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Experimental Analysis for Comparision of Effectiveness of Convective Oven With non Convection Otg Oven

Yuvraj Ranga UG Student, PEC University of Technology, Chandigarh

Shalom Akhai Faculty, PEC University of Technology, Chandigarh

ABSTRACT

An oven can be either be with convection or without convection. The comparison of both can help in determining which one is efficient and better at drying while keeping the parameters same. Sand samples were used with water being added to compare the drying or removing moisture. Taguchi analysis method for SN ratios, L9 array and contour plots were used for observations and results. Convection in an oven leads to greater change in weight thus pointing out better efficiency and drying as shown by the experimental results. Thus by doing similar analysis for comparing different types of ovens one can make a better choice for selection of oven for the desired industrial applications like drying of different ores of metals etc.

KEYWORDS : Oven, Convection, Efficiency, Drying, Power, Time, Weight

INTRODUCTION

An oven is a thermally insulated chamber used for the heating, baking or drying of a substance, and most commonly used for cooking. Kilns and furnaces are special-purpose ovens, used in pottery and metalworking, respectively.

In the early part of the 19th century, coal ovens were developed. The first electric ovens were invented in the very late 19th century, however, like many electrical inventions destined for commercial use, mass ownership of electrical ovens could not be a reality until better and more efficient use of electricity was available. Recently, ovens have become slightly more high-tech in terms of cooking strategy and various industrial purposes like drying ores etc.

EXPERIMENTATION

In this project an oven was fabricated and forced convection was done using a fan. No such convection is present in the existing oven which was used for comparison. Sand samples with added moisture were used in each of the oven, these samples are similar to drying processes in ores and the efficiency of both the ovens was compared using various methods and the results obtained were interesting.

Taguchi statistical method was used for analysis. This method is usually used for improving the quality of manufactured goods, and more recently also applied to engineering, biotechnology, marketing and advertising.

Consider a system which has 3 parameters and each of them has 3 values. To test all the possible combinations of these parameters (i.e. exhaustive testing) we will need a set of 3^3 = 27 test cases. But instead of testing the system for each combination of parameters, we can use an orthogonal array to select only a subset of these combinations. Using orthogonal array testing, we can maximize the test coverage while minimizing the number of test cases to consider. We here assume that the pair, that maximizes interaction between the parameters, will have more defects and that the technique works.

Benefits of using it are that it **r**educes testing cycle time and analysis is simpler. It is also balances test cases ensure straightforward defect isolation and performance assessments. This provides a significant cost savings over pair-wise testing

FABRICATED OVEN WITH CONVECTION

An oven was designed using a cylindrical aluminium box as the core chamber and plaster of paris as the refractory material within it. Nichrome coils were used as the heating source of my oven which was powered by electricity. The samples were placed on the wire mesh kept right above the heating element and in between the oven. A fan which served as an exhaust for outflow of heat uniformly passing through the sample was used to create convection in this furnace. The following powers were used :

1000W, 1500W, 2000W. The purpose of oven is to dry ore hence sand samples with added moisture were used to successfully compare the efficiency of ovens by calculating the change in mass of the sample in a fixed duration of time.

Table 1.1 Readings taken for oven with convection

Power	Initial Weight (gm)	Time (min)	Weight Change (gm)
1000	55	2	2.5
1000	85	3	4
1000	115	5	8
1500	55	5	9
1500	85	2	4
1500	115	3	7
2000	55	3	7
2000	85	5	10
2000	115	2	5

OVEN WITHOUT CONVECTION

The existing oven without convection is a thermally insulated chamber which can be used for drying of a substance. It is powered by electricity and has two heating elements, one at the top and bottom. It also has a thermostat with which we can control the temperature of the oven. Similar sand samples were used and moisture content was added. The readings were as follows-

Table 1.2 Readings of oven without convection

Power	Initial Weight (gm)	Time (min)	Weight Change (gm)
1000	55	2	2
1000	85	3	3
1000	115	5	6.5
1500	55	5	8
1500	85	2	2.5
1500	115	3	5.5
2000	55	3	6
2000	85	5	8.5
2000	115	2	4

RESULTS & DISCUSSION

Preparation of 18 different samples of sand was done out of which 6 samples were of 50gm each, 6 samples of 75 gm each and remaining six were 100gm. After adding particular amount of water in each sample, the initial weight of sand sample became 6*55gm, 6*85gm,

6*115gm

Now after keeping each sample for 2, 3 and 5 mints, an orthogonal table was prepared.

Using all the readings obtained, Taguchi analysis was used to plot SN ratios. The results obtained are as follows-

OBSERVATIONS IN CONVECTIVE OVEN
Taguchi Analysis: Weight Change (gm) versus Power, Initial Weight (gm), Time (min)

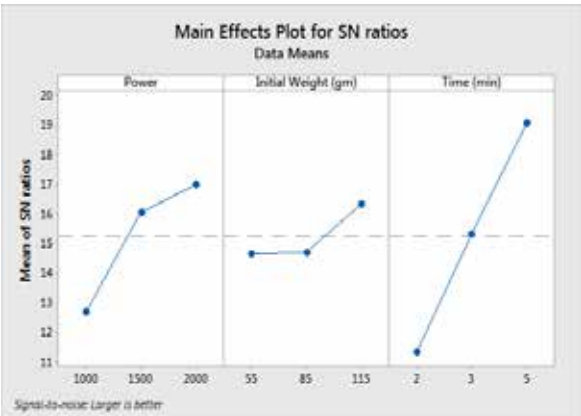

Fig1.1

The above SN ratio graph was made using 3 variables i.e. Power, Initial Weight and Time. As observed from graph, it is clear that at 2000w power, 115gm weight and 5 minutes time gives the best output in terms of the change in weight. And greater change in weight means better drying and efficiency**.**

Table 1.3 General linear Model (ANOVA)

Source	DF	Adj SS	Adj MS	F	P	Contribution %
Power	2	30.20	15.10	32.88	0.030	23.97
Initial weight	2	5.402	2.70	5.88	0.145	79.19
Time	2	89.47	44.73	97.42	0.010	71.57
Residual Error	2	0.918	0.45			
Total	8	125.99				

First of all we draw the ANOVA table to check the adequacy of the model ANOVA table is shown in table 4.9, the calculations are done at 95% confidence level. In an analysis of variance table, the P value determines the most significant factor. The factor whose P value is less than 0.05 will be most effective factor. Time is the main contributing factor with contribution% as 71.97 followed by Power with 23.97%.

Contour Plots :
Contours along with three dimensional surfaces are shown below with the help of these contours the change in weight can be calculated at any point.

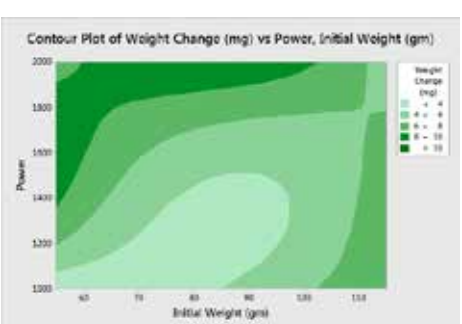

Fig. 1.2

We can find the change in weight at any power and initial weight from the above Fig 1.2. The maximum weight change range is greater than 10. This came out to be the key in comparison with the existing oven.

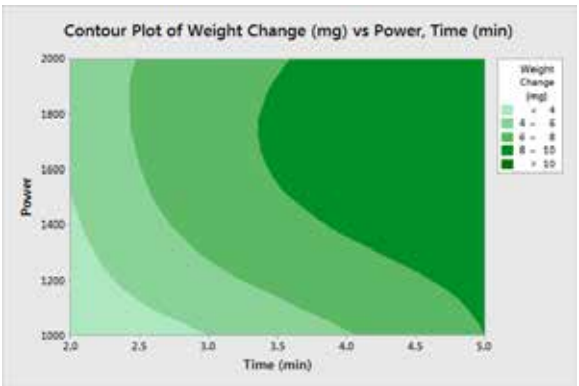

Fig 1.3

Fig 1.3 shows another contour plt but this time the variables used are Power and Time. The change in weight can be observed from the graph using these two values. Again the key here is to note the maximum weight change being greater than 10.

OBSERVATIONS IN NON CONVECTIVE OVEN
Taguchi Analysis: Weight Change (gm) versus Power, Initial Weight (gm), Time (min)

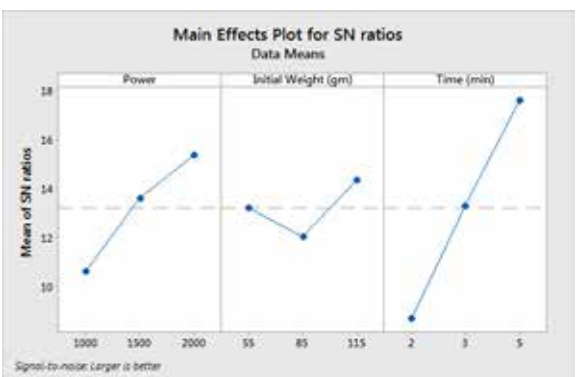

Fig 1.4

Fig 1.4 shows the S/N ratio curve for existing oven with no convection. At maximum power i.e. 2000w, and intial weight as 115gm the maximum change in weight is observed at 5 minutes time. Thus, the maximum drying was on these parameters. Showing us its efficiency which can be compared with fig 1.1

Linear Model Analysis: SN ratios versus Power, Initial Weight (gm), Time (min)

Source	DF	Seq SS	Adj SS	Adj MS	F	P	Contribution %
Power	2	35.159	35.15	17.58	1558.33	0.001	12.79
Initial wt	2	8.207	8.20	4.10	363.76	0.003	79.19
Time	2	120.537	120.53	60.26	5342.47	0.000	5.56
Residual Error	2	0.023	0.023	0.011			
Total	8	163.926	163.92				

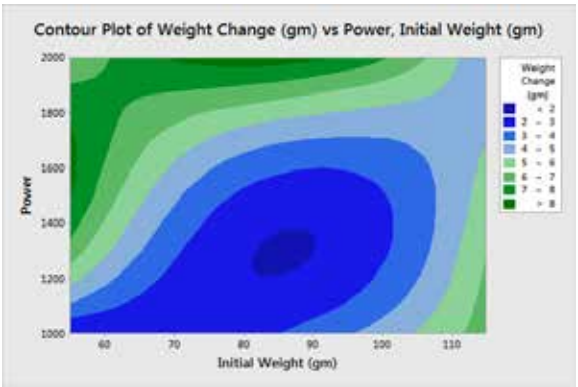

Fig 1.5

Fig 1.5 shows the contour plot with variables as Power and Initial weight. The change in weight can be observed using these two parameters. The greater the change in weight, the more is the efficiency. Key here is to note that te maximum weight change at any time and power is greater than 8. This can be compared to Fig 1.2

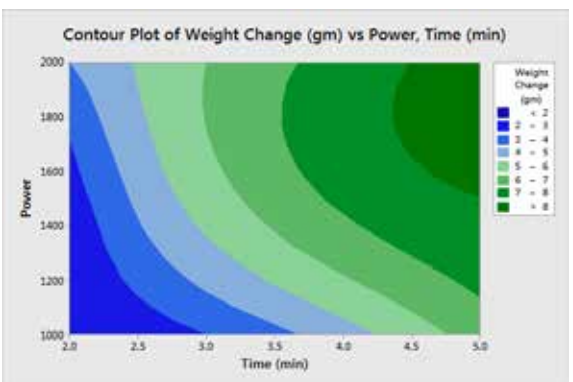

Fig 1.6

Fig 1.6 shows another contour plot using variables power and time. The change in weight can be seen using different colors and observation. We can note that the maximum change in weight at any parameter is greater than 8.

Comparison of the above results:-

In this project an oven was fabricated and forced convection was done using a fan. No such convection is present in the existing oven which was used for comparison. Sand samples with added moisture were used in each of the oven, these samples are similar to drying processes in ores and the efficiency of both the ovens was compared using various methods and the results obtained were that the efficiency of drying with convection was greater than oven without convection. The SN ratio and contour plots clearly supports our results.

CONCLUSION

As we know that the larger change in weight accounts to better drying and hence better efficiency. After all observations from our experimentations and Results we can conclude that our self designed and fabricated oven with convection was better in drying sand at same power and for same time as the change in weight was significantly greater. Also the S/N ratio and Contour plots adds up to this positivity. Thus:-

- Convection in an oven leads to better efficiency keeping all parameters such as Power,Weight and Time as constant.
- Greater change in weight accounts to better drying of ores and better efficiency.
- Designing was done using Taguchi method which came out to be in favour of our results as well.

Future Scope

- The comparison can be used in various large scale projects as both ovens with convection and without convections are used globally.
- An oven can be selected for the needed purpose using the results and the work can be done efficiently.
- Case 1:- (with convection) the drying is better and efficient as the weight change is greater.
- Case 2:- (without convection) the drying is not better as compared to case 1 and the weight change was significantly lesser.

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