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STUDY OF SOME ENGINEERING FACTORS AFFECTING ON SEED COATING EFFICIENCY IN SEED PROCESSING TREATMENT

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ABSTRACT

The present study aimed to evaluate the effect of some engineering factors involved in processes of corn and wheat seed coating. The engineering factors were speed of the coating pan, diameter of the spinner disk, slope of the coating pan and speed of the spinner disk. The results revealed that, the coating efficiency increased as the slope of coating pan increased up to 27.66×10^{-3} rad., then tends to decrease with higher angle of slope. Also, a significant coefficient of variation was found only with corn seeds. The coating efficiency increased as rotating pan speed increased up to 0.056 m/s, then tends to decrease with higher rates of speed. The coating efficiency increased as disc diameter and/or speed increased. The study can be concluded that the effect of the spinning disk properties as its diameter or speed is the significant effect on the coating seeds compared with the coating pan as its slope angle or speed.

INTRODUCTION

Seed coating is considered one of the most important treatments applied to seeds after harvesting and before storing and/or planting. It aims in wide variety of objectives such as bacterial, viruses, insects, nematodes and fungicides application. In the field of farm machinery, seed coating is applied for improving geometric properties of seeds i.e. sizing and shaping of seeds to improve mechanical plant ability. Successful application systems should meet acceptable standards of coating efficiency where the target dose of coating material is applied, maintained on the seeds until planting, uniform coverage, minimize seed damage in addition to the operation should be economically acceptable.

The critical processing variables that affect content uniformity and loading of active agent coated on tablets, using a statistical experimental design. They found that a good correlation between observed and predicted values for content uniformity and recovery (Bhagwant *et al*., 2002). The uniformity of coating applied to large particles and tablets in rotating drum coating devices. They conducted that, decreasing trends for circulation and surface times were observed with increasing drum speeds, drum loadings, and tablet size (Michael *et al*., 2006). Therefore, Laurent (2006) studied the effect of diameter and revolution speed of rotating disk on uniformity of mixing. His results revealed that the numbers of revolutions are necessary for a uniform mixing of solids. On the other side Daniel *et al*. (2009) found that the spinning disc technique is an established industrial technique and there is commercially available equipment used sufficiently for preparing the seeds. It is a technique to produce coatings of adequate quality. They mentioned that the movement of mixing drum and disk rotation speed must be adjusted to a suitable rate seeds stick together as the coating dries.

This study aimed to evaluate the effect of some engineering factors involved in processes of corn and wheat seed coating.

MATERIALS AND METHODS

In an endeavor to characterize the engineering factors contributed in efficient operation processes of seed coating, a research study was carried out at El-Gemmiza Research Station – Gharbia Governorate. To adjust the optimum operating circumstances, some of performing engineering inputs such as agitator speed or coating pan speed, speed and diameter of the spinner disk and the coating pan slope were studied. Corn (*Zea Maize*) and wheat (*Triticum aestivum L*.) seeds were used as a material of study. Gustafson's Metered Slurry Treater, G17- Gross Bagger-SS-6 film coater was used, the sketchmatic diagrams for the machine is shown in Fig. (1). Corn and wheat seeds were treated by a fungicide, Sumi- eight WP 2% at a rate of 0.5 g of soluted active ingredient for one kilogram of seeds (Ministry of Agriculture recommendation, 2006). The weight of the metered seed was controlled by placement of the counterweight, while the amount of the chemical metered was determined by the size of chemical cup. The treatments were arranged in split- plot design with three replicates, i.e;

- Four rates of coating pan speed "V", 0.37, 0.47, 0.56 and 0.65 m/s were excluded where V_2 (initial speed) was considered as the control. These values of pan speed were controlled by adjusting the number of teeth of small drive cogwheel through changing the cogwheel teeth number. Three drive cogwheels of 18, 28 and 33 teeth were manufactured and replaced with the original sprocket, which has 23 teeth.
- Four degrees of coating pan slope "θ" were measured as angle between the pan and the horizontal fixed frame of the set. The angles were 9.043×10^{-3} (0º 31´ 5.19˝), 18.086×10^{-3} (1º 2´ 10˝) (control), 27.66×10^{-3} (1º 35´ 5.9˝) and 36.71×10^{-3} rad. (2º 6` 12˝).
- Four diameters of the spinner disk "D" were trialed, where three disks of 13.5, 16.5 and 18.0 cm diameter were manufactured and replaced with the original disk (15 cm diameter). In addition, the manufactured disks were modified to be corrugated surface in the aim of efficient atomization for droplets of coating material.
- Four speed rates of spinner disk "a" were obtained through manufacturing three drive pulleys of 7.5, 9.5 and 11.5 cm in addition to the original one that of 5.5 cm. These pulleys were fixed to the spinner disk on the same shaft, which produced speeds of 1430, 1049, 828 and 684 rpm for 5.5, 7.5, 9.5 and 11.5 cm diameters respectively. The speed was measured using a Hand Contact Tachometer.

To evaluate the performance of coating machine coating efficiency (CE) was indirectly determined where the color intensity of extracted solution of each treatment was compared to the intensity color of original coating material following the colorimetric assay to determine the concentration of a substance that is in the solution. The determination of coating efficiency was carried out by a spectrophotometer.

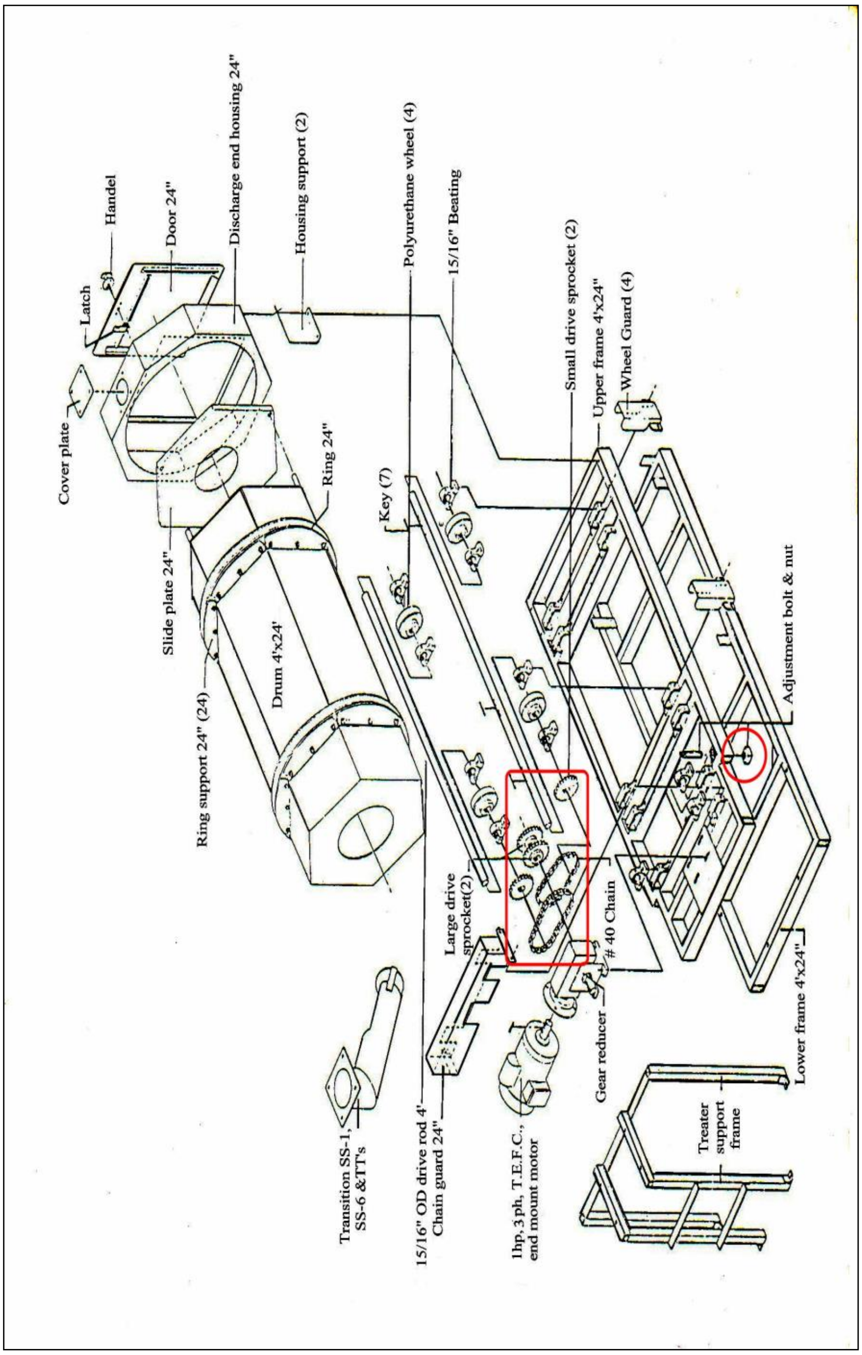

Fig. 1: Construction of the coating pan

Method description: A series of standard solutions were prepared. A standard solution is a solution in which the analyte concentration is accurately known (A series of dilutions of original coating material). The absorbance of the standard solutions was measured and used to prepare a calibration curve, which is a plot of absorbance vs. concentration. The points on the calibration curve yielded straight lines shown in Fig. (2).

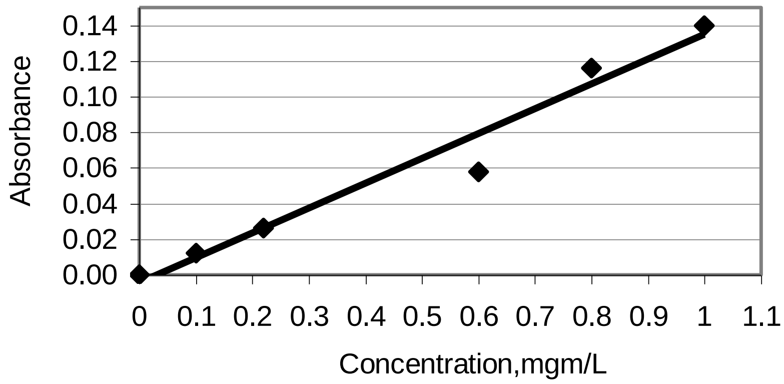

Fig. 2: The standard curve

The relationship of the approximated line is described as:

$$Y= a + bX$$

Where: Y: concentration (micro gram / Liter), and X: Absorbance of the light.

These extract of different treatments were analyzed. The extract absorbance readings of all treatments were used in conjunction with the calibration curve to determine the concentration of the analyte. The data obtained from the standard are used to plot a straight line as the following relationship between the unknown absorbance and concentration as follows:

$$Absorbance\ (A_u) = slope\ C_u + intercept$$

The absorbance of the unknown solution (A_u), is then used with the slope and intercept to calculate the concentration of the unknown solution (C_u) as follows:

$$C_u = \frac{A_u - \text{int}\,ercept}{slope}$$

Standard curve was plotted as concentration values of graded dilutions of the original solution of coating substance to spam all expected concentrations. After treating, a weight of 25 gm of each treatment was shaked in 50 ml of distilled water for 30 minutes using a lab. Shaker. The extract ants of different treatments were analyzed. The absorbance of the unknown solutions were conjuncted with the calibration curve to determine the concentration of the analyte. The concentration of the unknown solution, (C_u) was calculated as a percent of the color of the original coating material.

In this research, the seeds of corn and wheat were treated with a co-pest-fungicide mixed with colored inorganic reagent at a rate of 0.022. The conception of this measurement is to measure how much colored reagent reached the treated seeds under applied studying factors through measuring the intensity of colored washing solutions of treated seeds by the spectrophotometer and establish a relationship between the absorbance of transmitted light and the concentration of colored reagent in the solution. An intensely colored solution should yield a higher absorbance and in turn, a higher colored inorganic reagent, which means a higher coating efficiency. Five dilutions of initial coating solution were prepared. The apparatus was adjusted to zero using (re-distilled) water by setting it to 880 nanometers and zero percent transmittance, and then was used to measure absorbance of each working standard, starting with lowest concentration. The same procedure was followed to measure the absorbance of different samples of washing solutions of treated seeds as previously mentioned above in materials and methods. Following the method previously described, a record of measured absorbance for each of five standard solutions is shown in Table 1.

Table 1: Measured absorbance and concentration standard solutions

Absorbance	**0.012**	**0.026**	**0.058**	**0.116**	**0.14**
Concentration (μg/L)	0.10	0.22	0.60	0.80	1.00

The concentration of different samples were determined and referred to the initial concentration to measure the coating efficiency (CE) as a percent of original concentration by applying Equation (1)

$$\text{Concentration} = 776.14 \times \text{absorbance} \qquad \ldots\ldots\ldots\ldots\ldots (1)$$

RESULTS AND DISCUSSION

The effect of coating pan slope on coating efficiency

The coating efficiency was increased of 68.30% as the slope of coating pan increased up to 27.66×10^{-3} rad., then tends to decrease with a higher slope angle (Fig. 3). These finding may be understood on the basis that the higher slope value (36.71×10^{-3} rad.) may cause high acceleration of seed movement passing through the coating pan axial trip and does not permit enough time for seeds to be well mixed with the coating material.

The effect of coating pan speed on coating efficiency:

Fig. 4 shows that, coating efficiency was increased as rotating speed of pan increased but this trend is observed only up to 0.056 m/s, then tends to decrease with higher rates of speed of 66.36%. The results were found to be similar with the two treated crops. This may be interpreted as increasing rotating speed of pan could save a chance for coating material to be well mixed with seeds and produces a higher coating efficiency of 72.18%, but at higher speeds than 0.056 m/s, the opportunity time for mixing is not enough for well coating.

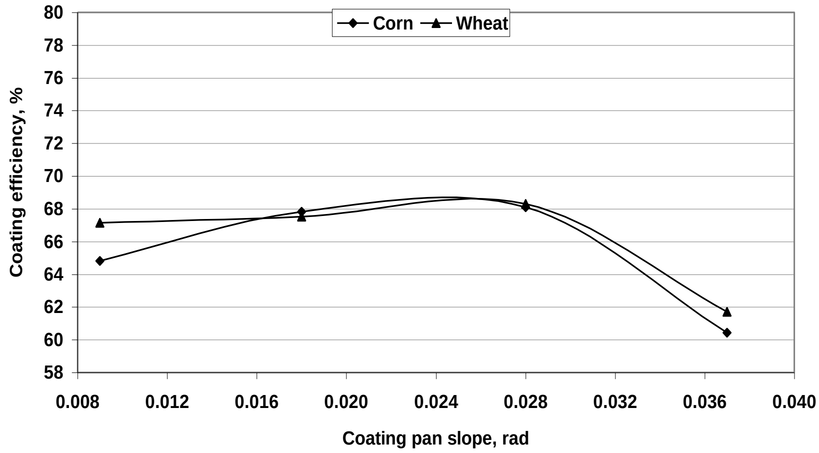

Fig. 3: The effect of coating pan slope on coating efficiency of treated seeds

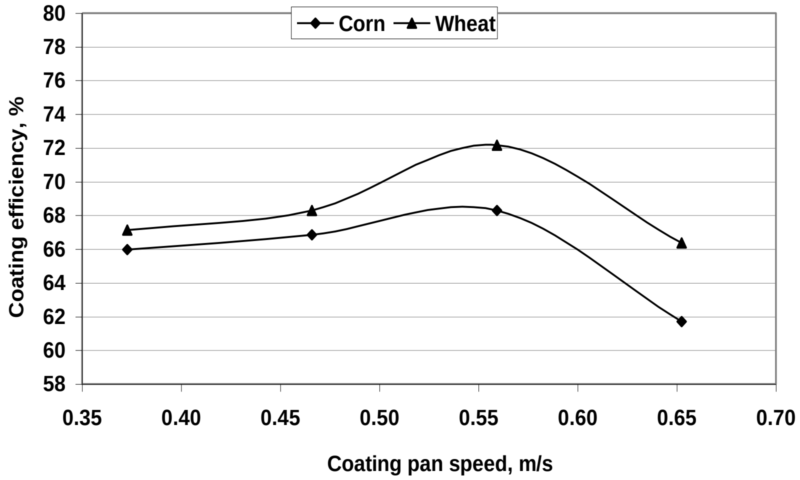

Fig. 4: The effect of coating pan speed on coating efficiency of treated seeds

The effect of spinner disk diameter on coating efficiency:

The coating efficiency was increased by increasing the spinner disk diameter Fig. 5. This may due to the increasing of the spinner disk diameter creates a narrow distance that seeds pass from the distance between the disk edge and the cone walls. This may give enough opportunity for seeds to receipt more coating material which means higher coating efficiency of 77.23%. The differences were obvious with corn seeds than those with wheat because the flat surface area of corn is greater than the flat surface area of wheat, so that corn seeds receipt a higher amount of coating material.

The effect of spinner disk speed on coating efficiency:

Fig. 6 illustrated that, the clear differences were found between (a_4 = 1430 rpm) and (a1 = 684 rpm and a_2 = 828 rpm). It non-significant between (a_4) and a_3 = 1049 rpm.

These results could be explained on the basis that higher speed of spinning disk leads to decrease the size of droplet of coating material and more efficient distribution on seed surfaces. There results are agree with the results found by Michael *et al*. (2006); found that, disc rotation speed had the most significant effect on droplet size and predicted deposition efficiencies decreased as droplet size increased. The same trend of results was found with all of treated seeds.

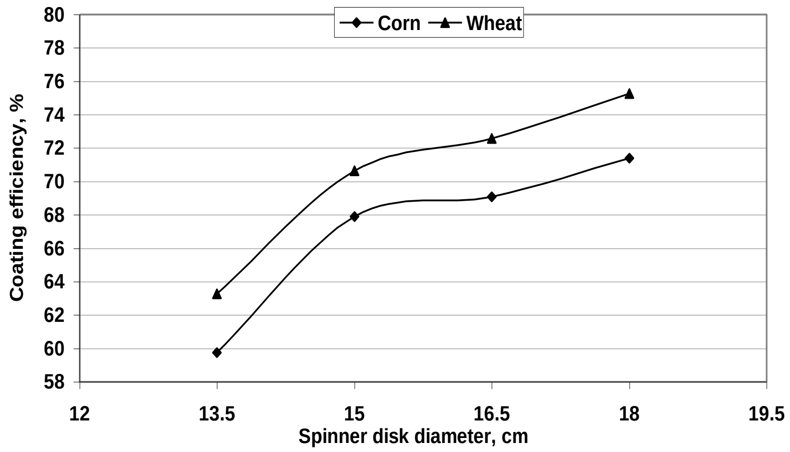

Fig. 5: The effect of spinner disk diameter on coating efficiency of treated seeds

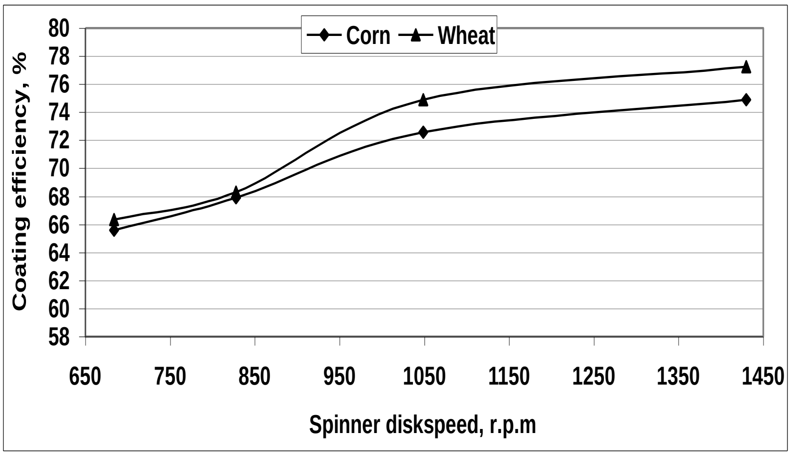

Fig. 6: The effect of spinner disk speed on coating efficiency of treated seeds

Regression analysis was performed to identify the best fitting relationship that represents the correlation between coating efficiency (CE) and different studied factors. The most representative equations are detailed in Table 2.

Table 2: The correlation between coating efficiency and the factors under study

The relationship	The equation	
	corn	wheat
CE vs. - Ɵ	$CE=72.4067 - 267.508\Theta$	$CE=70.1625\times(e)^{-2.5996\Theta}$
CE vs. - V	$CE=72.4713\times(e)^{-0.1925V}$	$CE=67.0829-2.9359V$
CE vs. - D	$CE=-38.0166+38.186\ln D$	$CE=-39.5995+39.9945\ln D$
CE vs. - a	$CE=37.4104\times(a)^{0.0971}$	$CE=18.4596+8.2266\ln a$

Conclusions

The study can be concluded that the effect of the spinning disk properties as its diameter or speed is the significant effect on the coating seeds compared with the coating pan as its slope angle or speed.

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دراسة بعض العوامل الهندسية المؤثرة على كفاءة تغطية البذور فى عمليات معالجة التقاوى

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أجريت هذه الدراسة بمحطة إعداد وتجهيز التقاوى بمحطة البحوث الزراعية بالجميزة - محافظة الغربية حيث تمت دراسة تأثير كل من زاوية ميل اسطوانة الخلط وسرعة اسطوانة الخلط وقطر القرص الدوار وسرعة القرص الدوار وتهدف دراسة ودراسة تأثير هذه العوامل على كفاءة تغطية تقاوى كل من الذرة والقمح بالمبيد الفطرى (سومي – إيت2%). حيث تم دراسة أربع مستويات لزاوية ميل إسطوانة خلط التقاوي (θ) بالمبيد الفطرى ($\theta_1 = 9.043\times10^{-3}$، $\theta_2 = 18.086\times10^{-3}$ (اتخذت هذه الزاوية كمقارنة حيث أنها الزاوية المستخدمة قبل إدخال التعديلات)، $\theta_3 = 27.66\times10^{-3}$، $\theta_4 = 36.70\times10^{-3}$) زاوية نصف قطرية. وأربع مستويات لسرعة دوران إسطوانة خلط التقاوي بالمبيد الفطرى (V) (0.37، 0.47 (اتخذت هذه السرعة كمقارنة حيث أنها السرعة المستخدمة قبل إدخال التعديلات)، 0.56، 0.65 م/ث). وقطر القرص الدوار Spinning disk الذى يقوم بترزيز بالمبيد الفطرى (D) حيث صنّعت ثلاثة أقراص ذات أقطار 13.5، 16.5،18 سم بنفس مواصفات القرص الأصلى من حيث مادة الصنع وطبيعة السطح المتعرج وتم استبدالها بالقرص الأصلى ذو القطر 15 سم. وكانت السرعات المقاسة للقرص (a) (358، 477 (السرعة الأصلية التى اتخذت كمقارنة)، 715، 1430لفة/دقيقة).

وقد أظهرت النتائج ما يلى:

- تزداد كفاءة التغطية بزيادة زاوية ميل الإسطوانة حتى (27.66×10^{-3} rad.) (ثم تتناقص بزيادة زاوية ميل الإسطوانة وكانت أقل نسبة لكفاءة التغطية مع أعلى زاوية ميل (36.71×10^{-3} rad.) بينما كانت أعلى كفاءة مع زاوية ميل الإسطوانة (27.66×10^{-3}) حيث بلغت الكفاءة 68.30% وكانت الفروق معنوية مع حبوب الذرة بينما لم تكن هناك فروقاً معنوية مع حبوب القمح.
- أظهرت النتائج أن كفاءة التغطية تزداد بزيادة سرعة الإسطوانة (V) حتى السرعة (0.56 m/s=V3) ثم تميل إلى التناقص بزيادة السرعة وكانت أقل كفاءة قد وجدت مع سرعة الإسطوانة (V4 =0.65 m/s) حيث بلغت الكفاءة 66.4% بينما كانت أعلى كفاءة مع سرعة الإسطوانة (V3 = 0.56 m/s) حيث بلغت الكفاءة 72.2%.
- فيما يتعلق بتأثير قطر القرص الدوار(D) فقد بينت النتائج المتحصل عليها أن كفاءة التغطية تزداد بزيادة قطر القرص وكانت أعلى كفاءة للتغطية قد سجلت عند قطر (D_3 = 16.5 cm)
- أما تأثير سرعة دوران القرص (a) على كفاءة التغطية فقد وجد أن الكفاءة تزداد بزيادة سرعة الدوران حيث بلغت أعلى كفاءة تغطية (77.23 %) ووجدت مع سرعة دوران للقرص (1430 rpm).

وقد تبين من التجارب أن العامل الأكثر تأثيراً على كفاءة التغطية هو مواصفات القرص الدوار (قطر وسرعة) مقارنة بمواصفات الإسطوانة من حيث زاوية ميلها وسرعتها.

قام بتحكيم البحث

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