Coolprop test

Saurabh Shirish Prabhu

Coolprop python library is widely used for importing fluid properties in python.

In [3]:
```python
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from CoolProp.CoolProp import PropsSI

# Define CoolProp-based Cp and density functions for liquid water
def cp_water_func(T_C):
    """
    Returns specific heat of liquid water at atmospheric pressure.
    Input: T_C (float or array) = temperature in °C
    Output: Cp in J/kg·K
    """
    T_K = np.array(T_C) + 273.15  # Convert to Kelvin
    return PropsSI('C', 'T', T_K, 'P', 101325, 'Water')  # 'C' = specific heat

def rho_water_func(T_C):
    """
    Returns density of liquid water at atmospheric pressure.
    Input: T_C (float or array) = temperature in °C
    Output: density in kg/m³
    """
    T_K = np.array(T_C) + 273.15
    return PropsSI('D', 'T', T_K, 'P', 101325, 'Water')  # 'D' = density

# Define a function that generates the table and plots
def generate_water_properties_table_and_plot(T_min, T_max, num_points):
    """
    Generate Cp and Density table for water using CoolProp, and plot them.

    Parameters:
        T_min (float): Minimum temperature in °C
        T_max (float): Maximum temperature in °C
        num_points (int): Number of points between T_min and T_max
    Returns:
        DataFrame with Temperature, Cp, and Density
    """
    # Generate temperature range
    temps_C = np.linspace(T_min, T_max, num_points)

    # Calculate properties
    cp_vals = cp_water_func(temps_C)
    rho_vals = rho_water_func(temps_C)

    # Create DataFrame
    water_props_df = pd.DataFrame({
        "Temperature (°C)": temps_C,
```

```
        "Specific Heat (J/kg·K)": cp_vals,
        "Density (kg/m³)": rho_vals
    })

    # Plotting
    fig, (ax1, ax2) = plt.subplots(2, 1, figsize=(9, 8))

    # Specific Heat plot
    ax1.plot(temps_C, cp_vals, color='blue', marker='o')
    ax1.set_xlabel("Temperature (°C)")
    ax1.set_ylabel("Specific Heat (J/kg·K)")
    ax1.set_title("Specific Heat of Water vs Temperature")
    ax1.grid(True)

    # Density plot
    ax2.plot(temps_C, rho_vals, color='green', marker='o')
    ax2.set_xlabel("Temperature (°C)")
    ax2.set_ylabel("Density (kg/m³)")
    ax2.set_title("Density of Water vs Temperature")
    ax2.grid(True)

    plt.tight_layout()
    plt.show()

    return water_props_df
```

In [5]:
```
temps_C = np.linspace(0.01, 99, 21)
```

In [7]:
```
cp_vals = cp_water_func(temps_C)
```

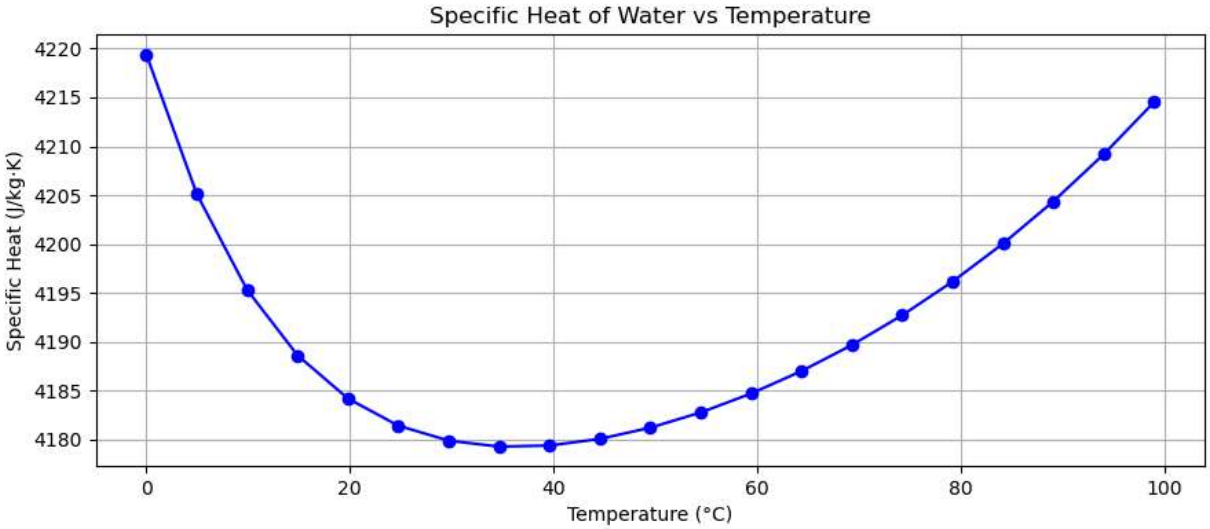
In [11]:
```
rho_vals = rho_water_func(temps_C)
```

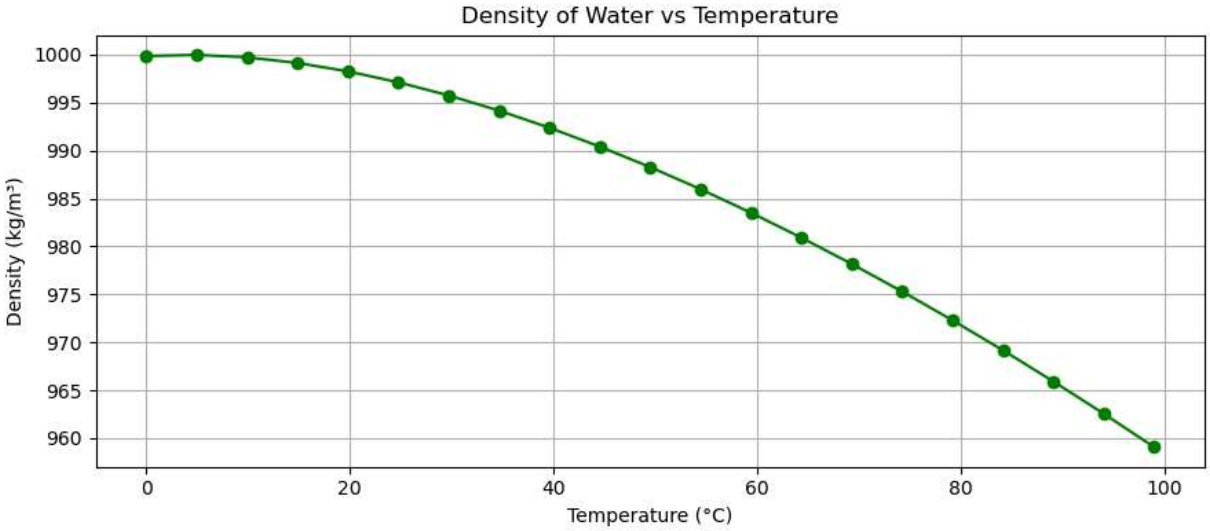
In [13]:
```
coolprop_df = pd.DataFrame({
    "Temperature (°C)": temps_C,
    "Specific Heat (J/kg·K)": cp_vals,
    "Density (kg/m³)": rho_vals
})

print(coolprop_df)
```

	Temperature (°C)	Specific Heat (J/kg·K)	Density (kg/m³)
0	0.0100	4219.410230	999.843762
1	4.9595	4205.133961	999.967271
2	9.9090	4195.307007	999.710414
3	14.8585	4188.615274	999.123828
4	19.8080	4184.186084	998.246592
5	24.7575	4181.416130	997.109564
6	29.7070	4179.879042	995.737582
7	34.6565	4179.271666	994.150946
8	39.6060	4179.380172	992.366470
9	44.5555	4180.057002	990.398232
10	49.5050	4181.204286	988.258128
11	54.4545	4182.761439	985.956289
12	59.4040	4184.695687	983.501391
13	64.3535	4186.994782	980.900904
14	69.3030	4189.661399	978.161275
15	74.2525	4192.708857	975.288084
16	79.2020	4196.157903	972.286156
17	84.1515	4200.034319	969.159659
18	89.1010	4204.367207	965.912180
19	94.0505	4209.187791	962.546783
20	99.0000	4214.528625	959.066060

In [15]:
```
generate_water_properties_table_and_plot(0.01, 99, 21)
```


Specific Heat of Water vs Temperature
Specific Heat (J/kg·K)
4220
4215
4210
4205
4200
4195
4190
4185
4180
0
20
40
60
80
100
Temperature (°C)


Density of Water vs Temperature
Density (kg/m³)
1000
995
990
985
980
975
970
965
960
0
20
40
60
80
100
Temperature (°C)

Out[15]:

	Temperature (°C)	Specific Heat (J/kg·K)	Density (kg/m³)
0	0.0100	4219.410230	999.843762
1	4.9595	4205.133961	999.967271
2	9.9090	4195.307007	999.710414
3	14.8585	4188.615274	999.123828
4	19.8080	4184.186084	998.246592
5	24.7575	4181.416130	997.109564
6	29.7070	4179.879042	995.737582
7	34.6565	4179.271666	994.150946
8	39.6060	4179.380172	992.366470
9	44.5555	4180.057002	990.398232
10	49.5050	4181.204286	988.258128
11	54.4545	4182.761439	985.956289
12	59.4040	4184.695687	983.501391
13	64.3535	4186.994782	980.900904
14	69.3030	4189.661399	978.161275
15	74.2525	4192.708857	975.288084
16	79.2020	4196.157903	972.286156
17	84.1515	4200.034319	969.159659
18	89.1010	4204.367207	965.912180
19	94.0505	4209.187791	962.546783
20	99.0000	4214.528625	959.066060

References

[1]https://www.engineeringtoolbox.com/specific-heat-capacity-water-d_660.html
[2] http://www.coolprop.org/
[3] ChatGPT 4o for generating functions