```
#Importing the necessary libraries
import numpy as np
import pandas as pd
from scipy.stats import stats

df = pd.read_csv("C:\\Users\\jayaraman\\Main Flow Services And
Technology Internship\\01.Data Cleaning and Preprocessing.csv")

print(df.info)
```

```
<bound method DataFrame.info of     Observation  Y-Kappa  ChipRate
BF-CMratio  BlowFlow  ChipLevel4   \
0      31-00:00    23.10    16.520     121.717  1177.607      169.805

1      31-01:00    27.60    16.810      79.022  1328.360      341.327

2      31-02:00    23.19    16.709      79.562  1329.407      239.161

3      31-03:00    23.60    16.478      81.011  1334.877      213.527

4      31-04:00    22.90    15.618      93.244  1334.168      243.131

..          ...      ...       ...         ...       ...          ...

319    10-16:00    23.75    12.667      93.450  1178.252      276.955

320     9-19:00    19.80    12.558      94.352  1184.119      297.071

321     9-20:00    23.01    12.550      90.842  1188.517      289.826

322     9-21:00    24.32    13.083      88.910  1192.879      318.006

323     9-22:00    25.75    13.417      85.451  1186.342      248.312


     T-upperExt-2   T-lowerExt-2    UCZAA  WhiteFlow-4   ...
SteamFlow-4   \
0          358.282         329.545  1.443       599.253  ...
67.122
1          351.050         329.067  1.549       537.201  ...
60.012
2          350.022         329.260  1.600       549.611  ...
61.304
3          350.938         331.142  1.604       623.362  ...
68.496
4          351.640         332.709    NaN       638.672  ...
70.022
..             ...             ...    ...           ...  ...
...
319        347.286         310.970  1.523       513.956  ...
61.141
```

```
320        399.135         319.576  1.451       570.058  ...
67.667
321        373.633         314.591  1.457       549.306  ...
66.446
322        364.081         308.559  1.523       504.852  ...
61.054
323        356.289         310.482  1.474       497.375  ...
58.247

     Lower-HeatT-3  Upper-HeatT-3   ChipMass-4   WeakLiquorF
BlackFlow-2   \
0          329.432         303.099      175.964      1127.197
1319.039
1          330.823         304.879      163.202       665.975
1297.317
2          329.140         303.383      164.013       677.534
1327.072
3          328.875         302.254      181.487       767.853
1324.461
4          328.352         300.954      183.929       888.448
1343.424
..             ...             ...          ...           ...
...
319        330.117         304.006      148.174      1027.201
1357.271
320        330.848         304.616      165.178       906.962
1311.177
321        330.226         304.686      160.841       887.125
1319.226
322        327.346         304.363      147.589       804.423
1320.225
323        328.092         304.093      144.218       828.328
1320.848

     WeakWashF   SteamHeatF-3   T-Top-Chips-4   SulphidityL-4
0       257.325         54.612         252.077             NaN
1       241.182         46.603         251.406           29.11
2       237.272         51.795         251.335             NaN
3       239.478         54.846         250.312           29.02
4       215.372         54.186         249.916           29.01
..          ...            ...             ...             ...
319     381.643         45.264         252.947           30.86
320      25.494         50.528         252.092           30.70
321       0.638         45.549         252.438             NaN
322       0.000         43.725         253.176           31.13
323       1.276         43.840         253.216             NaN

[324 rows x 23 columns]>

type(df)
```

```
pandas.core.frame.DataFrame

df.head()

  Observation  Y-Kappa  ChipRate  BF-CMratio  BlowFlow  ChipLevel4   \
0    31-00:00    23.10    16.520     121.717  1177.607      169.805
1    31-01:00    27.60    16.810      79.022  1328.360      341.327
2    31-02:00    23.19    16.709      79.562  1329.407      239.161
3    31-03:00    23.60    16.478      81.011  1334.877      213.527
4    31-04:00    22.90    15.618      93.244  1334.168      243.131

   T-upperExt-2   T-lowerExt-2    UCZAA  WhiteFlow-4   ...  SteamFlow-
4   \
0        358.282         329.545  1.443       599.253  ...
67.122
1        351.050         329.067  1.549       537.201  ...
60.012
2        350.022         329.260  1.600       549.611  ...
61.304
3        350.938         331.142  1.604       623.362  ...
68.496
4        351.640         332.709    NaN       638.672  ...
70.022

   Lower-HeatT-3  Upper-HeatT-3   ChipMass-4   WeakLiquorF
BlackFlow-2   \
0        329.432         303.099      175.964      1127.197
1319.039
1        330.823         304.879      163.202       665.975
1297.317
2        329.140         303.383      164.013       677.534
1327.072
3        328.875         302.254      181.487       767.853
1324.461
4        328.352         300.954      183.929       888.448
1343.424

   WeakWashF   SteamHeatF-3   T-Top-Chips-4   SulphidityL-4
0     257.325         54.612         252.077             NaN
1     241.182         46.603         251.406           29.11
2     237.272         51.795         251.335             NaN
3     239.478         54.846         250.312           29.02
4     215.372         54.186         249.916           29.01

[5 rows x 23 columns]

df.tail()

    Observation  Y-Kappa  ChipRate  BF-CMratio  BlowFlow  ChipLevel4
\
319    10-16:00    23.75    12.667      93.450  1178.252      276.955
```

```
320     9-19:00    19.80    12.558      94.352  1184.119      297.071

321     9-20:00    23.01    12.550      90.842  1188.517      289.826

322     9-21:00    24.32    13.083      88.910  1192.879      318.006

323     9-22:00    25.75    13.417      85.451  1186.342      248.312


     T-upperExt-2   T-lowerExt-2    UCZAA  WhiteFlow-4   ...
SteamFlow-4   \
319        347.286         310.970  1.523       513.956  ...
61.141
320        399.135         319.576  1.451       570.058  ...
67.667
321        373.633         314.591  1.457       549.306  ...
66.446
322        364.081         308.559  1.523       504.852  ...
61.054
323        356.289         310.482  1.474       497.375  ...
58.247

     Lower-HeatT-3  Upper-HeatT-3   ChipMass-4   WeakLiquorF
BlackFlow-2   \
319        330.117         304.006      148.174      1027.201
1357.271
320        330.848         304.616      165.178       906.962
1311.177
321        330.226         304.686      160.841       887.125
1319.226
322        327.346         304.363      147.589       804.423
1320.225
323        328.092         304.093      144.218       828.328
1320.848

     WeakWashF   SteamHeatF-3   T-Top-Chips-4   SulphidityL-4
319     381.643         45.264         252.947           30.86
320      25.494         50.528         252.092           30.70
321       0.638         45.549         252.438             NaN
322       0.000         43.725         253.176           31.13
323       1.276         43.840         253.216             NaN

[5 rows x 23 columns]

df.describe()

          Y-Kappa    ChipRate  BF-CMratio     BlowFlow  ChipLevel4   \
count  324.000000  319.000000  307.000000   308.000000   323.000000
mean    20.635370   14.347937   87.464456  1237.837614   258.164483
std      3.070036    1.499095    7.995012   100.593735    87.987452
```

```
min     12.170000    9.983000   68.645000     0.000000     0.000000
25%     18.382500   13.358000   81.823000  1193.215250   213.527000
50%     20.845000   14.308000   86.739000  1273.138500   271.792000
75%     23.032500   15.517000   92.372000  1289.196000   321.680000
max     27.600000   16.958000  121.717000  1351.240000   419.014000

       T-upperExt-2   T-lowerExt-2         UCZAA  WhiteFlow-4
AAWhiteSt-4   \
count     322.000000      322.000000  299.000000    323.000000
173.000000
mean      356.904295      324.020180    1.492010    591.732260
6.140410
std         9.209290        7.621402    0.105923     67.016351
0.081609
min       339.168000      284.633000    1.182000    405.111000
5.890000
25%       350.241250      321.420000    1.431500    540.989500
6.089000
50%       356.843000      325.669000    1.498000    592.895000
6.135000
75%       362.242250      329.175000    1.560500    639.480500
6.199000
max       399.135000      337.012000    1.747000    731.394000
6.340000

       ...  SteamFlow-4   Lower-HeatT-3  Upper-HeatT-3   ChipMass-
4   \
count  ...    323.000000     322.000000      322.000000   323.000000

mean   ...     66.668285     325.567820      300.525699   162.222322

std    ...      5.708587       4.609862        4.568484    14.160688

min    ...     48.568000     318.051000      293.312000   113.922000

25%    ...     62.518000     321.385500      296.513250   153.032500

50%    ...     67.429000     324.741000      299.126000   163.690000

75%    ...     71.522000     329.845250      304.244750   172.555000

max    ...     76.147000     333.854000      311.146000   189.268000


       WeakLiquorF   BlackFlow-2   WeakWashF   SteamHeatF-3   T-Top-
Chips-4   \
count    323.000000    322.000000  323.000000     322.000000
323.000000
mean     873.828941   1175.917016  263.543068      49.696907
251.240087
```

```
std      122.073521    149.334010  163.666942       4.551909
1.283432
min      486.938000    838.948000    0.000000      35.510000
248.359000
25%      792.019500   1044.817500  134.649000      46.389750
250.312000
50%      865.254000   1150.221500  269.193000      50.277000
251.380000
75%      965.286500   1319.021250  405.563000      53.294250
252.323500
max     1226.277000   1395.767000  715.715000      63.332000
254.122000

       SulphidityL-4
count      173.000000
mean        30.411671
std          0.701317
min         29.010000
25%         29.970000
50%         30.370000
75%         30.820000
max         32.840000

[8 rows x 22 columns]
```

```
df.shape
```

```
(324, 23)
```

```
df.isnull()
```

```
     Observation  Y-Kappa  ChipRate  BF-CMratio  BlowFlow  ChipLevel4
\
0          False    False     False       False     False        False

1          False    False     False       False     False        False

2          False    False     False       False     False        False

3          False    False     False       False     False        False

4          False    False     False       False     False        False

..           ...      ...       ...         ...       ...          ...

319        False    False     False       False     False        False

320        False    False     False       False     False        False

321        False    False     False       False     False        False
```

```
322        False    False     False       False     False        False

323        False    False     False       False     False        False


     T-upperExt-2   T-lowerExt-2    UCZAA  WhiteFlow-4   ...
SteamFlow-4   \
0             False           False  False         False  ...
False
1             False           False  False         False  ...
False
2             False           False  False         False  ...
False
3             False           False  False         False  ...
False
4             False           False   True         False  ...
False
..              ...             ...    ...           ...  ...
...
319           False           False  False         False  ...
False
320           False           False  False         False  ...
False
321           False           False  False         False  ...
False
322           False           False  False         False  ...
False
323           False           False  False         False  ...
False

     Lower-HeatT-3  Upper-HeatT-3   ChipMass-4   WeakLiquorF
BlackFlow-2   \
0             False           False        False         False
False
1             False           False        False         False
False
2             False           False        False         False
False
3             False           False        False         False
False
4             False           False        False         False
False
..              ...             ...          ...           ...
...
319           False           False        False         False
False
320           False           False        False         False
False
321           False           False        False         False
False
```

```
322          False           False        False         False
False
323          False           False        False         False
False

     WeakWashF   SteamHeatF-3   T-Top-Chips-4   SulphidityL-4
0         False          False           False            True
1         False          False           False           False
2         False          False           False            True
3         False          False           False           False
4         False          False           False           False
..          ...            ...             ...             ...
319       False          False           False           False
320       False          False           False           False
321       False          False           False            True
322       False          False           False           False
323       False          False           False            True

[324 rows x 23 columns]
```

```
df.isnull().sum()
```

```
Observation           0
Y-Kappa               0
ChipRate              5
BF-CMratio           17
BlowFlow             16
ChipLevel4            1
T-upperExt-2          2
T-lowerExt-2          2
UCZAA                25
WhiteFlow-4           1
AAWhiteSt-4         151
AA-Wood-4             1
ChipMoisture-4        1
SteamFlow-4           1
Lower-HeatT-3         2
Upper-HeatT-3         2
ChipMass-4            1
WeakLiquorF           1
BlackFlow-2           2
WeakWashF             1
SteamHeatF-3          2
T-Top-Chips-4         1
SulphidityL-4       151
dtype: int64
```

```
df.isnull().sum().sum()
```

```
386
```

```
df.notnull()

     Observation  Y-Kappa  ChipRate  BF-CMratio  BlowFlow  ChipLevel4
\
0           True     True      True        True      True         True

1           True     True      True        True      True         True

2           True     True      True        True      True         True

3           True     True      True        True      True         True

4           True     True      True        True      True         True

..           ...      ...       ...         ...       ...          ...

319         True     True      True        True      True         True

320         True     True      True        True      True         True

321         True     True      True        True      True         True

322         True     True      True        True      True         True

323         True     True      True        True      True         True


     T-upperExt-2   T-lowerExt-2    UCZAA  WhiteFlow-4   ...
SteamFlow-4   \
0              True            True   True          True  ...
True
1              True            True   True          True  ...
True
2              True            True   True          True  ...
True
3              True            True   True          True  ...
True
4              True            True  False          True  ...
True
..              ...             ...    ...           ...  ...
...
319            True            True   True          True  ...
True
320            True            True   True          True  ...
True
321            True            True   True          True  ...
True
322            True            True   True          True  ...
True
323            True            True   True          True  ...
True
```

```
     Lower-HeatT-3  Upper-HeatT-3   ChipMass-4   WeakLiquorF
BlackFlow-2   \
0             True            True         True          True
True
1             True            True         True          True
True
2             True            True         True          True
True
3             True            True         True          True
True
4             True            True         True          True
True
..             ...             ...          ...           ...
...
319           True            True         True          True
True
320           True            True         True          True
True
321           True            True         True          True
True
322           True            True         True          True
True
323           True            True         True          True
True

     WeakWashF   SteamHeatF-3   T-Top-Chips-4   SulphidityL-4
0          True           True            True          False
1          True           True            True           True
2          True           True            True          False
3          True           True            True           True
4          True           True            True           True
..          ...            ...             ...            ...
319        True           True            True           True
320        True           True            True           True
321        True           True            True          False
322        True           True            True           True
323        True           True            True          False

[324 rows x 23 columns]

df_cleaned = df.dropna()
df_cleaned

    Observation  Y-Kappa  ChipRate  BF-CMratio  BlowFlow  ChipLevel4
\
1      31-01:00    27.60    16.810      79.022  1328.360      341.327

3      31-03:00    23.60    16.478      81.011  1334.877      213.527
```

```
5       1-08:00    14.23    15.350      85.518  1171.604      198.538

7      31-06:00    22.65    14.100      91.887  1307.852      288.989

9      31-08:00    24.70    13.850      96.208  1334.892      362.511

..          ...      ...       ...         ...       ...          ...

312    31-10:00    24.40    14.117      85.998  1330.104      394.234

317     4-16:00    17.80    16.625      78.367  1276.082      202.744

319    10-16:00    23.75    12.667      93.450  1178.252      276.955

320     9-19:00    19.80    12.558      94.352  1184.119      297.071

322     9-21:00    24.32    13.083      88.910  1192.879      318.006


     T-upperExt-2   T-lowerExt-2    UCZAA  WhiteFlow-4   ...
SteamFlow-4   \
1          351.050         329.067  1.549       537.201  ...
60.012
3          350.938         331.142  1.604       623.362  ...
68.496
5          344.014         325.195  1.436       628.245  ...
65.225
7          352.321         331.162  1.468       625.549  ...
71.298
9          352.372         327.358  1.515       553.172  ...
64.249
..             ...             ...    ...           ...  ...
...
312        348.089         319.027  1.429       540.558  ...
62.179
317        360.127         329.266  1.488       698.486  ...
75.296
319        347.286         310.970  1.523       513.956  ...
61.141
320        399.135         319.576  1.451       570.058  ...
67.667
322        364.081         308.559  1.523       504.852  ...
61.054

     Lower-HeatT-3  Upper-HeatT-3   ChipMass-4   WeakLiquorF
BlackFlow-2   \
1          330.823         304.879      163.202       665.975
1297.317
3          328.875         302.254      181.487       767.853
1324.461
```

```
5          322.103         298.517      165.814       826.243
907.641
7          329.662         301.539      179.886       837.178
1315.111
9          332.264         305.419      166.120       909.810
1318.725
..             ...             ...          ...           ...
...
312        329.831         302.652      163.258       827.107
1312.372
317        321.658         297.088      180.438      1017.333
1052.785
319        330.117         304.006      148.174      1027.201
1357.271
320        330.848         304.616      165.178       906.962
1311.177
322        327.346         304.363      147.589       804.423
1320.225

     WeakWashF   SteamHeatF-3   T-Top-Chips-4   SulphidityL-4
1       241.182         46.603         251.406          29.110
3       239.478         54.846         250.312          29.020
5       595.875         52.807         249.580          30.340
7       234.047         53.805         249.971          29.220
9       180.375         48.842         251.121          29.210
..          ...            ...             ...             ...
312     132.163         49.446         251.406          29.292
317     433.089         54.675         251.747          30.320
319     381.643         45.264         252.947          30.860
320      25.494         50.528         252.092          30.700
322       0.000         43.725         253.176          31.130

[141 rows x 23 columns]

print(df_cleaned.head())

  Observation  Y-Kappa  ChipRate  BF-CMratio  BlowFlow  ChipLevel4   \
1    31-01:00    27.60    16.810      79.022  1328.360      341.327
3    31-03:00    23.60    16.478      81.011  1334.877      213.527
5     1-08:00    14.23    15.350      85.518  1171.604      198.538
7    31-06:00    22.65    14.100      91.887  1307.852      288.989
9    31-08:00    24.70    13.850      96.208  1334.892      362.511

   T-upperExt-2   T-lowerExt-2    UCZAA  WhiteFlow-4   ...  SteamFlow-
4   \
1        351.050         329.067  1.549       537.201  ...
60.012
3        350.938         331.142  1.604       623.362  ...
68.496
5        344.014         325.195  1.436       628.245  ...
```

```
65.225
7        352.321         331.162  1.468       625.549  ...
71.298
9        352.372         327.358  1.515       553.172  ...
64.249

   Lower-HeatT-3  Upper-HeatT-3   ChipMass-4   WeakLiquorF
BlackFlow-2   \
1        330.823         304.879      163.202       665.975
1297.317
3        328.875         302.254      181.487       767.853
1324.461
5        322.103         298.517      165.814       826.243
907.641
7        329.662         301.539      179.886       837.178
1315.111
9        332.264         305.419      166.120       909.810
1318.725

   WeakWashF   SteamHeatF-3   T-Top-Chips-4   SulphidityL-4
1     241.182         46.603         251.406           29.11
3     239.478         54.846         250.312           29.02
5     595.875         52.807         249.580           30.34
7     234.047         53.805         249.971           29.22
9     180.375         48.842         251.121           29.21

[5 rows x 23 columns]

df_filled = df.fillna(value=0)
df_filled

    Observation  Y-Kappa  ChipRate  BF-CMratio  BlowFlow  ChipLevel4
\
0      31-00:00    23.10    16.520     121.717  1177.607      169.805

1      31-01:00    27.60    16.810      79.022  1328.360      341.327

2      31-02:00    23.19    16.709      79.562  1329.407      239.161

3      31-03:00    23.60    16.478      81.011  1334.877      213.527

4      31-04:00    22.90    15.618      93.244  1334.168      243.131

..          ...      ...       ...         ...       ...          ...

319    10-16:00    23.75    12.667      93.450  1178.252      276.955

320     9-19:00    19.80    12.558      94.352  1184.119      297.071

321     9-20:00    23.01    12.550      90.842  1188.517      289.826
```

```
322     9-21:00    24.32    13.083      88.910  1192.879      318.006

323     9-22:00    25.75    13.417      85.451  1186.342      248.312


     T-upperExt-2   T-lowerExt-2    UCZAA  WhiteFlow-4   ...
SteamFlow-4   \
0          358.282         329.545  1.443       599.253  ...
67.122
1          351.050         329.067  1.549       537.201  ...
60.012
2          350.022         329.260  1.600       549.611  ...
61.304
3          350.938         331.142  1.604       623.362  ...
68.496
4          351.640         332.709  0.000       638.672  ...
70.022
..             ...             ...    ...           ...  ...
...
319        347.286         310.970  1.523       513.956  ...
61.141
320        399.135         319.576  1.451       570.058  ...
67.667
321        373.633         314.591  1.457       549.306  ...
66.446
322        364.081         308.559  1.523       504.852  ...
61.054
323        356.289         310.482  1.474       497.375  ...
58.247

     Lower-HeatT-3  Upper-HeatT-3   ChipMass-4   WeakLiquorF
BlackFlow-2   \
0          329.432         303.099      175.964      1127.197
1319.039
1          330.823         304.879      163.202       665.975
1297.317
2          329.140         303.383      164.013       677.534
1327.072
3          328.875         302.254      181.487       767.853
1324.461
4          328.352         300.954      183.929       888.448
1343.424
..             ...             ...          ...           ...
...
319        330.117         304.006      148.174      1027.201
1357.271
320        330.848         304.616      165.178       906.962
1311.177
321        330.226         304.686      160.841       887.125
1319.226
```

```
322        327.346         304.363      147.589       804.423
1320.225
323        328.092         304.093      144.218       828.328
1320.848

     WeakWashF   SteamHeatF-3   T-Top-Chips-4   SulphidityL-4
0       257.325         54.612         252.077            0.00
1       241.182         46.603         251.406           29.11
2       237.272         51.795         251.335            0.00
3       239.478         54.846         250.312           29.02
4       215.372         54.186         249.916           29.01
..          ...            ...             ...             ...
319     381.643         45.264         252.947           30.86
320      25.494         50.528         252.092           30.70
321       0.638         45.549         252.438            0.00
322       0.000         43.725         253.176           31.13
323       1.276         43.840         253.216            0.00

[324 rows x 23 columns]

df.fillna(method="pad")
df

C:\Users\jayaraman\AppData\Local\Temp\ipykernel_19016\3567329548.py:1:
FutureWarning: DataFrame.fillna with 'method' is deprecated and will
raise in a future version. Use obj.ffill() or obj.bfill() instead.
  df.fillna(method="pad")

    Observation  Y-Kappa  ChipRate  BF-CMratio  BlowFlow  ChipLevel4
\
0      31-00:00    23.10    16.520     121.717  1177.607      169.805

1      31-01:00    27.60    16.810      79.022  1328.360      341.327

2      31-02:00    23.19    16.709      79.562  1329.407      239.161

3      31-03:00    23.60    16.478      81.011  1334.877      213.527

4      31-04:00    22.90    15.618      93.244  1334.168      243.131

..          ...      ...       ...         ...       ...          ...

319    10-16:00    23.75    12.667      93.450  1178.252      276.955

320     9-19:00    19.80    12.558      94.352  1184.119      297.071

321     9-20:00    23.01    12.550      90.842  1188.517      289.826

322     9-21:00    24.32    13.083      88.910  1192.879      318.006

323     9-22:00    25.75    13.417      85.451  1186.342      248.312
```

```
     T-upperExt-2   T-lowerExt-2    UCZAA  WhiteFlow-4   ...
SteamFlow-4   \
0          358.282         329.545  1.443       599.253  ...
67.122
1          351.050         329.067  1.549       537.201  ...
60.012
2          350.022         329.260  1.600       549.611  ...
61.304
3          350.938         331.142  1.604       623.362  ...
68.496
4          351.640         332.709    NaN       638.672  ...
70.022
..             ...             ...    ...           ...  ...
...
319        347.286         310.970  1.523       513.956  ...
61.141
320        399.135         319.576  1.451       570.058  ...
67.667
321        373.633         314.591  1.457       549.306  ...
66.446
322        364.081         308.559  1.523       504.852  ...
61.054
323        356.289         310.482  1.474       497.375  ...
58.247

     Lower-HeatT-3  Upper-HeatT-3   ChipMass-4   WeakLiquorF
BlackFlow-2   \
0          329.432         303.099      175.964      1127.197
1319.039
1          330.823         304.879      163.202       665.975
1297.317
2          329.140         303.383      164.013       677.534
1327.072
3          328.875         302.254      181.487       767.853
1324.461
4          328.352         300.954      183.929       888.448
1343.424
..             ...             ...          ...           ...
...
319        330.117         304.006      148.174      1027.201
1357.271
320        330.848         304.616      165.178       906.962
1311.177
321        330.226         304.686      160.841       887.125
1319.226
322        327.346         304.363      147.589       804.423
1320.225
323        328.092         304.093      144.218       828.328
```

```
1320.848
```

	WeakWashF	SteamHeatF-3	T-Top-Chips-4	SulphidityL-4
0	257.325	54.612	252.077	NaN
1	241.182	46.603	251.406	29.11
2	237.272	51.795	251.335	NaN
3	239.478	54.846	250.312	29.02
4	215.372	54.186	249.916	29.01
..	...	...	...	...
319	381.643	45.264	252.947	30.86
320	25.494	50.528	252.092	30.70
321	0.638	45.549	252.438	NaN
322	0.000	43.725	253.176	31.13
323	1.276	43.840	253.216	NaN

[324 rows x 23 columns]

```
df.fillna(method="ffill")
df
```

```
C:\Users\jayaraman\AppData\Local\Temp\ipykernel_19016\1737168024.py:1:
FutureWarning: DataFrame.fillna with 'method' is deprecated and will
raise in a future version. Use obj.ffill() or obj.bfill() instead.
  df.fillna(method="ffill")
```

	Observation	Y-Kappa	ChipRate	BF-CMratio	BlowFlow	ChipLevel4
0	31-00:00	23.10	16.520	121.717	1177.607	169.805
1	31-01:00	27.60	16.810	79.022	1328.360	341.327
2	31-02:00	23.19	16.709	79.562	1329.407	239.161
3	31-03:00	23.60	16.478	81.011	1334.877	213.527
4	31-04:00	22.90	15.618	93.244	1334.168	243.131
..	...	...	...	...	...	...
319	10-16:00	23.75	12.667	93.450	1178.252	276.955
320	9-19:00	19.80	12.558	94.352	1184.119	297.071
321	9-20:00	23.01	12.550	90.842	1188.517	289.826
322	9-21:00	24.32	13.083	88.910	1192.879	318.006
323	9-22:00	25.75	13.417	85.451	1186.342	248.312

	T-upperExt-2	T-lowerExt-2	UCZAA	WhiteFlow-4	...

```
SteamFlow-4   \
0          358.282         329.545  1.443       599.253  ...
67.122
1          351.050         329.067  1.549       537.201  ...
60.012
2          350.022         329.260  1.600       549.611  ...
61.304
3          350.938         331.142  1.604       623.362  ...
68.496
4          351.640         332.709    NaN       638.672  ...
70.022
..             ...             ...    ...           ...  ...
...
319        347.286         310.970  1.523       513.956  ...
61.141
320        399.135         319.576  1.451       570.058  ...
67.667
321        373.633         314.591  1.457       549.306  ...
66.446
322        364.081         308.559  1.523       504.852  ...
61.054
323        356.289         310.482  1.474       497.375  ...
58.247

     Lower-HeatT-3  Upper-HeatT-3   ChipMass-4   WeakLiquorF
BlackFlow-2   \
0          329.432         303.099      175.964      1127.197
1319.039
1          330.823         304.879      163.202       665.975
1297.317
2          329.140         303.383      164.013       677.534
1327.072
3          328.875         302.254      181.487       767.853
1324.461
4          328.352         300.954      183.929       888.448
1343.424
..             ...             ...          ...           ...
...
319        330.117         304.006      148.174      1027.201
1357.271
320        330.848         304.616      165.178       906.962
1311.177
321        330.226         304.686      160.841       887.125
1319.226
322        327.346         304.363      147.589       804.423
1320.225
323        328.092         304.093      144.218       828.328
1320.848
```

```
     WeakWashF   SteamHeatF-3   T-Top-Chips-4   SulphidityL-4
0       257.325         54.612         252.077             NaN
1       241.182         46.603         251.406           29.11
2       237.272         51.795         251.335             NaN
3       239.478         54.846         250.312           29.02
4       215.372         54.186         249.916           29.01
..          ...            ...             ...             ...
319     381.643         45.264         252.947           30.86
320      25.494         50.528         252.092           30.70
321       0.638         45.549         252.438             NaN
322       0.000         43.725         253.176           31.13
323       1.276         43.840         253.216             NaN

[324 rows x 23 columns]
```

```
df.fillna(method="bfill")
df
```

```
C:\Users\jayaraman\AppData\Local\Temp\ipykernel_19016\967781409.py:1:
FutureWarning: DataFrame.fillna with 'method' is deprecated and will
raise in a future version. Use obj.ffill() or obj.bfill() instead.
  df.fillna(method="bfill")
```

```
    Observation  Y-Kappa  ChipRate  BF-CMratio  BlowFlow  ChipLevel4
\
0      31-00:00    23.10    16.520     121.717  1177.607      169.805

1      31-01:00    27.60    16.810      79.022  1328.360      341.327

2      31-02:00    23.19    16.709      79.562  1329.407      239.161

3      31-03:00    23.60    16.478      81.011  1334.877      213.527

4      31-04:00    22.90    15.618      93.244  1334.168      243.131

..          ...      ...       ...         ...       ...          ...

319    10-16:00    23.75    12.667      93.450  1178.252      276.955

320     9-19:00    19.80    12.558      94.352  1184.119      297.071

321     9-20:00    23.01    12.550      90.842  1188.517      289.826

322     9-21:00    24.32    13.083      88.910  1192.879      318.006

323     9-22:00    25.75    13.417      85.451  1186.342      248.312


     T-upperExt-2   T-lowerExt-2    UCZAA  WhiteFlow-4   ...
SteamFlow-4   \
0          358.282         329.545  1.443       599.253  ...
```

```
67.122
1          351.050          329.067  1.549       537.201  ...
60.012
2          350.022          329.260  1.600       549.611  ...
61.304
3          350.938          331.142  1.604       623.362  ...
68.496
4          351.640          332.709    NaN       638.672  ...
70.022
..             ...              ...    ...           ...  ...
...
319        347.286          310.970  1.523       513.956  ...
61.141
320        399.135          319.576  1.451       570.058  ...
67.667
321        373.633          314.591  1.457       549.306  ...
66.446
322        364.081          308.559  1.523       504.852  ...
61.054
323        356.289          310.482  1.474       497.375  ...
58.247

     Lower-HeatT-3  Upper-HeatT-3   ChipMass-4   WeakLiquorF
BlackFlow-2   \
0          329.432          303.099      175.964      1127.197
1319.039
1          330.823          304.879      163.202       665.975
1297.317
2          329.140          303.383      164.013       677.534
1327.072
3          328.875          302.254      181.487       767.853
1324.461
4          328.352          300.954      183.929       888.448
1343.424
..             ...              ...          ...           ...
...
319        330.117          304.006      148.174      1027.201
1357.271
320        330.848          304.616      165.178       906.962
1311.177
321        330.226          304.686      160.841       887.125
1319.226
322        327.346          304.363      147.589       804.423
1320.225
323        328.092          304.093      144.218       828.328
1320.848

     WeakWashF   SteamHeatF-3   T-Top-Chips-4   SulphidityL-4
0       257.325         54.612         252.077             NaN
```

```
1       241.182         46.603         251.406           29.11
2       237.272         51.795         251.335             NaN
3       239.478         54.846         250.312           29.02
4       215.372         54.186         249.916           29.01
..          ...            ...             ...             ...
319     381.643         45.264         252.947           30.86
320      25.494         50.528         252.092           30.70
321       0.638         45.549         252.438             NaN
322       0.000         43.725         253.176           31.13
323       1.276         43.840         253.216             NaN

[324 rows x 23 columns]
```

```
df.columns
```

```
Index(['Observation', 'Y-Kappa', 'ChipRate', 'BF-CMratio', 'BlowFlow',
       'ChipLevel4 ', 'T-upperExt-2 ', 'T-lowerExt-2  ', 'UCZAA',
       'WhiteFlow-4 ', 'AAWhiteSt-4 ', 'AA-Wood-4  ', 'ChipMoisture-4
',
       'SteamFlow-4 ', 'Lower-HeatT-3', 'Upper-HeatT-3 ', 'ChipMass-4
',
       'WeakLiquorF ', 'BlackFlow-2 ', 'WeakWashF ', 'SteamHeatF-3 ',
       'T-Top-Chips-4 ', 'SulphidityL-4 '],
      dtype='object')
```

```
print(df_filled.head())
```

```
  Observation  Y-Kappa  ChipRate  BF-CMratio  BlowFlow  ChipLevel4   \
0    31-00:00    23.10    16.520     121.717  1177.607      169.805
1    31-01:00    27.60    16.810      79.022  1328.360      341.327
2    31-02:00    23.19    16.709      79.562  1329.407      239.161
3    31-03:00    23.60    16.478      81.011  1334.877      213.527
4    31-04:00    22.90    15.618      93.244  1334.168      243.131

   T-upperExt-2   T-lowerExt-2    UCZAA  WhiteFlow-4   ...  SteamFlow-
4   \
0        358.282         329.545  1.443       599.253  ...
67.122
1        351.050         329.067  1.549       537.201  ...
60.012
2        350.022         329.260  1.600       549.611  ...
61.304
3        350.938         331.142  1.604       623.362  ...
68.496
4        351.640         332.709  0.000       638.672  ...
70.022

   Lower-HeatT-3  Upper-HeatT-3   ChipMass-4   WeakLiquorF
BlackFlow-2   \
0        329.432         303.099      175.964      1127.197
```

```
1319.039
1        330.823         304.879      163.202       665.975
1297.317
2        329.140         303.383      164.013       677.534
1327.072
3        328.875         302.254      181.487       767.853
1324.461
4        328.352         300.954      183.929       888.448
1343.424

   WeakWashF   SteamHeatF-3   T-Top-Chips-4   SulphidityL-4
0     257.325         54.612         252.077            0.00
1     241.182         46.603         251.406           29.11
2     237.272         51.795         251.335            0.00
3     239.478         54.846         250.312           29.02
4     215.372         54.186         249.916           29.01

[5 rows x 23 columns]

df_no_duplicates = df.drop_duplicates()
df_no_duplicates

    Observation  Y-Kappa  ChipRate  BF-CMratio  BlowFlow  ChipLevel4
\
0      31-00:00    23.10    16.520     121.717  1177.607      169.805

1      31-01:00    27.60    16.810      79.022  1328.360      341.327

2      31-02:00    23.19    16.709      79.562  1329.407      239.161

3      31-03:00    23.60    16.478      81.011  1334.877      213.527

4      31-04:00    22.90    15.618      93.244  1334.168      243.131

..          ...      ...       ...         ...       ...          ...

298    12-09:00    20.90    15.167      84.640  1283.706      339.440

299    12-10:00    24.98       NaN      85.034  1278.345      368.564

300    12-11:00    21.00       NaN      88.013  1307.722      278.842

301    12-12:00    21.40       NaN      85.490  1255.986      273.484

307    31-05:00    20.89    14.308      94.172  1327.832      251.120


     T-upperExt-2   T-lowerExt-2    UCZAA  WhiteFlow-4   ...
SteamFlow-4   \
0          358.282         329.545  1.443       599.253  ...
67.122
```

```
1          351.050          329.067  1.549       537.201  ...
60.012
2          350.022          329.260  1.600       549.611  ...
61.304
3          350.938          331.142  1.604       623.362  ...
68.496
4          351.640          332.709    NaN       638.672  ...
70.022
..             ...              ...    ...           ...  ...
...
298        354.803          311.041  1.635       532.419  ...
65.561
299        357.723          321.387    NaN       520.365  ...
65.729
300        357.438          323.757    NaN       553.070  ...
65.795
301        361.365          322.689    NaN       590.199  ...
71.456
307        351.263          332.485  1.522       631.514  ...
71.286

     Lower-HeatT-3  Upper-HeatT-3   ChipMass-4   WeakLiquorF
BlackFlow-2   \
0          329.432          303.099      175.964      1127.197
1319.039
1          330.823          304.879      163.202       665.975
1297.317
2          329.140          303.383      164.013       677.534
1327.072
3          328.875          302.254      181.487       767.853
1324.461
4          328.352          300.954      183.929       888.448
1343.424
..             ...              ...          ...           ...
...
298        332.924          307.626      145.299       832.906
1344.708
299        332.523          307.169      151.544       905.639
1344.469
300        331.263          306.400      157.954       908.691
1344.588
301        333.032          308.732      174.069       986.206
1348.747
307        328.699          300.706      180.229       903.605
1323.082

     WeakWashF   SteamHeatF-3   T-Top-Chips-4   SulphidityL-4
0       257.325         54.612         252.077             NaN
1       241.182         46.603         251.406           29.11
```

```
2       237.272          51.795          251.335              NaN
3       239.478          54.846          250.312            29.02
4       215.372          54.186          249.916            29.01
..          ...             ...              ...              ...
298     388.911          49.524          251.833            30.29
299     418.979          48.135          251.614            30.47
300     462.712          54.373          251.197              NaN
301     457.313          53.194          251.324            30.46
307     232.729          54.503          250.084              NaN

[301 rows x 23 columns]
```

```
print(df_no_duplicates.head())
```

```
  Observation  Y-Kappa  ChipRate  BF-CMratio  BlowFlow  ChipLevel4   \
0    31-00:00    23.10    16.520     121.717  1177.607      169.805
1    31-01:00    27.60    16.810      79.022  1328.360      341.327
2    31-02:00    23.19    16.709      79.562  1329.407      239.161
3    31-03:00    23.60    16.478      81.011  1334.877      213.527
4    31-04:00    22.90    15.618      93.244  1334.168      243.131

   T-upperExt-2   T-lowerExt-2    UCZAA  WhiteFlow-4   ...  SteamFlow-
4   \
0        358.282         329.545  1.443       599.253  ...
67.122
1        351.050         329.067  1.549       537.201  ...
60.012
2        350.022         329.260  1.600       549.611  ...
61.304
3        350.938         331.142  1.604       623.362  ...
68.496
4        351.640         332.709    NaN       638.672  ...
70.022

   Lower-HeatT-3  Upper-HeatT-3   ChipMass-4   WeakLiquorF
BlackFlow-2   \
0        329.432         303.099      175.964      1127.197
1319.039
1        330.823         304.879      163.202       665.975
1297.317
2        329.140         303.383      164.013       677.534
1327.072
3        328.875         302.254      181.487       767.853
1324.461
4        328.352         300.954      183.929       888.448
1343.424

   WeakWashF   SteamHeatF-3   T-Top-Chips-4   SulphidityL-4
0     257.325         54.612         252.077             NaN
1     241.182         46.603         251.406           29.11
```

```
2     237.272         51.795         251.335             NaN
3     239.478         54.846         250.312           29.02
4     215.372         54.186         249.916           29.01

[5 rows x 23 columns]
```

```
filtered_data = df[df["BlowFlow"]>16]
filtered_data
```

```
    Observation  Y-Kappa  ChipRate  BF-CMratio  BlowFlow  ChipLevel4
\
0      31-00:00    23.10    16.520     121.717  1177.607      169.805

1      31-01:00    27.60    16.810      79.022  1328.360      341.327

2      31-02:00    23.19    16.709      79.562  1329.407      239.161

3      31-03:00    23.60    16.478      81.011  1334.877      213.527

4      31-04:00    22.90    15.618      93.244  1334.168      243.131

..          ...      ...       ...         ...       ...          ...

319    10-16:00    23.75    12.667      93.450  1178.252      276.955

320     9-19:00    19.80    12.558      94.352  1184.119      297.071

321     9-20:00    23.01    12.550      90.842  1188.517      289.826

322     9-21:00    24.32    13.083      88.910  1192.879      318.006

323     9-22:00    25.75    13.417      85.451  1186.342      248.312


     T-upperExt-2   T-lowerExt-2    UCZAA  WhiteFlow-4   ...
SteamFlow-4   \
0          358.282         329.545  1.443       599.253  ...
67.122
1          351.050         329.067  1.549       537.201  ...
60.012
2          350.022         329.260  1.600       549.611  ...
61.304
3          350.938         331.142  1.604       623.362  ...
68.496
4          351.640         332.709    NaN       638.672  ...
70.022
..             ...             ...    ...           ...  ...
...
319        347.286         310.970  1.523       513.956  ...
61.141
320        399.135         319.576  1.451       570.058  ...
```

```
67.667
321        373.633         314.591  1.457       549.306  ...
66.446
322        364.081         308.559  1.523       504.852  ...
61.054
323        356.289         310.482  1.474       497.375  ...
58.247

     Lower-HeatT-3  Upper-HeatT-3   ChipMass-4   WeakLiquorF
BlackFlow-2   \
0          329.432         303.099      175.964      1127.197
1319.039
1          330.823         304.879      163.202       665.975
1297.317
2          329.140         303.383      164.013       677.534
1327.072
3          328.875         302.254      181.487       767.853
1324.461
4          328.352         300.954      183.929       888.448
1343.424
..             ...             ...          ...           ...
...
319        330.117         304.006      148.174      1027.201
1357.271
320        330.848         304.616      165.178       906.962
1311.177
321        330.226         304.686      160.841       887.125
1319.226
322        327.346         304.363      147.589       804.423
1320.225
323        328.092         304.093      144.218       828.328
1320.848

     WeakWashF   SteamHeatF-3   T-Top-Chips-4   SulphidityL-4
0       257.325         54.612         252.077             NaN
1       241.182         46.603         251.406           29.11
2       237.272         51.795         251.335             NaN
3       239.478         54.846         250.312           29.02
4       215.372         54.186         249.916           29.01
..          ...            ...             ...             ...
319     381.643         45.264         252.947           30.86
320      25.494         50.528         252.092           30.70
321       0.638         45.549         252.438             NaN
322       0.000         43.725         253.176           31.13
323       1.276         43.840         253.216             NaN

[307 rows x 23 columns]
```

```
print(filtered_data.head())
```

```
  Observation  Y-Kappa  ChipRate  BF-CMratio  BlowFlow  ChipLevel4   \
0    31-00:00    23.10    16.520     121.717  1177.607      169.805
1    31-01:00    27.60    16.810      79.022  1328.360      341.327
2    31-02:00    23.19    16.709      79.562  1329.407      239.161
3    31-03:00    23.60    16.478      81.011  1334.877      213.527
4    31-04:00    22.90    15.618      93.244  1334.168      243.131

   T-upperExt-2   T-lowerExt-2    UCZAA  WhiteFlow-4   ...  SteamFlow-
4   \
0        358.282         329.545  1.443       599.253  ...
67.122
1        351.050         329.067  1.549       537.201  ...
60.012
2        350.022         329.260  1.600       549.611  ...
61.304
3        350.938         331.142  1.604       623.362  ...
68.496
4        351.640         332.709    NaN       638.672  ...
70.022

   Lower-HeatT-3  Upper-HeatT-3   ChipMass-4   WeakLiquorF
BlackFlow-2   \
0        329.432         303.099      175.964      1127.197
1319.039
1        330.823         304.879      163.202       665.975
1297.317
2        329.140         303.383      164.013       677.534
1327.072
3        328.875         302.254      181.487       767.853
1324.461
4        328.352         300.954      183.929       888.448
1343.424

   WeakWashF   SteamHeatF-3   T-Top-Chips-4   SulphidityL-4
0     257.325         54.612         252.077             NaN
1     241.182         46.603         251.406           29.11
2     237.272         51.795         251.335             NaN
3     239.478         54.846         250.312           29.02
4     215.372         54.186         249.916           29.01

[5 rows x 23 columns]
```

```
sorted_data = df.sort_values(by='ChipRate', ascending=True)
sorted_data
```

```
    Observation  Y-Kappa  ChipRate  BF-CMratio  BlowFlow  ChipLevel4
\
284    11-19:00    20.20     9.983     102.237  1027.485      369.632

289    12-00:00    22.50    10.625      89.193  1010.855      322.470
```

```
37      1-12:00    14.53    10.833      93.121  1202.818      339.119
288    11-23:00    22.10    10.933      97.752  1038.618      333.743
36      1-11:00    12.81    10.942     114.567  1241.142      215.485
..          ...      ...       ...         ...       ...          ...
206     8-13:00    16.70       NaN         NaN       NaN        0.000
299    12-10:00    24.98       NaN      85.034  1278.345      368.564
300    12-11:00    21.00       NaN      88.013  1307.722      278.842
301    12-12:00    21.40       NaN      85.490  1255.986      273.484
314     8-13:00    16.70       NaN         NaN       NaN        0.000

     T-upperExt-2   T-lowerExt-2    UCZAA  WhiteFlow-4   ...
SteamFlow-4   \
284        342.576         298.560  1.639       454.091  ...
54.259
289        342.637         305.806  1.571       447.743  ...
58.147
37         342.535         324.194  1.258       601.694  ...
63.969
288        343.695         305.528    NaN       437.205  ...
56.182
36         346.411         328.375  1.378       654.744  ...
70.261
..             ...             ...    ...           ...  ...
...
206        373.867         324.184  1.596       533.538  ...
59.310
299        357.723         321.387    NaN       520.365  ...
65.729
300        357.438         323.757    NaN       553.070  ...
65.795
301        361.365         322.689    NaN       590.199  ...
71.456
314        373.867         324.184  1.596       533.538  ...
59.310

     Lower-HeatT-3  Upper-HeatT-3   ChipMass-4   WeakLiquorF
BlackFlow-2   \
284        328.976         304.282      130.177      1000.752
1361.314
289        330.078         307.162      130.474       848.433
```

```
1290.827
37         322.040         299.894      146.584       602.040
838.948
288        329.052         307.915      122.927       910.166
1294.447
36         323.855         300.942      172.085       486.938
989.378
..             ...             ...          ...           ...
...
206        328.206         304.038      150.399       705.880
1145.549
299        332.523         307.169      151.544       905.639
1344.469
300        331.263         306.400      157.954       908.691
1344.588
301        333.032         308.732      174.069       986.206
1348.747
314        328.206         304.038      150.399       705.880
1145.549

     WeakWashF   SteamHeatF-3   T-Top-Chips-4   SulphidityL-4
284       3.880         41.850         252.565             NaN
289     390.214         42.822         253.180             NaN
37       48.632         41.508         251.630          30.650
288     386.579         39.162         253.796          30.750
36       51.412         47.804         250.373             NaN
..          ...            ...             ...             ...
206     481.277         50.671         250.683          29.252
299     418.979         48.135         251.614          30.470
300     462.712         54.373         251.197             NaN
301     457.313         53.194         251.324          30.460
314     481.277         50.671         250.683          29.252

[324 rows x 23 columns]

print(sorted_data.head())

    Observation  Y-Kappa  ChipRate  BF-CMratio  BlowFlow  ChipLevel4
\
284    11-19:00    20.20     9.983     102.237  1027.485      369.632

289    12-00:00    22.50    10.625      89.193  1010.855      322.470

37      1-12:00    14.53    10.833      93.121  1202.818      339.119

288    11-23:00    22.10    10.933      97.752  1038.618      333.743

36      1-11:00    12.81    10.942     114.567  1241.142      215.485
```

```
     T-upperExt-2   T-lowerExt-2    UCZAA  WhiteFlow-4   ...
SteamFlow-4   \
284         342.576         298.560  1.639       454.091  ...
54.259
289         342.637         305.806  1.571       447.743  ...
58.147
37          342.535         324.194  1.258       601.694  ...
63.969
288         343.695         305.528    NaN       437.205  ...
56.182
36          346.411         328.375  1.378       654.744  ...
70.261

     Lower-HeatT-3  Upper-HeatT-3   ChipMass-4   WeakLiquorF
BlackFlow-2   \
284         328.976         304.282      130.177      1000.752
1361.314
289         330.078         307.162      130.474       848.433
1290.827
37          322.040         299.894      146.584       602.040
838.948
288         329.052         307.915      122.927       910.166
1294.447
36          323.855         300.942      172.085       486.938
989.378

     WeakWashF   SteamHeatF-3   T-Top-Chips-4   SulphidityL-4
284       3.880         41.850         252.565             NaN
289     390.214         42.822         253.180             NaN
37       48.632         41.508         251.630           30.65
288     386.579         39.162         253.796           30.75
36       51.412         47.804         250.373             NaN

[5 rows x 23 columns]

grouped_data = df.groupby('ChipMass-4 ').sum()
grouped_data

            Observation  Y-Kappa  ChipRate  BF-CMratio  BlowFlow
ChipLevel4   \
ChipMass-4

113.922        11-22:00    21.20    11.292      92.194  1041.020
388.538
116.333         8-17:00    19.20    14.183      85.406  1211.339
354.500
121.490        12-04:00    19.50    12.567      96.937  1204.438
300.098
122.011        12-03:00    22.00    11.858      93.199  1171.206
366.787
```

```
122.927        11-23:00    22.10    10.933      97.752  1038.618
333.743
...                 ...      ...       ...         ...       ...
...
186.165         2-23:00    18.13    16.825      84.836  1246.387
259.527
186.241         3-01:00    18.90    15.067      83.178  1245.584
106.110
187.665         2-11:00    18.86    13.550      91.876  1244.918
157.417
187.777         3-00:00    18.30    16.833      91.341  1236.911
287.397
189.268         2-19:00    22.30    15.492      75.395  1232.071
266.968

             T-upperExt-2   T-lowerExt-2    UCZAA  WhiteFlow-
4   ...  \
ChipMass-4                                                    ...

113.922             341.538         297.247  1.457       405.111  ...

116.333             366.827         321.326  1.478       562.029  ...

121.490             345.516         311.489  1.578       454.678  ...

122.011             345.261         310.115  1.513       428.202  ...

122.927             343.695         305.528  0.000       437.205  ...

...                     ...             ...    ...           ...  ...

186.165             355.515         325.985  0.000       662.577  ...

186.241             362.677         330.216  1.480       676.106  ...

187.665             357.865         330.227  1.393       688.720  ...

187.777             356.787         327.856  1.540       661.532  ...

189.268             354.244         325.212  1.416       662.780  ...


             ChipMoisture-4   SteamFlow-4   Lower-HeatT-3  Upper-
HeatT-3   \
ChipMass-4

113.922               47.381        51.192        328.289
305.824
116.333               44.938        69.674        329.238
301.817
121.490               47.820        58.135        330.093
```

```
307.904
122.011                48.216        52.494        330.589
309.152
122.927                47.825        56.182        329.052
307.915
...                       ...           ...            ...
...
186.165                48.312        72.407        321.904
296.185
186.241                46.345        71.263        324.407
297.655
187.665                46.167        72.997        322.716
298.414
187.777                47.809        71.891        323.285
297.755
189.268                45.883        70.978        322.028
299.212

              WeakLiquorF   BlackFlow-2   WeakWashF   SteamHeatF-3   \
ChipMass-4
113.922            838.094      1292.599     353.625          38.642
116.333            819.783      1247.445     282.044          50.032
121.490            918.355      1296.989     388.881          44.507
122.011            816.020      1294.891     391.607          42.080
122.927            910.166      1294.447     386.579          39.162
...                    ...           ...         ...             ...
186.165            810.272      1132.813       0.000          54.044
186.241            707.326      1142.856       0.000          54.000
187.665            858.439       995.964      83.763          54.684
187.777            841.552      1144.876       0.000          53.897
189.268            776.143      1103.063     412.781          50.496

              T-Top-Chips-4   SulphidityL-4
ChipMass-4
113.922               253.161           30.57
116.333               248.390           30.21
121.490               253.308            0.00
122.011               253.206           30.24
122.927               253.796           30.75
...                       ...             ...
186.165               250.266           29.63
186.241               250.083           31.03
187.665               250.399           29.80
187.777               250.212            0.00
189.268               250.251            0.00

[291 rows x 22 columns]

print(grouped_data.head())
```

```
             Observation  Y-Kappa  ChipRate  BF-CMratio  BlowFlow
ChipLevel4   \
ChipMass-4

113.922        11-22:00     21.2    11.292      92.194  1041.020
388.538
116.333         8-17:00     19.2    14.183      85.406  1211.339
354.500
121.490        12-04:00     19.5    12.567      96.937  1204.438
300.098
122.011        12-03:00     22.0    11.858      93.199  1171.206
366.787
122.927        11-23:00     22.1    10.933      97.752  1038.618
333.743

             T-upperExt-2   T-lowerExt-2    UCZAA  WhiteFlow-
4   ...  \
ChipMass-4                                                    ...

113.922             341.538         297.247  1.457       405.111  ...

116.333             366.827         321.326  1.478       562.029  ...

121.490             345.516         311.489  1.578       454.678  ...

122.011             345.261         310.115  1.513       428.202  ...

122.927             343.695         305.528  0.000       437.205  ...


             ChipMoisture-4   SteamFlow-4   Lower-HeatT-3  Upper-
HeatT-3   \
ChipMass-4

113.922               47.381        51.192        328.289
305.824
116.333               44.938        69.674        329.238
301.817
121.490               47.820        58.135        330.093
307.904
122.011               48.216        52.494        330.589
309.152
122.927               47.825        56.182        329.052
307.915

             WeakLiquorF   BlackFlow-2   WeakWashF   SteamHeatF-3   \
ChipMass-4
113.922           838.094      1292.599     353.625         38.642
116.333           819.783      1247.445     282.044         50.032
121.490           918.355      1296.989     388.881         44.507
122.011           816.020      1294.891     391.607         42.080
```

```
122.927            910.166      1294.447     386.579          39.162

              T-Top-Chips-4   SulphidityL-4
ChipMass-4
113.922              253.161           30.57
116.333              248.390           30.21
121.490              253.308            0.00
122.011              253.206           30.24
122.927              253.796           30.75

[5 rows x 22 columns]
```