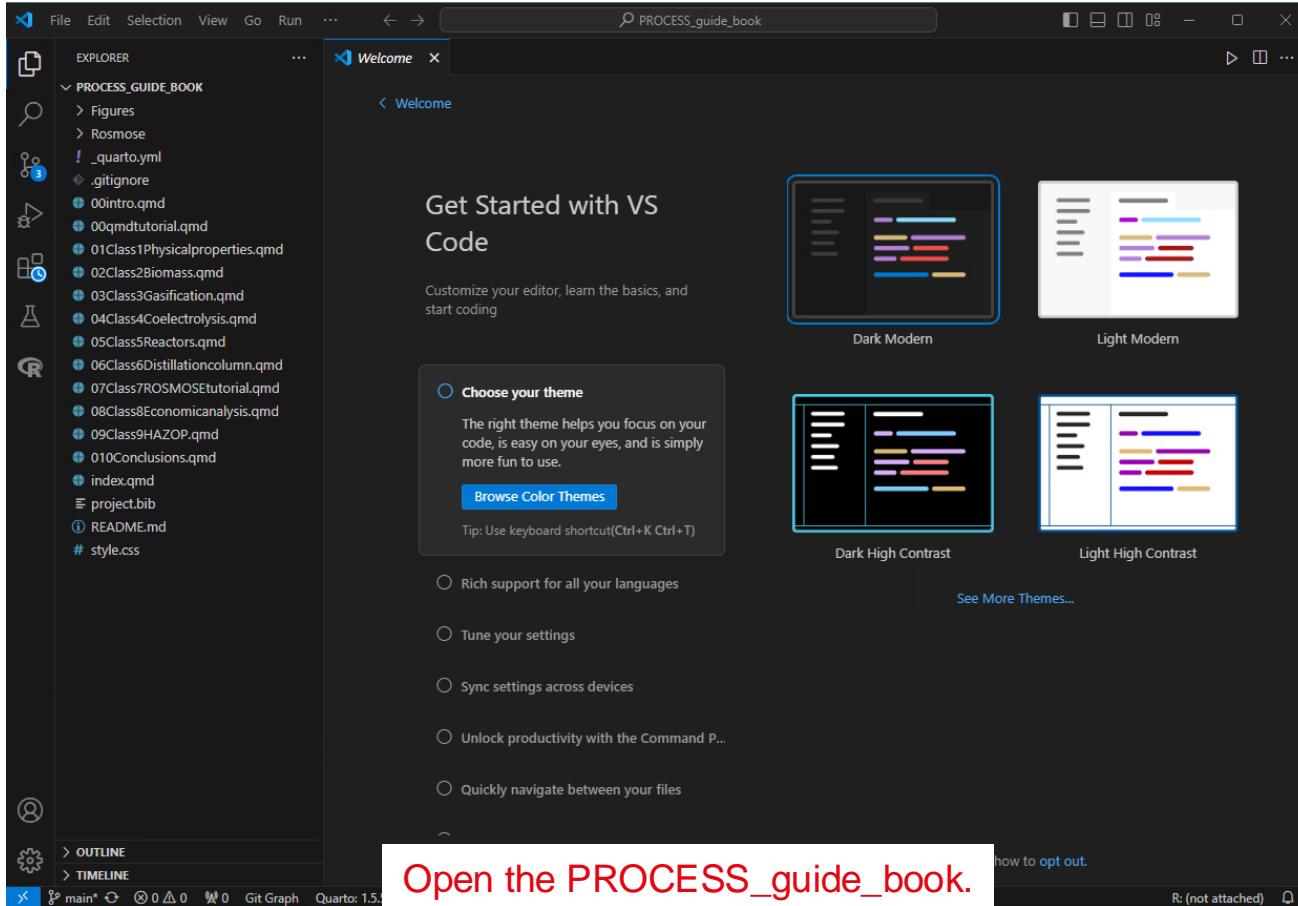
```
from equipment_costs import cost_compressor_axial  
  
Cost_BM, Cost_TM, Cost_GR = cost_compressor_axial(shaftpower, material='CS')  
print(Cost_BM, Cost_TM, Cost_GR)
```



► Details

Copy and paste

Equipment Cost Calculation - Overview



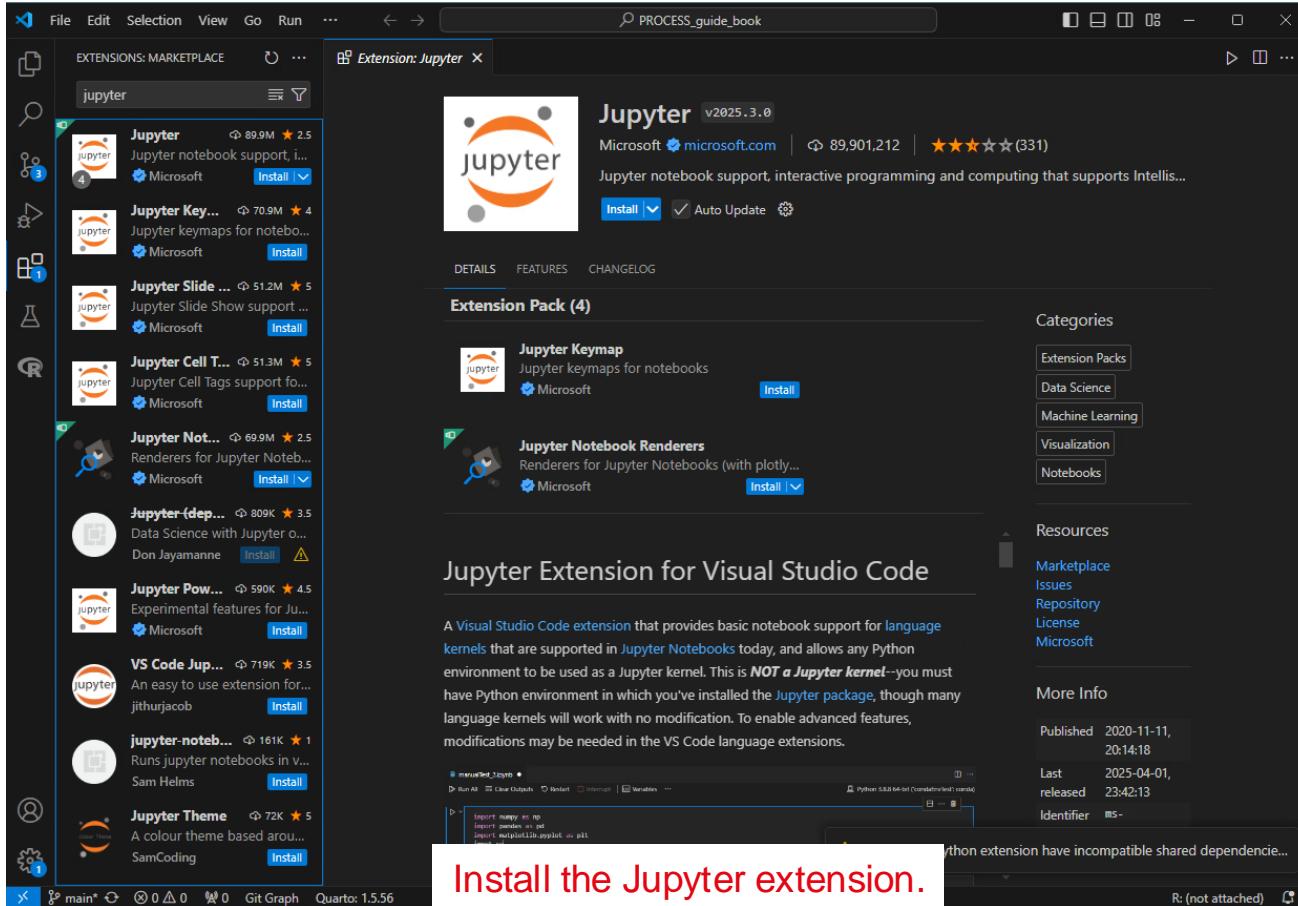
The screenshot shows the Visual Studio Code (VS Code) interface. The Explorer sidebar on the left lists files and folders for a project named "PROCESS_guide_book". The "PROCESS_guide_book" folder contains "Figures", "Rosmose", ".quarto.yml", ".gitignore", and several QMD files (00intro.qmd, 00qmduutorial.qmd, 01Class1Physicalproperties.qmd, 02Class2Biomass.qmd, 03Class3Gasification.qmd, 04Class4Coelectrolysis.qmd, 05Class5Reactors.qmd, 06Class6Distillationcolumn.qmd, 07Class7ROSMOETutorial.qmd, 08Class8Economicanalysis.qmd, 09Class9HAZOP.qmd, 010Conclusions.qmd, index.qmd, project.bib, README.md, and style.css. The "OUTLINE" and "TIMELINE" sections are also visible in the Explorer sidebar.

The main "Welcome" screen features a "Get Started with VS Code" section. It includes a "Choose your theme" section with four color schemes: "Dark Modern" (selected), "Light Modern", "Dark High Contrast", and "Light High Contrast". A "Browse Color Themes" button and a keyboard shortcut tip ("Tip: Use keyboard shortcut(Ctrl+K Ctrl+T)") are also present. Below this, there are three more sections: "Rich support for all your languages", "Tune your settings", and "Sync settings across devices". A "See More Themes..." link is located at the bottom of the theme section. At the bottom of the screen, a red banner reads "Open the PROCESS_guide_book." and "how to [opt out](#)". The status bar at the bottom shows "main" and "Quarto: 1.5.1".

Equipment Cost Calculation - Overview

The screenshot shows the VS Code Extension Marketplace with the search term "PROCESS_guide_book" in the search bar. The results list includes the "Quarto" extension by "quarto" (v1.119.0), which is highlighted. The extension details page for "Quarto" shows a large circular icon, the version v1.119.0, and a 5-star rating of 18. The description states it is an extension for the Quarto scientific and technical publishing system. The "Install" button is visible, along with an "Auto Update" checkbox and a settings gear icon. Below the main extension details, there is a section for the "quarto-vscode" extension, which is a VS Code extension for Quarto. It provides language support for Quarto .qmd files, including rendering, syntax highlighting, and completion for embedded languages like Python, R, and LaTeX. The "Install" button is also present for this extension. The right sidebar contains sections for "Categories" (Programming Languages, Data Science, Machine Learning, Notebooks), "Resources" (Marketplace, Issues, Repository, License, Quarto), and "More Info" (Published: 2022-02-10, 19:32:08; Last released: 2025-03-21, 20:08:02; Last updated: 2025-04-02, 16:29:58; Identifier: quarto.quarto). A large red call-to-action button at the bottom right says "Install the Quarto extension."

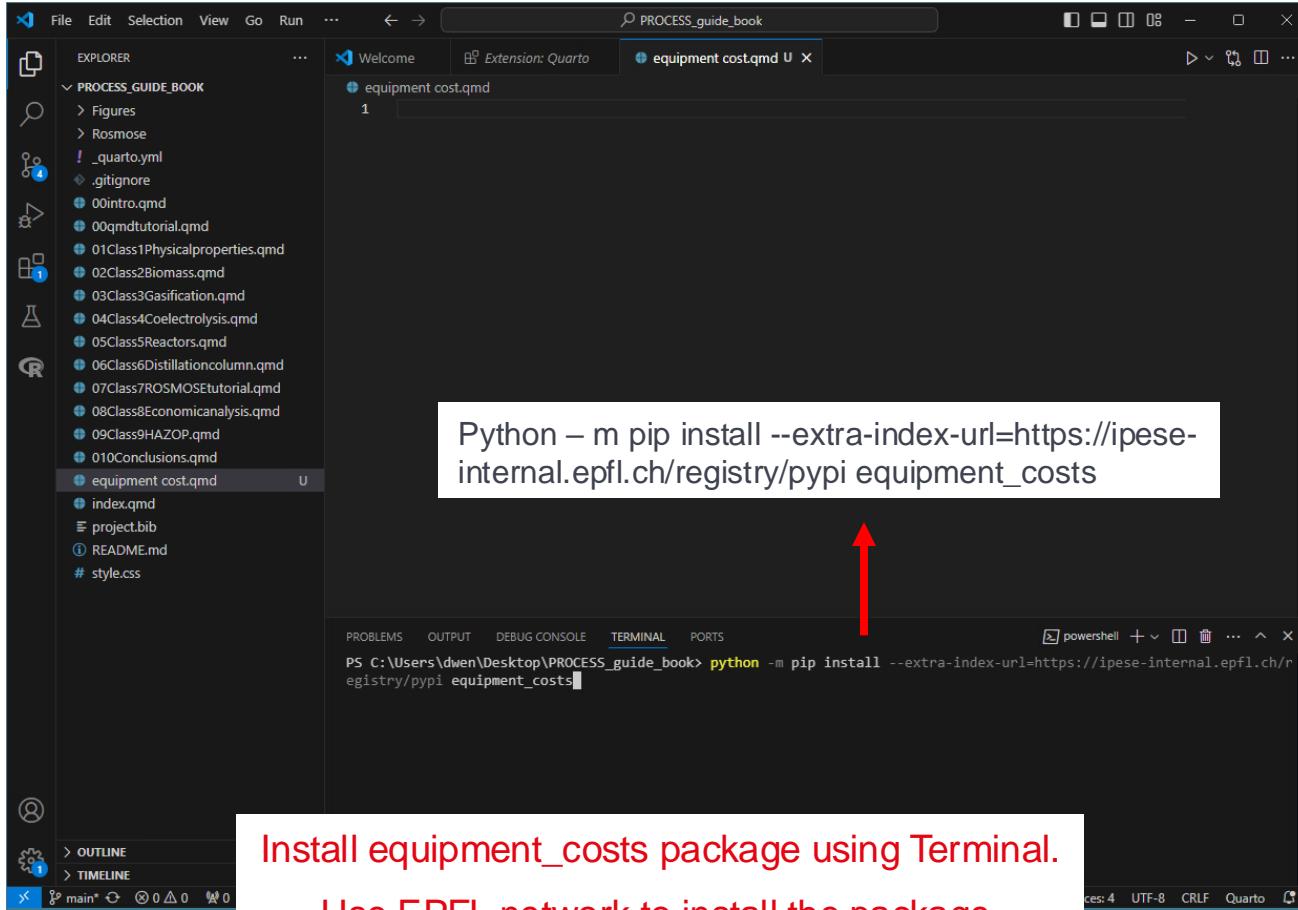
Equipment Cost Calculation - Overview



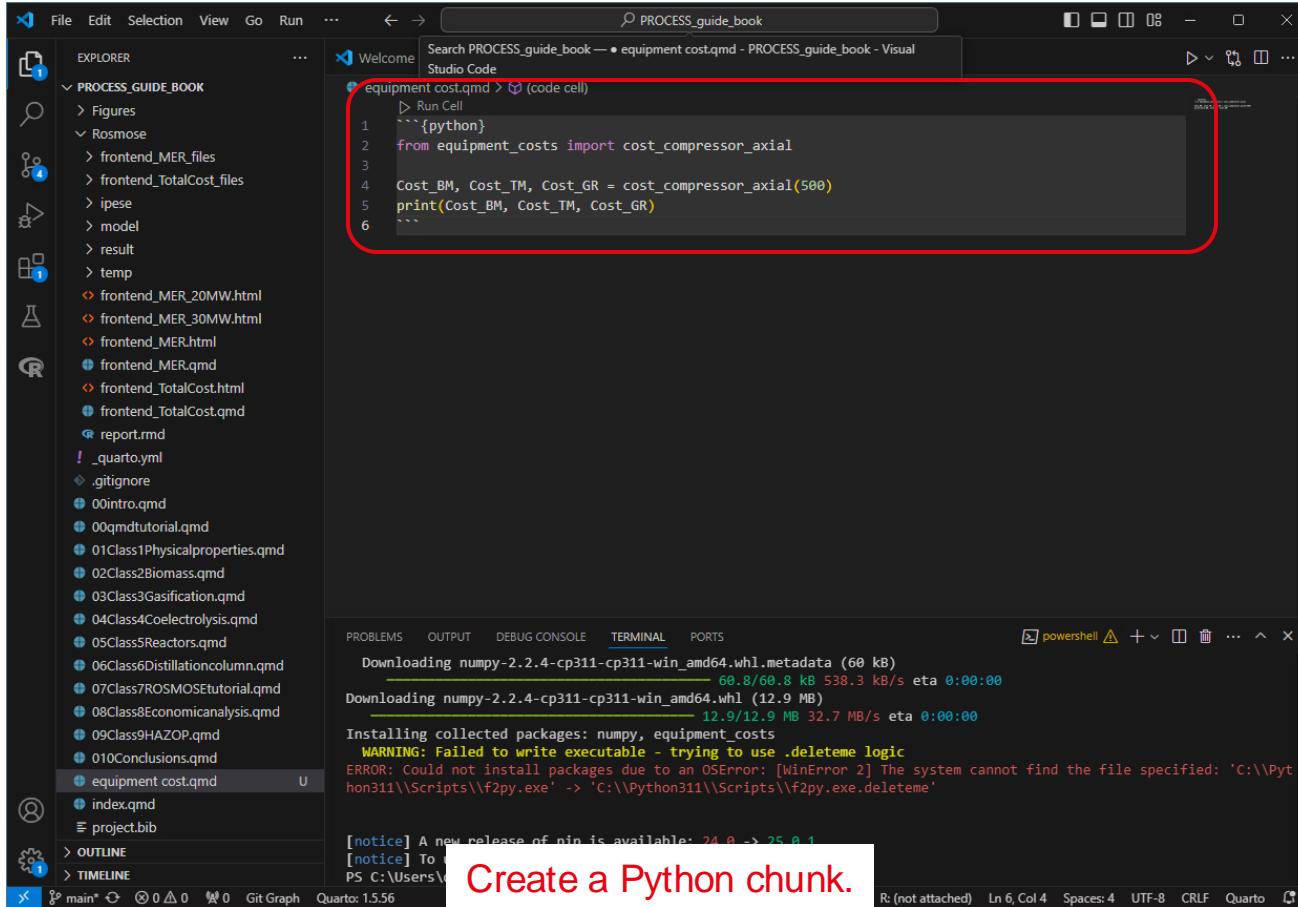
The screenshot shows the Visual Studio Code Extension Marketplace. The search bar at the top is set to "PROCESS_guide_book". The main panel displays the "Extension: Jupyter" page. The extension is version 2025.3.0, developed by Microsoft, with 89,901,212 installs and a 4.5-star rating. It is described as "Jupyter notebook support, interactive programming and computing that supports IntelliSense, code completion, and type checking." The "Install" button is visible. Below the main description, a "Extension Pack (4)" section lists four related extensions: "Jupyter Keymap", "Jupyter Notebook Renderers", "Jupyter Cell Tags", and "Jupyter Slide Show". The "Categories" sidebar on the right includes "Extension Packs", "Data Science", "Machine Learning", "Visualization", and "Notebooks". The "Resources" sidebar includes links to "Marketplace", "Issues", "Repository", "License", and "Microsoft". The "More Info" sidebar shows the extension was published on 2020-11-11, last released on 2025-04-01, and has an identifier of ms-. The bottom of the screen shows a snippet of Python code with a tooltip: "Python extension have incompatible shared dependencies..." and a status bar with "Quarto: 1.5.56".

Install the Jupyter extension.

Equipment Cost Calculation - Overview



Equipment Cost Calculation - Overview



The screenshot shows a Visual Studio Code interface with the following details:

- File Explorer:** Shows a project structure under "PROCESS_GUIDE_BOOK" including "Figures", "Rosmose", "frontend_MER_files", "frontend_TotalCost_files", "ipese", "model", "result", "temp", "report.rmd", ".quarto.yml", ".gitignore", "00intro.qmd", "00qmdtutorial.qmd", "01Class1Physicalproperties.qmd", "02Class2Biomass.qmd", "03Class3Gasification.qmd", "04Class4Coelectrolysis.qmd", "05Class5Reactors.qmd", "06Class6Distillationcolumn.qmd", "07Class7ROSMOETutorial.qmd", "08Class8Economicanalysis.qmd", "09Class9HAZOP.qmd", "010Conclusions.qmd", "equipment cost.qmd", "index.qmd", and "project.bib".
- Code Editor:** A code cell titled "equipment cost.qmd" is highlighted with a red box. The code is as follows:

```
```{python}
from equipment_costs import cost_compressor_axial

Cost_BM, Cost_TM, Cost_GR = cost_compressor_axial(500)
print(Cost_BM, Cost_TM, Cost_GR)
```
```
- Terminal:** Shows package installations and an error message:

```
Downloading numpy-2.2.4-cp311-cp311-win_amd64.whl.metadata (60 kB) 60.8/60.8 kB 538.3 kB/s eta 0:00:00
Downloading numpy-2.2.4-cp311-cp311-win_amd64.whl (12.9 MB) 12.9/12.9 MB 32.7 MB/s eta 0:00:00
Installing collected packages: numpy, equipment_costs
WARNING: Failed to write executable - trying to use .deleteMe logic
ERROR: Could not install packages due to an OSError: [WinError 2] The system cannot find the file specified: 'C:\\\\Python311\\\\Scripts\\\\f2py.exe' -> 'C:\\\\Python311\\\\Scripts\\\\f2py.exe.deleteMe'
```
- Bottom Status Bar:** Shows "main* 0 0 0 Git Graph Quarto: 1.5.56" and "Create a Python chunk." in red text.

Equipment Cost Calculation - Overview

File Edit Selection View Go Run ... ← → ⌂ PROCESS_guide_book

EXPLORER

PROCESS_GUIDE_BOOK

- Figures
- Rosmose
 - frontend_MER_files
 - frontend_TotalCost_files
- ipse
- model
- result
- temp
 - frontend_MER_20MW.html
 - frontend_MER_30MW.html
 - frontend_MER.html
 - frontend_MER.qmd
 - frontend_TotalCost.html
 - frontend_TotalCost.qmd
- report.rmd
- _quarto.yml
- .gitignore
- 00intro.qmd
- 00qmdtutorial.qmd
- 01Class1Physicalproperties.qmd
- 02Class2Biomass.qmd
- 03Class3Gasification.qmd
- 04Class4Coelectrolysis.qmd
- 05Class5Reactors.qmd
- 06Class6Distillationcolumn.qmd
- 07Class7ROSMOSTutorial.qmd
- 08Class8Economicanalysis.qmd
- 09Class9HAZOP.qmd
- 010Conclusions.qmd
- equipment cost.qmd
- index.qmd
- project.bib

WELCOME equipment cost.qmd U

equipment cost.qmd > (code cell)

Run Cell

```
1  ``{python}
2  from equipment_costs import
3      cost_compressor_axial
4  Cost_BM, Cost_TM, Cost_GR =
5      cost_compressor_axial(500)
6  print(Cost_BM, Cost_TM, Cost_GR)
7  ````
```

Interactive-1

Interrupt Clear All Restart Python 3.11.9

Connecting to Python 3.11.9...

from equipment_costs import

Visual Studio Code

Running cells with 'Python 3.11.9' requires the ipykernel package.

Install Change Kernel More Info Cancel

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS JUPYTER

Downloading numpy-2.2.4-cp311-cp311-win_amd64.whl.metadata (60 kB) 60.8/60.8 kB 538.3 kB/s eta 0:00:00

Downloading numpy-2.2.4-cp311-cp311-win_amd64.whl (12.9 MB) 12.9/12.9 MB 32.7 MB/s eta 0:00:00

Installing collected packages: numpy, equipment_costs

WARNING: Failed to write executable - trying to use .deleteMe logic

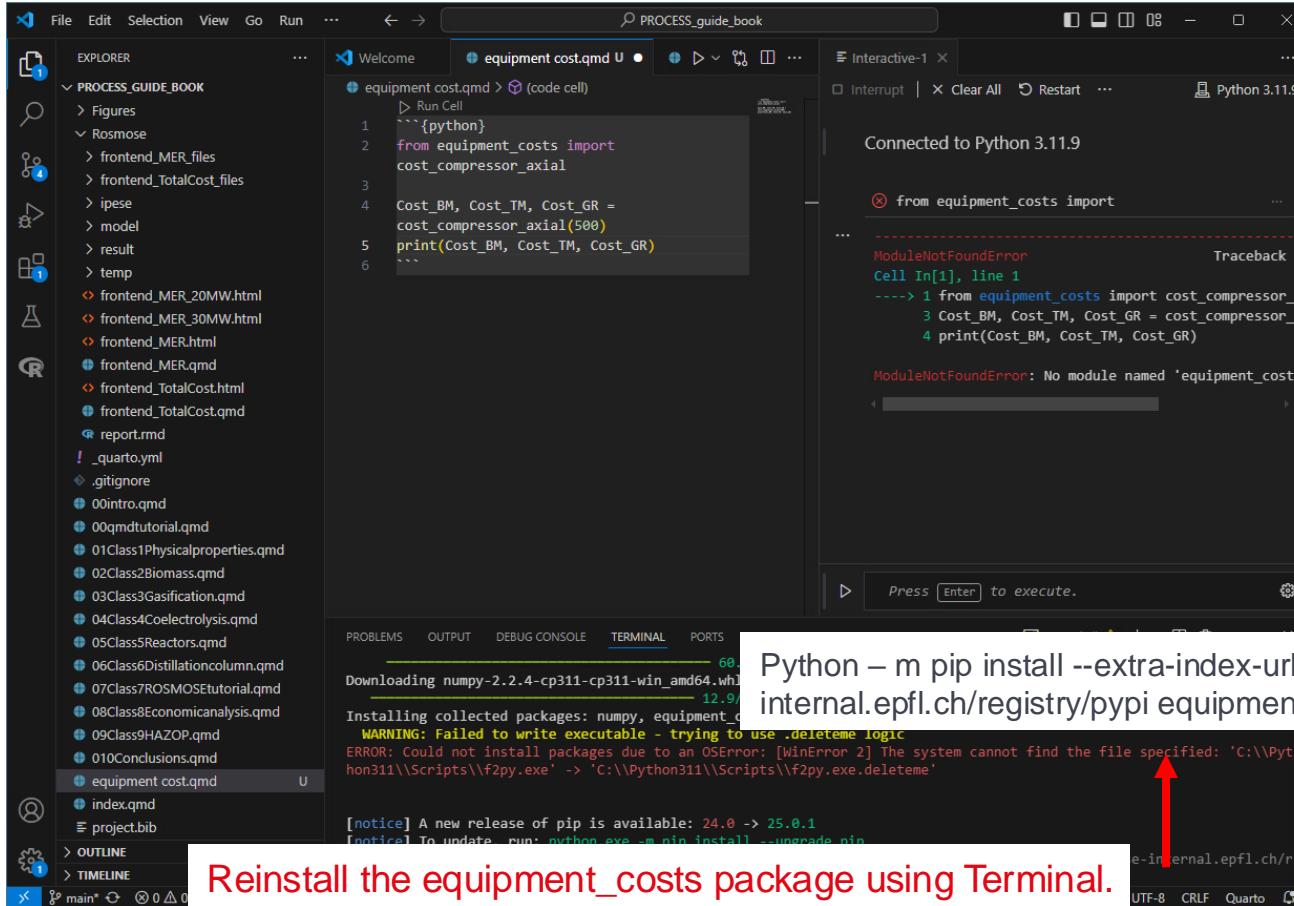
ERROR: Could not install packages due to an OSError: [WinError 2] The system cannot find the file specified: 'C:\\\\Python311\\\\Scripts\\\\f2py.exe' -> 'C:\\\\Python311\\\\Scripts\\\\f2py.exe.deleteMe'

[notice] A new release of nin is available: 24.0 -> 25.0.1

Install one more package.

not attached) Ln 6, Col 4 Spaces: 4 UTF-8 CRLF Quarto

Equipment Cost Calculation - Overview



The screenshot shows a Jupyter Notebook interface with the following components:

- EXPLORER** panel on the left, showing a project structure with files like `frontend_MER_files`, `model`, `result`, and `temp`.
- WELCOME** panel showing the current notebook is `equipment cost.qmd`.
- Code Cell** (cell 1) containing Python code:

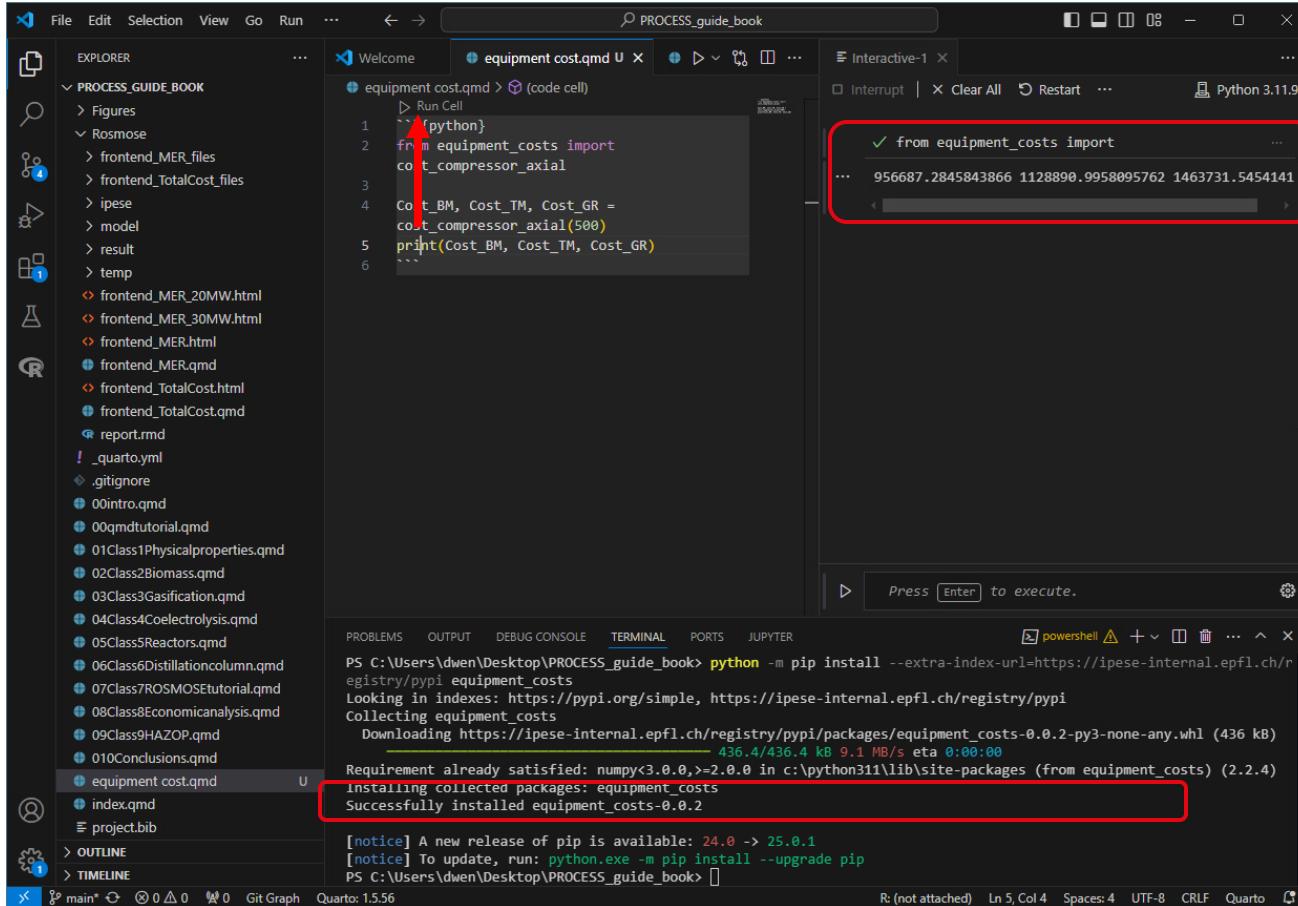
```
```{python}\nfrom equipment_costs import\ncost_compressor_axial\n\nCost_BM, Cost_TM, Cost_GR =\ncost_compressor_axial(500)\nprint(Cost_BM, Cost_TM, Cost_GR)\n```
```
- Interactive-1** panel showing the output of the code cell: "Connected to Python 3.11.9".
- TERMINAL** panel at the bottom showing a pip install command:

```
Python -m pip install --extra-index-url=https://ipese-internal.epfl.ch/registry/pypi equipment_costs
```
- Output** of the terminal command:

```
WARNING: Failed to write executable - trying to use .deleteMe logic\nERROR: Could not install packages due to an OSError: [WinError 2] The system cannot find the file specified: 'C:\\\\Python311\\\\Scripts\\\\f2py.exe' -> 'C:\\\\Python311\\\\Scripts\\\\f2py.exe.deleteMe'\n[notice] A new release of pip is available: 24.0 -> 25.0.1\n[notice] To update, run: python -m pip install --upgrade pip
```

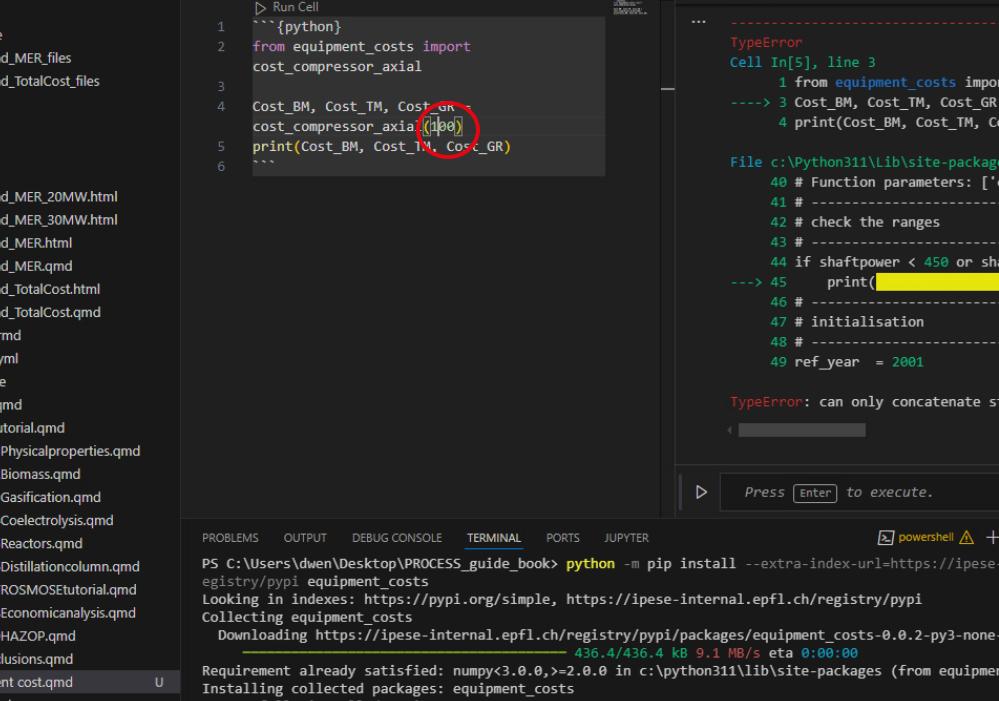
**Reinstall the equipment\_costs package using Terminal.**

# Equipment Cost Calculation - Compressor



The screenshot shows a Jupyter Notebook interface with the following details:

- File Explorer:** Shows a directory structure for "PROCESS\_GUIDE\_BOOK" containing various files and notebooks.
- Code Cell:** The cell contains Python code to import the "cost\_compressor\_axial" function from the "equipment\_costs" module and calculate costs for a 500 unit.
- Output:** The output shows the calculated costs: 956687.2845843866, 1128890.9958095762, and 1463731.5454141.
- Terminal:** The terminal shows the command to install the "equipment\_costs" package using pip, and the successful installation of the package.



The screenshot shows a Jupyter Notebook interface within VS Code. The code cell contains the following Python code:

```
1 ```{python}
2 from equipment_costs import
3 cost_compressor_axial
4 Cost_BM, Cost_TM, Cost_GR
5 cost_compressor_axial([100])
6 print(Cost_BM, Cost_TM, Cost_GR)
7 ```
```

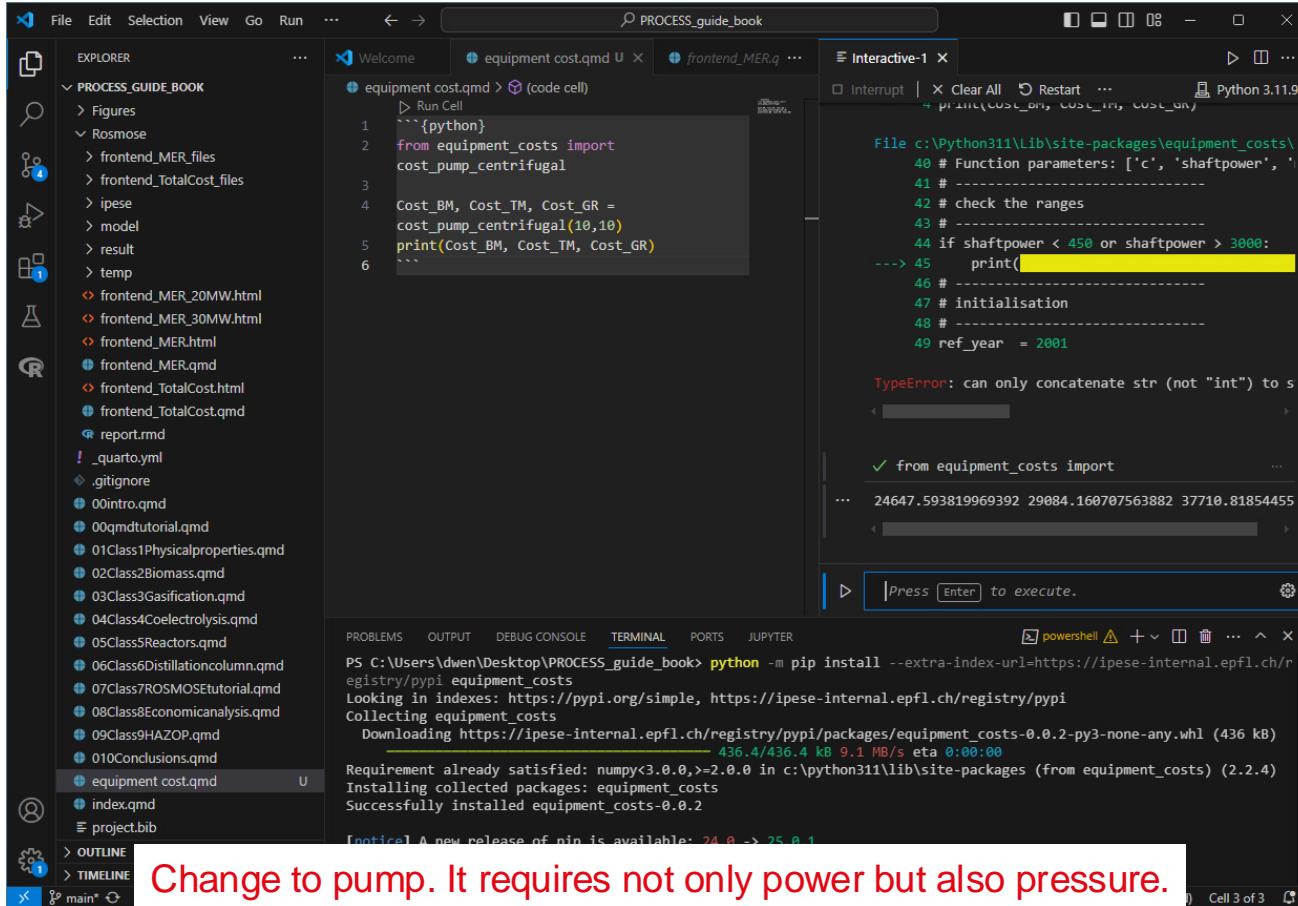
A red circle highlights the line `cost_compressor_axial([100])`. A tooltip at the bottom of the screen reads **Change the input. Error, Why?**. The output pane shows the following error:

```
File c:\Python311\lib\site-packages\equipment_costs__init__.py:40: TypeError: can only concatenate str (not "int") to str
 40 # Function parameters: ['c', 'shaftpower', 'temp']
 41 #
 42 # check the ranges
 43 #
 44 if shaftpower < 450 or shaftpower > 3000:
--> 45 print('
 46 #
 47 # initialisation
 48 #
 49 ref_year = 2001
```

The terminal pane shows the command `python -m pip install --extra-index-url=https://ipese-internal.epfl.ch/registry/pypi equipment_costs` being run, and the output of the package installation.

## Change the input. Error, Why?

# Equipment Cost Calculation - Pump



PROCESS\_guide\_book

EXPLORER

PROCESS\_GUIDE\_BOOK

- Figures
- Rosmose
- frontend\_MER\_files
- frontend\_TotalCost\_files
- ipese
- model
- result
- temp
- frontend\_MER\_20MW.html
- frontend\_MER\_30MW.html
- frontend\_MER.html
- frontend\_MER.qmd
- frontend\_TotalCost.html
- frontend\_TotalCost.qmd
- report.rmd
- .quarto.yml
- .gitignore
- 00intro.qmd
- 00qmduitutorial.qmd
- 01Class1Physicalproperties.qmd
- 02Class2Biomass.qmd
- 03Class3Gasification.qmd
- 04Class4Coelectrolysis.qmd
- 05Class5Reactors.qmd
- 06Class6Distillationcolumn.qmd
- 07Class7ROSMSETutorial.qmd
- 08Class8Economicanalysis.qmd
- 09Class9HAZOP.qmd
- 010Conclusions.qmd
- equipment cost.qmd
- index.qmd
- project.bib

WELCOME

equipment cost.qmd

frontend\_MER.qmd

Interactive-1

File c:\Python311\Lib\site-packages\equipment\_costs\

```

40 # Function parameters: ['c', 'shaftpower', '']
41 #
42 # check the ranges
43 #
44 if shaftpower < 450 or shaftpower > 3000:
--> 45 print(
46 #
47 # initialisation
48 #
49 ref_year = 2001

```

TypeError: can only concatenate str (not "int") to str

from equipment\_costs import

24647.593819969392 29084.160707563882 37710.81854455

Press Enter to execute.

TERMINAL

```

PS C:\Users\dwen\Desktop\PROCESS_guide_book> python -m pip install --extra-index-url=https://ipese-internal.epfl.ch/registry/pypi equipment_costs
Looking in indexes: https://pypi.org/simple, https://ipese-internal.epfl.ch/registry/pypi
Collecting equipment_costs
 Downloading https://ipese-internal.epfl.ch/registry/pypi/packages/equipment_costs-0.0.2-py3-none-any.whl (436 kB)
Requirement already satisfied: numpy<3.0.0,>=2.0.0 in c:\python311\lib\site-packages (from equipment_costs) (2.2.4)
Installing collected packages: equipment_costs
Successfully installed equipment_costs-0.0.2

```

Notice A new release of nin is available: 24.0 -> 25.0.1

Cell 3 of 3

Change to pump. It requires not only power but also pressure.

The screenshot shows a Jupyter Notebook interface with the following details:

- File Explorer:** Shows a tree view of files and folders, including a folder named "PROCESS\_GUIDE\_BOOK" containing various QMD and HTML files, and a "report.rmd" file.
- Code Cell:** An open code cell titled "equipment cost.qmd" contains Python code to calculate equipment costs. The code imports "equipment\_costs" and uses the "cost\_HeatExchanger\_FixedTubeSheet" function with parameters (10,1). It then prints the results for Cost\_BM, Cost\_TM, and Cost\_GR.
- Interactive Terminal:** An "Interactive-1" terminal window shows the execution of the code. It prints the results for Cost\_BM, Cost\_TM, and Cost\_GR, and then attempts to print the results again, resulting in a `TypeError` because it tries to concatenate a string and an integer.
- Terminal Output:** The terminal output shows the command `python -m pip install --extra-index-url=https://ipese-internal.epfl.ch/registry/pypi equipment_costs` being run, and the successful download and installation of the "equipment\_costs" package version 0.0.2.
- Bottom Status Bar:** A message in red text reads: "Change to heat exchanger. It requires area and pressure."

Change to heat exchanger. It requires area and pressure.

# Equipment Cost Calculation - Overview

File Edit Selection View Go Run ... ← → ⌂ PROCESS\_guide\_book

EXPLORER

PROCESS\_GUIDE\_BOOK

- Figures
- Rosmose
  - frontend\_MER\_files
  - frontend\_TotalCost\_files
- ipese
  - model
  - result
- temp
  - frontend\_MER\_20MW.html
  - frontend\_MER\_30MW.html
  - frontend\_MER.html
  - frontend\_MER.qmd
  - frontend\_TotalCost.html
  - frontend\_TotalCost.qmd
  - report.rmd
- ! .quarto.yml
- .gitignore
- 00intro.qmd
- 00qmdtutorial.qmd
- 01Class1Physicalproperties.qmd
- 02Class2Biomass.qmd
- 03Class3Gasification.qmd
- 04Class4Coelectrolysis.qmd
- 05Class5Reactors.qmd
- 06Class6Distillationcolumn.qmd
- 07Class7ROSMOSETutorial.qmd
- 08Class8Economicanalysis.qmd
- 09Class9HAZOP.qmd
- 010Conclusions.qmd
- equipment cost.qmd
- index.qmd
- project.bib

Welcome equipment cost.qmd U

equipment cost.qmd > (code cell)

Run Cell

```
1 ``{python}
2 from equipment_costs import
3 cost_VerticalVessels
4 Cost_BM, Cost_TM, Cost_GR =
5 cost_VerticalVessels(1,3,10)
6 print(Cost_BM, Cost_TM, Cost_GR)
7 ````
```

Interactive-1

Interrupt | Clear All | Restart ... Python 3.11.9

49 ret\_year = 2001

TypeError: can only concatenate str (not "int") to str

from equipment\_costs import ...

24647.593819969392 29084.160707563882 37710.81854455

from equipment\_costs import ...

16280.272428003518 19210.72146504415 24908.816814845

from equipment\_costs import ...

66816.39564740781 78843.34686394122 102229.085340533

Press Enter to execute.

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS JUPYTER

PS C:\Users\dwen\Desktop\PROCESS\_guide\_book> python -m pip install --extra-index-url=https://ipese-internal.epfl.ch/registry/pypi equipment\_costs

Looking in indexes: https://pypi.org/simple, https://ipese-internal.epfl.ch/registry/pypi

Collecting equipment\_costs

  Downloading https://ipese-internal.epfl.ch/registry/pypi/packages/equipment\_costs-0.0.2-py3-none-any.whl (436 kB)

Requirement already satisfied: numpy<3.0.0,>=2.0.0 in c:\python311\lib\site-packages (from equipment\_costs) (2.2.4)

Installing collected packages: equipment\_costs

Successfully installed equipment\_costs-0.0.2

Notice: A new release of nin is available: 24.0 → 25.0.1

Change to vertical vessel. It requires diameter, height, and pressure.

What is the bare module cost of a centrifugal compressor with 500 kW?

What is the bare module cost of a reciprocating pump with 100 kW and 1 bar?

What is the bare module cost of a double pipe heat exchanger with 100 m<sup>2</sup> and 10 bar?

What is the bare module cost of a horizontal vessel with 1 m in diameter, 3 m in length, and 10 bar?