Basic_EDA

March 27, 2025

1 Membrane Technology Data Analysis Project

1.0.1 *Step 1: Import Required Libraries and Load Dataset*

In this step, we will: - Import all the necessary Python libraries. - Load the `.xlsx` Excel dataset into a pandas DataFrame. - View the first few rows of the data to understand its structure.

[12]:
```
# Importing necessary libraries
import pandas as pd       # For data handling
import numpy as np        # For numerical operations
import matplotlib.pyplot as plt  # For plotting
import seaborn as sns     # For data visualization

# Load the Excel dataset
file_path = 'TFC_NF_membrane_data.xlsx'  # Make sure this file is in the same␣
 ↪directory as your notebook
data = pd.read_excel(file_path)

# Check the first 5 rows of the dataset
data.head()
```

[12]:

	Type	Size (nm)	Shape	Pore size (Å)	Bond-ing*	Char-ge	\
0	NaN	NaN	NaN	NaN	NaN	(+, -, 0)	
1	NaA zeolite	100.0	Spherical	4.0	0.0	-	
2	NaA zeolite	100.0	Spherical	4.0	0.0	-	
3	NaA zeolite	100.0	Spherical	4.0	0.0	-	
4	NaA zeolite	100.0	Spherical	4.0	0.0	-	

	Phase**,	Loading	RR	RCA	CWP	CSP	RWP	RSP
0	A or O	NaN	NaN	NaN	(LMH/bar)	(%)	NaN	NaN
1	A	0.00004	1.015	0.903	0.767	6.5	1.023	0.892
2	A	0.00010	0.956	0.857	0.767	6.5	1.174	0.908
3	A	0.00040	0.931	0.824	0.767	6.5	1.343	0.892
4	A	0.00100	0.952	0.713	0.767	6.5	1.488	0.969

1.0.2 *Step 2: Dataset Overview and Initial Cleaning*

- Check column names for any irregularities or unnecessary characters.
- Check for missing values.

- Review data types to ensure they are appropriate.

[15]:
```
# View the column names
data.columns

# Check for missing values
data.isnull().sum()

# Check data types of each column
data.dtypes
```

[15]:
```
Type              object
Size (nm)        float64
Shape             object
Pore size (Å)    float64
Bond-ing*        float64
Char-ge           object
Phase**,          object
Loading          float64
RR               float64
RCA              float64
CWP               object
CSP               object
RWP              float64
RSP              float64
dtype: object
```

1.0.3 *Step 3: Clean Column Names and Data Types*

- We will clean the column names by removing special characters and spaces.
- Convert columns `CWP` and `CSP` to numeric (if they contain unwanted characters).
- Re-check the data.

[18]:
```
# Clean column names
data.rename(columns={
    'Type': 'Type',
    'Size (nm)': 'Size_nm',
    'Shape': 'Shape',
    'Pore size (Å)': 'Pore_size_A',
    'Bond-ing*': 'Bonding',
    'Char-ge': 'Charge',
    'Phase**,': 'Phase',
    'Loading': 'Loading',
    'RR': 'RR',
    'RCA': 'RCA',
    'CWP': 'CWP',
    'CSP': 'CSP',
    'RWP': 'RWP',
```

```
    'RSP': 'RSP'
}, inplace=True)

# If CWP and CSP are strings with commas or other characters, convert to numeric
data['CWP'] = pd.to_numeric(data['CWP'], errors='coerce')
data['CSP'] = pd.to_numeric(data['CSP'], errors='coerce')

# Check again
data.info()
data.head()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 189 entries, 0 to 188
Data columns (total 14 columns):
 #   Column       Non-Null Count  Dtype
---  ------       --------------  -----
 0   Type         188 non-null    object
 1   Size_nm      188 non-null    float64
 2   Shape        188 non-null    object
 3   Pore_size_A  188 non-null    float64
 4   Bonding      188 non-null    float64
 5   Charge       189 non-null    object
 6   Phase        189 non-null    object
 7   Loading      188 non-null    float64
 8   RR           78 non-null     float64
 9   RCA          134 non-null    float64
 10  CWP          188 non-null    float64
 11  CSP          188 non-null    float64
 12  RWP          188 non-null    float64
 13  RSP          188 non-null    float64
dtypes: float64(10), object(4)
memory usage: 20.8+ KB
```

[18]:

	Type	Size_nm	Shape	Pore_size_A	Bonding	Charge	Phase	\
0	NaN	NaN	NaN	NaN	NaN	(+, -, 0)	A or O	
1	NaA zeolite	100.0	Spherical	4.0	0.0	-	A	
2	NaA zeolite	100.0	Spherical	4.0	0.0	-	A	
3	NaA zeolite	100.0	Spherical	4.0	0.0	-	A	
4	NaA zeolite	100.0	Spherical	4.0	0.0	-	A	

	Loading	RR	RCA	CWP	CSP	RWP	RSP
0	NaN	NaN	NaN	NaN	NaN	NaN	NaN
1	0.00004	1.015	0.903	0.767	6.5	1.023	0.892
2	0.00010	0.956	0.857	0.767	6.5	1.174	0.908
3	0.00040	0.931	0.824	0.767	6.5	1.343	0.892
4	0.00100	0.952	0.713	0.767	6.5	1.488	0.969

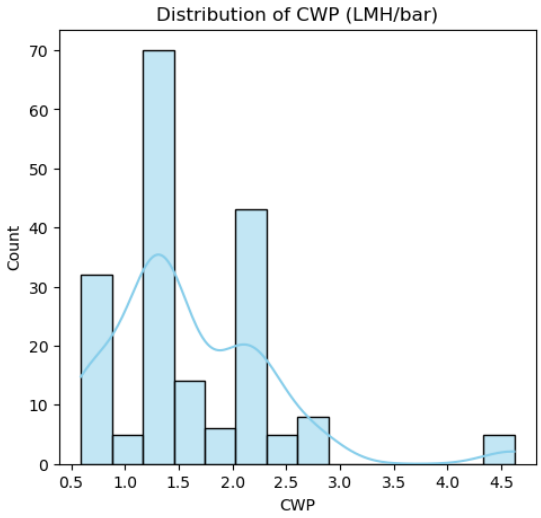
1.1 Step 4: Data Cleaning & Initial Exploratory Data Analysis (EDA)

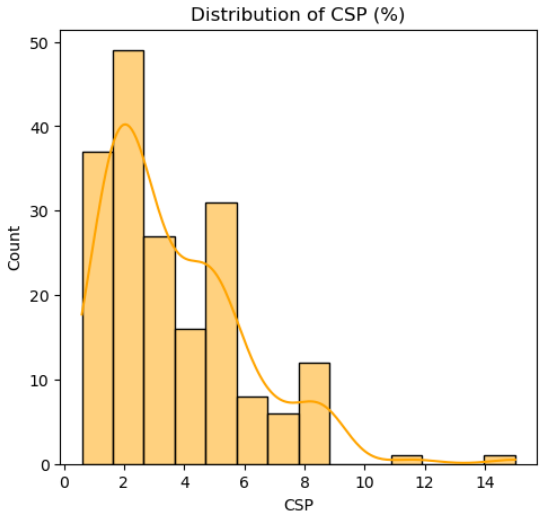
- Remove the first row with NaNs (artifact row).
- Check missing values.
- Plot distributions of outputs (CWP and CSP).
- Plot correlation matrix to understand relationships.

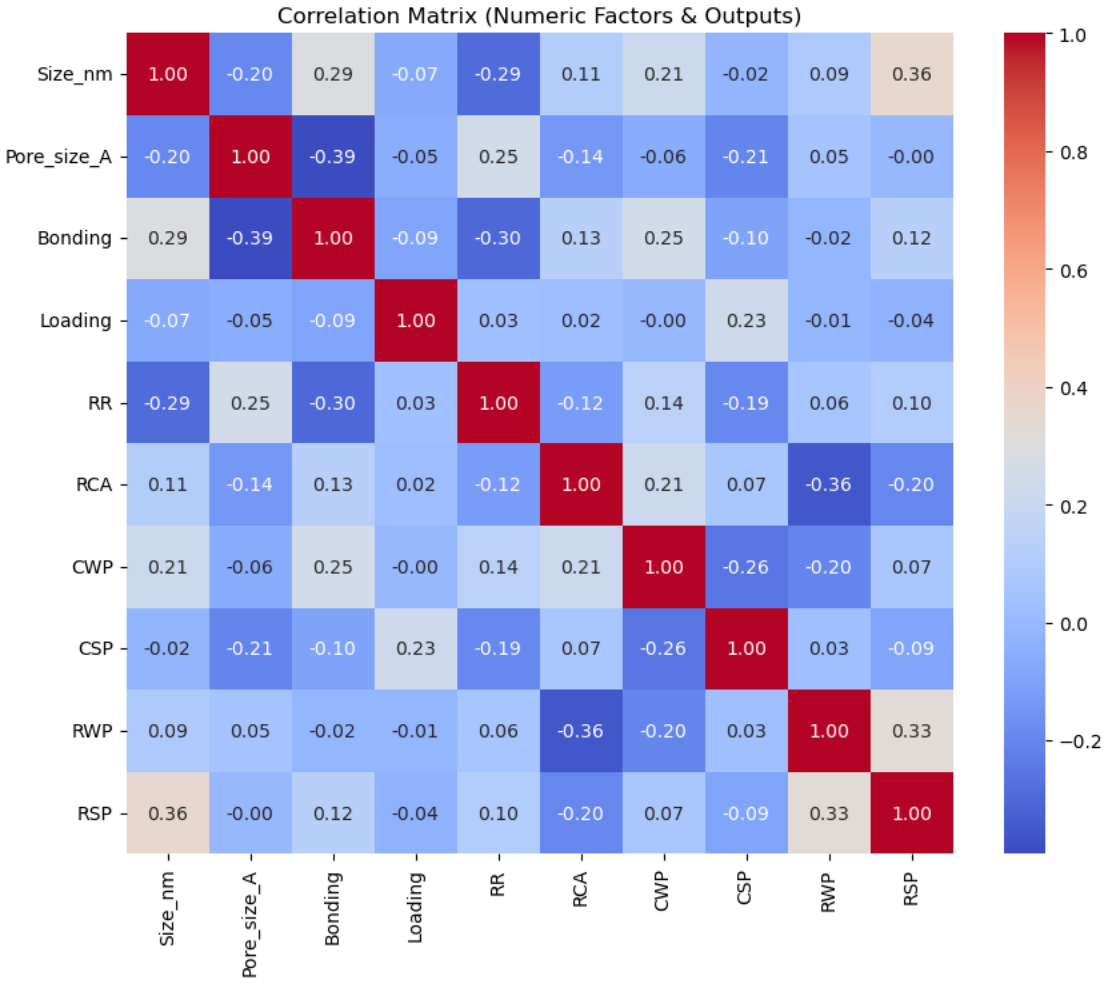
[21]:
```
# Remove row with all NaNs (index 0)
data_cleaned = data.drop(index=0).reset_index(drop=True)

# Check missing values
missing_values = data_cleaned.isnull().sum()
print("Missing values in each column:\n", missing_values)

# Plot distribution of outputs
import matplotlib.pyplot as plt
import seaborn as sns

plt.figure(figsize=(12,5))

plt.subplot(1,2,1)
sns.histplot(data_cleaned['CWP'], kde=True, color='skyblue')
plt.title('Distribution of CWP (LMH/bar)')

plt.subplot(1,2,2)
sns.histplot(data_cleaned['CSP'], kde=True, color='orange')
plt.title('Distribution of CSP (%)')

plt.show()

# Correlation heatmap (for numeric columns only)
plt.figure(figsize=(10,8))
numeric_data = data_cleaned.select_dtypes(include=['float64'])
sns.heatmap(numeric_data.corr(), annot=True, cmap='coolwarm', fmt=".2f")
plt.title('Correlation Matrix (Numeric Factors & Outputs)')
plt.show()
```

```
Missing values in each column:
 Type             0
Size_nm           0
Shape             0
Pore_size_A       0
Bonding           0
Charge            0
Phase             0
Loading           0
RR              110
RCA              54
CWP               0
```

```
CSP                 0
RWP                 0
RSP                 0
dtype: int64
```






Correlation Matrix (Numeric Factors & Outputs)
Size_nm 1.00 -0.20 0.29 -0.07 -0.29 0.11 0.21 -0.02 0.09 0.36
Pore_size_A -0.20 1.00 -0.39 -0.05 0.25 -0.14 -0.06 -0.21 0.05 -0.00
Bonding 0.29 -0.39 1.00 -0.09 -0.30 0.13 0.25 -0.10 -0.02 0.12
Loading -0.07 -0.05 -0.09 1.00 0.03 0.02 -0.00 0.23 -0.01 -0.04
RR -0.29 0.25 -0.30 0.03 1.00 -0.12 0.14 -0.19 0.06 0.10
RCA 0.11 -0.14 0.13 0.02 -0.12 1.00 0.21 0.07 -0.36 -0.20
CWP 0.21 -0.06 0.25 -0.00 0.14 0.21 1.00 -0.26 -0.20 0.07
CSP -0.02 -0.21 -0.10 0.23 -0.19 0.07 -0.26 1.00 0.03 -0.09
RWP 0.09 0.05 -0.02 -0.01 0.06 -0.36 -0.20 0.03 1.00 0.33
RSP 0.36 -0.00 0.12 -0.04 0.10 -0.20 0.07 -0.09 0.33 1.00
Size_nm
Pore_size_A
Bonding
Loading
RR
RCA
CWP
CSP
RWP
RSP
1.0
0.8
0.6
0.4
0.2
0.0
−0.2

[ ]: