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## Loading Essential libraries

In [1]:

```
import pandas as pd
import numpy as np
import seaborn as sns
import scipy
from sklearn.neighbors import LocalOutlierFactor
import matplotlib.pyplot as plt
```

In [2]:

```
data=pd.read_excel("D://Exact space technologies//data.xlsx")
```

```
D:\Anaconda\lib\site-packages\openpyxl\worksheet\_read_only.py:79: UserWarning: Unknown extensio
n is not supported and will be removed
  for idx, row in parser.parse():
```

In [3]:

```
data.head()
```

Out[3]:

| | time | Cyclone_Inlet_Gas_Temp | Cyclone_Material_Temp | Cyclone_Outlet_Gas_draft | Cyclone_cone_draft | Cyclone |
|---|---|---|---|---|---|---|
| **0** | 2017-01-01 00:00:00 | 867.63 | 910.42 | -189.54 | -186.04 | |
| **1** | 2017-01-01 00:05:00 | 879.23 | 918.14 | -184.33 | -182.1 | |
| **2** | 2017-01-01 00:10:00 | 875.67 | 924.18 | -181.26 | -166.47 | |
| **3** | 2017-01-01 00:15:00 | 875.28 | 923.15 | -179.15 | -174.83 | |
| **4** | 2017-01-01 00:20:00 | 891.66 | 934.26 | -178.32 | -173.72 | |

In [4]:

```
data.shape
```

Out[4]:

```
(377719, 7)
```

In [5]:

```
data.dtypes
```

```
Out[5]: time                         datetime64[ns]
        Cyclone_Inlet_Gas_Temp               object
        Cyclone_Material_Temp                object
        Cyclone_Outlet_Gas_draft             object
        Cyclone_cone_draft                   object
        Cyclone_Gas_Outlet_Temp              object
        Cyclone_Inlet_Draft                  object
        dtype: object
```

### Converting the columns starting from two to six to float data type

```
In [4]: data['Cyclone_Inlet_Gas_Temp']=pd.to_numeric(data['Cyclone_Material_Temp'],errors='coerce')
        data['Cyclone_Material_Temp']=pd.to_numeric(data['Cyclone_Material_Temp'],errors='coerce')
        data['Cyclone_Outlet_Gas_draft']=pd.to_numeric(data['Cyclone_Outlet_Gas_draft'],errors='coerce')
        data['Cyclone_cone_draft']=pd.to_numeric(data['Cyclone_cone_draft'],errors='coerce')
        data['Cyclone_Gas_Outlet_Temp']=pd.to_numeric(data['Cyclone_Gas_Outlet_Temp'],errors='coerce')
        data['Cyclone_Inlet_Draft']=pd.to_numeric(data['Cyclone_Inlet_Draft'],errors='coerce')
```

```
In [5]: data.dtypes
```

```
Out[5]: time                         datetime64[ns]
        Cyclone_Inlet_Gas_Temp              float64
        Cyclone_Material_Temp               float64
        Cyclone_Outlet_Gas_draft            float64
        Cyclone_cone_draft                  float64
        Cyclone_Gas_Outlet_Temp             float64
        Cyclone_Inlet_Draft                 float64
        dtype: object
```

# Data Exploration

### I will be exploring the above dataset through summary statistics

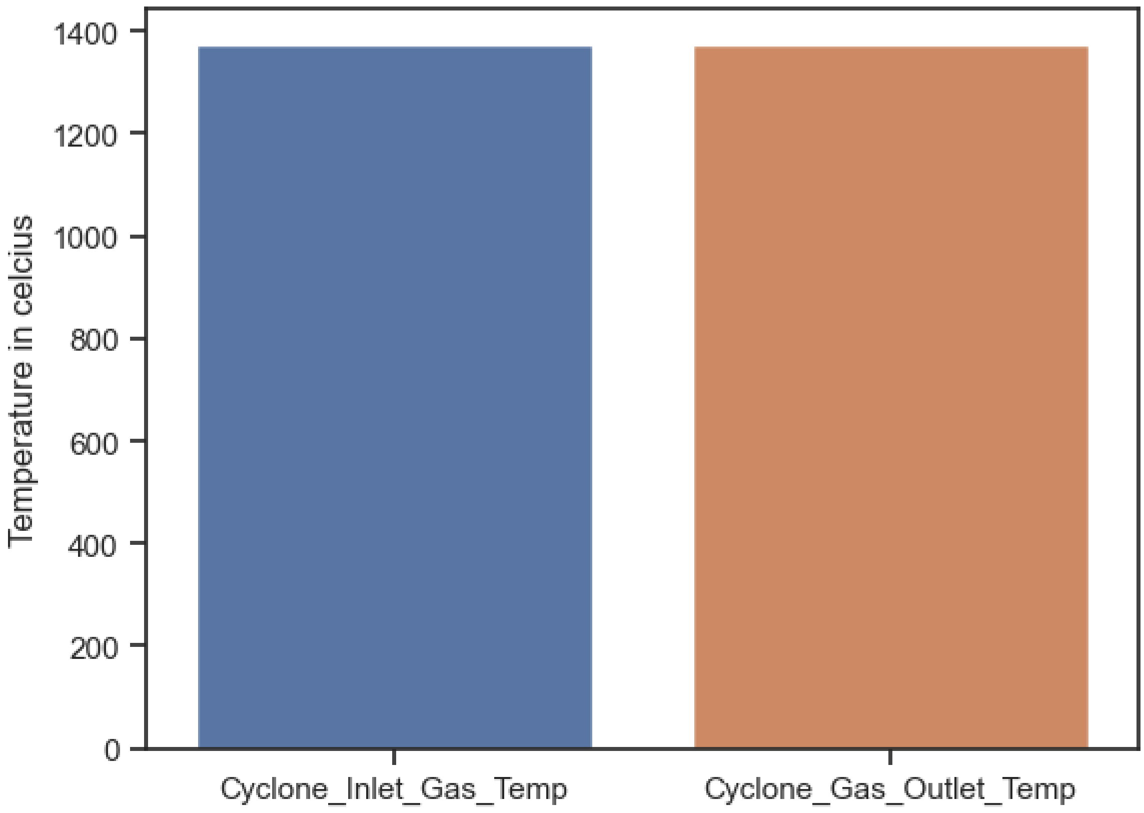
### 1:Maximum

### Finding out maximum amount temperature of hot gas that is entering into the cyclone and leaving out the cyclone.

### Finding out the maximum pressure that is present at outlet of cyclone, at cone section of cyclone and at inlet of the cyclone.

### Finding out maximum temperature of the material at the outlet of the cyclone.

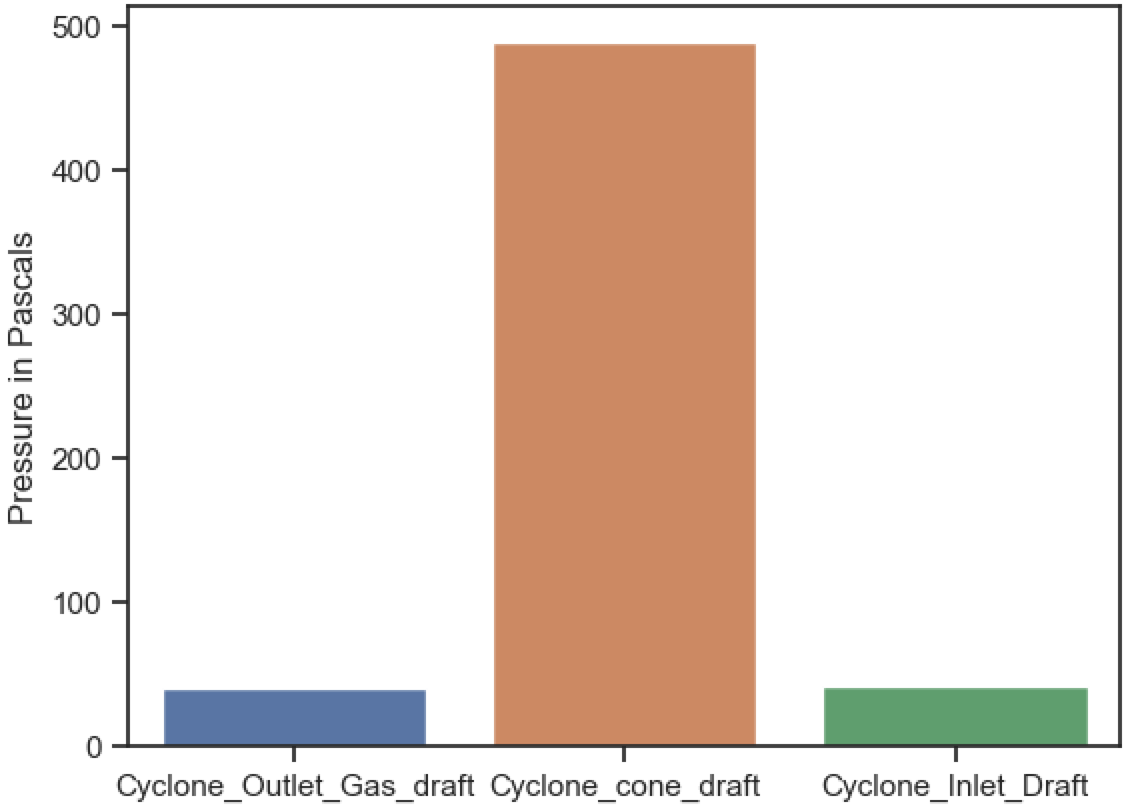
```
In [25]: r_data=data[['Cyclone_Inlet_Gas_Temp','Cyclone_Gas_Outlet_Temp']]
         max_values=r_data.max()
         sns.barplot(x=r_data.columns, y=max_values)
         plt.ylabel('Temperature in celcius')
         plt.show()
```



**Therefore the maximum temperature of hot gas that is entering into the cyclone and leaving out the cyclone is around 1300 degree celcius.**

In [26]:

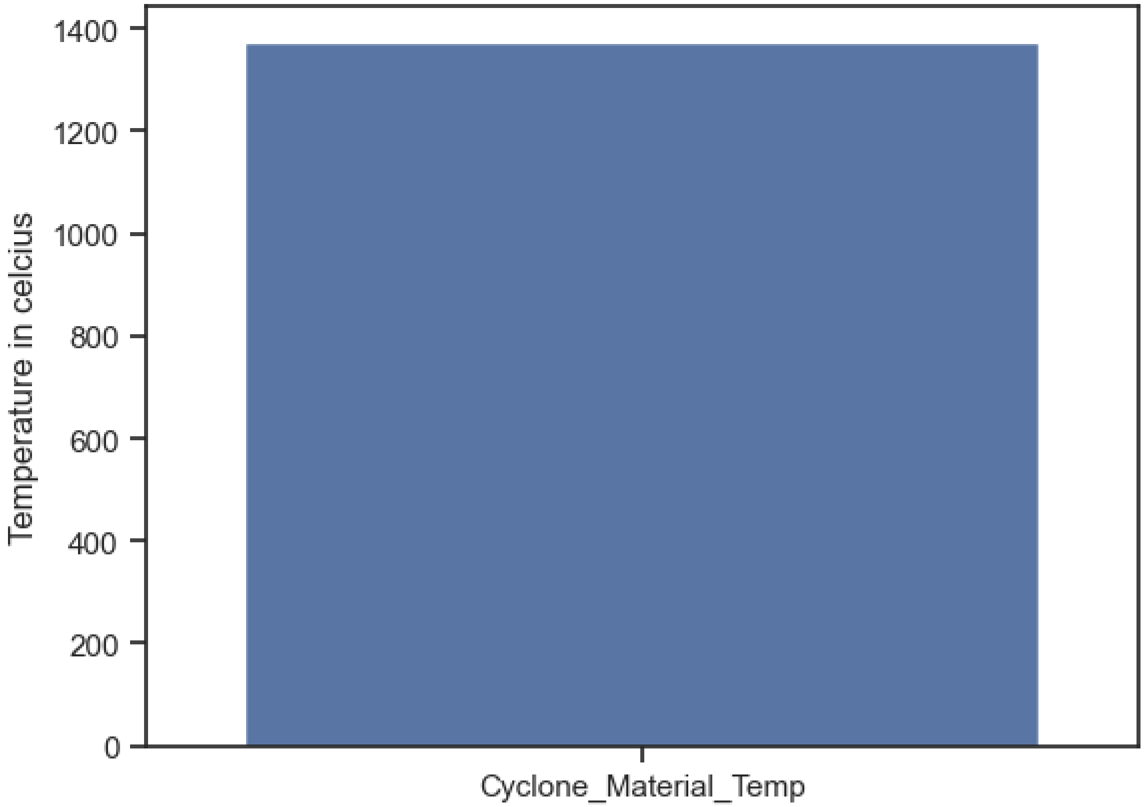
```
r_data=data[['Cyclone_Outlet_Gas_draft','Cyclone_cone_draft','Cyclone_Inlet_Draft']]
max_values=r_data.max()
sns.barplot(x=r_data.columns, y=max_values)
plt.ylabel("Pressure in Pascals")
plt.show()
```



### Maximum pressure that is present at outlet of cyclone, at cone section of cyclone and at inlet of the cyclone is 60, 500 and 60 pascals respectively¶

In [27]:
```
r_data=data[['Cyclone_Material_Temp']]
max_values=r_data.max()
sns.barplot(x=r_data.columns, y=max_values)
plt.ylabel("Temperature in celcius")
```

Out[27]:
```
Text(0, 0.5, 'Temperature in celcius')
```



### Maximum temperature of the material at the outlet of the cyclone is around 1300 degree celcius.

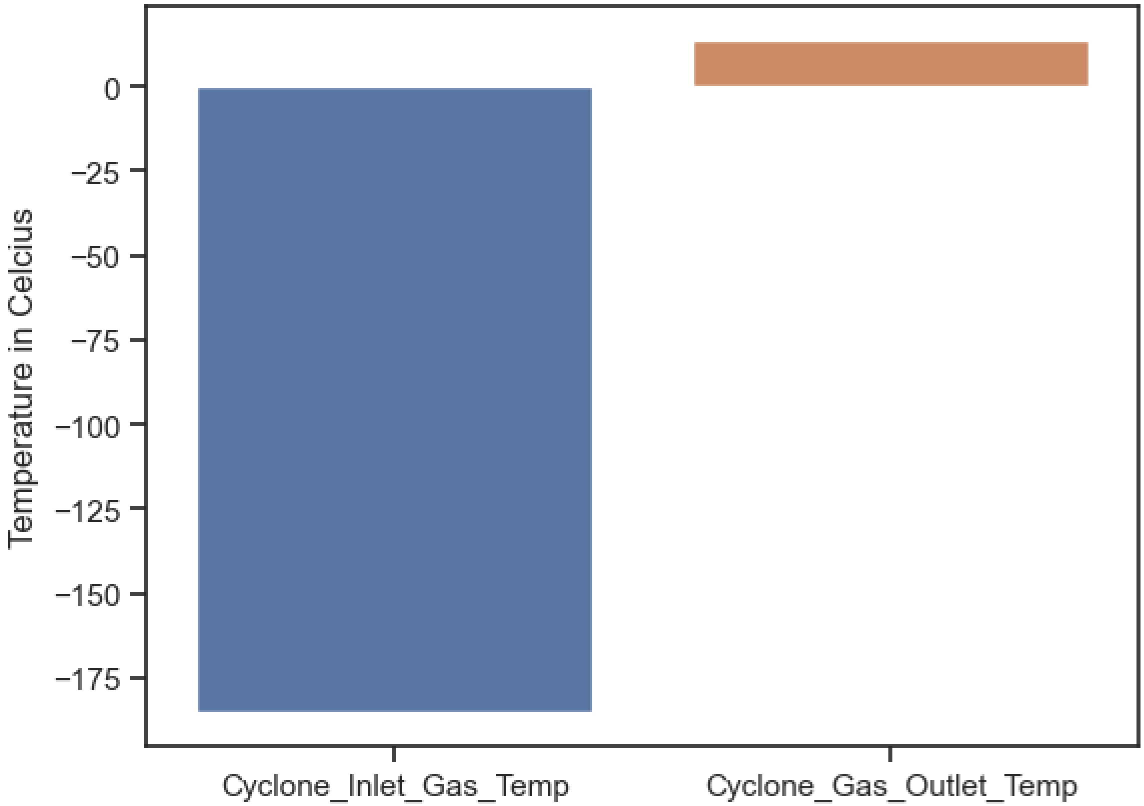
### 2: Minimum

### Finding out minimum amount temperature of hot gas that is entering into the cyclone and leaving out the cyclone.

### Finding out the minimum pressure that is present at outlet of cyclone, at cone section of cyclone and at inlet of the cyclone.

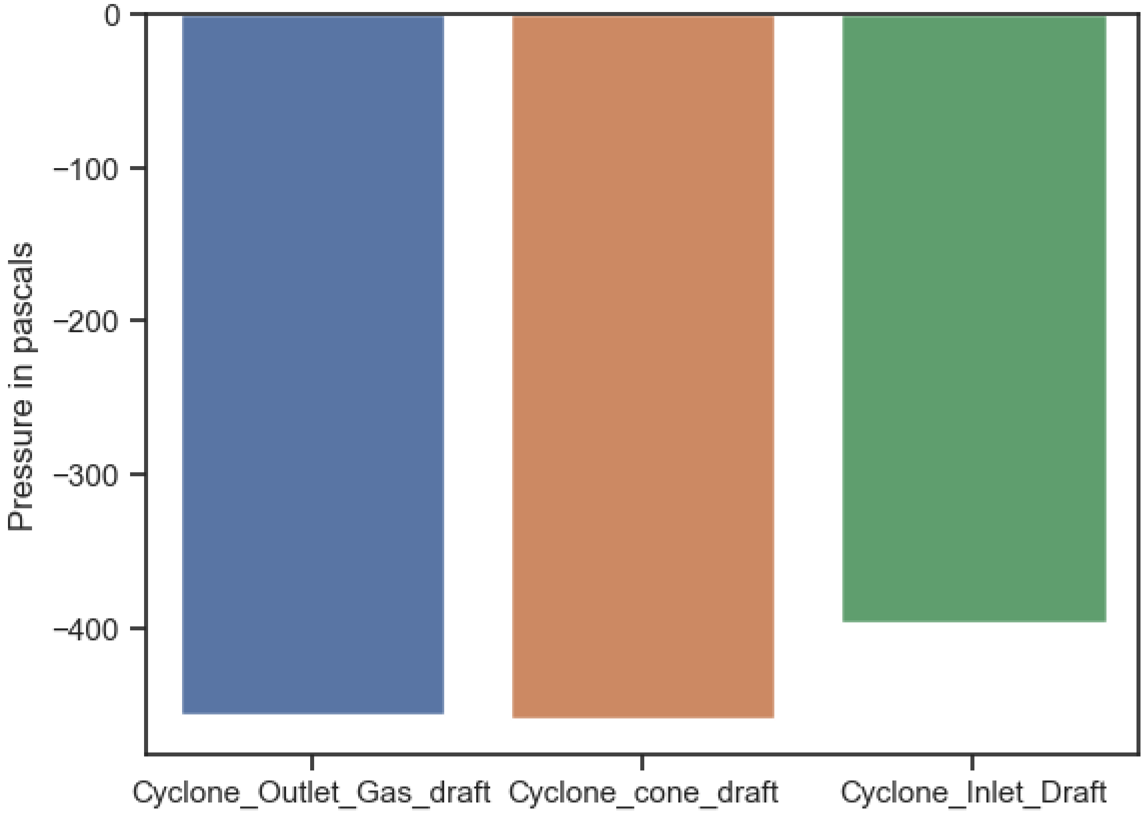
### Finding out minimum temperature of the material at the outlet of the cyclone.

In [28]:
```
r_data=data[['Cyclone_Inlet_Gas_Temp','Cyclone_Gas_Outlet_Temp']]
min_values=r_data.min()
sns.barplot(x=r_data.columns, y=min_values)
plt.ylabel("Temperature in Celcius")
plt.show()
```



### Minimum amount temperature of hot gas that is entering into the cyclone and leaving out the cyclone is -175 degree celcius and -15 degree celcius respectively¶

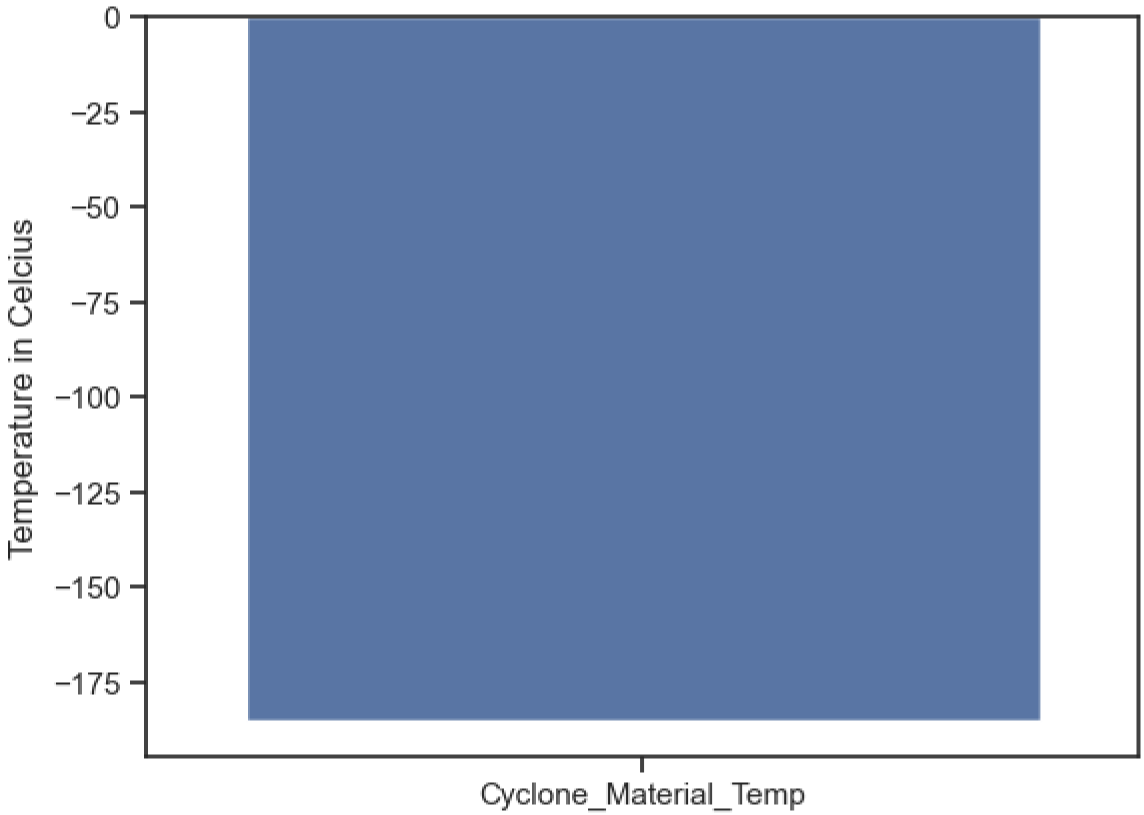
In [29]:
```
r_data=data[['Cyclone_Outlet_Gas_draft','Cyclone_cone_draft','Cyclone_Inlet_Draft']]
min_values=r_data.min()
sns.barplot(x=r_data.columns, y=min_values)
plt.ylabel("Pressure in pascals")
plt.show()
```



### Minimum pressure that is present at outlet of cyclone, at cone section of cyclone and at inlet of the cyclone is around -450 degree celcius , -470 degree celcius and -380 degree celcius respectively¶

In [30]:

```
r_data=data[['Cyclone_Material_Temp']]
min_values=r_data.min()
sns.barplot(x=r_data.columns, y=min_values)
plt.ylabel("Temperature in Celcius")
plt.show()
```



### Minimum temperature of the material at the outlet of the cyclone is -175 degree celcius.

#### 3: Average

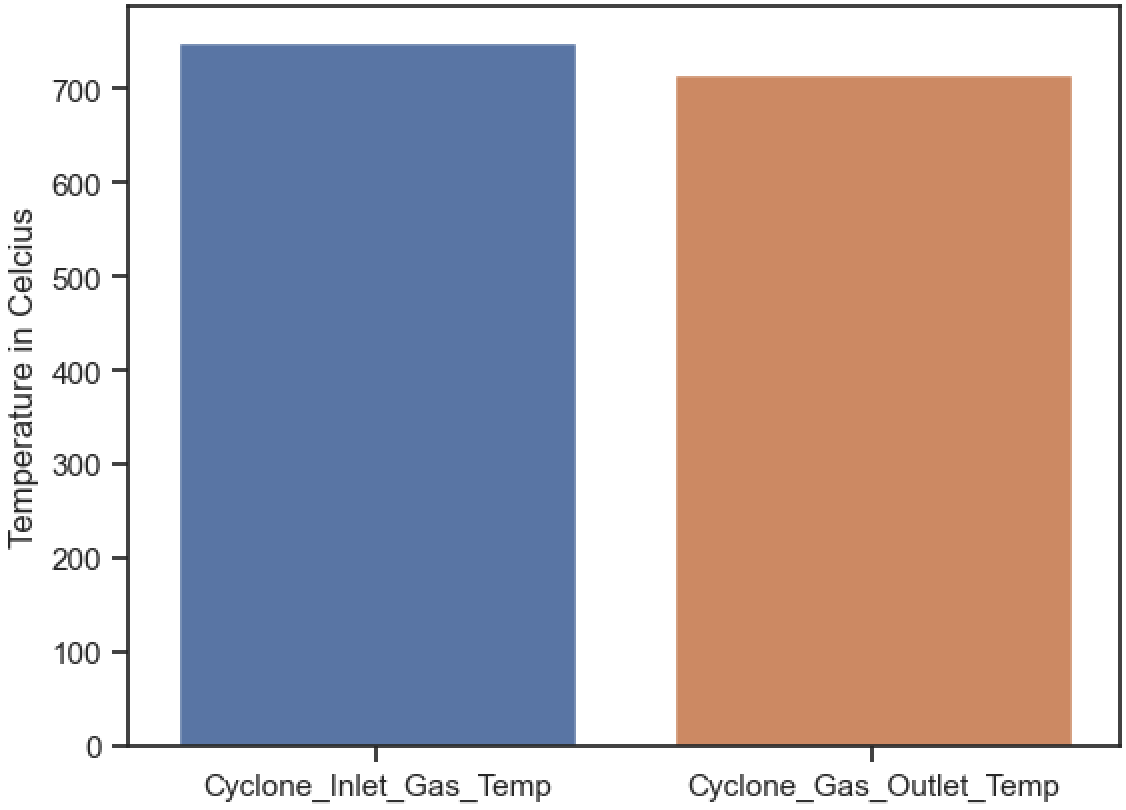
### Finding out average amount temperature of hot gas that is entering into the cyclone and leaving out the cyclone.

### Finding out the average pressure that is present at outlet of cyclone, at cone section of cyclone and at inlet of the cyclone.

### Finding out average temperature of the material at the outlet of the cyclone.

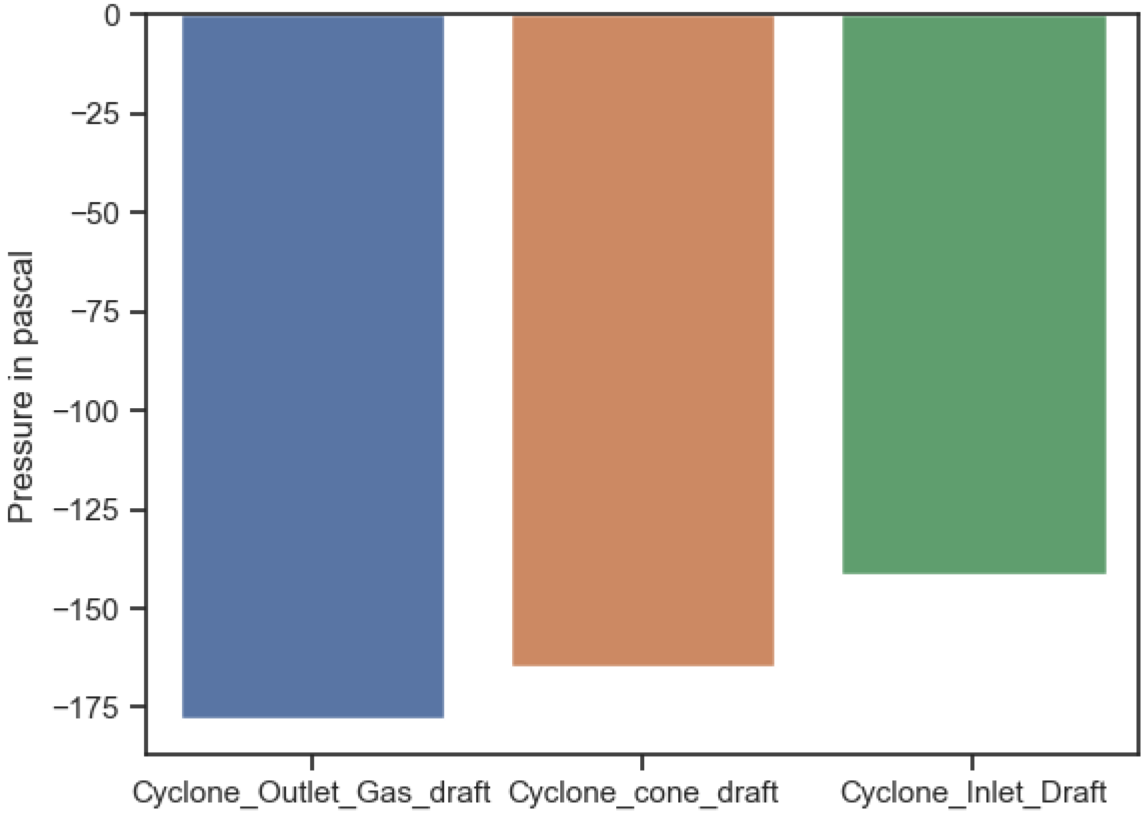
In [31]:

```
r_data=data[['Cyclone_Inlet_Gas_Temp','Cyclone_Gas_Outlet_Temp']]
mean_values=r_data.mean()
sns.barplot(x=r_data.columns, y=mean_values)
plt.ylabel("Temperature in Celcius")
plt.show()
```



### Average amount temperature of hot gas that is entering into the cyclone and leaving out the cyclone is around 700 degree celcius and 680 degree celcius.¶

In [32]:
```
r_data=data[['Cyclone_Outlet_Gas_draft','Cyclone_cone_draft','Cyclone_Inlet_Draft']]
mean_values=r_data.mean()
sns.barplot(x=r_data.columns, y=mean_values)
plt.ylabel("Pressure in pascal")
plt.show()
```



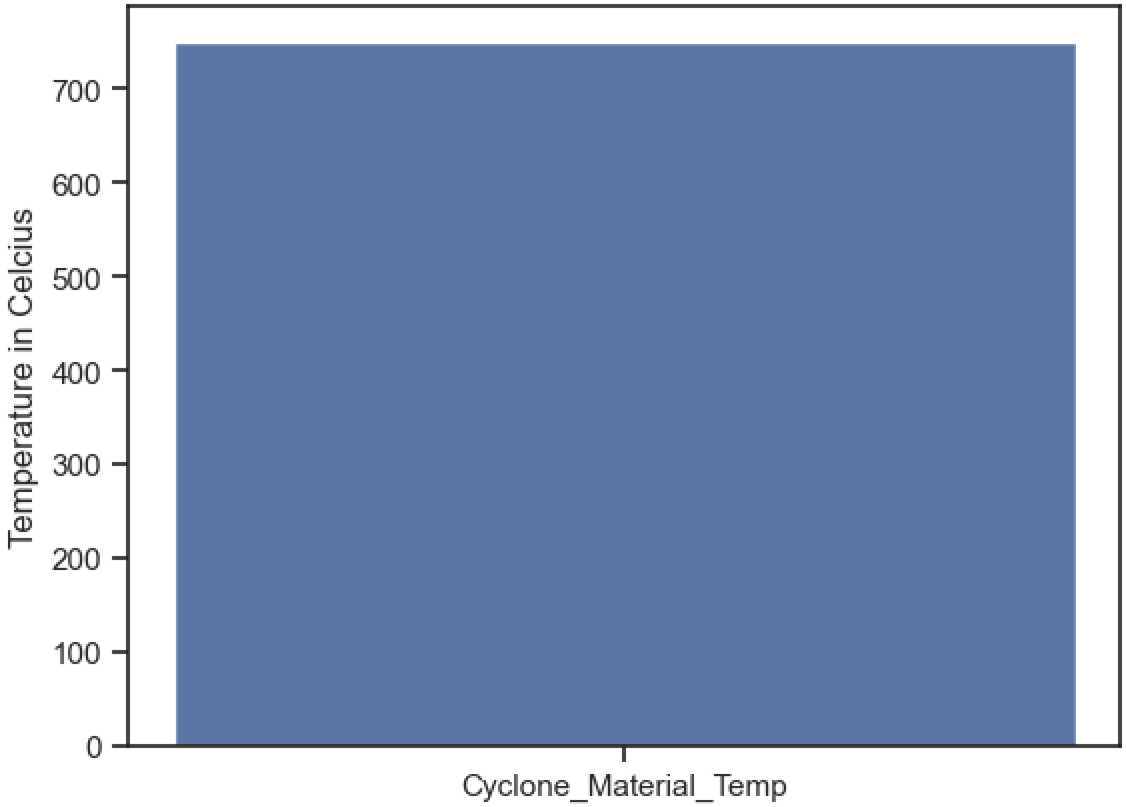
### Average pressure that is present at outlet of cyclone, at cone section of cyclone and at inlet of the cyclone is around -175 degree celcius, -160 degree celcius and -130 degree celcius respectively

In [33]:

```
r_data=data[['Cyclone_Material_Temp']]
mean_values=r_data.mean()
sns.barplot(x=r_data.columns, y=mean_values)
plt.ylabel("Temperature in Celcius")
plt.plot()
```

Out[33]:

```
[]
```

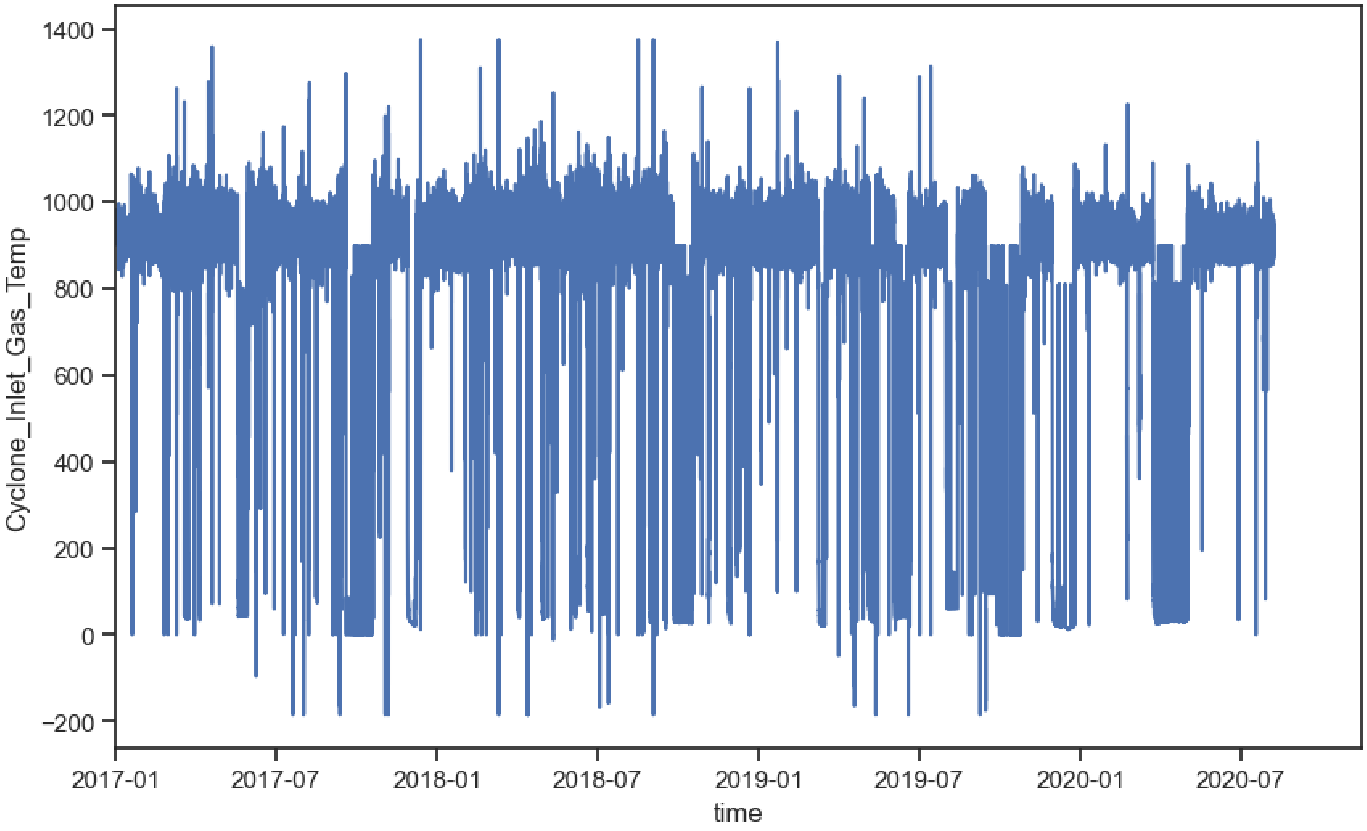


### Average temperature of the material at the outlet of the cyclone is around 720 degree celcius.

## I will be exploring the utilization of cyclone

In [19]:

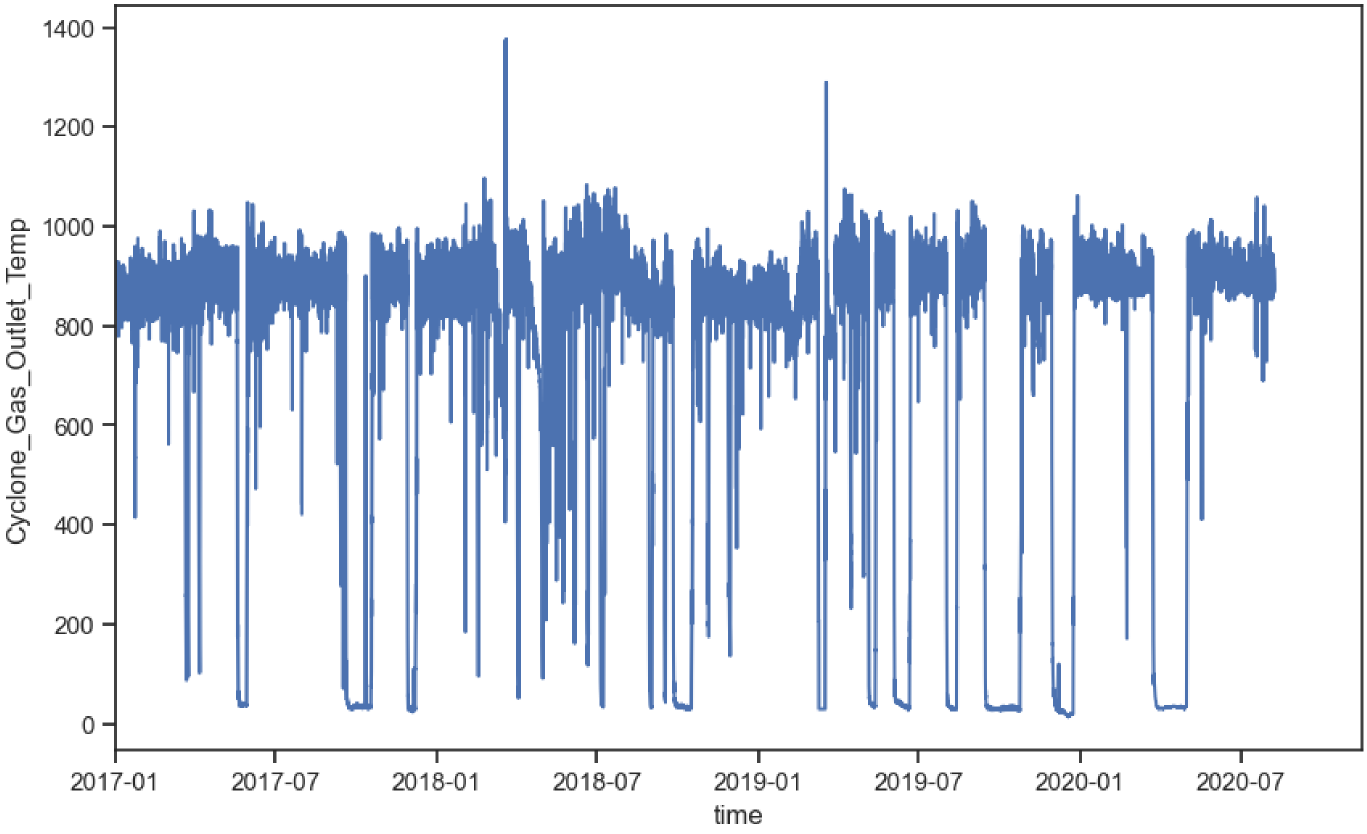
```
sns.set(style="ticks",color_codes=True)
plt.figure(figsize=(10, 6))
sns.lineplot(x=data['time'],y=data['Cyclone_Inlet_Gas_Temp'])
plt.xlim(data['time'].min(), data['time'].max() + pd.DateOffset(days=100))
plt.show()
```



### There is a complete utilization of cyclone during 2017-07 to 2018-01 at the time of hot gas entering into the cyclone

In [22]:

```
sns.set(style="ticks",color_codes=True)
plt.figure(figsize=(10, 6))
sns.lineplot(x=data['time'],y=data['Cyclone_Gas_Outlet_Temp'])
plt.xlim(data['time'].min(), data['time'].max() + pd.DateOffset(days=100))
plt.show()
```



### There is a complete utilisation of cyclone during 2018-01 to 2019-01 at the time of hot gas leaving the cyclone

## Data Preprocessing

### I will be checking the data if it has missing values

```
In [17]: data.isna().sum()
```

```
Out[17]: time                          0
         Cyclone_Inlet_Gas_Temp     1591
         Cyclone_Material_Temp      1591
         Cyclone_Outlet_Gas_draft   1321
         Cyclone_cone_draft         1320
         Cyclone_Gas_Outlet_Temp    1321
         Cyclone_Inlet_Draft        1322
         dtype: int64
```

### Since we have some missing values I will be filling those values using fillna method.

```
In [18]: df=data.fillna(method ='bfill')
```

```
In [19]: df.isna().sum()
```

```
Out[19]: time                        0
         Cyclone_Inlet_Gas_Temp      0
         Cyclone_Material_Temp       0
         Cyclone_Outlet_Gas_draft    0
         Cyclone_cone_draft          0
         Cyclone_Gas_Outlet_Temp     0
         Cyclone_Inlet_Draft         0
         dtype: int64
```

## Comming to actutal problem

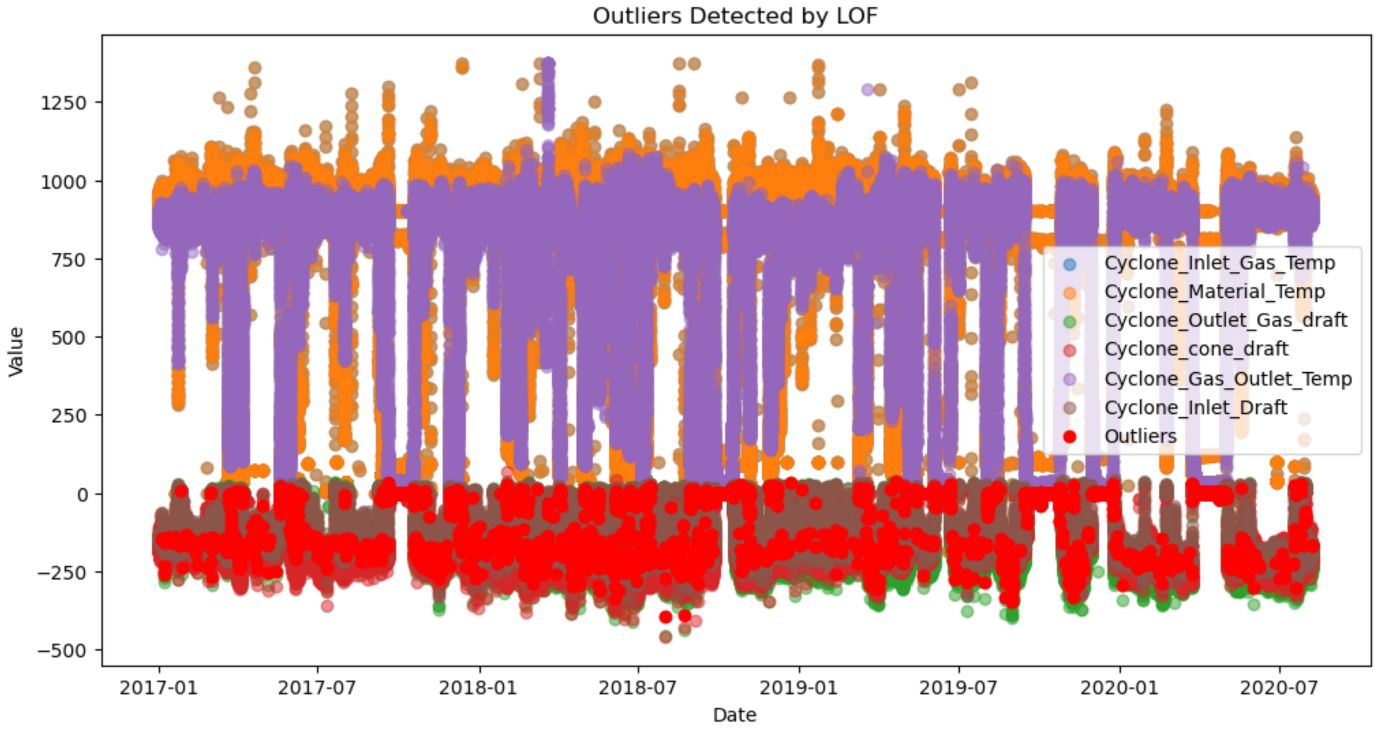
### The main objective is to highlight the time periods where abnormality can be observed. For that I need to use some anamoly/outlier based detection methods.I will be using Local outlier factor which is a density based outlier detection

```
In [51]: required=['Cyclone_Inlet_Gas_Temp','Cyclone_Material_Temp','Cyclone_Outlet_Gas_draft','Cyclone_c
                     'Cyclone_Inlet_Draft']

         # Extract the "Date" column
         date_column = df['time']

         # Selecting the data for outlier detection
         data_for_outliers = df[required]

         # Calculate the LOF scores for each sample in the dataset
         lof = LocalOutlierFactor(n_neighbors=20)
         outlier_scores = lof.fit_predict(data_for_outliers)
```

```
# Identify the outliers based on their LOF scores
outliers = df[outlier_scores == -1]
```

```
In [54]: # Plot the outliers corresponding to each date
plt.figure(figsize=(12, 6))
for column in required:
    plt.scatter(date_column, data[column], label=column, alpha=0.5)
plt.scatter(outliers['time'], outliers[column], color='r', label='Outliers')
plt.xlabel('Date')
plt.ylabel('Value')
plt.legend()
plt.title('Outliers Detected by LOF')
plt.show()
```

```
D:\Anaconda\lib\site-packages\IPython\core\pylabtools.py:151: UserWarning:

Creating legend with loc="best" can be slow with large amounts of data.
```



# Conclusion

1.The above plot is obtained by using scatter plot. As you can see that the points highligted in red are all outliers. The other points are considered as normal points.

2. We can clearly obeserve that there are abnormalities that are ouccrring quite frequently.So we cannot find out a particular date an abnormality is happening during operation.

3. We can observe collective outliers at negative values rather than positive values which might contribute to the abnormality frequently during operation.

4. Intensive handling should be done to prevent abnormality to certain extent.

note: I used plotify earlier for iteractive plots. But the problem is the plot wont be embedded into the notebook and should be ran each time when the jupyter notebook is opened. So I used seaborn and matplotlib