Importing libraries

In [4]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.linear_model import LinearRegression
from sklearn.ensemble import RandomForestRegressor
from sklearn.metrics import mean_squared_error, r2_score
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
```

Reading data

In [5]:

```
df = pd.read_csv('well2.csv')
df_1 = pd.read_csv('well 16A.csv')
df_2 = pd.read_excel("well F-4.xlsx", sheet_name='Drilling Parameters')
```

In [6]:

```
df.head()
```

Out[6]:

	Depth (ft)	Weight on bit (k-lbs)	Hook load (k-lbs)	Surface Torque (psi)	Rotary Speed (rpm)	Flow In (gal/min)	ROP (ft/hr)
0	91.39	0.76	29.33	8.97	62.07	1102.06	450.72
1	97.75	2.13	27.96	8.97	56.05	1103.28	348.28
2	114.50	2.82	27.27	8.82	97.45	1066.39	368.77
3	117.63	0.61	29.48	8.82	89.82	1073.92	348.28
4	286.71	6.08	74.32	11.22	0.00	1037.12	58.22

In [7]:

```
df_1.sample(6)
```

Out[7]:

	Time	Total Depth	Block Position	Weight on Bit	Hookload	ROP Depth/Hour	Top Drive RPM	Top Drive Torque (ft-lbs)	Flow In	Return Flow
336487	12/11/2020 18:35	8535.0	84.70821	208.38437	44.48251	0.0	0.15080	0.0	43.50702	42.35579
449167	12/29/2020 10:53	10987.0	52.04353	16.33865	202.74973	0.0	0.41245	0.0	0.00000	1.43153
479308	1/4/2021 20:57	10987.0	40.60451	186.10196	40.30299	0.0	0.00000	0.0	0.00000	0.00000
333365	12/11/2020 9:52	8535.0	84.72376	212.70111	40.17505	0.0	0.37219	0.0	0.00000	2.76115
111872	11/11/2020 14:20	5113.0	78.11756	172.26292	43.54425	0.0	0.21118	0.0	0.00000	53.22832
436017	12/27/2020 0:51	10987.0	4.07331	1.86132	36.12347	0.0	0.15080	0.0	0.00000	2.55400

First model

Merge two data sets into new data set

In [8]:

```
ROP = df['ROP (ft/hr)'].append(df_1['ROP Depth/Hour'])
rpm = df['Rotary Speed (rpm)'].append(df_1['Top Drive RPM'])
WOB = df['Weight on bit (k-lbs)'].append(df_1['Weight on Bit'])
Torque = df['Surface Torque (psi)'].append(df_1['Top Drive Torque (ft-lbs)'])
```

```
C:\Users\IT_Center\AppData\Local\Temp\ipykernel_3252\2023585234.py:1: FutureWarning: The series.append method is deprecated and
will be removed from pandas in a future version. Use pandas.concat instead.
  ROP = df['ROP (ft/hr)'].append(df_1['ROP Depth/Hour'])
C:\Users\IT_Center\AppData\Local\Temp\ipykernel_3252\2023585234.py:2: FutureWarning: The series.append method is deprecated and
will be removed from pandas in a future version. Use pandas.concat instead.
  rpm = df['Rotary Speed (rpm)'].append(df_1['Top Drive RPM'])
C:\Users\IT_Center\AppData\Local\Temp\ipykernel_3252\2023585234.py:3: FutureWarning: The series.append method is deprecated and
will be removed from pandas in a future version. Use pandas.concat instead.
  WOB = df['Weight on bit (k-lbs)'].append(df_1['Weight on Bit'])
C:\Users\IT_Center\AppData\Local\Temp\ipykernel_3252\2023585234.py:4: FutureWarning: The series.append method is deprecated and
will be removed from pandas in a future version. Use pandas.concat instead.
  Torque = df['Surface Torque (psi)'].append(df_1['Top Drive Torque (ft-lbs)'])
```

In [6]:

```
print(len(ROP))
print(len(rpm))
print(len(WOB))
print(len(Torque))
```

```
491141
491141
491141
491141
```

In [10]:

```
data = pd.DataFrame({'ROP':ROP, 'rpm': rpm, 'WOB': WOB, 'Torque': Torque})
```

In [11]:

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 491141 entries, 0 to 484031
Data columns (total 4 columns):
 #   Column  Non-Null Count   Dtype  
---  ------  --------------   -----  
 0   ROP     491140 non-null  float64
 1   rpm     491140 non-null  float64
 2   WOB     491140 non-null  float64
 3   Torque  491140 non-null  float64
dtypes: float64(4)
memory usage: 18.7 MB
```

In [12]:

```
data = data.dropna()
data.sample(20)
```

Out[12]:

	ROP	rpm	WOB	Torque
221228	0.00000	0.23131	155.89081	0.0000
79453	0.00000	0.55333	149.07356	0.0000
304878	0.00000	0.19106	174.25092	0.0000
477301	0.00000	0.11055	185.18495	0.0000
462937	0.00000	0.05017	183.67418	1922.3568
67183	23.89062	73.59242	37.78608	3718.3967
20011	0.00000	0.16929	0.11667	0.0000
459589	0.00000	0.03004	183.32132	0.0000
435527	0.00000	0.41245	0.38516	0.0000
342181	116.74545	69.54699	37.58836	10228.2820
14721	0.00000	0.45113	6.67081	0.0000
82518	26.56556	39.63900	44.25723	3963.4033
15121	0.00000	0.45113	6.38984	0.0000
208752	47.23237	49.27960	45.57443	5372.6973
336298	0.00000	0.31182	208.91124	0.0000
372246	67.20520	64.95815	39.04610	11595.0550
66779	37.31055	77.03404	33.87355	4384.5720
20880	0.00000	0.14916	0.96471	0.0000
402141	0.00000	51.11111	2.19461	11979.7750
292240	0.00000	14.76264	13.24668	7616.2285

Make standard scaler to data

In [14]:

```
target_1 = data['Torque']
inputs_1 = data[['ROP', 'rpm','WOB']]
```

In [16]:

```
scaler_standard = StandardScaler()
input_scaled = scaler_standard.fit_transform(inputs_1)
```

In [17]:

```
X_train, X_test, y_train, y_test = train_test_split(input_scaled, target_1, test_size=0.2)
```

Train the model

In [18]:

```
Reg = RandomForestRegressor()
Reg.fit(X_train, y_train)
Reg.score(X_test, y_test)
```

Out[18]:

```
0.8632196199836359
```

In [19]:

```
y_pred = Reg.predict(X_test)
```

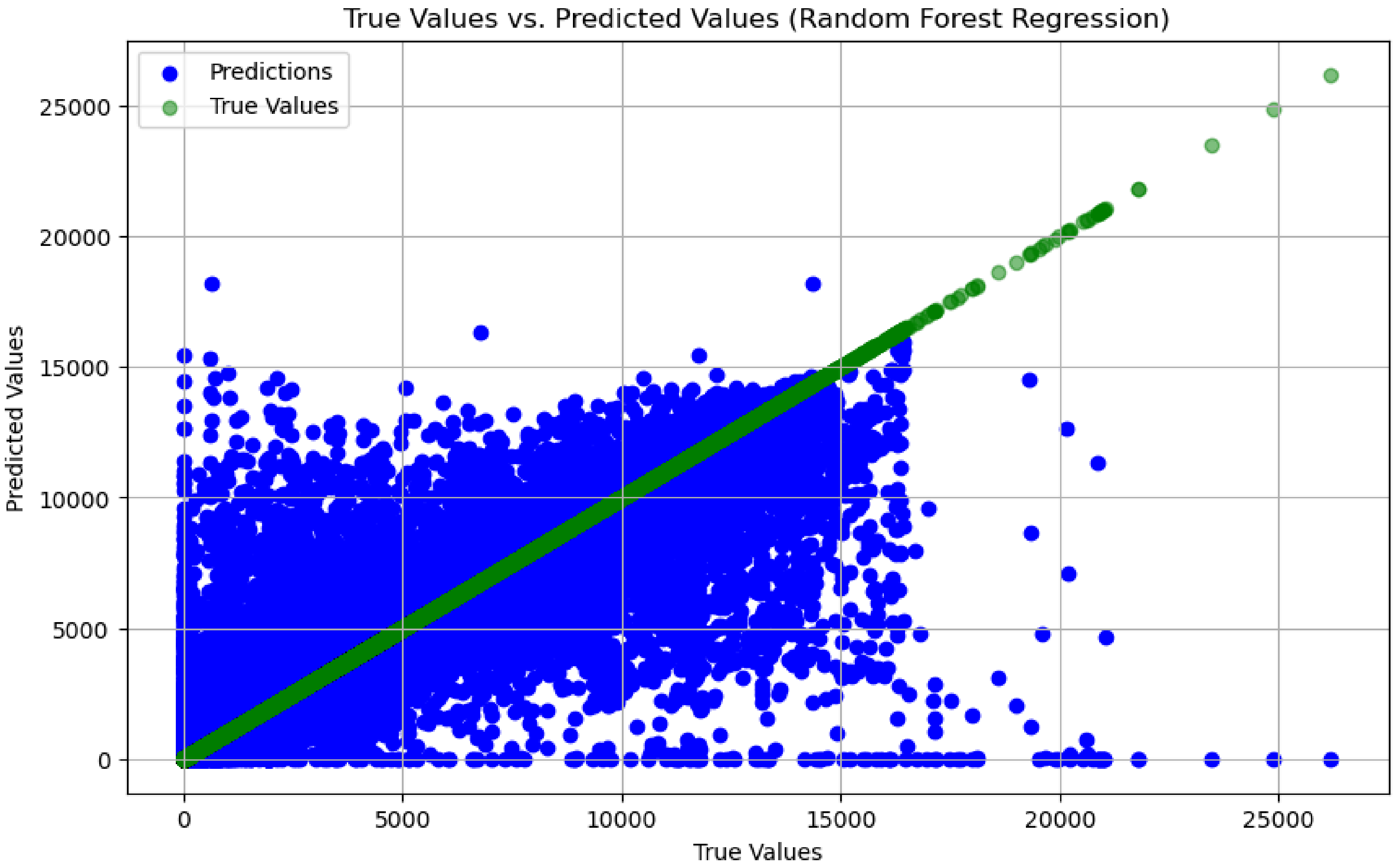
In [20]:

```
r2 = r2_score(y_test, y_pred)
mse = mean_squared_error(y_test, y_pred)
```

Visualize model performance

In [21]:

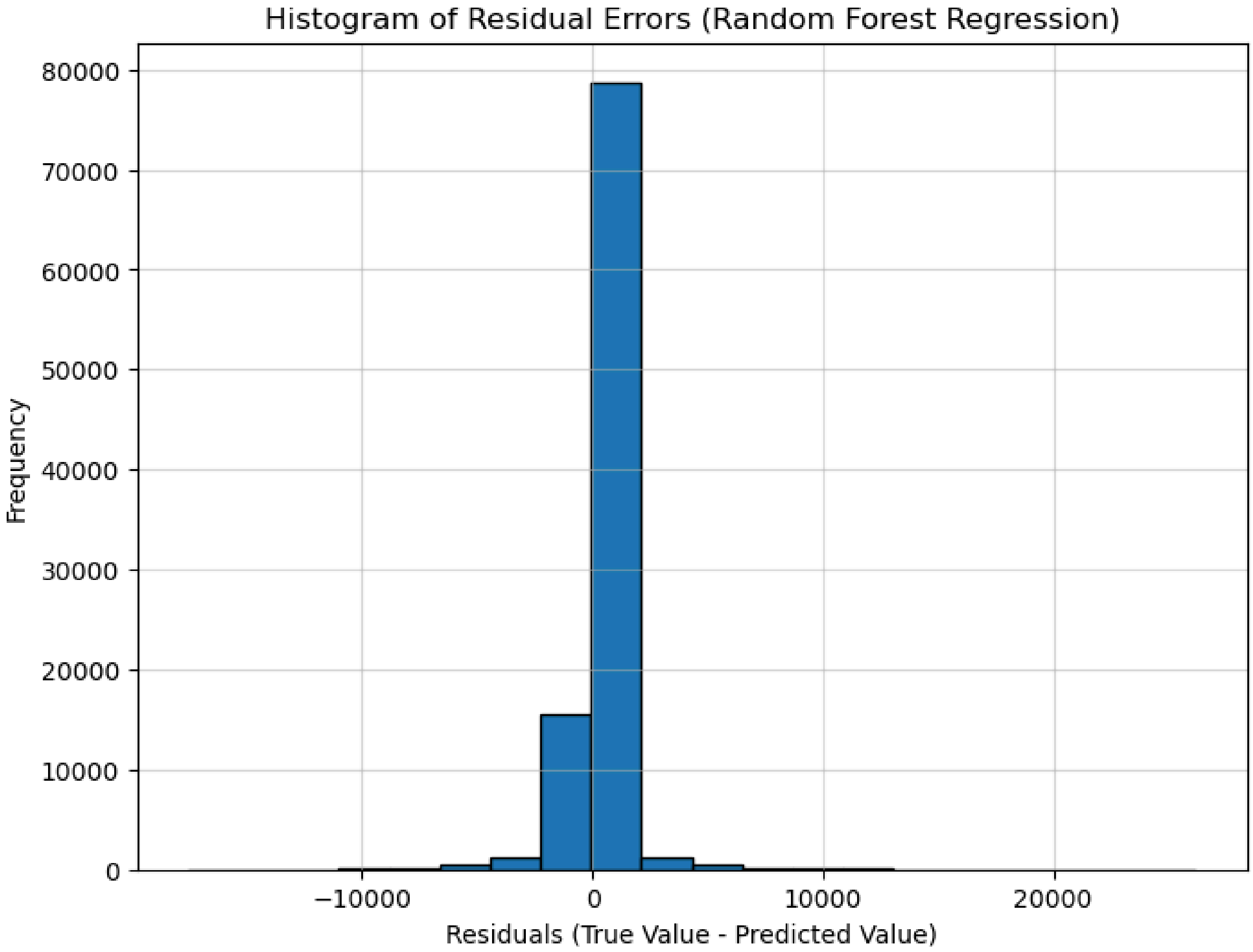
```
plt.figure(figsize=(10, 6))
plt.scatter(y_test, y_pred, color='blue', label='Predictions')
plt.scatter(y_test, y_test, color='green', label='True Values', alpha=0.5)
plt.xlabel('True Values')
plt.ylabel('Predicted Values')
plt.title('True Values vs. Predicted Values (Random Forest Regression)')
plt.legend()
plt.grid(True)
plt.show()
```



In [22]:

```
residuals = y_test - y_pred

plt.figure(figsize=(8, 6))
plt.hist(residuals, bins=20, edgecolor='black')
plt.xlabel('Residuals (True Value - Predicted Value)')
plt.ylabel('Frequency')
plt.title('Histogram of Residual Errors (Random Forest Regression)')
plt.grid(True, alpha=0.5)
plt.show()
```



Model score

```
In [25]: print(f'model score is {np.round(r2*100,2)} %', f'\nmean square error {np.round(mse,2)}') # add round
```

```
model score is 86.32 %
mean square error 1345890.43
```

Second model

Check data quality

In [26]:
```
df_1.isnull().sum()
```

Out[26]:
```
Time                             0
Total Depth                      1
Block Position                   0
Weight on Bit                    1
Hookload                         1
ROP Depth/Hour                   1
Top Drive RPM                    1
Top Drive Torque (ft-lbs)        1
Flow In                       1012
Return Flow                      1
dtype: int64
```

In [27]:
```
df_1 = df_1.dropna()
```

In [28]:
```
df_1.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 483019 entries, 0 to 484031
Data columns (total 10 columns):
 #   Column                     Non-Null Count   Dtype  
---  ------                     --------------   -----  
 0   Time                       483019 non-null  object 
 1   Total Depth                483019 non-null  float64
 2   Block Position             483019 non-null  float64
 3   Weight on Bit              483019 non-null  float64
 4   Hookload                   483019 non-null  float64
 5   ROP Depth/Hour             483019 non-null  float64
 6   Top Drive RPM              483019 non-null  float64
 7   Top Drive Torque (ft-lbs)  483019 non-null  float64
 8   Flow In                    483019 non-null  float64
 9   Return Flow                483019 non-null  float64
dtypes: float64(9), object(1)
memory usage: 40.5+ MB
```

In [29]:
```
df_2.isnull().sum()
```

Out[29]:
```
Depth          0
TVD           21
ROP           21
WOB           21
Torque        21
RPm           21
SPP           21
Flow pumps    21
Tot Gas       21
mW IN         21
D Exp         21
dtype: int64
```

In [30]:
```
df_2.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 675 entries, 0 to 674
Data columns (total 11 columns):
 #   Column      Non-Null Count  Dtype 
---  ------      --------------  ----- 
 0   Depth       675 non-null    object
 1   TVD         654 non-null    object
 2   ROP         654 non-null    object
 3   WOB         654 non-null    object
 4   Torque      654 non-null    object
 5   RPm         654 non-null    object
 6   SPP         654 non-null    object
 7   Flow pumps  654 non-null    object
 8   Tot Gas     654 non-null    object
 9   mW IN       654 non-null    object
 10  D Exp       654 non-null    object
dtypes: object(11)
memory usage: 58.1+ KB
```

In [31]:
```
df_2 = df_2.dropna()
```

In [32]:
```
target_2 = df_1['Hookload']
inputs_2 = df_1[['Weight on Bit', 'ROP Depth/Hour', 'Top Drive Torque (ft-lbs)', 'Flow In', 'Block Position', 'Top Drive RPM']]
```

In [33]:
```
X_train_1, X_test_1, y_train_1, y_test_1 = train_test_split(inputs_2, target_2, test_size=0.2)
```

Model training

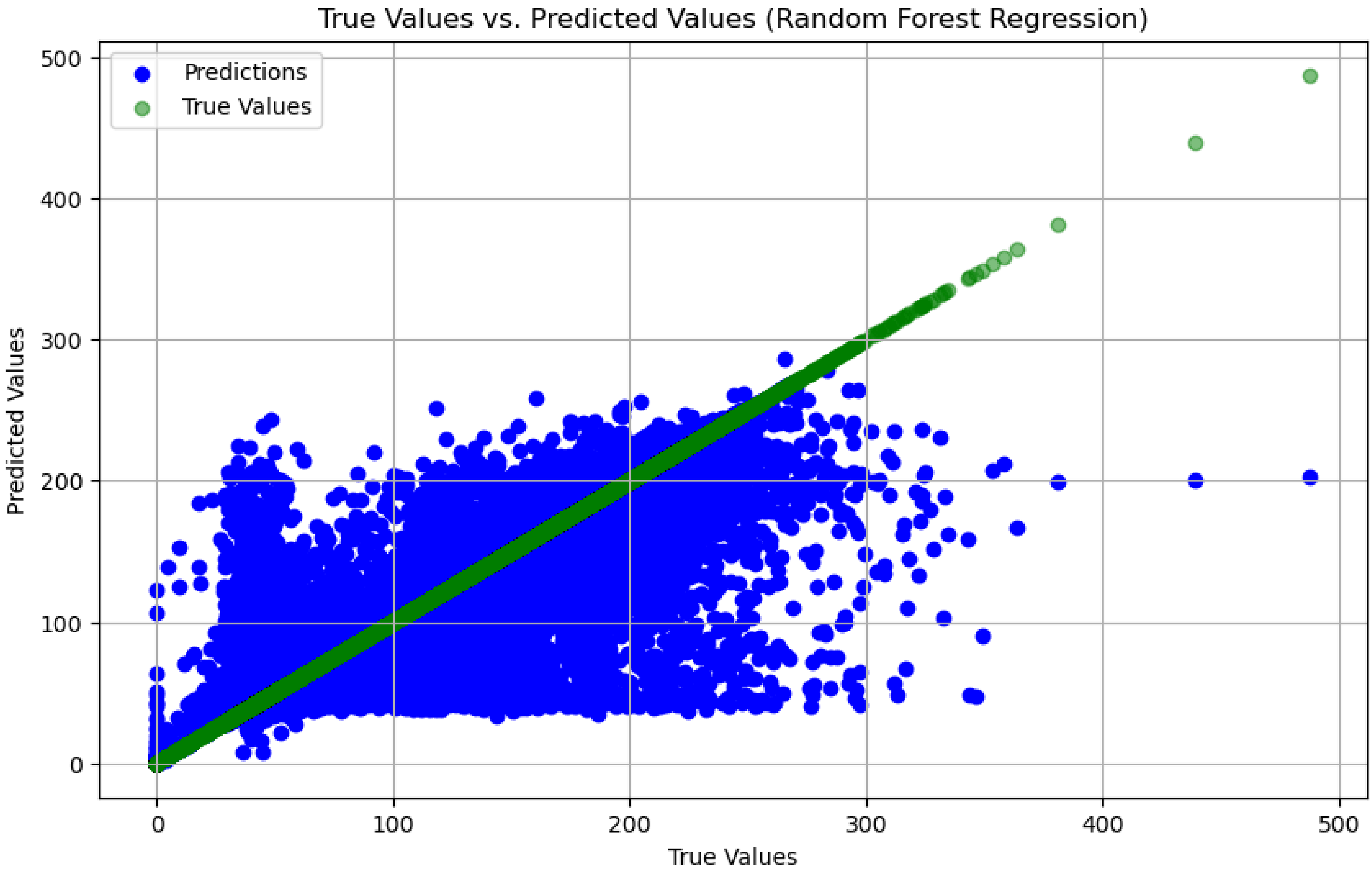
In [34]:
```
model = RandomForestRegressor()
model.fit(X_train_1, y_train_1)
model.score(X_test_1, y_test_1)
```

Out[34]:
```
0.9425561210883305
```

In [35]:
```
y_pred_1 = model.predict(X_test_1)
```

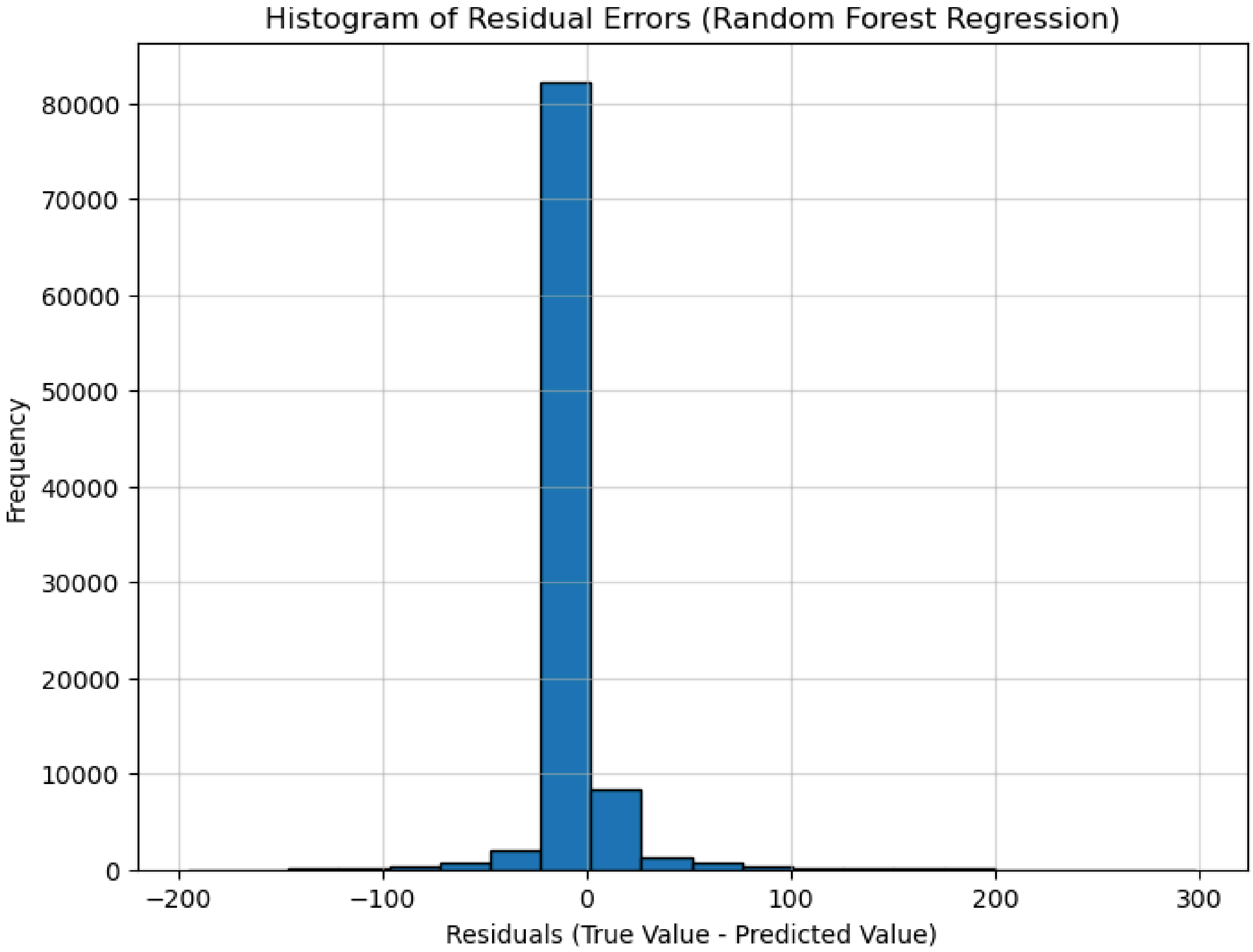
Visualize model performance

In [36]:
```
plt.figure(figsize=(10, 6))
plt.scatter(y_test_1, y_pred_1, color='blue', label='Predictions')
plt.scatter(y_test_1, y_test_1, color='green', label='True Values', alpha=0.5)
plt.xlabel('True Values')
plt.ylabel('Predicted Values')
plt.title('True Values vs. Predicted Values (Random Forest Regression)')
plt.legend()
plt.grid(True)
plt.show()
```



In [37]:
```
residuals = y_test_1 - y_pred_1

plt.figure(figsize=(8, 6))
plt.hist(residuals, bins=20, edgecolor='black')
plt.xlabel('Residuals (True Value - Predicted Value)')
plt.ylabel('Frequency')
plt.title('Histogram of Residual Errors (Random Forest Regression)')
plt.grid(True, alpha=0.5)
plt.show()
```



In [38]:
```
r2_1 = r2_score(y_test_1, y_pred_1)
mse_1 = mean_squared_error(y_test_1, y_pred_1)
```

model score

In [40]:
```
print(f'model score is {np.round(r2_1*100, 2)} %', f'\nmean square error {np.round(mse_1,2)}') # add round
```

```
model score is 94.26 %
mean square error 314.36
```

Third model

In [41]:

```
# df_2 = df_2.iloc[1:] #uncomment to remove first row
df_2
```

Out[41]:

	Depth	TVD	ROP	WOB	Torque	RPm	SPP	Flow pumps	Tot Gas	mW IN	D Exp
22	255	255	101.54	6.63	1.38	150	86.4	3675	0	1.03	0.66
23	260	260	78.68	5.52	4.8	150	91.9	3675	0	1.03	0.7
24	265	265	45.84	2.39	3.58	150	90.5	3675	0	1.03	0.68
25	270	270	37.43	2.46	4.16	150	90.9	3675	0	1.03	0.72
26	275	275	28.63	2.47	3.4	138	77.9	3278	0	1.03	0.89
...	...	...	...	...	...	...	...	...	...	...	...
670	3495	3091.82	27.88	3.57	21.72	140	209.1	2227	0.28	1.4	0.74
671	3500	3094.85	27.82	3.57	21.45	140	209.9	2227	0.3	1.4	0.74
672	3505	3097.87	28.21	3.6	21.62	140	209.4	2227	0.27	1.4	0.74
673	3510	3100.9	19.33	5.9	22.39	140	209.3	2227	0.2	1.4	0.91
674	3515	3103.93	20.43	6.15	22.39	140	208.9	2227	0.15	1.4	0.9

653 rows × 11 columns

In [42]:

```
df_2.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 653 entries, 22 to 674
Data columns (total 11 columns):
 #   Column       Non-Null Count  Dtype 
---  ------       --------------  ----- 
 0   Depth        653 non-null    object
 1   TVD          653 non-null    object
 2   ROP          653 non-null    object
 3   WOB          653 non-null    object
 4   Torque       653 non-null    object
 5   RPm          653 non-null    object
 6   SPP          653 non-null    object
 7   Flow pumps   653 non-null    object
 8   Tot Gas      653 non-null    object
 9   mW IN        653 non-null    object
 10  D Exp        653 non-null    object
dtypes: object(11)
memory usage: 61.2+ KB
```

convert features to approprete data type

In [43]:

```
df_2['SPP'] = df_2['SPP'].astype(float)
df_2['Flow pumps'] = df_2['Flow pumps'].astype(float)
df_2['ROP'] = df_2['ROP'].astype(float)
df_2['WOB'] = df_2['WOB'].astype(float)
```

In [44]:

```
target_3 = df_2['SPP']
inputs_3 = df_2[['Flow pumps', 'ROP', 'WOB']]
```

In [45]:

```
X_train_2, X_test_2, y_train_2, y_test_2 = train_test_split(inputs_3, target_3, test_size=0.2)
```

Train the model

In [46]:

```
model = RandomForestRegressor()
model.fit(X_train_2, y_train_2)
model.score(X_test_2, y_test_2)
```

Out[46]:

```
0.9099799625057349
```

In [47]:

```
y_pred_2 = model.predict(X_test_2)
```

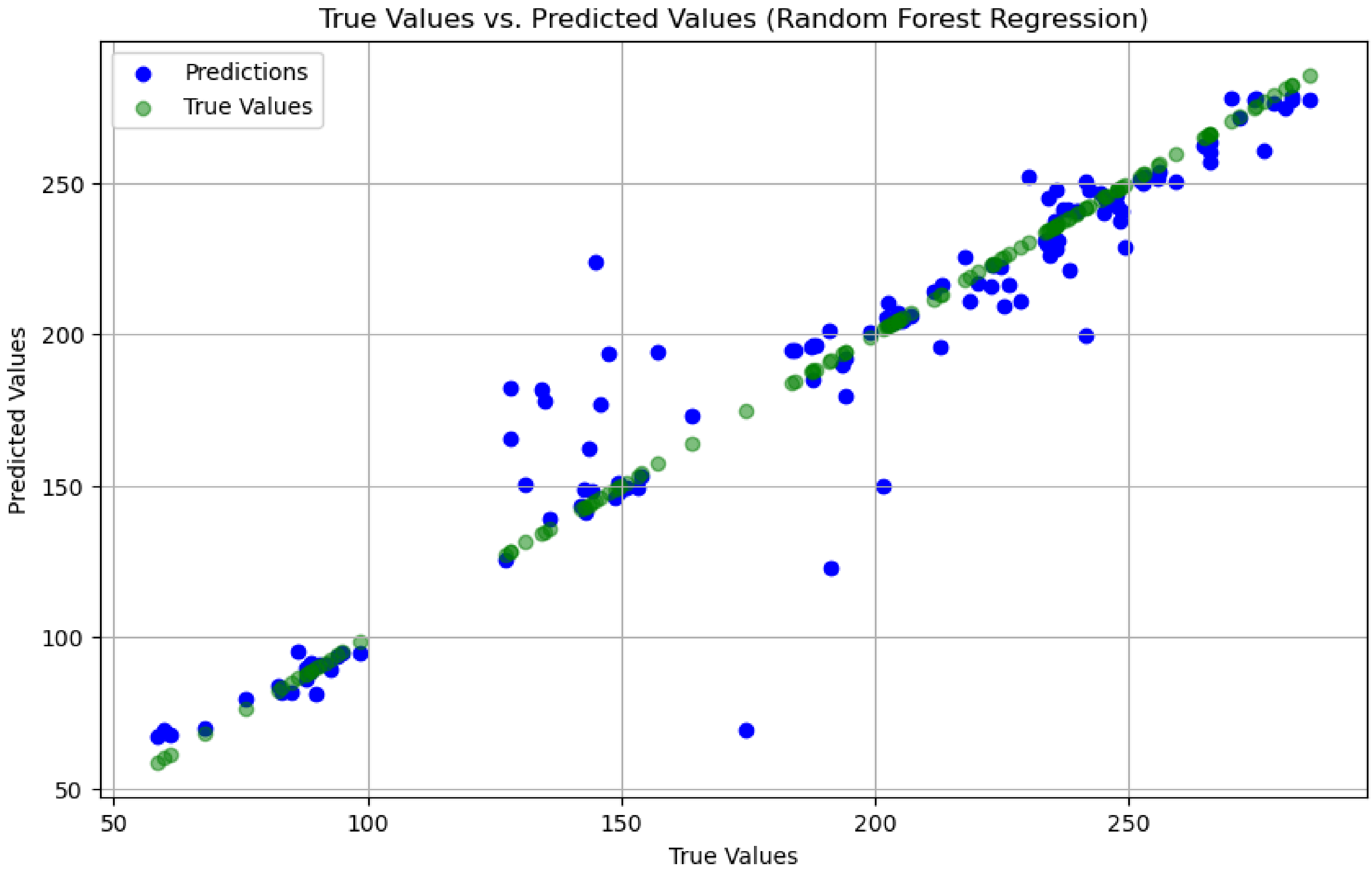
In [48]:

```
r2_2 = r2_score(y_test_2, y_pred_2)
mse_2 = mean_squared_error(y_test_2, y_pred_2)
```

Visualize model performance

In [49]:

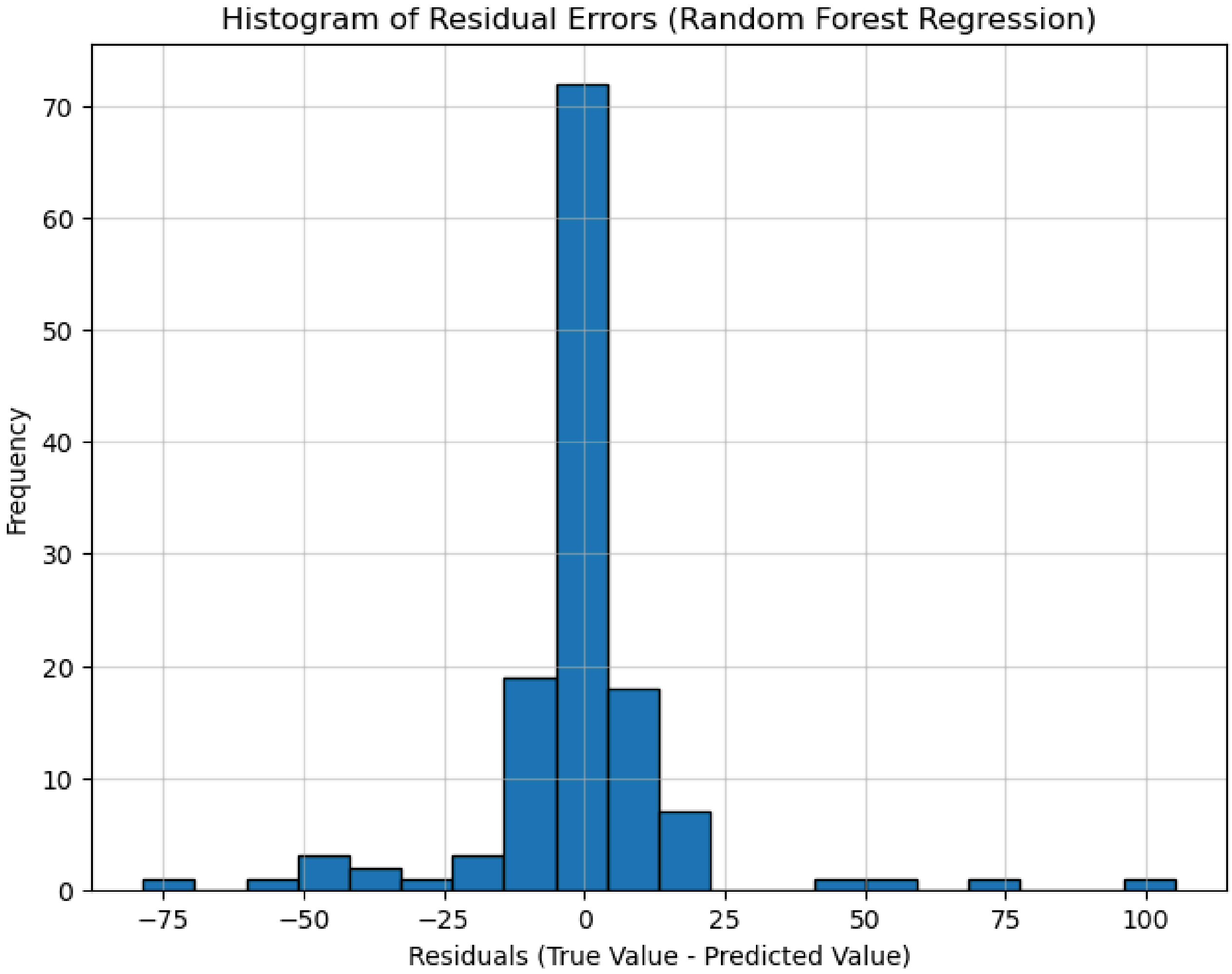
```
plt.figure(figsize=(10, 6))
plt.scatter(y_test_2, y_pred_2, color='blue', label='Predictions')
plt.scatter(y_test_2, y_test_2, color='green', label='True Values', alpha=0.5)
plt.xlabel('True Values')
plt.ylabel('Predicted Values')
plt.title('True Values vs. Predicted Values (Random Forest Regression)')
plt.legend()
plt.grid(True)
plt.show()
```



In [50]:

```
residuals = y_test_2 - y_pred_2

plt.figure(figsize=(8, 6))
plt.hist(residuals, bins=20, edgecolor='black')
plt.xlabel('Residuals (True Value - Predicted Value)')
plt.ylabel('Frequency')
plt.title('Histogram of Residual Errors (Random Forest Regression)')
plt.grid(True, alpha=0.5)
plt.show()
```



Model score

In [52]:
```
print(r2_2, mse_2)
print(f'model score is {np.round(r2_2*100, 2)} %', f'\nmean square error {np.round(mse_2, 2)}')
```

```
0.9099799625057349 347.14374749618304
model score is 91.0 %
mean square error 347.14
```

In [ ]: