

Development of Intelligent Type Design to escape the chalk dust from the duster eraser used for classroom blackboard in Schools/Colleges

Mr. Sunil R. Kewate¹, Mr. Vivek R. Gandhewar²

Mr. Swapnil V. Thorat³ Mr. Hitesh R. Pant⁴

¹(Asst. Professor, Mechanical Engg. Dept. Govt. COE and R, Awasari, Dist.: Pune, Pune University, India)

²(Associate Professor, Mechanical Engg. Dept. J.D.I.E.T., Yavatmal, Amravati University, India)

^{3,4}(Student, Mechanical Engg. Dept. Govt. COE and R, Awasari, Dist.: Pune, Pune University, India)

Abstract

The traditional duster eraser chalk dust is a common problem. It is generally known that erasers for cleaning the black boards in school rooms soon become saturated with chalk dust and have to be cleaned. In the past, this has usually been done by clapping the erasers together. In short, swallowing a piece of white chalkboard chalk won't kill a person, but breathing in the dust for a number of years can create or trigger respiratory problems. Therefore, it is necessary to have the provision for automatic cleaning of the duster eraser and also the provision for collecting the dust so that it cannot permit to fly in the atmosphere for health problem. For this reason, the design is based on the traditional duster-eraser vibrator called intelligent vibrator system, its connotation of "intelligent" includes vibratory motion, suction to suck dust particle, dust particle collection. In this research paper, concept puts forward a kind of mechanism design scheme, the mechanism can automatically detect the chalk dust particle after putting the duster eraser in fixture and erase the duster eraser, keep the duster eraser free from dust particle. The further research work will be based on computer processing i.e. on two parts of information processing unit and motion control unit.

Keywords - *Duster eraser institution, experimentation, intelligent, mechanical structure, sensor, vibrator system, etc.*

1. Introduction

From the time when the concept of classroom teaching came into existence Blackboard chalk and duster eraser is its integral part. With the passage of time Blackboard were replaced by green boards but no alternative of chalk and duster eraser were found. Even in this age of mechanization and automation and advanced electronics, they are not being replaced even in the developed countries like United States and United Kingdom. These days we are using projectors in the class rooms but till today no such a device has been made which has the ease and the simplicity of the blackboard and chalk. Writing on the board is very easy job and erasing is still easier one the main problem arises when the task of cleaning the duster eraser comes. After quite some time the duster eraser becomes saturated and it doesn't clean the black board efficiently. Then it needs cleaning. Cleaning the duster eraser is very simple job just rub it or bangs it against the wall, similar to rug beating, and most of the dust falls off. Generally the teacher needs to clean the blackboard while he is teaching. Banging of duster against the wall produces noise, destroys the whitewash, makes the class dirty, and worst of all quite a lot of chalk dust is released which, when inhaled can lead to troubles like bronchitis that is asthma or if it goes into the eyes it may cause irritation in the eyes. The chalk is made from "plaster of Paris and calcium carbonate", that is $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$ which is hydrated and allowed to set in fixed. If the colored chalks are to be prepared some pigments and dyes are added to it which may be toxic or nontoxic. Hence looking at the above disadvantages of the conventional cleaning, the concept of a machine was thought of, which would clean the duster eraser without spilling the chalk dust. One may argue that if a duster eraser is being used again and again it would not be logical to fit it in the machine during the class for cleaning. When the duster eraser is cleaned once a day also and even if teacher uses chalk 75% of the time he teaches. The duster erasers will not require cleaning as it is cleaned thoroughly and will absorb more dust. Even greater than that of the conventionally cleaned duster eraser which is being cleaned in the class by rubbing or beating against the wall after regular intervals.

There are two separate issues buried in the question of chalk dust safety. In one sense, the main ingredients of this dust are considered to be *non-toxic*, which simply means they do not pose a threat when ingested. In another sense, this material can and does accumulate in the human respiratory system, which means it can create long-term health problems due to overexposure. The various improved duster eraser vibrator structure device came into being, but these improvements not fundamentally solve the problem and it is being too costly and difficult to spread. [1] For this reason, the design is based on the traditional duster-eraser vibrator called intelligent vibrator system, its connotation of “intelligent” includes vibratory motion, suction to suck dust particle, dust particle collection. The design is able to achieve automated clean the duster eraser and collect dust in one stroke. In this research paper, concept puts forward a kind of mechanism design scheme, the mechanism can automatically detect the chalk dust particle after putting the duster eraser in fixture and erase the duster eraser, keep the duster eraser free from dust particle. Also In this paper, it introduces the design and principle of Vibratory type mechanism for school chalk dust duster eraser.

2. Survey Taken for the Concept Developed and Suggested Medical Report

A survey was conducted in the Shivaji High School, Amolakchand Mahavidyalaya, Govt. Polytechnic & Govt. Residential Women’s Polytechnic, Yavatmal. The opinion of teachers was taken on questionnaire in which the teachers were asked to fill up the answer. This report is based on the questionnaire and its findings come out. as shown in fig.1

Some of the senior teachers of the above-mentioned institutions were surveyed and their opinion on the whole is summarized as below:

- Consumption of Chalks: a) Science Stream: 3 - 4 per Period, b) Non-science Stream: 1 - 2 per Period
- Material of Duster eraser: a) Fabric -90%, b) Sponge-10%
- In survey, almost 90% of the teachers were facing problems due to Chalk Dust and majority agreed that it happened due to improper way of cleaning the Duster eraser.
- In survey, it is observed that about 33 to 40% of the teachers were ignorant of the problems caused by the Chalk Dust.
- While conducting survey, almost all the teachers about 90% agreed, that the Chalk Dust released during cleaning of the duster eraser in the class resulted in the loss of concentration and various other reactions from the students sitting in the front row.
- In survey it is found that almost all the teachers agreed to the need of the instrument for cleaning the Duster, so as to confine the dust released in the process.
- The frequency of cleaning the Duster eraser varied according to the consumption of chalks.

A survey was made in the various colleges, and the opinion of the various teachers was taken about the dust hazards due to the chalk dust, Most of the teachers in the favour of the instrument, which can Cleanthes duster with dust spilling. The survey was also conducted to find out the ill effects of the dust spilling. This survey was conducted under the guidance of Dr. Dilip Deshmukh, a chest and TB specialist of the TB hospital of Yavatmal. The survey consisted of finding the frequency of duster eraser cleaning, chalk consumption, and the medical survey, which consisted of taking the Peak Expiratory Flow Rate (P.E.F.R) of the teachers. Three readings were taken, one normal, second after exposing to the chalk dust and the last one after fifteen minutes. The senior teachers from Amolakchand Mahavidyalaya, Yavatmal and J.D.I.E.T., Yavatmal were examined.

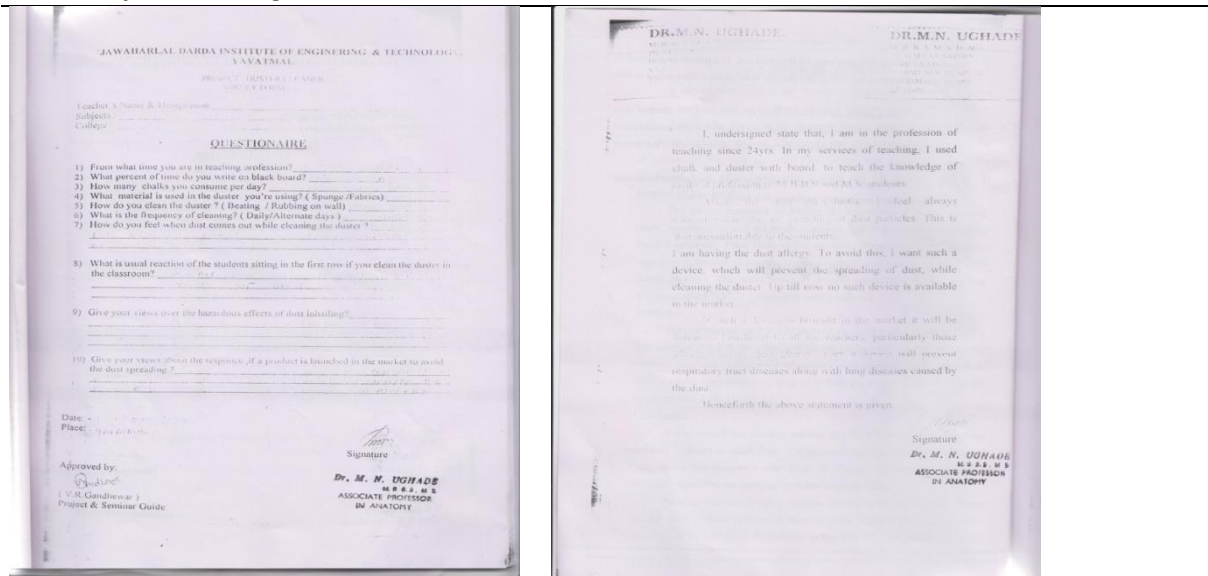
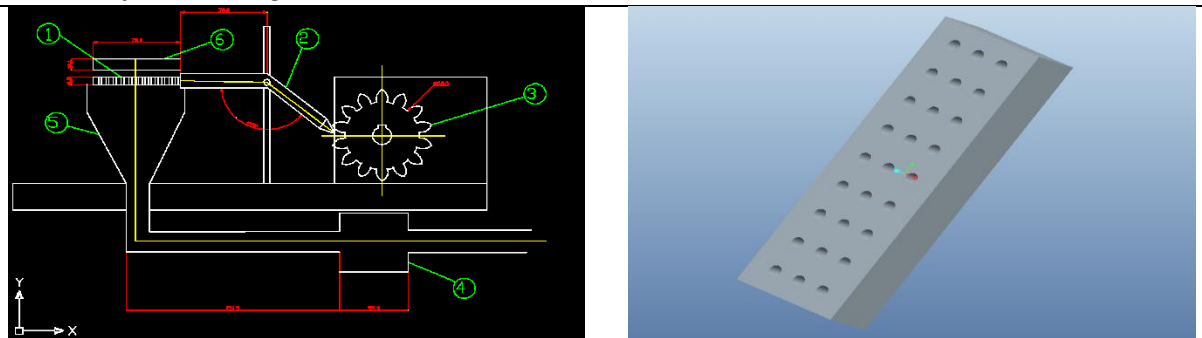


Fig. 1. Scan copy of filled questionnaire and chalk dust report letter from doctor

Findings come out-The readings of the P.E.F.R showed an average drop of about 9.08%, The average P.E.F.R variation was in the range of 4 to 12 percent. The teachers were not feeling good when they were exposed to the chalk dust. Nine teachers were examined, four were from the A.M.V and the rest of the teachers were from engineering College in Yavatmal. It is observed that there is definite drop in P.E.F.R. in almost all the persons, exposed to chalk dust. The obstruction in the airways is of acute type, which was reversible after 15 to 20 minutes. As the obstruction was not more than 20% the persons were not asymptomatic. Particles between 0.1 to 2 microns are in diameter nearly all reach the alveoli most of those bellow 0.1 microns settle on bronchial epithelium by the process of diffusion. Deposition is list in 0.4 to 0.5 ranges and about 80% of particles in this size may be breathed out. If a person is exposed to 1000 parts of dust in one ml. of air, then he may retain 0.5% of dust in one year. The working environment does not contain 1000 parts of dust in one ml of air throughout the teaching period, but the environment does have sufficient quantity of chalk dust particles when the duster is cleaned. Prolonged exposure to chalk dust with obstruction in airway can produce respiratory problems in a sensitive person.

3. Construction and Working Principle of Duster Eraser Vibrator Mechanism

The vibratory type fixture mechanism consists of only one motor for suction and vibratory motion. The brief construction of mechanical structure is that vibrator which is called as L type lever pivoted at one point other than two ends and one end of l type lever is exactly with the bottom surface of duster eraser having small holes which vibrates and other end is free and hammered by the projected pin of the circular disc which is fixed on motor shaft. Motor drives the circular disc and same motor used for creating the vacuum in the bottom surface of the duster eraser to suck the dust particle. Vibrator vibrates so that the dust particles free from duster eraser and suck the dust particles through small holes and collect it by doing together. The sensor is fitted at the bottom face of the duster eraser mounting fixture to sense the duster eraser position and signal passed to the motor to start and the vibrator vibrates continuously. It takes 60 to 100 seconds for cleaning the duster eraser completely [2, 5]



1-Vibrating Pad with holes through it, 2-Lever, 3- Curved teeth Gear with Keyway, 4-Vaccum (Suction) Pump,5- Dust Collecting Chamber, 6-Duster with sensor

Fig.2. Duster eraser Vibrator Mechanism and vibrator pad with holes (Autocad and Catia diagram)

4. Design Methodology

4.1 Selection of Motor-The system is required to vibrate the pad so that it can remove the dust from the sponge area of the duster. As shown in fig.4, Volume of the duster = $4.5 \times 14 \times 2.5 = 157.5 \text{ cm}^3$, For nylon material, we have density = 1.15 gm/cc , Therefore, Mass = $1.15 \times 157.5 = 0.18113 \text{ Kg}$, Force required to escape the dust from class room duster (Measured force) = 1.8113 N , Torque acting on vibrator pad working face structure = $1.81 \times 1.4 = 2.534 \text{ N-m}$

Assume the vibrating speed for the vibrating pad structure to escape the dust from class room duster 100 rpm

Therefore, we have $P = \frac{2\pi NT}{60} = 26.53 \text{ W}$, In. HP it is 0.0358 HP, So, we have selected the A. C. motor of having capacity is 0.05 HP [3]

4.2 Gear Design -Gear is required to transmit intermittent motion to vibrate the pad. Thus it is under variable load. So the gear designs for beam strength and Selected the gear of 20° pressure angle who has 20 teeth. Teeth are selected according to vibration required $F_b = \sigma_b m Y = 80.1 \text{ m}^2$, Calculated effective load $F_t = P/V = 356.255/\text{m}$ and $F_{eff} = \frac{K_a * K_m * Ft}{60}$, $F_w = N_f * F_{eff} = 2.07$, where N_f for small load = 1.5

From design data book nearest and safe value of module is 3 mm

Dimensions $m = 3 \text{ mm}$, $b = 10 \text{ m} = 30 \text{ mm}$ $D = m * z = 3 * 20 = 60 \text{ mm}$

4.3 Pin Design-Pin is under bearing Pressure, For $P_b = F/dt$, from design data book for nylon bearing pressure is 2 N/mm^2 , $d = 14.42 \approx 15 \text{ mm}$ [4]

4.4 Lever Design – The different forces on lever as shown in fig. 3, Now $M_{max} = 721 * 2 = 504623 \text{ N-mm}$, from Bending stress $= \frac{32 * M}{\pi d^3}$, $d = 23.9 \approx 25 \text{ mm}$ [4]

4.5 Selection of Bearing -As no axial load is acting on shaft; single groove ball bearing can be used. The max. Radial force acting on the bearing $F_r = 89.88 \text{ N}$ Now, for single groove ball bearing used, We find $F_a / V * F_r = 0 / 1 * 3.36 = 0$ Where, $V =$ rotation factor = 1 for inner race rotation, Then $F_a / V * F_r < e$, Taking $X = 1$ & $Y = 0$, X & Y are radial & thrust factor And taking K_s (Service factor) 1.5 for light shock load, Therefore, Equivalent load. $P = (X * V * F_r + Y * F_a) * 1.5 = 134.82 \text{ N}$,

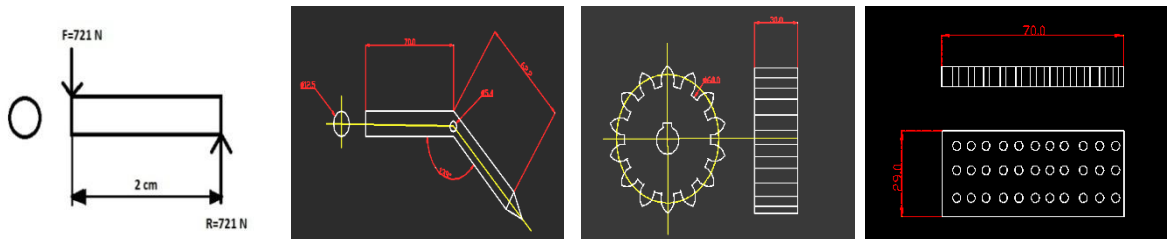


Fig.3. Forces on the lever.

Fig.4 The design dimensions i) Lever ii) Gear iii) Vibrator pad with holes thro.

Considering the working period of bearing in its total life is 10000hrs, we have $L = \text{life in hrs.} = 10000 \text{ hrs}$ and $N = \text{no. of rev.} = 350 \text{ rpm}$. Therefore, $L = (C/P)^3 * 10^6 / 60 * N$ where, C is dynamic load capacity = equivalent load in KN = 0.13482KN, Hence $C = 0.80\text{KN}$, The basic dynamic capacity of the bearing is very small. So due to the limitation of shaft diameter and availability of bearing in market, it is decided to select the bearing of specification 6203 having ID =15mm and OD = 35mm. [4]

5. Conclusion

According to the survey and the medical report from specialist various doctors, it was concluded that the most of the teachers did not know or were ignorant about the problems caused by the chalk dust, which is an unwanted obligation thrust upon them. Putting in all our caliber and sincere efforts to help our teachers, our design made for Duster Eraser Vibrator Mechanism and this designed device will be of great help to the teachers, as it will avoid dust inhaling and hence, the various other problems related with it. This machine mechanism automatically cleans the duster eraser; the only effort one has to do is to put the duster eraser in the duster Eraser Fixture device.

6. Acknowledgements

“Completing a task is never a one man’s effort. Several prominent people in production, academics, and administrative field have helped in the development of Duster Eraser Vibrator Machine Mechanism for this present research work. Their collective support has led in successful design and development of this work. To name them all is impossible.” I am thankful to colleagues, at, Government College of Engineering, Awasari, Pune, and various other institutions for cooperation provided by them. Special thanks to the Principal and teaching staff of GCOEAR, Awasari, for needful support and encouragement for making successful.

References

- [1] Ren, Z. G. (2002). Chalk dust on the health hazards of teachers (in Chinese). *Chinese Journal of School Health*, 2, 189.
- [2] Yang, S. Z., & Chong, Y. K. (2007). *Mechanical engineering control*. Wuhan: Hua zhong University of Science and Technology Press.
- [3] Deng, X. Z. (2002). *Electric Drive Control*. Wuhan: Hua zhong University of Science and Technology Press.
- [4] Pu, L. G., & Ji, M. G. (2001). *Mechanical design* (7th ed.). pp. 167-170. Beijing: Higher Education Press.
- [5] Jinzan Liu¹, Zhong Zeng¹ & Lang Xu¹ “New Smart Eraser Design” *Modern Applied Science*; Vol. 7, No. 2; 2013 ,ISSN 1913-1844 E-ISSN 1913-1852.