

Investigation of the Performance Characteristics of a Rotary Electronic Tablet Counter

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Abstract

The performance of an Electronic Tablet Counter was investigated to find the best combination of vibration intensity and turntable speed to achieve the minimum count time for Chloroquine tablets. 66 experimental runs were carried out, and the minimum count time of 16 seconds was achievable. This result was tested and found to be both reliable and consistent.

Keywords

Tablets, turntable speed, vibration intensity, count time, targets.

1. Introduction

In a production environment, supervision plays a very important role in ensuring efficiency and effectiveness. Equipment operation requires scientific approach to setting achievable and measurable targets. The result would be improved efficiency, effectiveness and optimum utilization of human resources.

Rotary tablet counting machines are used especially by pharmaceutical companies for the counting of tablets where volume is high and accuracy is required. Although gravimetric estimation of quantity of tablets is in use, it is effective only where volume is low. Furthermore, it is not a desirable method in view of multiple handling which is opposed to current Good manufacturing Practice.

The model TB4 machine used for this study is a two-unit system: a feeder unit consisting of a hopper, a vibrating trough with a glass disc rotating under its outlet, a counting unit consisting of a photo-electric cell (P.E.C.) and a light source operating a counter. The hopper contains the bulk product of tablets with an adjustable plate at its outlet to allow various sizes of tablets to pass through.

The products move along the trough by vibration and drop onto a rotating and vibrating glass turntable driven by a geared d.c. motor with a speed controller. The turntable carries the tablets in a clockwise direction causing the tablets to be deflected outwards into a single line by guides mounted close to the glass disc, until they reach an outlet arrangement at the front of the machine. At the outlet position is a photo electric cell and a light source assembly positioned such that a single row of the tablets fall individually through, breaks the light beam and causes them to be registered on the electronic counter. The counter is capable of counting any number of tablets from 1 to 10,000 at one time. Count required for any operation can be preset.

This machine did not come with any parameter setting chart. It is expected that the user will do the setting by trial and error method. This type of investigation is therefore necessary in industries on equipment in order to get the best out of them.

2. Literature Review

Various experimental works similar to this have shown the usefulness of multiple regression in resolving optimization problems. Statistical methods such as multiple regression and response surface method could be used to establish optimum conditions [1, 5]. Second order regression model, contour plotting and statistical optimization for the characterization of a hot melt fluid bed coating process for fire granules was

used to establish set parameters for the operation of the coating equipment [4]. In this investigative work, the use of multiple regression and contour plotting is adopted as used in similar studies [2, 3].

3. Objectives

The objective of this study is to establish the optimum setting for vibration intensity and turntable speed that would ensure minimum count time for Chloroquine tablets without compromising accuracy, thereby eliminating guess works, save time and promote quantitative target setting for operators and managers. This study could easily be extended to other tablets of different sizes, weight and shapes. In this study, the effect of weight is not considered since only similar tablets will be counted at any given time. Therefore, weight becomes a constant under such circumstance. Determinable.

4. Methodology

4.1 Materials and Procedure

A rotary tablet counter model TB4 manufactured by C.E.King Limited, 41 London Street, Chertsey, Surrey was used for the study. The materials used was Evans Chloroquine tablets (diameter = 8mm, thickness = 1.5mm, weight = 10g). A hand-held mechanical stopwatch was used to record count time.

Since the number of tablets per count is 500, about 600 were placed directly on the turntable without allowing any over the other. The turntable's diameter is enough to allow this. Since the rate at which tablets fall through to break the light beam depends on the intensity of vibration of the chute and the rotation/vibration of the turntable (the vibrator impacts on both the chute and the turntable simultaneously), necessary precautions were made to prevent dust build-up on the lenses of the light source and P.E.C. which may cause a reduction of light beam intensity falling on the photocell and thereby led to count inaccuracy. After every 6 runs (based on experience), the eye of the photocell is wiped clean.

After placing the tablets on the turntable, the machine is switched on to begin the counting process. Various pre-determined combinations of turntable speed and vibration intensity were used and time to count 500 tablets per setting was recorded. In all, 66 runs (6 x11) were carried out (table. 1).

Table 1: Chloroquine tablets count time(500 tablets per count)

Speed(rpm)	Vibration Levels					
	130	135	140	145	150	155
100	35	34.5	36.2	38	38.5	36
110	38.2	35.9	36.5	39	37.5	37
120	34.5	31.2	32.3	32.8	34.4	35.2
130	34.5	30.6	30.5	32.3	31.5	33.3
140	34	29.1	29.3	17	18	15.7
150	28.5	17.8	16.2	16	17	16.5
160	28.3	19	15.3	16.05	16	17.7
170	26.8	18	14.7	16.1	14.8	15.4
180	26.5	19.5	17.8	16.3	14.5	15
190	18.5	16.7	12	16.5	15	13.5
200	15.3	17	14	15.5	14.3	13.5

The runs were carried out by setting a particular speed or vibration, and varying the other variable within the range determined from experience (turntable range: 100 rpm – 200 rpm, vibration intensity: 130 – 155). After each count, the tablets collected in a cup were returned onto the turntable for the next run. The graduations on the machine were relied upon for the settings.

4.2 Analysis

First, a trial plot of count time (z) against different vibration intensity(y) at different turntable speeds(x) was attempted (fig.1). A negative linear relationship (negatively sloping curves) exists between them and all the plots have equal gradient (-1.062) with slight differences in intercepts decreasing from 40.44 to 15.48 with increasing vibration intensity at a particular turntable speed.

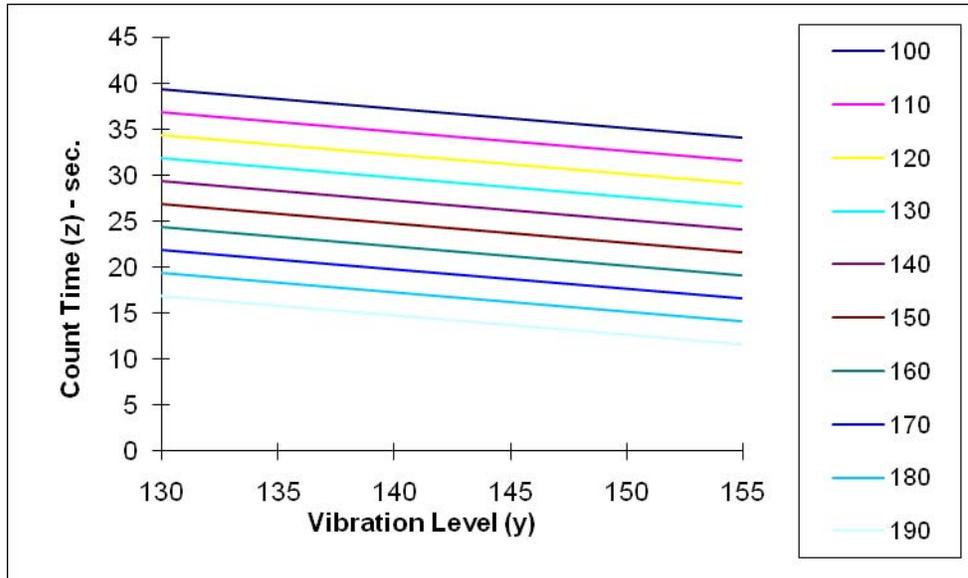


Figure 1. Effect of vibration intensity on count time at different turntable speeds (100 - 190)

Secondly, a trial plot of count time (z) against different turntable speed(x) at different vibration intensity(y) was attempted (fig.2) and non linear relationships existed between them.

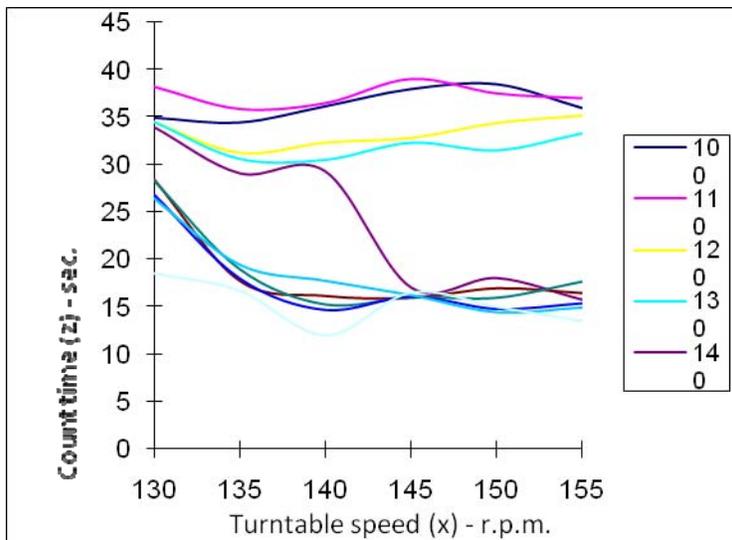


Figure 2. Effect of turntable speed on count time at different vibration intensities

Based on the observations above, a multiple regression was carried out with count time (z) as the dependent variable while turntable speed(x) and vibration intensity(y) are the independent variables and μ is the error term. The coefficients α and β are expected to be negative. The model is of the form:

$$z = \alpha x + \beta y + \mu \quad (\alpha < 0, \beta < 0), \quad (1)$$

Where $Z = f(x, y) \quad \forall 100 \leq x \leq 200, 130 \leq y \leq 155$.

5. Empirical Results

This section presents the result of the model estimation. The estimated equation is shown together with its R^2 coefficient, standard errors (se) and t-statistics, with the latter between parentheses below each estimated coefficient.

The estimated equation is:

$$CTIME = 91.98 - 0.25.TSPEED - 0.21.VIBRINT \quad (2)$$

se 10.1 0.02 0.07

t (9.34) (12.5) (3.3)

$t^* = 2.02 < \text{all } t^* \text{'s. Significant (} t^* \text{ is } t \text{ critical from table)}$

$$R^2 = 0.79$$

Adj. $R^2 = 0.78$

The model (2) is in total agreement with theoretical expectation that as either or both the vibration intensity (VIBRINT) and turntable speed (TSPEED) increases, count time (CTIME) should be decreasing (inverse relationship). It is applicable only to the range of speed and vibration intensity indicated ($100 \leq x \leq 200, 130 \leq y \leq 155$).

6. Conclusion

The performance of a rotary electronic tablet counter was successfully carried out using multiple regression method. The model specified and tested is statistically significant and, its result is in agreement with the underlying engineering theories. The relevant parameters obtained in the regression are significant by the Student's t-test, and have the sign foreseen in the model specification. The R^2 coefficient is satisfactory.

The result of this study is only applicable to the equipment and materials used during the study. The methodology could be replicated for other material sizes and other operations where process optimization is an issue. I expect that the result obtained might inspire the development of further empirical research on critical manufacturing equipment.

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