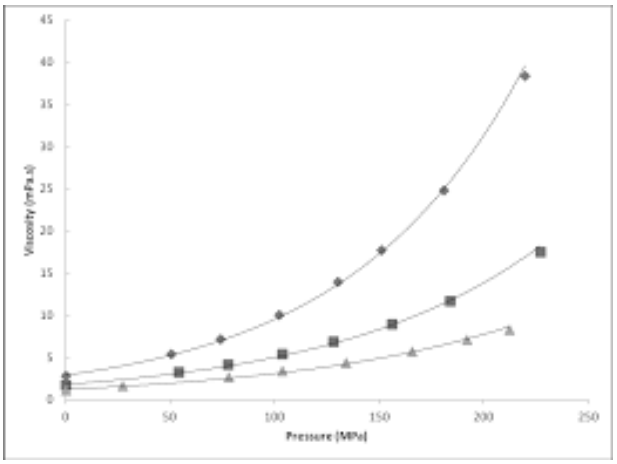

Statistical and Quality control analysis of diesel

Gokhale Education Society's

H.P.T. Arts & R.Y.K. Science college, Nashik-422005

NAAC Re-Accredited: `A' Grade-ISO 9001: 2015 Certified

DEPARTMENT OF STATISTICS

CERTIFICATE

This is to certify that the project work entitled "Statistical and Quality control analysis of diesel" is a bonafide work carried out by

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With partial fulfilment for the statistics project of the Savitribai Phule Pune University during the year 2020-21. The project report has been approved as it satisfies the academic requirements in respect of Project Work prescribed for the said degree

Signature of the Guide

Signature Of H.O.D

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INDEX

OBJECTIVE

The overall objective of the project is to provide analysis of diesel data for three months and it's quality analysis. Out of that brief objectives are as follow:

1) **To study the relationship between density and temperature of diesel.**
2) **To estimate the trend of dependence of density of diesel on temperature.**
3) **To estimate the trend of density and temperature over three month (Dec-2020 , Jan-2021 ,Feb-2021)**
4) **To predict the future behavior of these two variables i.e (Density and temperature)**
5) **To check whether density of diesel for two tanks A and B for each of three months is equal or not (i.e diesel from each tank A and B is of equal quality or not.)**
6) **To check whether densities of diesel are in control from average point of view and variation point of view (i.e whether they meet specified quality criteria or not.)**
7) **To check whether densities of diesel meet the specification limits or not. (i.e performing process capability analysis)**

INTRODUCTION

Diesel fuel testing is important for program health. This proactive maintenance approach can help us prevent engine failure, contamination and fuel dilution, among other types of equipment damage.

Testing your diesel fuel can help you avoid engine failure, minimize the number of expensive repairs performed, and ensure the quality of the fuel. Additional issues to consider include:

- **Injector damage**
- **Water and sediment contamination**
- **Bacteria, fungi and mold**
- **Reduced combustion efficiency**
- **Impact of seasonal changes**
- **Increased corrosion of fuel components**
- **Plugged fuel filters**
- **Smoking**

For this purpose we have performed analysis of diesel fuel by using various tools of statistics, which are as follows:

Correlation and regression analysis, normality test, f-test, t-test, control charts and process capability analysis

By using these tools we have drawn respective conclusions about quality of diesel

Procedure

To check density of diesel, we need a 500 ml jar , hydrometer , thermometer and density conversion chart or fuel converter application.

Opening Density – Fill about ¾ th jar with diesel , through the nozzle (i.e from tank no- 45 KL A & tank no-45 kl B) , Dip the thermometer & hydrometer in jar and record the temperature and density as indicated. Convert the density recorded into density at 15 Degree centigrade with the help of conversion chart.

Observed Density – When new goods arrive before unloading the tanker check density by using hydrometer then convert into at 15 Degree centigrade. this converted density is then compared maintained at the retail outlet on the basis of the density recorded on delivery challans (invoice) (Density at 15 degree centigrade is mentioned on each delivery challan issued by the Supplying depot for every load sent to the retail outlet) Quality at that time is to be checked properly for eg. Is there any adulteration in the diesel should be checked after that density of this diesel at observation and in challan are match then the tanker is unloaded.

How To Match Both Densities – for eg. Density at in challan is 822.6 then observation density should be in tolerance of -3 or +3 i.e –ve =821.6 , 820.6 , 819.6 , +ve = 823.6 , 824.6 , 825.6that difference in acceptable .

After Decantation Density – The diesel in the tanker is unloaded in the tank, then approximately after 1 hour the after decantation density in measured , procedure of measuring after decantation density is similar as density measured at observation .

Why Take After Decantation Density – for opening density was 820.1 mix with observation density 820.1 then after 1 hour after decantation density should be come in between or closer.

DATA COLLECTION

Collection of data is very important work and it is to be done carefully. The methods of data collection are

1) Survey

2) Laboratory Experiments

3) Simulation

For our project we decide to use survey we decided to use survey method and we have collected secondary data.

We collected secondary data for different densities of diesel at different temperature from nearby petrol pump where they use to register everything for every day. We collected data for three months

(December-2020, January-2021, February-2021) and procedure which they follow to examine the quality of diesel.

LIMITATIONS

- **Conclusions drawn from this analysis are limited to this data only, results may vary for other data from other petrol pumps.**
- **In regression analysis we considered only linear relationship and there may be variables other than temperature which are not studied, yet do influence the density of diesel.**
- **Statistical quality control analysis cannot be indiscriminately applied as a solution to all quality evils.**

DATA ANALYSIS :

Correlation and regression for all three months (Tank A & B)

SUMMARY
OUTPUT

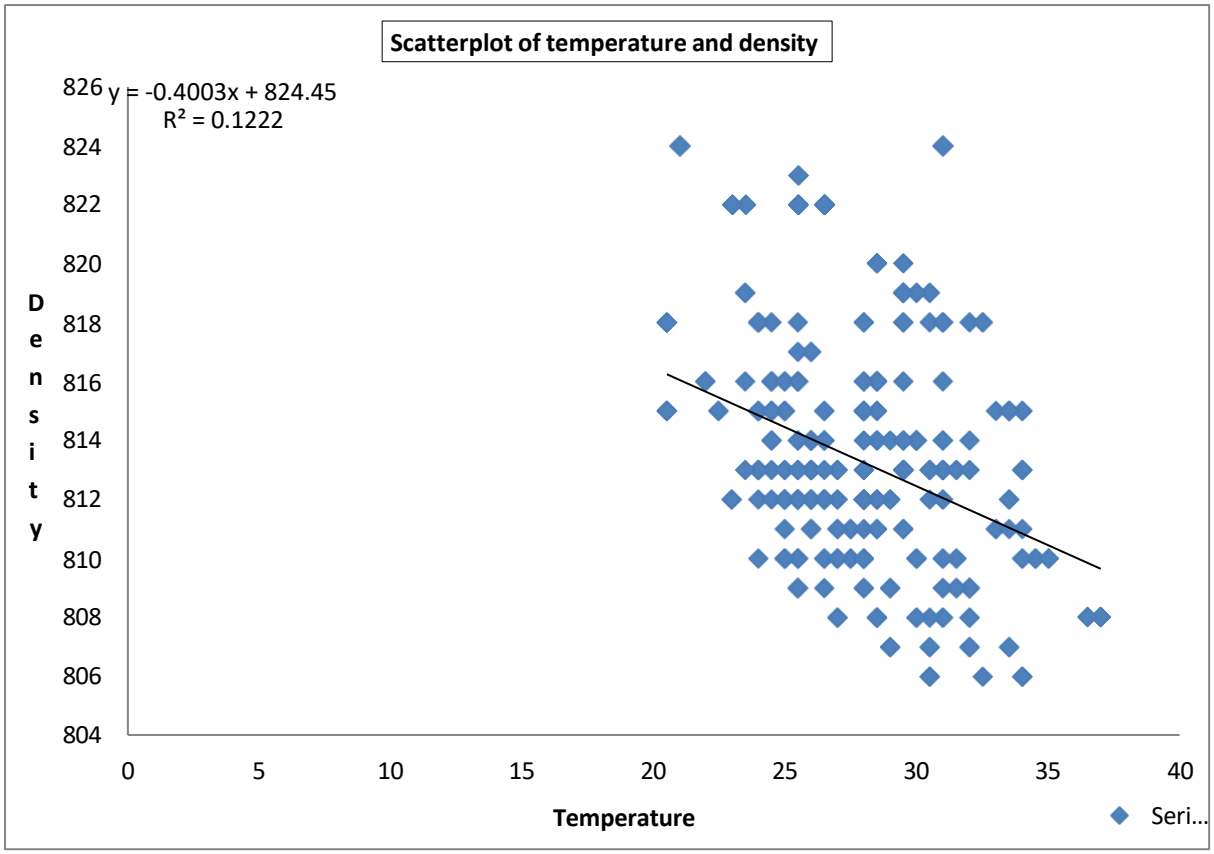
Regression Statistics	
Multiple R	0.34957152
R Square	0.122200247
Adjusted R Square	0.119254611
Standard Error	3.538595254
Observations	300

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	519.4630679	519.4631	41.48517197	4.75347E-10
Residual	298	3731.453599	12.52166		
Total	299	4250.916667			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	824.4507347	1.756101633	469.4778019	0
Temperature	-0.400287478	0.062147771	-6.440898382	4.75347E-10

Correlation between temperature and density at nat = -0.3495
Regression equation for temperature and density at nat is = [y = 824.4507 - 0.4002(x)]
i.e Density = 824.4507 - 0.4002(Temperature) ; where B0 = 824.4507 & B1 = -0.4002
Here correlation is negative and moderate between temperature and density
Also p-value = 4.75347E-10 < significance level i.e. 0.05 : therefore we reject Ho
Hence the regressor i.e. temperature is significant
Here R square = 0.1222 which is approximately much < 1, hence variability in density is not well explained by temperature



Scatterplot also shows same result which are shown above :

Data Analysis of December 2021 :

Checking normality of data (December tank A):

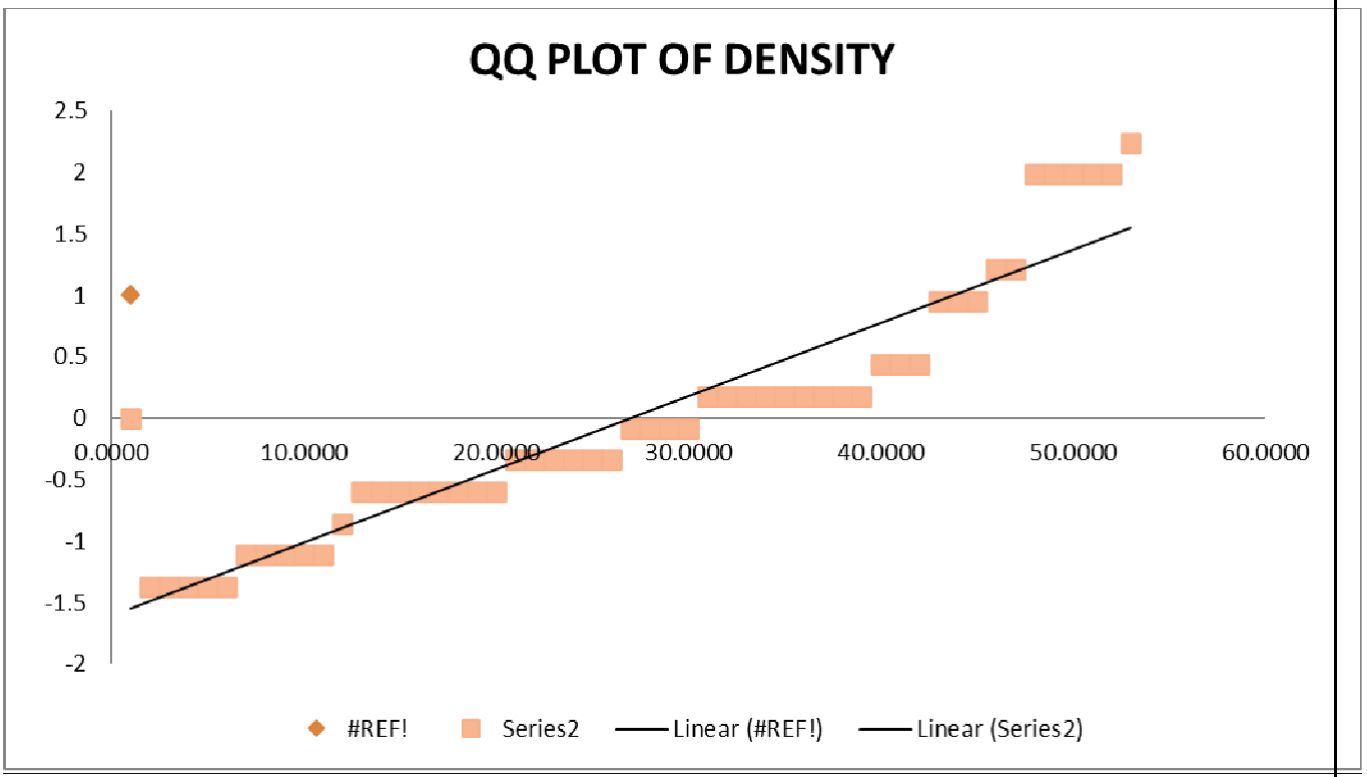
sr. no.	Density	p=(I -0.5)/n	Standardised density
1	809	0.0096	-1.3686
2	809	0.0288	-1.3686
3	809	0.0481	-1.3686
4	809	0.0673	-1.3686
5	809	0.0865	-1.3686
6	810	0.1058	-1.1107
7	810	0.1250	-1.1107
8	810	0.1442	-1.1107
9	810	0.1635	-1.1107
10	810	0.1827	-1.1107
11	811	0.2019	-0.8529
12	812	0.2212	-0.5950
13	812	0.2404	-0.5950
14	812	0.2596	-0.5950
15	812	0.2788	-0.5950
16	812	0.2981	-0.5950
17	812	0.3173	-0.5950
18	812	0.3365	-0.5950
19	812	0.3558	-0.5950
20	813	0.3750	-0.3372
21	813	0.3942	-0.3372
22	813	0.4135	-0.3372
23	813	0.4327	-0.3372
24	813	0.4519	-0.3372
25	813	0.4712	-0.3372
26	814	0.4904	-0.0793
27	814	0.5096	-0.0793
28	814	0.5288	-0.0793
29	814	0.5481	-0.0793
30	815	0.5673	0.1785
31	815	0.5865	0.1785
32	815	0.6058	0.1785
33	815	0.6250	0.1785
34	815	0.6442	0.1785
35	815	0.6635	0.1785
36	815	0.6827	0.1785
37	815	0.7019	0.1785
38	815	0.7212	0.1785
39	816	0.7404	0.4364

40	816	0.7596	0.4364
41	816	0.7788	0.4364
42	818	0.7981	0.9521
43	818	0.8173	0.9521
44	818	0.8365	0.9521
45	819	0.8558	1.2099
46	819	0.8750	1.2099
47	822	0.8942	1.9835
48	822	0.9135	1.9835
49	822	0.9327	1.9835
50	822	0.9519	1.9835
51	822	0.9712	1.9835
52	823	0.9904	2.2413

Assumptions of t-test :

Mean : 814.3076923

Sd : 3.878237226



Conclusion: **Most of the data points are close to trend line or straight line ,so we can conclude that our data of observed densities in tank A are normally distributed**

Checking normality of Data (December tank B):

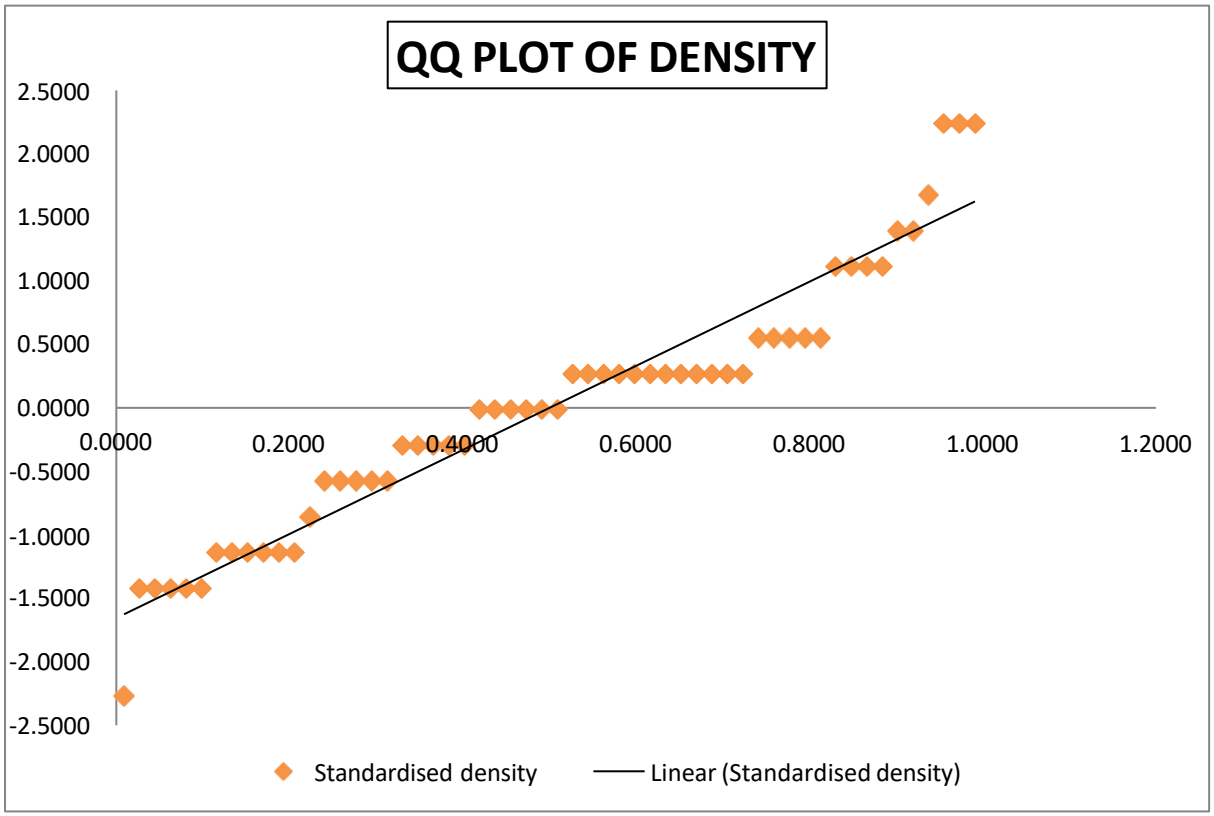
sr. no.	Density	p=(I -0.5)/n	Standardised density
1	806	0.0089	-2.2691
2	809	0.0268	-1.4238
3	809	0.0446	-1.4238
4	809	0.0625	-1.4238
5	809	0.0804	-1.4238
6	809	0.0982	-1.4238
7	810	0.1161	-1.1421
8	810	0.1339	-1.1421
9	810	0.1518	-1.1421
10	810	0.1696	-1.1421
11	810	0.1875	-1.1421
12	810	0.2054	-1.1421
13	811	0.2232	-0.8603
14	812	0.2411	-0.5786
15	812	0.2589	-0.5786
16	812	0.2768	-0.5786
17	812	0.2946	-0.5786
18	812	0.3125	-0.5786
19	813	0.3304	-0.2968
20	813	0.3482	-0.2968
21	813	0.3661	-0.2968
22	813	0.3839	-0.2968
23	813	0.4018	-0.2968
24	814	0.4196	-0.0151
25	814	0.4375	-0.0151
26	814	0.4554	-0.0151
27	814	0.4732	-0.0151
28	814	0.4911	-0.0151
29	814	0.5089	-0.0151
30	815	0.5268	0.2667
31	815	0.5446	0.2667
32	815	0.5625	0.2667
33	815	0.5804	0.2667
34	815	0.5982	0.2667
35	815	0.6161	0.2667
36	815	0.6339	0.2667
37	815	0.6518	0.2667
38	815	0.6696	0.2667
39	815	0.6875	0.2667
40	815	0.7054	0.2667
41	815	0.7232	0.2667

42	816	0.7411	0.5484
43	816	0.7589	0.5484
44	816	0.7768	0.5484
45	816	0.7946	0.5484
46	816	0.8125	0.5484
47	818	0.8304	1.1119
48	818	0.8482	1.1119
49	818	0.8661	1.1119
50	818	0.8839	1.1119
51	819	0.9018	1.3937
52	819	0.9196	1.3937
53	820	0.9375	1.6754
54	822	0.9554	2.2390
55	822	0.9732	2.2390
56	822	0.9911	2.2390

Assumption of T-test:

Mean= 814.0535714

sd= 3.549236245



Conclusion : **Most of data points are close to trend line hence we can say that our data of observed densities in tank B are normally distributed**

Checking equality of variances of densities of tank A and tank B:

Tank A	Tank B
811	811
813	813
812	815
815	822
822	815
822	822
822	820
819	819
809	809
815	816
823	815
815	818
819	815
818	819
818	818
822	818
822	822
815	815
815	815
812	815
813	812
814	813
815	816
812	814
814	814
815	815
814	815
813	814
813	815
813	815
812	814
812	813
810	813
810	812
809	812
812	810
815	810

809	809
812	815
812	809
809	812
809	812
810	806
810	809
815	809
818	810
816	810
813	810
814	818
816	816
816	813
810	814
	814
	816
	816
	810

F-Test Two-Sample for Variances:

	Tank A	*Tank B*
Mean	814.3076923	814.0536
Variance	15.04072398	12.59708
Observations	52	56
df	51	55
F	1.193985151	
P(F<=f) one-tail	0.259257226	
F Critical one-tail	1.574626874	

Conclusion :

Here F(cal)=1.1939 < F(tab)= 1.5746 ,so we accept null hypothesis
i.e. Variance of tank A = Variance tank B
Also P-value= 0.2592 > 0.05 ,we can conclude that variances of tank A & B are equal

Applying T- Test to check equality of means of tank-A & tank-B

t-Test: Two-Sample Assuming Equal Variances:

	Tank A	*Tank B*
Mean	814.3076923	814.0535714
Variance	15.04072398	12.59707792
Observations	52	56
Pooled Variance	13.77279442	
Hypothesized Mean Difference	0	
df	106	
t Stat	0.355560186	
P(T<=t) one-tail	0.361438275	
t Critical one-tail	1.659356034	
P(T<=t) two-tail	0.722876549	
t Critical two-tail	1.982597204	

Conclusion:

Here t(stst)= 0.3555 < t(critical) = 1.6593

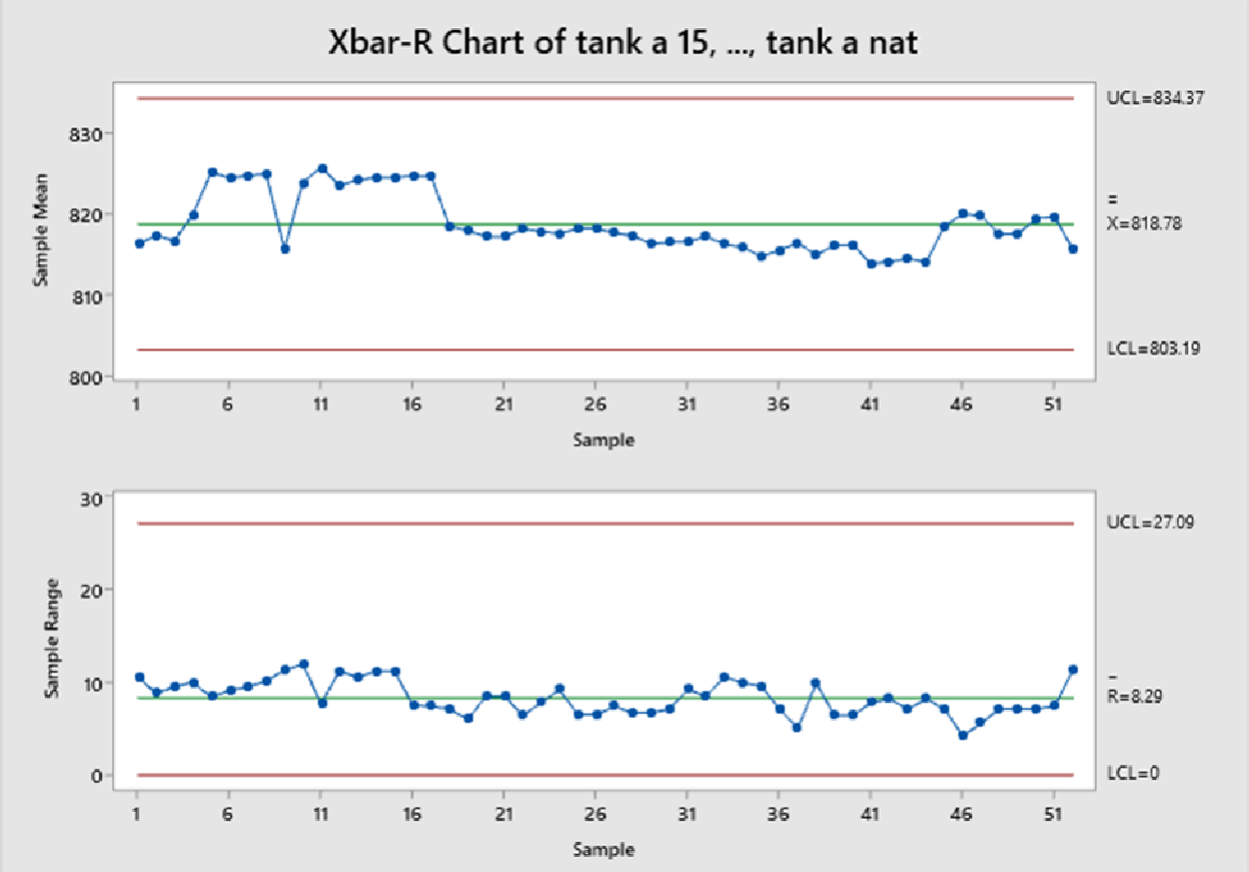
Therefore we can say that mean density of tank A = mean density of tank B

Also P-value= 0.3614 > 0.05

So it also states that mean density of tank A = tank B

Control Charts:

December Tank-A:

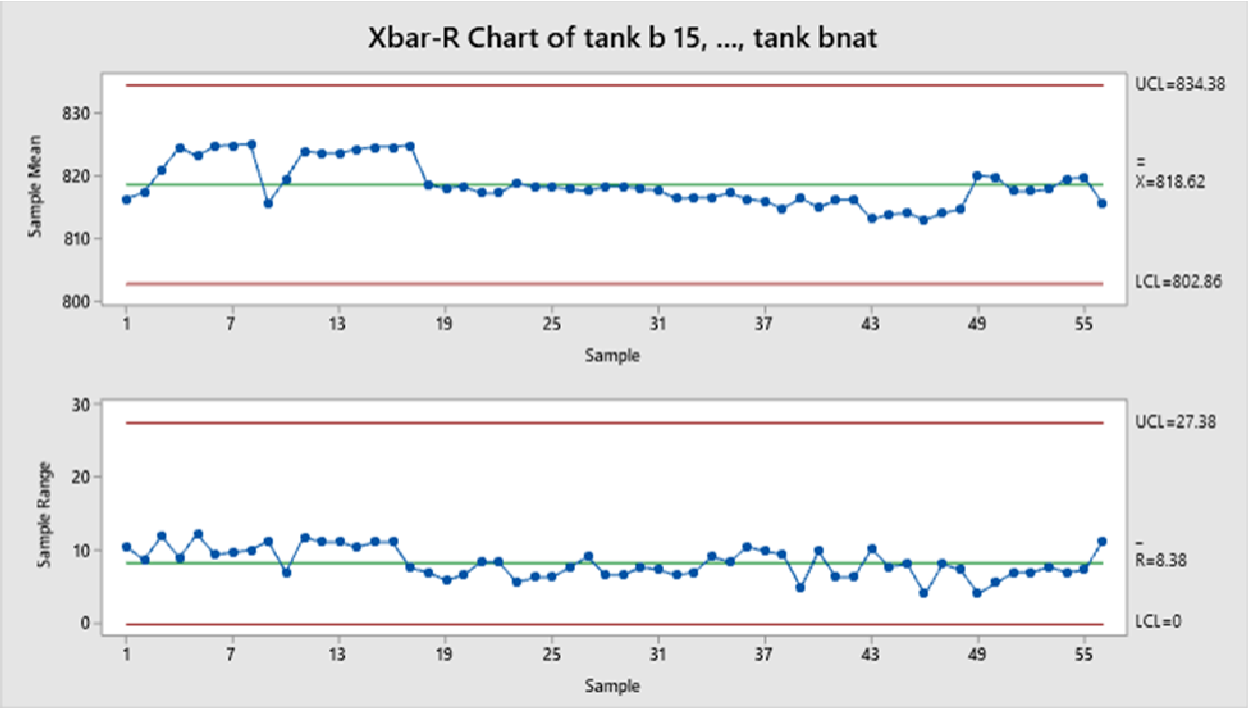


Conclusion:

For X-bar chart : From centering point of view the process is in control.

For R-bar chart : From variation point of view the process is in control.

December Tank-B:



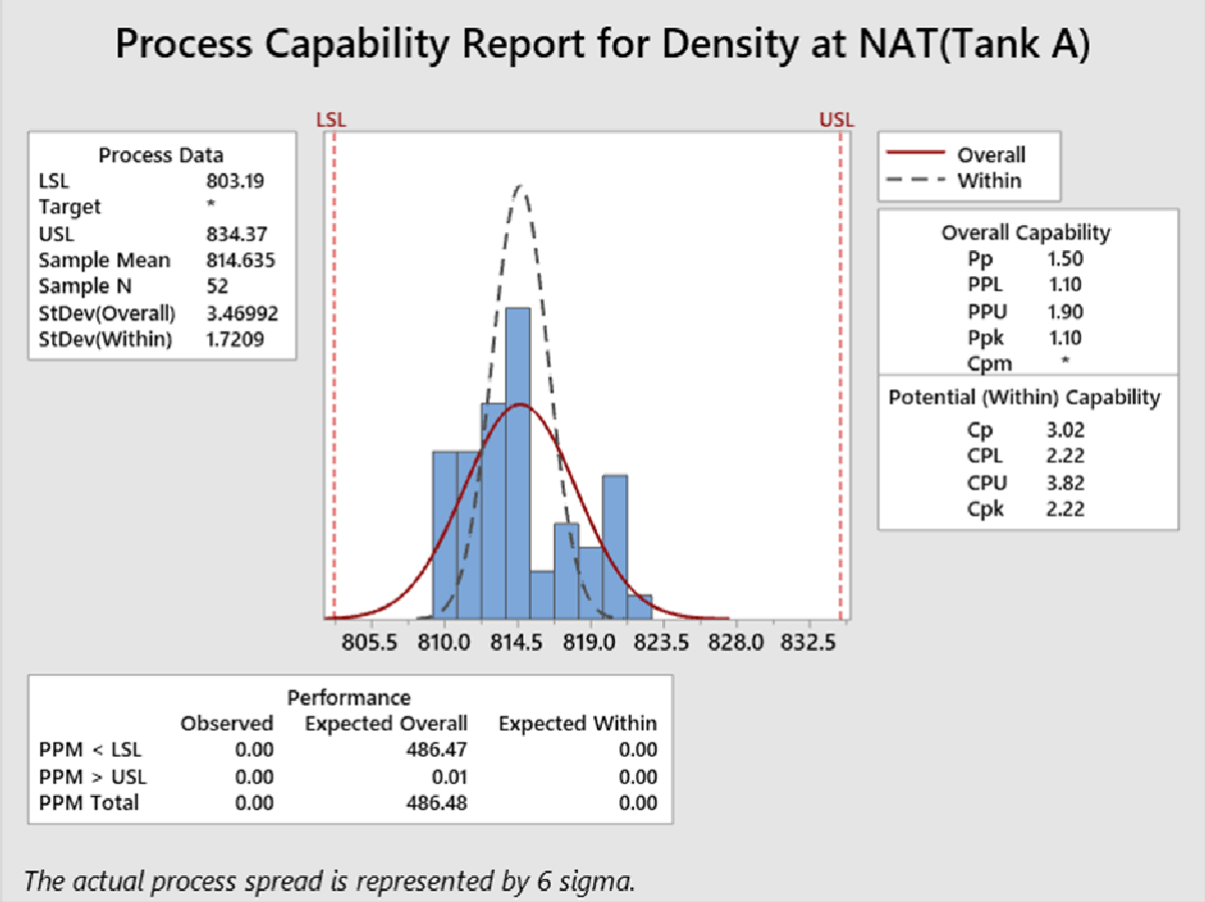
Conclusion:

For X-bar chart : From centering point of view the process is in control.

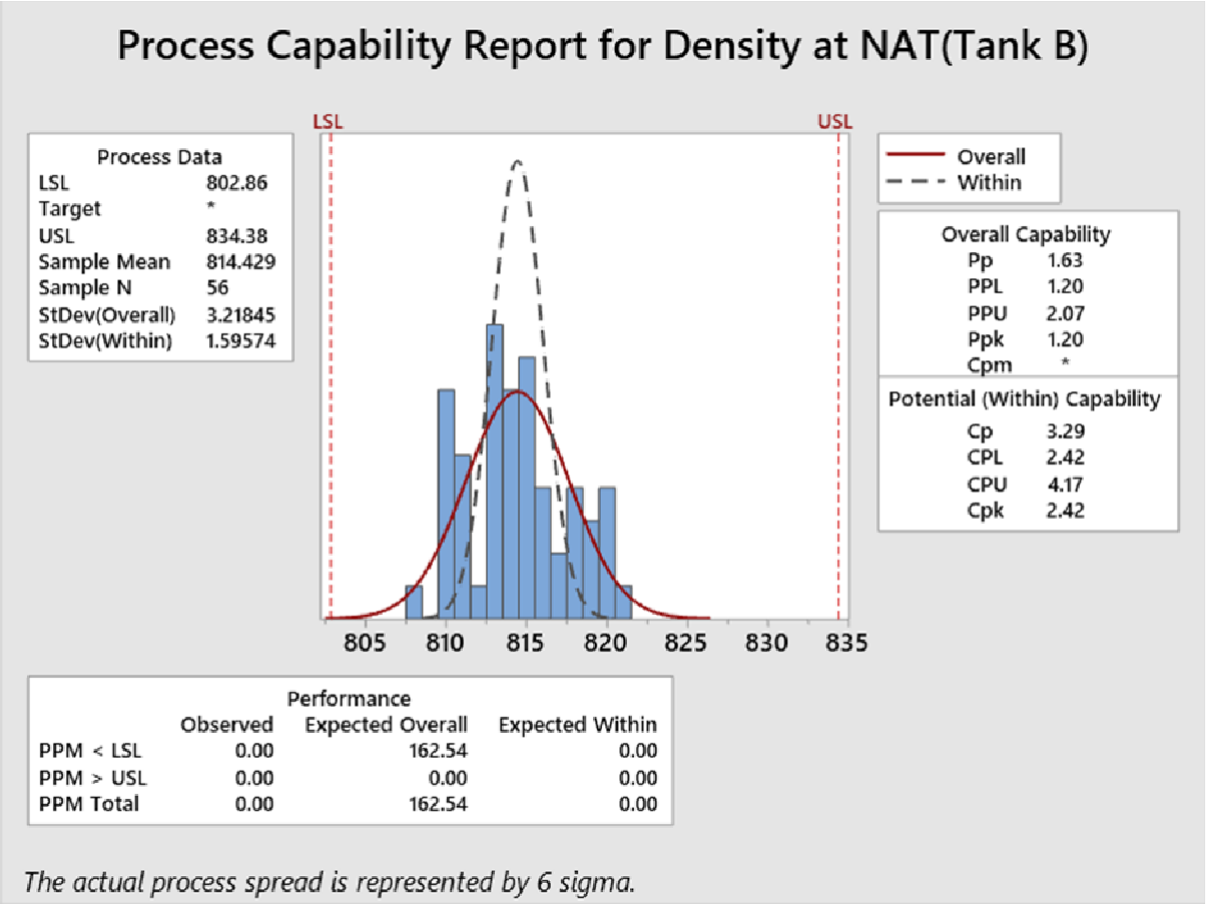
For R-bar chart : From variation point of view the process is in control.

Process Capabilty Test:

Tank-A and Tank-B:



Conclusion: As the value of CPK is greater than 1.33. Therefore, the densities of diesel in tank-A are meeting the specification limit or customers requirement.



Conclusion: As the value of CPK is greater than 1.33. Therefore, the densities of diesel in tank-B are meeting the specification limit or customers requirement.

Data Analysis of January-2021:

Checking normality of Data (January Tank-A) :

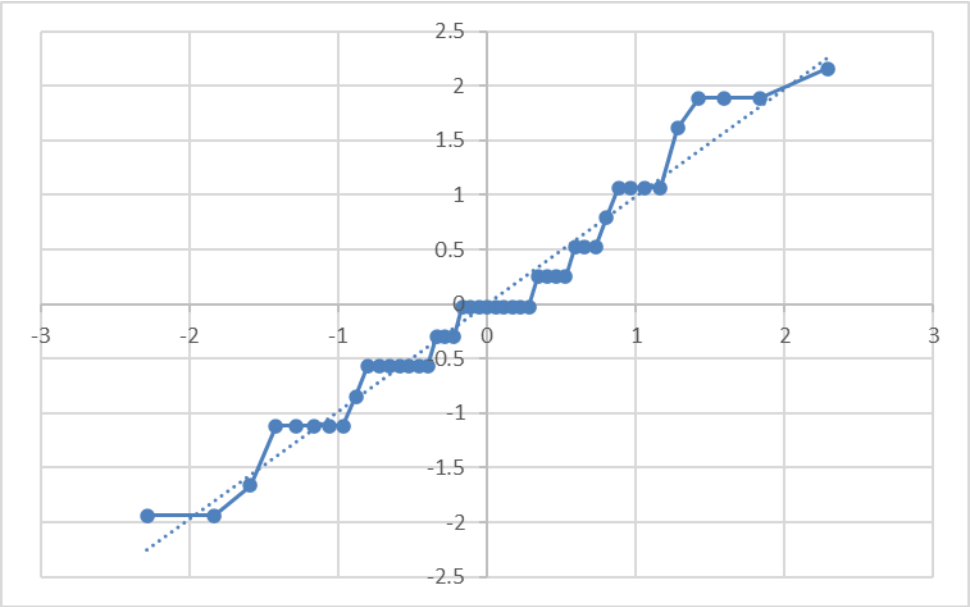
i	Density At Nat	Prob	z score i	standardised density
1	805	0.011111111	-2.286547951	-1.936463886
2	805	0.033333333	-1.833914636	-1.936463886
3	806	0.055555556	-1.593218818	-1.663294999
4	808	0.077777778	-1.420179069	-1.116957226
5	808	0.1	-1.281551566	-1.116957226
6	808	0.122222222	-1.163949582	-1.116957226
7	808	0.144444444	-1.060562244	-1.116957226
8	808	0.166666667	-0.967421566	-1.116957226
9	809	0.188888889	-0.881998205	-0.843788339
10	810	0.211111111	-0.802571888	-0.570619452
11	810	0.233333333	-0.727913291	-0.570619452
12	810	0.255555556	-0.657108566	-0.570619452
13	810	0.277777778	-0.589455798	-0.570619452
14	810	0.3	-0.524400513	-0.570619452
15	810	0.322222222	-0.461493694	-0.570619452
16	810	0.344444444	-0.400363385	-0.570619452
17	811	0.366666667	-0.340694827	-0.297450566
18	811	0.388888889	-0.282216147	-0.297450566
19	811	0.411111111	-0.224687715	-0.297450566
20	812	0.433333333	-0.167894005	-0.024281679
21	812	0.455555556	-0.111637155	-0.024281679
22	812	0.477777778	-0.055731688	-0.024281679
23	812	0.5	0	-0.024281679
24	812	0.522222222	0.055731688	-0.024281679
25	812	0.544444444	0.111637155	-0.024281679
26	812	0.566666667	0.167894005	-0.024281679
27	812	0.588888889	0.224687715	-0.024281679
28	812	0.611111111	0.282216147	-0.024281679
29	813	0.633333333	0.340694827	0.248887208
30	813	0.655555556	0.400363385	0.248887208
31	813	0.677777778	0.461493694	0.248887208
32	813	0.7	0.524400513	0.248887208
33	814	0.722222222	0.589455798	0.522056095
34	814	0.744444444	0.657108566	0.522056095
35	814	0.766666667	0.727913291	0.522056095
36	815	0.788888889	0.802571888	0.795224981
37	816	0.811111111	0.881998205	1.068393868
38	816	0.833333333	0.967421566	1.068393868

39	816	0.855555556	1.060562244	1.068393868
40	816	0.877777778	1.163949582	1.068393868
41	818	0.9	1.281551566	1.614731642
42	819	0.922222222	1.420179069	1.887900528
43	819	0.944444444	1.593218818	1.887900528
44	819	0.966666667	1.833914636	1.887900528
45	820	0.988888889	2.286547951	2.161069415

Assumptions of t-test :

Mean : 812.0889

Sd : 3.660739



Conclusion: **Most of the data points are close to trend line or straight line ,so we can conclude that our data of observed densities in tank A are normally distributed**

Checking normality of data (January Tank-B):

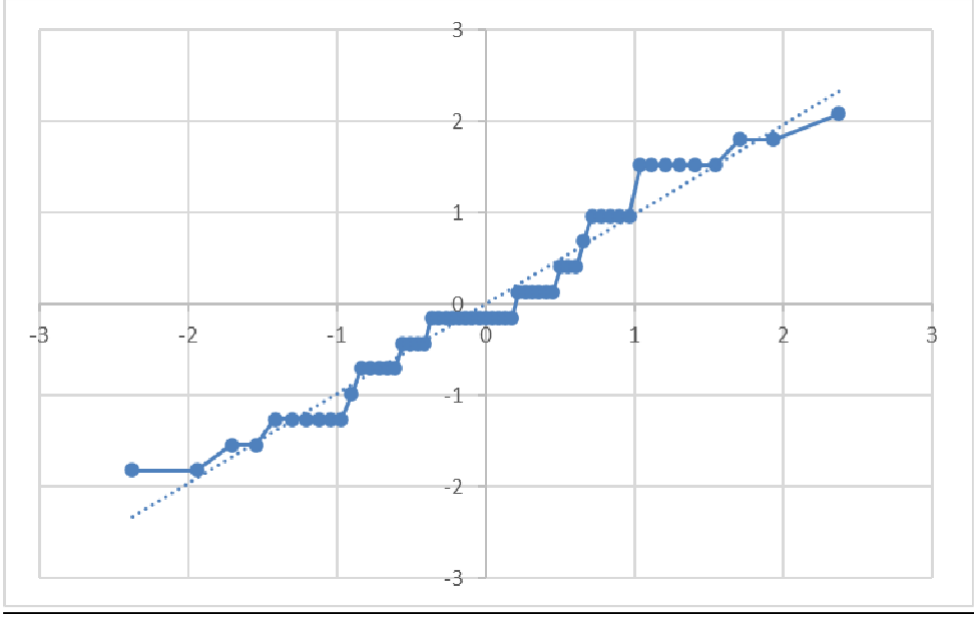
i	Density at nat	prob	z score of i	std x
1	806	0.00877193	-2.37510708	-1.81983648
2	806	0.026315789	-1.93793151	-1.81983648
3	807	0.043859649	-1.70755309	-1.54099056
4	807	0.061403509	-1.54309793	-1.54099056
5	808	0.078947368	-1.41218758	-1.26214465
6	808	0.096491228	-1.30180675	-1.26214465
7	808	0.114035088	-1.20534492	-1.26214465
8	808	0.131578947	-1.11895838	-1.26214465
9	808	0.149122807	-1.04020297	-1.26214465
10	808	0.166666667	-0.96742157	-1.26214465
11	809	0.184210526	-0.89943491	-0.98329874
12	810	0.201754386	-0.83537114	-0.70445283
13	810	0.219298246	-0.77456543	-0.70445283
14	810	0.236842105	-0.7164975	-0.70445283
15	810	0.254385965	-0.66075113	-0.70445283
16	810	0.271929825	-0.60698683	-0.70445283
17	811	0.289473684	-0.55492294	-0.42560692
18	811	0.307017544	-0.50432205	-0.42560692
19	811	0.324561404	-0.45498114	-0.42560692
20	811	0.342105263	-0.40672425	-0.42560692
21	812	0.359649123	-0.35939683	-0.14676101
22	812	0.377192982	-0.3128614	-0.14676101
23	812	0.394736842	-0.26699413	-0.14676101
24	812	0.412280702	-0.22168205	-0.14676101
25	812	0.429824561	-0.17682084	-0.14676101
26	812	0.447368421	-0.13231285	-0.14676101
27	812	0.464912281	-0.08806557	-0.14676101
28	812	0.48245614	-0.04399012	-0.14676101
29	812	0.5	0	-0.14676101
30	812	0.51754386	0.043990118	-0.14676101
31	812	0.535087719	0.08806557	-0.14676101
32	812	0.552631579	0.132312852	-0.14676101
33	812	0.570175439	0.176820835	-0.14676101
34	813	0.587719298	0.221682051	0.132084905
35	813	0.605263158	0.266994125	0.132084905
36	813	0.622807018	0.3128614	0.132084905
37	813	0.640350877	0.35939683	0.132084905
38	813	0.657894737	0.406724252	0.132084905
39	813	0.675438596	0.45498114	0.132084905
40	814	0.692982456	0.504322046	0.410930817
41	814	0.710526316	0.554922943	0.410930817

42	814	0.728070175	0.606986835	0.410930817
43	815	0.745614035	0.660751127	0.689776729
44	816	0.763157895	0.7164975	0.96862264
45	816	0.780701754	0.77456543	0.96862264
46	816	0.798245614	0.835371144	0.96862264
47	816	0.815789474	0.899434908	0.96862264
48	816	0.833333333	0.967421566	0.96862264
49	818	0.850877193	1.040202966	1.526314463
50	818	0.868421053	1.118958381	1.526314463
51	818	0.885964912	1.20534492	1.526314463
52	818	0.903508772	1.301806749	1.526314463
53	818	0.921052632	1.412187579	1.526314463
54	818	0.938596491	1.543097927	1.526314463
55	819	0.956140351	1.707553094	1.805160375
56	819	0.973684211	1.937931511	1.805160375
57	820	0.99122807	2.375107084	2.084006286

Assumption of T-test:

Mean : 812.5263

Sd : 3.58621



Conclusion : Most of data points are close to trend line hence we can say that our data of observed densities in tank B are normally distributed

Checking equality of variances of tank-A and tank-B:

tank A	Tank B
810	810
813	813
812	812
812	812
810	810
805	807
808	808
806	806
805	809
810	807
808	808
811	811
811	811
812	812
812	812
808	811
809	808
808	806
808	808
810	808
810	808
818	810
816	810
820	812
819	818
819	818
814	820
812	819
816	819
816	818
819	814
813	812
813	816
814	816
810	818
812	816
812	813
812	813
816	818
810	813
813	813

811	818
814	814
812	810
815	812
	812
	812
	812
	816
	813
	811
	814
	816
	812
	815
	812

F-Test Two-Sample for Variances:

	Variable 1	*Variable 2*
Mean	812.0888889	812.5263158
Variance	13.4010101	12.86090226
Observations	45	57
df	44	56
F	1.041996108	
P(F<=f) one-tail	0.43832687	
F Critical one-tail	1.592741053	

Conclusion :

Here F(cal)=1.0419 < F(tab)= 1.5792 ,so we accept null hypothesis
i.e. Variance of tank A = Variance tank B
Also P-value= 0.4383 > 0.05 ,we can conclude that variances of tank A & B are equal

Applying T-Test to check equality of means of tank A & tank B

t-Test: Two-Sample Assuming Equal Variances :

	810	*810*
Mean	812.1363636	812.571429
Variance	13.60887949	12.9766234
Observations	44	56
Pooled Variance	13.25404188	
Hypothesized Mean Difference	0	
df	98	
t Stat	-0.593198801	
P(T<=t) one-tail	0.277207334	
t Critical one-tail	1.660551217	
P(T<=t) two-tail	0.554414669	
t Critical two-tail	1.984467455	

Conclusion:

Here t(stst)= 0.5931 < t(critical) = 1.6605

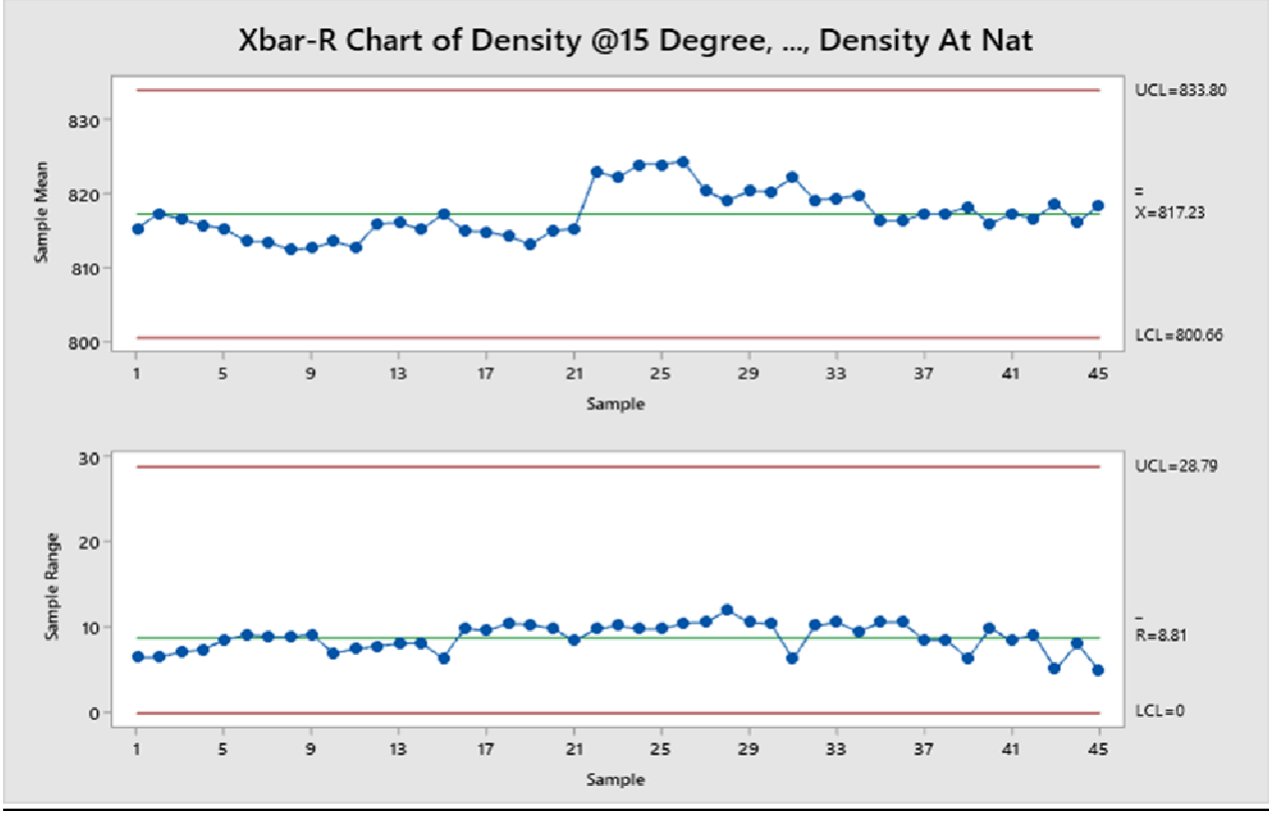
Therefore we can say that mean density of tank A = mean density of tank B

Also P-value= 0.2772 > 0.05

So it also states that mean density of tank A = tank B

Control Charts:

January Tank-A:

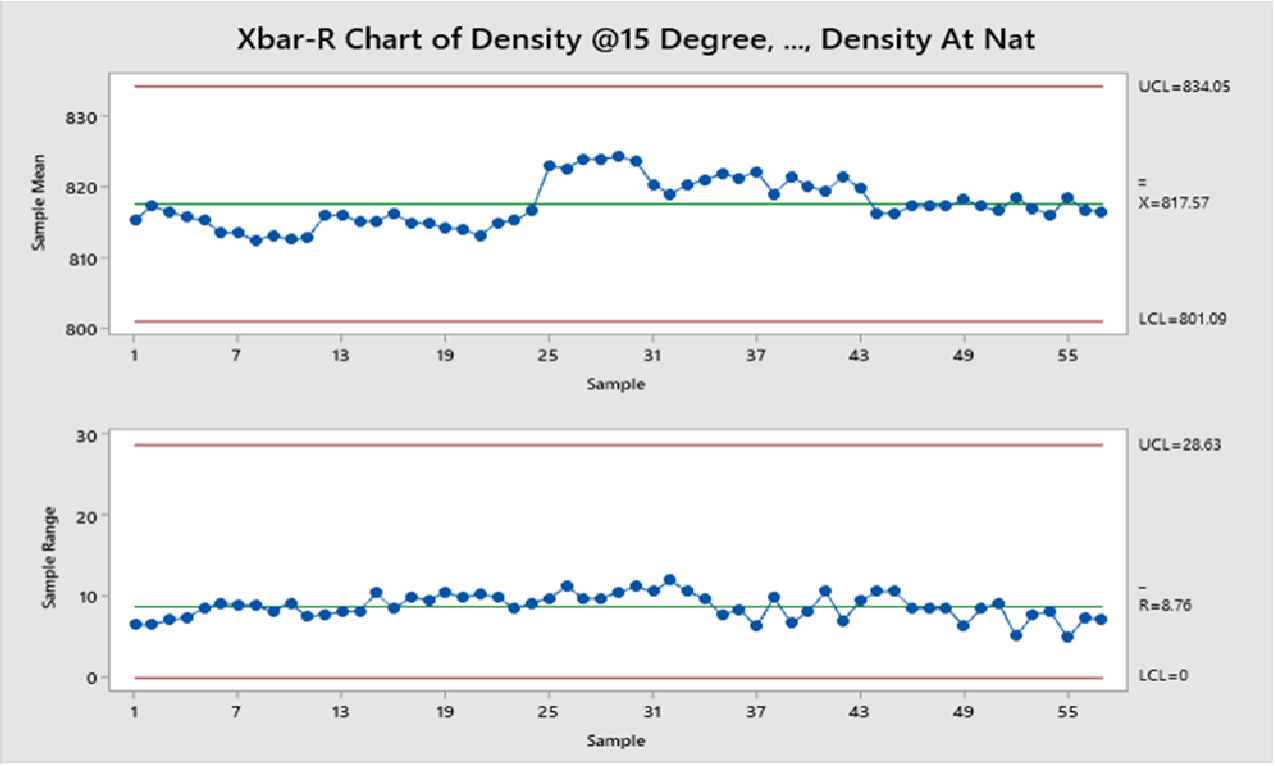


Conclusion :

For X-bar chart : From centering point of view the process is in control.

For R-bar chart : From variation point of view the process is in control.

January Tank-B:



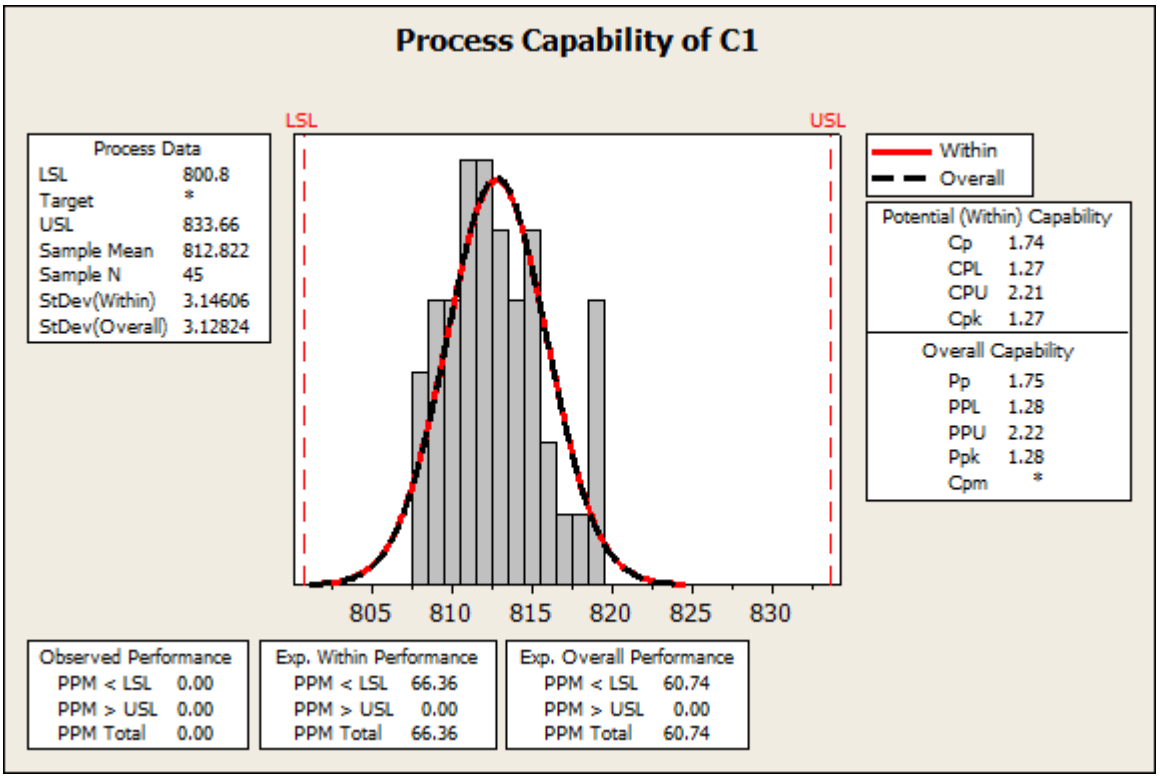
Conclusion:

For X-bar chart : From centering point of view the process is in control.

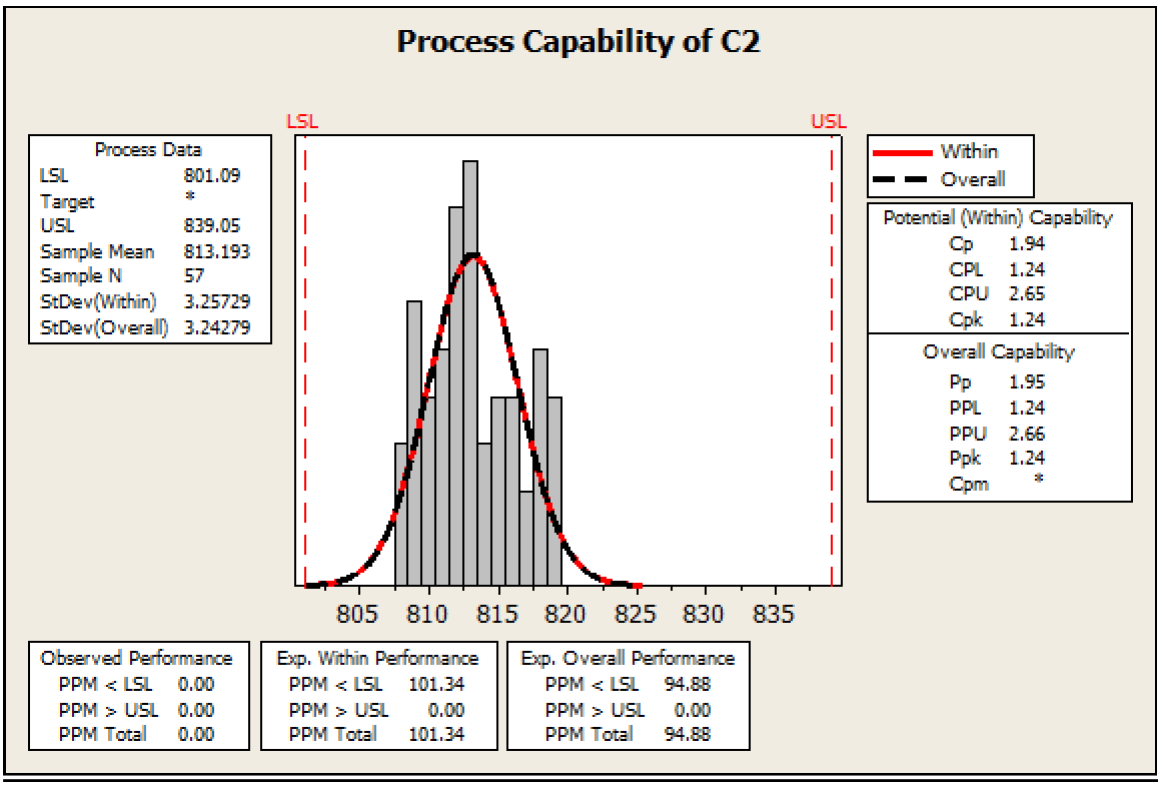
For R-bar chart : From variation point of view the process is in control.

Process Capabilty Test:

Tank-A and Tank-B:



Conclusion: As the value of CPK is greater than 1 . Therefore, the densities of diesel in tank-A are meeting the specification limit or customers requirement.



Conclusion: As the value of CPK is greater than 1 . Therefore, the densities of diesel in tank-B are meeting the specification limit or customers requirement.

Data Analysis of February 2021 :

Checking normality of data (February tank A):

Sr No.	Density at NAT (X)	p_i=(i-0.5)/n	Standardized density
1	806	0.012195122	-1.744784569
2	807	0.036585366	-1.488382535
3	807	0.06097561	-1.488382535
4	808	0.085365854	-1.231980502
5	808	0.109756098	-1.231980502
6	809	0.134146341	-0.975578469
7	809	0.158536585	-0.975578469
8	809	0.182926829	-0.975578469
9	810	0.207317073	-0.719176435
10	810	0.231707317	-0.719176435
11	810	0.256097561	-0.719176435
12	810	0.280487805	-0.719176435
13	810	0.304878049	-0.719176435
14	811	0.329268293	-0.462774402
15	811	0.353658537	-0.462774402
16	811	0.37804878	-0.462774402
17	812	0.402439024	-0.206372368
18	812	0.426829268	-0.206372368
19	812	0.451219512	-0.206372368
20	813	0.475609756	0.050029665
21	813	0.5	0.050029665
22	813	0.524390244	0.050029665
23	813	0.548780488	0.050029665
24	813	0.573170732	0.050029665
25	813	0.597560976	0.050029665
26	814	0.62195122	0.306431698
27	814	0.646341463	0.306431698
28	814	0.670731707	0.306431698
29	814	0.695121951	0.306431698
30	815	0.719512195	0.562833732
31	815	0.743902439	0.562833732
32	815	0.768292683	0.562833732
33	815	0.792682927	0.562833732
34	816	0.817073171	0.819235765
35	816	0.841463415	0.819235765
36	817	0.865853659	1.075637799
37	818	0.890243902	1.332039832
38	818	0.914634146	1.332039832

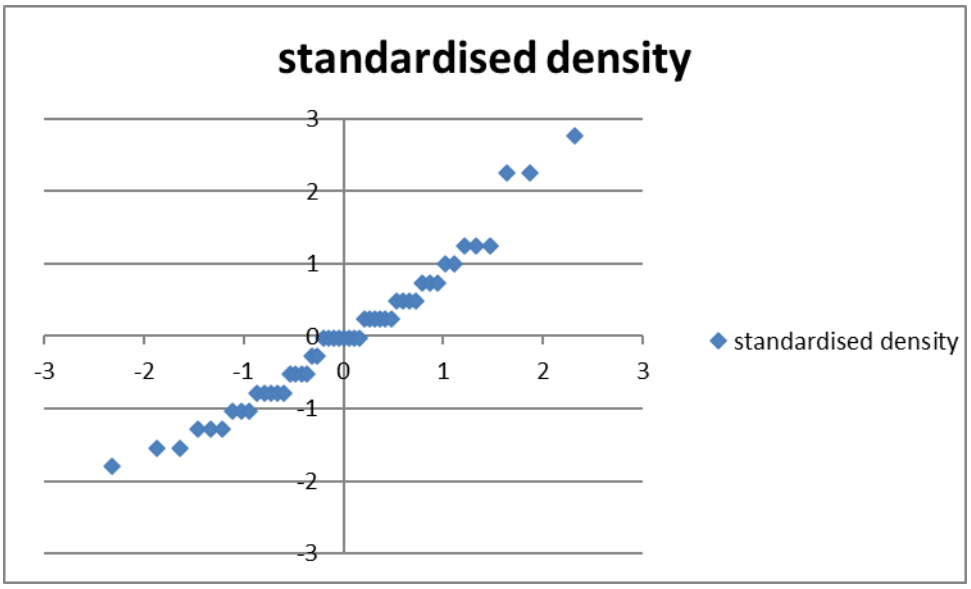
39	818	0.93902439	1.332039832
40	822	0.963414634	2.357647966
41	824	0.987804878	2.870452032

Assumptions of t-test :

Mean:812.804878

Sd:3.900125076

QQ PLOT OF DENSITY :



Conclusion: **Most of the data points are close to trend line or straight line ,so we can conclude that our data of observed densities in tank A are normally distributed**

Checking normality of Data (February tank B):

Sr No.	Density	p_i=(i-0.5)/n	standardised density
1	806	0.010204082	-1.796716962
2	807	0.030612245	-1.543001886
3	807	0.051020408	-1.543001886
4	808	0.071428571	-1.289286811
5	808	0.091836735	-1.289286811
6	808	0.112244898	-1.289286811
7	809	0.132653061	-1.035571736
8	809	0.153061224	-1.035571736
9	809	0.173469388	-1.035571736
10	810	0.193877551	-0.781856661
11	810	0.214285714	-0.781856661
12	810	0.234693878	-0.781856661
13	810	0.255102041	-0.781856661
14	810	0.275510204	-0.781856661
15	811	0.295918367	-0.528141585
16	811	0.316326531	-0.528141585
17	811	0.336734694	-0.528141585
18	811	0.357142857	-0.528141585
19	812	0.37755102	-0.27442651
20	812	0.397959184	-0.27442651
21	813	0.418367347	-0.020711435
22	813	0.43877551	-0.020711435
23	813	0.459183673	-0.020711435
24	813	0.479591837	-0.020711435
25	813	0.5	-0.020711435
26	813	0.520408163	-0.020711435
27	813	0.540816327	-0.020711435
28	813	0.56122449	-0.020711435
29	814	0.581632653	0.233003641
30	814	0.602040816	0.233003641
31	814	0.62244898	0.233003641
32	814	0.642857143	0.233003641
33	814	0.663265306	0.233003641
34	814	0.683673469	0.233003641
35	815	0.704081633	0.486718716
36	815	0.724489796	0.486718716
37	815	0.744897959	0.486718716
38	815	0.765306122	0.486718716

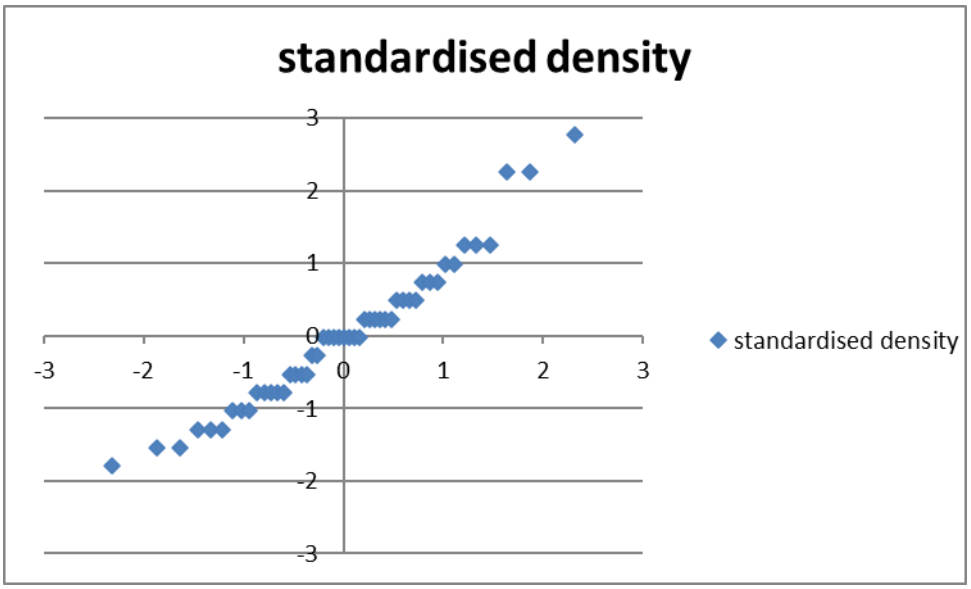
39	816	0.785714286	0.740433791	
40	816	0.806122449	0.740433791	
41	816	0.826530612	0.740433791	
42	817	0.846938776	0.994148866	
43	817	0.867346939	0.994148866	
44	818	0.887755102	1.247863942	
45	818	0.908163265	1.247863942	
46	818	0.928571429	1.247863942	
47	822	0.948979592	2.262724243	
48	822	0.969387755	2.262724243	
49	824	0.989795918	2.770154393	

Assumption of T-test:

Mean:813.08163

Sd: 3.9414292

QQ PLOT OF DENSITY :



Conclusion : Most of data points are close to trend line hence we can say that our data of observed densities in tank B are normally distributed

Checking equality of variances of densities of tank A and tank B:

Tank A	Tank B
809	809
809	809
813	813
807	807
810	810
806	806
810	
811	813
812	811
809	812
818	811
824	809
822	818
814	824
813	822
814	822
816	816
817	813
811	814
813	816
815	817
807	814
808	813
813	813
818	815
810	807
811	808
814	813
818	818
816	810
815	817
810	811
808	814
810	818
813	811
814	816
815	810
812	814
812	815
813	810
815	814

	808
	813
	810
	814
	815
	812
	813
	808
	815

F-Test Two-Sample for Variances:

	Variable 1	*Variable 2*
Mean	813.0816327	812.804878
Variance	15.53486395	15.21097561
Observations	49	41
df	48	40
F	1.021293068	
P(F<=f) one-tail	0.476091034	
F Critical one-tail	1.66557506	

Conclusion:

here, F(cal)=1.0212<F(tab)=1.6655, so we accept the null hypothesis

i.e. Variance of tank A = Variance of tank B

Also P-value=0.476091034>0.05, we can conclude that variance of tank A & B are equal

Applying T- Test to check equality of means of tank-A & tank-B

t-Test: Two-Sample Assuming Equal Variances:

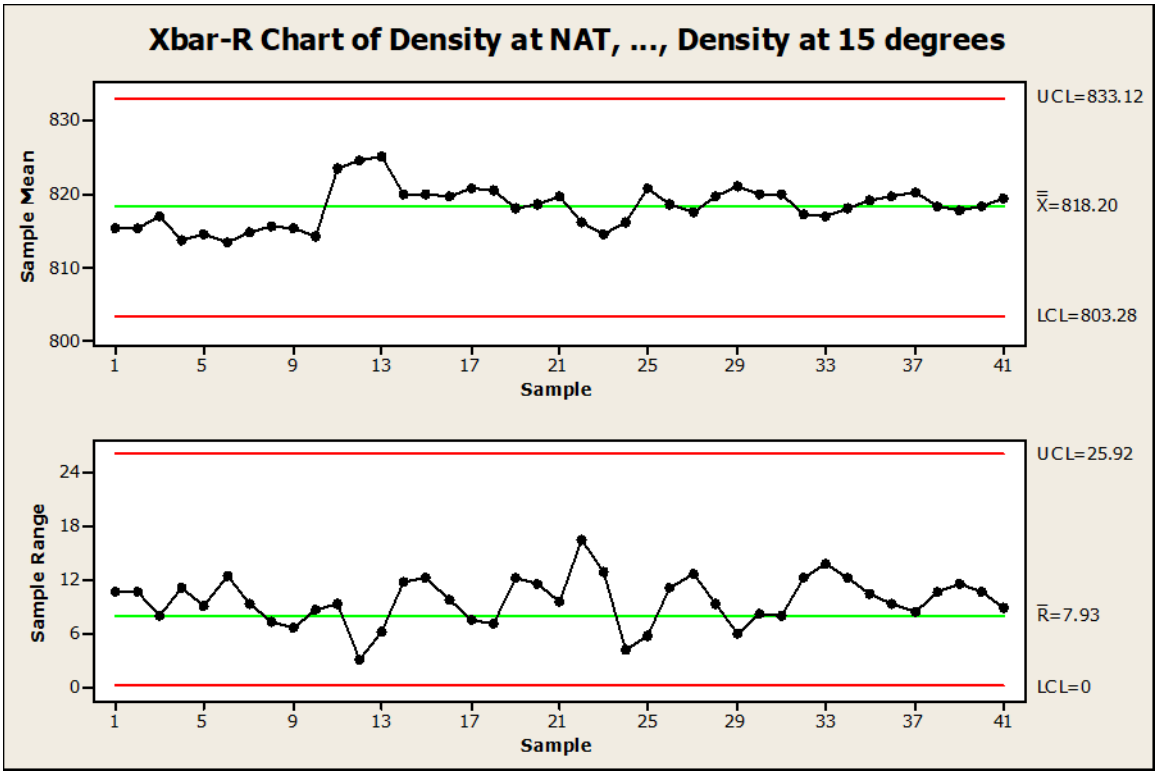
	Variable 1	*Variable 2*
Mean	813.0816327	812.804878
Variance	15.53486395	15.21097561
Observations	49	41
Pooled Variance	15.38764197	
Hypothesized Mean Difference	0	
df	88	
t Stat	0.333332402	
P(T<=t) one-tail	0.369838146	
t Critical one-tail	1.66235403	
P(T<=t) two-tail	0.739676292	
t Critical two-tail	1.987289823	

conclusion:

Here t(stat)=0.3333<t(critical)=1.6623
therefore we can say that mean density of tank A= mean density of tank B
Also P-value=0.3698>0.05
So it also states that mean density of tank A= mean density of tank B

Control Charts:

December Tank-A:

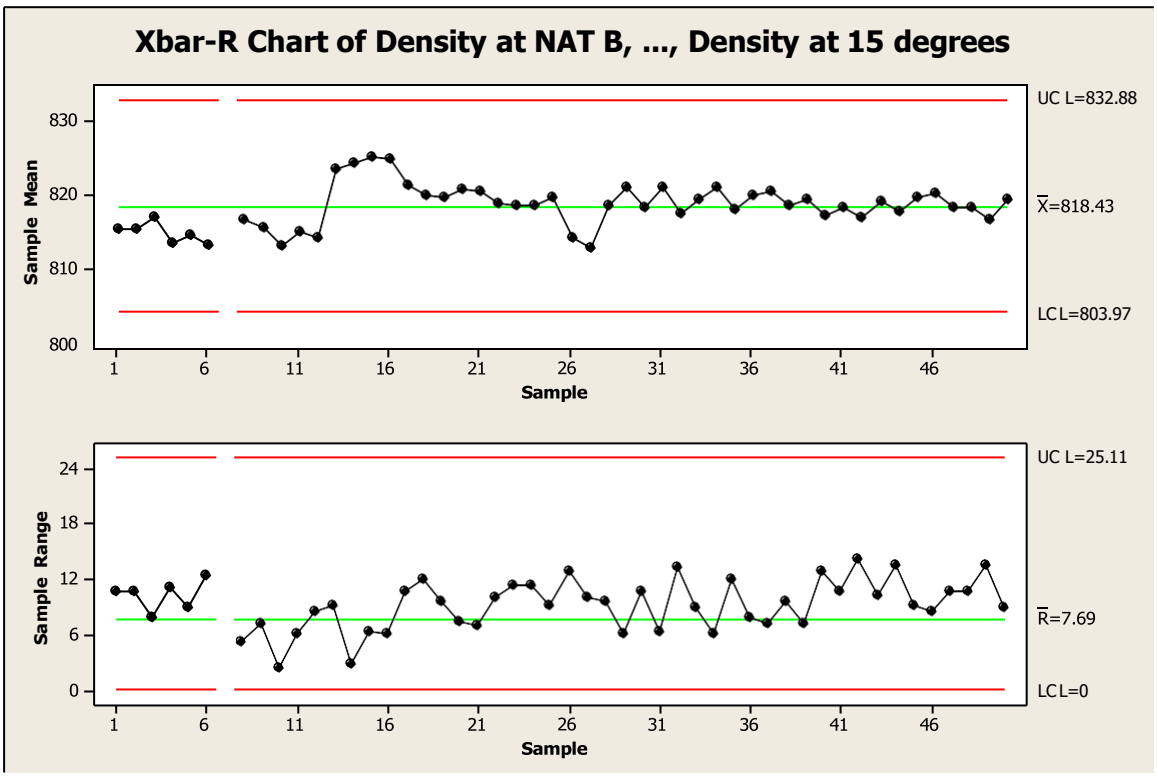


Conclusion:

For X-bar chart : From centering point of view the process is in control.

For R-bar chart : From variation point of view the process is in control.

December Tank-B:



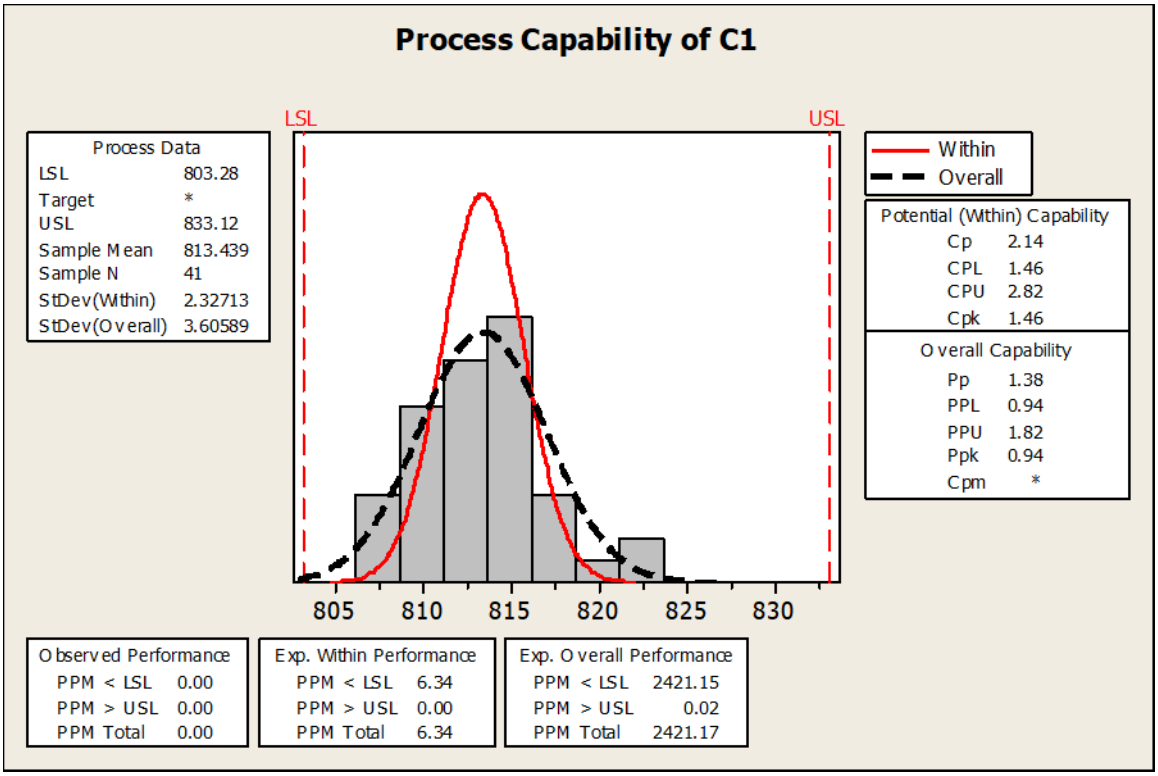
Conclusion:

For X-bar chart: From centering point of view the process is in control.

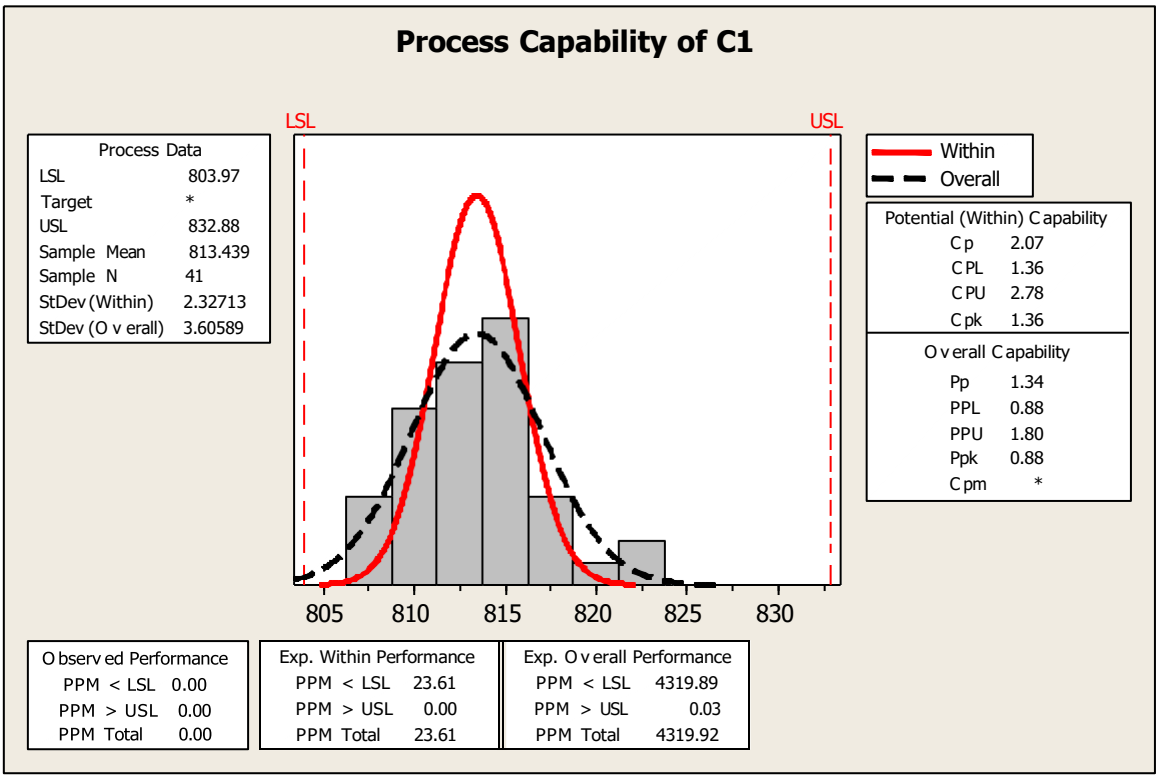
For R-bar chart: From variation point of view the process is in control.

Process Capabilty Test:

Tank-A and Tank-B:



Conclusion: As the value of CPK is greater than 1.33. Therefore, the densities of diesel in tank-A are meeting the specification limit or customers requirement.



Conclusion: As the value of CPK is greater than 1.33. Therefore, the densities of diesel in tank-B are meeting the specification limit or customers requirement.

REFERENCES

Software used for analysis:

- **R-software**
- **Ms-excel**
- **Minitab**

Books used for analysis:

- **F.Y. and S.Y. statistics text book (Nirali publication)**
- **Regression analysis**
- **Fundamental of mathematical statistics**
- **Statistical computing using r-software**

Search engine used:

- **Google**