In [4]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from pmdarima import auto_arima
from sklearn.metrics import mean_absolute_error, mean_squared_error
df = pd.read_csv("ML471_S4_Datafile_Concept.csv")
df['Datetime'] = pd.to_datetime(df['Datetime'])
df.set_index('Datetime', inplace=True)
```

In [5]:

```
data = df['Consumption']
data = data.dropna()
train_size = int(len(data) * 0.8)
train, test = data[:train_size], data[train_size:]
model = auto_arima(
    train,
    seasonal=True,
    m=12,
    trace=True,
    suppress_warnings=True,
    stepwise=True
)
print(model.summary())
```

```
Performing stepwise search to minimize aic
 ARIMA(2,0,2)(1,1,1)[12] intercept   : AIC=1363.466, Time=7.93 sec
 ARIMA(0,0,0)(0,1,0)[12] intercept   : AIC=1561.800, Time=0.09 sec
 ARIMA(1,0,0)(1,1,0)[12] intercept   : AIC=1413.742, Time=0.92 sec
 ARIMA(0,0,1)(0,1,1)[12] intercept   : AIC=1389.558, Time=0.61 sec
 ARIMA(0,0,0)(0,1,0)[12]             : AIC=1630.770, Time=0.09 sec
 ARIMA(2,0,2)(0,1,1)[12] intercept   : AIC=1361.476, Time=6.72 sec
 ARIMA(2,0,2)(0,1,0)[12] intercept   : AIC=1460.445, Time=0.86 sec
 ARIMA(2,0,2)(0,1,2)[12] intercept   : AIC=1363.458, Time=14.73 sec
 ARIMA(2,0,2)(1,1,0)[12] intercept   : AIC=1410.788, Time=1.97 sec
 ARIMA(2,0,2)(1,1,2)[12] intercept   : AIC=1364.602, Time=15.12 sec
 ARIMA(1,0,2)(0,1,1)[12] intercept   : AIC=1360.401, Time=2.53 sec
 ARIMA(1,0,2)(0,1,0)[12] intercept   : AIC=1460.030, Time=0.54 sec
 ARIMA(1,0,2)(1,1,1)[12] intercept   : AIC=1362.315, Time=4.35 sec
 ARIMA(1,0,2)(0,1,2)[12] intercept   : AIC=1362.275, Time=7.44 sec
 ARIMA(1,0,2)(1,1,0)[12] intercept   : AIC=1410.540, Time=1.58 sec
 ARIMA(1,0,2)(1,1,2)[12] intercept   : AIC=1363.088, Time=8.64 sec
 ARIMA(0,0,2)(0,1,1)[12] intercept   : AIC=1381.449, Time=1.01 sec
 ARIMA(1,0,1)(0,1,1)[12] intercept   : AIC=1369.107, Time=1.31 sec
 ARIMA(1,0,3)(0,1,1)[12] intercept   : AIC=1361.906, Time=6.77 sec
 ARIMA(0,0,3)(0,1,1)[12] intercept   : AIC=1372.386, Time=1.43 sec
 ARIMA(2,0,1)(0,1,1)[12] intercept   : AIC=1368.786, Time=1.90 sec
 ARIMA(2,0,3)(0,1,1)[12] intercept   : AIC=1363.644, Time=7.37 sec
 ARIMA(1,0,2)(0,1,1)[12]             : AIC=1364.129, Time=2.55 sec

Best model:  ARIMA(1,0,2)(0,1,1)[12] intercept
Total fit time: 96.548 seconds
                                      SARIMAX Results                                      
===================================================================================
===========
Dep. Variable:                                    y   No. Observations:                  
317
Model:             SARIMAX(1, 0, 2)x(0, 1, [1], 12)   Log Likelihood                  
-674.201
Date:                              Fri, 30 Jan 2026   AIC                             
1360.401
Time:                                      15:18:38   BIC                             
1382.723
Sample:                                  01-01-1988   HQIC                            
1369.329
                                       - 05-01-2014                                       
Covariance Type:                                opg                                       
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
intercept      0.1107      0.065      1.694      0.090      -0.017       0.239
ar.L1          0.9302      0.041     22.452      0.000       0.849       1.011
ma.L1         -0.3395      0.079     -4.320      0.000      -0.494      -0.186
ma.L2         -0.3424      0.067     -5.113      0.000      -0.474      -0.211
ma.S.L12      -0.6950      0.048    -14.535      0.000      -0.789      -0.601
sigma2         4.7445      0.286     16.580      0.000       4.184       5.305
===================================================================================
==
Ljung-Box (L1) (Q):                   0.05   Jarque-Bera (JB):                 56.
92
Prob(Q):                              0.82   Prob(JB):                          0.
00
Heteroskedasticity (H):               2.48   Skew:                             -0.
32
Prob(H) (two-sided):                  0.00   Kurtosis:                          5.
```

```
02
==============================================================================
==

Warnings:
[1] Covariance matrix calculated using the outer product of gradients (complex-st
ep).
```

In [6]:

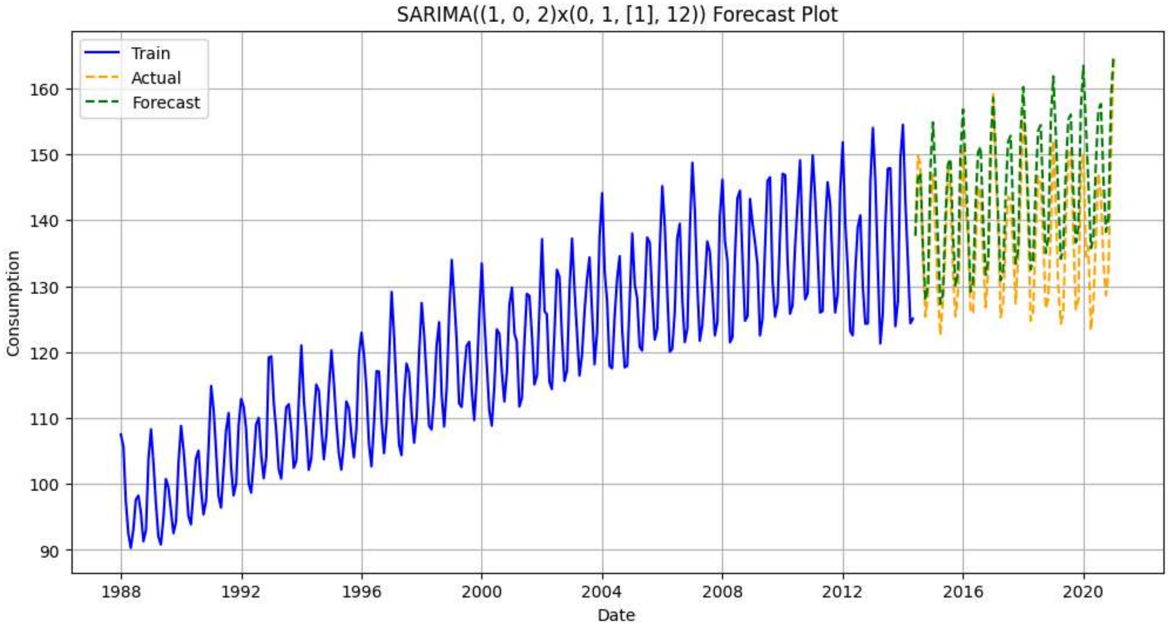
```
forecast = model.predict(n_periods=len(test))
forecast = pd.Series(forecast, index=test.index)
mae = mean_absolute_error(test, forecast)
mape = np.mean(np.abs((test - forecast) / test)) * 100
rmse = np.sqrt(mean_squared_error(test, forecast))

print(f"MAE  : {mae:.3f}")
print(f"MAPE : {mape:.2f}%")
print(f"RMSE : {rmse:.3f}")
```

```
MAE  : 6.687
MAPE : 4.91%
RMSE : 7.792
```

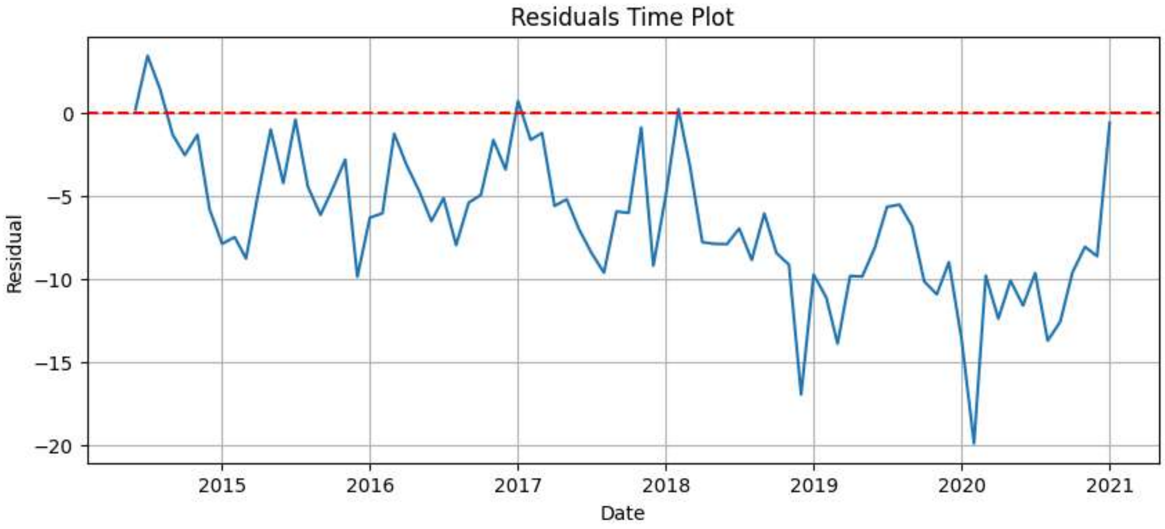
In [9]:

```
plt.figure(figsize=(12, 6))
plt.plot(train, label='Train', color='blue')
plt.plot(test, label='Actual', color='orange', linestyle='--')
plt.plot(forecast, label='Forecast', color='green', linestyle='--')
plt.title("SARIMA((1, 0, 2)x(0, 1, [1], 12)) Forecast Plot")
plt.xlabel("Date")
plt.ylabel("Consumption")
plt.legend()
plt.grid()
plt.show()
```



In [10]:

```
residuals = test - forecast
plt.figure(figsize=(10, 4))
plt.plot(residuals)
plt.axhline(0, linestyle='--', color='red')
plt.title("Residuals Time Plot")
plt.xlabel("Date")
plt.ylabel("Residual")
plt.grid()
plt.show()
```



```
In [ ]:
```