Design and Analysis of Granulator Machine

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Abstract- **Rotary granulator is a machine which can granulate materials into specific shapes. It is suitable for large scale production of cold, hot granulation and high and low concentration complex fertilizer. What is more, it is one of key facilities to make compound fertilizer. You can equip with other machines to form a complete compound fertilizers production line. The rotary wet granulator can produce not only compound fertilizers, but also organic fertilizer as the disc pans granulator machines. Meanwhile, it also uses wet granulation method. We have been able to develop a model which has been used in designing controls of granule size distribution. The growth of ten different granule size classes is descried each in its own differential equation. Each equation consists of factors that describe growth of granules within its class, growth from smaller classes and to bigger classes. A factor for granule breakage can be used.**

I. INTRODUCTION

Drum granulation is a commonly used process in a commercial fertilizer production. Many continuous granulation plants operate well below design capacity, suffering from high recycle rates and even periodic instabilities Propose the process simulator based on an extended modelling approach for continuous drum granulation-drying processes, focused on simulation and control. This approach involves the dynamic process model built from heterogeneous knowledge sources such as physical principles, empirical (measured) data and expert information. The mechanistic part incorporates the understanding of physics and underlying mechanisms (e.g., mass and energy balances, growth kinetics). The empirical part uses raw and/or filtered process sensors' data, their storage, and retrieval and parameter identification techniques in addition to the mechanistic (white box) model. The expert component involves the process experts' recommendations, which are of great value due to the lack of another knowledge mentioned above.

II. LITERATURE REVIEW

Ludmila Vesjolaja, Bjørn Glemmestad , Norway[1]The operation of granulation plants on an industrial scale is challenging. Periodic instability associated with the operation of the granulation loop causes the particle size distribution of the particles flowing out from the granulator to oscillate, thus making it difficult to maintain the desired product quality. To address this problem, two control strategies are proposed in this paper, including a novel approach, where product-sized particles are recycled back to maintain a stable granulation loop process.

Sebastian Schab, Piotr Rusek, Norway [2] A purpose of the research was to develop a method for the preparation of novel organ-mineral fertilizers with the use of brown coal and biochips as organic additives. Brown coal was blended simultaneously together with inorganic materials used for the process of urea superphosphate production in a laboratory scale using a pan granulator and in larger scale using a rapid mixer granulator. Biochips were used for the coating purposes of the urea superphosphate granules on a laboratory scale using a pan granulator.

Jacobs Engineering, Lakeland SA [3] Escher pointed out the value of bone as a fertilizer and suggested a "cheap and not too strong acid" to decompose the bones before applying to the soil. Later in 1840, the Duke of Richmond stated that the fertilizer value of bones was due to the phosphoric acid that they contained. In that same year, Justus Von Leibig added sulfuric acid to crushed bones to make them more soluble and proved that phosphate of lime and not gelatin was the fertilizing agent in the material.

Department of Process Control, Kaunas University of Technology, Kaunas, Lithuania [4] Drum granulation is a commonly used process in a commercial fertilizer production for particle size conversion. One of essential tasks in the granulation process is to produce particles with a controllable (predictable) mean size and the range of sizes with respect to plant throughput, the operation cost and stability.

Robert Siuda Jerzy Kwiatek, Szymon Szufa, Poland [5] non-pressure granulation of mineral materials used for the production of agricultural fertilizers for soil deacidification. In order to expand the product range of Nordkalk Poland sp. z o. o. located in Poland, the granulation conditions of the gypsum–lime mix were examined with the use of various granulation methods.

Loganathan I, M.J. HedleyI , Dunedin, New Zealand [6] Two types of finely crystalline ammonium sulphate (particle size distributions: white type 7% 2-3 mm, 45% l-2mm, 48% were granulated by adding calcium oxide and concentrated sulphuric acid using a rotating drum in the laboratory and pilot plant. The granules had satisfactory physical and chemical properties. The granules made in the pilot plant with 25 kg ammonium sulphate, 0.5 kg CaO, 1.26 liters of water and 0.9 to 1.125 liters of 98.5% H_2SO_4 had 80 to 97% of the granules within the size range of 1-3 mm, abrasion resistance of 0.4 to 0.8%critical relative humidity of 65-70%, pH 1.8 to 1.9 and N, S and Ca contents of 19, 24 and 1%. The quality of the granules when stored for 6 months alone or blended together with common fertilizers did not change.

Gediminas Valiulis, Rimvydas Simutis, Kaunas, Lithuania [7] The paper presents the model-based approach to process simulation and advanced control in the industrial granulation circuit of fertilizer production. Different knowledge sources, such as physical phenomena, statistical analysis of process parameters, expert information cover different cognition domains of the process.

III. WORKING

Granular organic compost fertilizers of 4 and 6 mm in diameter and of approximately equal length are produced. Binders are not used for granulating. This technology differs from other organic and organic fertilizer production technologies because it helps to produce granular fertilizers of the same length and without binders. As a result, granular fertilizers can be applied locally together with the plant seeds when sowing or planting. This is the new organic fertilizer spreading technology. Organic fertilizer granules are strong and stable and can be stored for a long period. These granular fertilizers are suitable for mechanical spreading of fertilizers using disc fertilizer spreaders. Prior to spreading with disc fertilizer spreaders, the desired rate has to be determined. Regulatory instructions for mineral fertilizer application rates are inappropriate. Fertilizers may be used in organic production in accordance with the requirements of Council Regulation.

Application of granulated fertilizers

- Locally together with plant seeds or planting material.
- Before sowing or planting with disc spreaders and then adding to the soil.
- At the beginning of vegetation without adding to the soil
- In later stages of vegetation when vegetables are grown in greenhouses and outdoors.
- Spread in all directions when fertilizing potted flowers.
- In horticulture and berry breeding, spreading in all directions under the fruit trees and berry bushes.

IV. CALCULATION

Motor Specifications: -

- H.P.= 15 (Three phase) = 11.19 Kw
- N=1440 R.P.M.

Torque available at the outlet of motor,

Power = $\frac{(2*\pi*N*T)}{60}$…………………… $eq^n(1)$

Torque (T_{input}) = 74.21 Nm = 74210. 00N.mm

G = $\frac{\text{Input Speed}}{\text{output speed}}$ ……………………………… eqn (2)

= $\frac{1440}{2}$ = 720

= $\frac{720}{25}$ = 28.8

Torque available at the outlet of gearbox,

T_{outlet} = Tinput *G

= 74210.00*28.8

= 207.47*10^3 N.mm

Design of belts and pulley

Drive System: -

Motor = 15 H.P, 1440 R.P.M

= 11.19 KW

F_a = 8 hr. per day

c/s of V belt is A

Speed ratio = $\frac{1440}{720}$

= 2

d = 3-inch D = 5-inch

- **Number of Belts**

$$N = \frac{P*F_a}{P_r*F_c*F_d}$$

$$= \frac{11.19(1.3)}{6.36*1.08*0.98}$$

= 2.14 = 2

No. of belts are 2

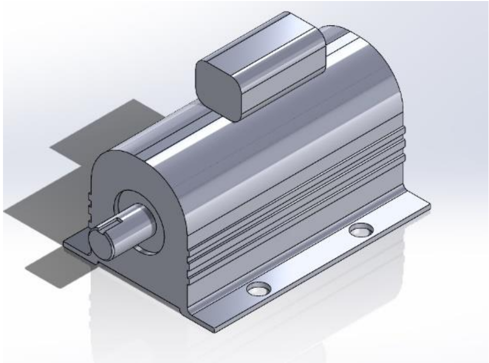
Design of shaft under torsional load,

T = (π/16) * Ʈ*d^3 ………………………….…eq^n (4)

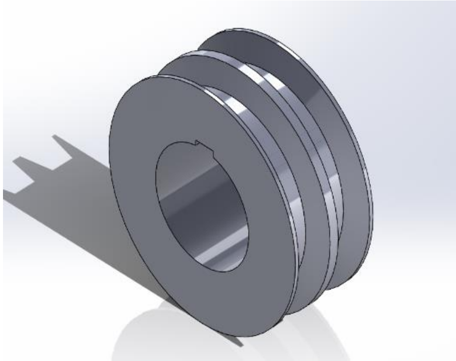
207.47*10^3 = (π/16) *88*d^3

d = 25.49 mm =30 mm

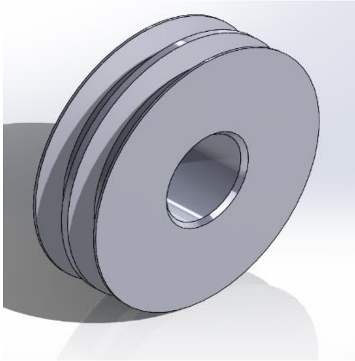
V. MODEL



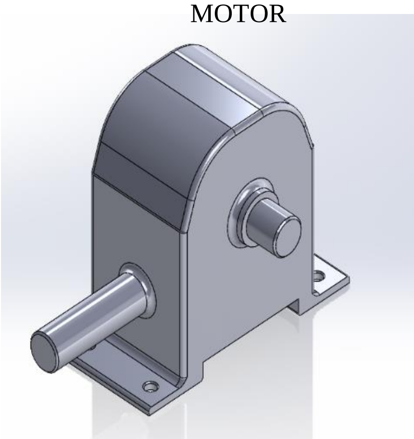
MOTOR



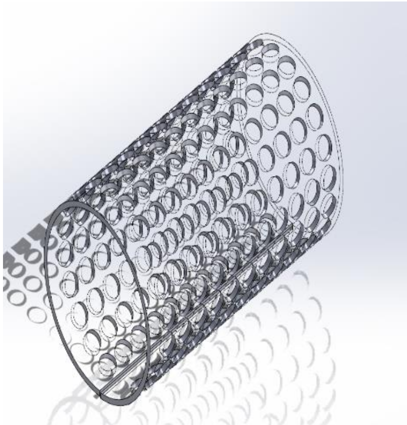
PULLEY



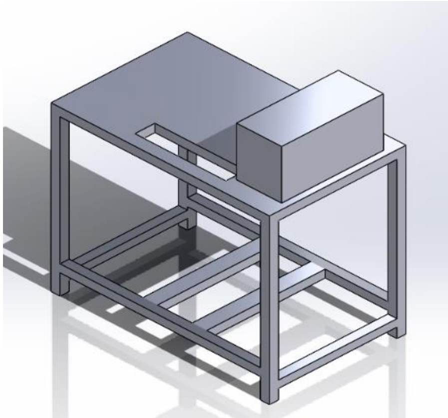
PULLEY



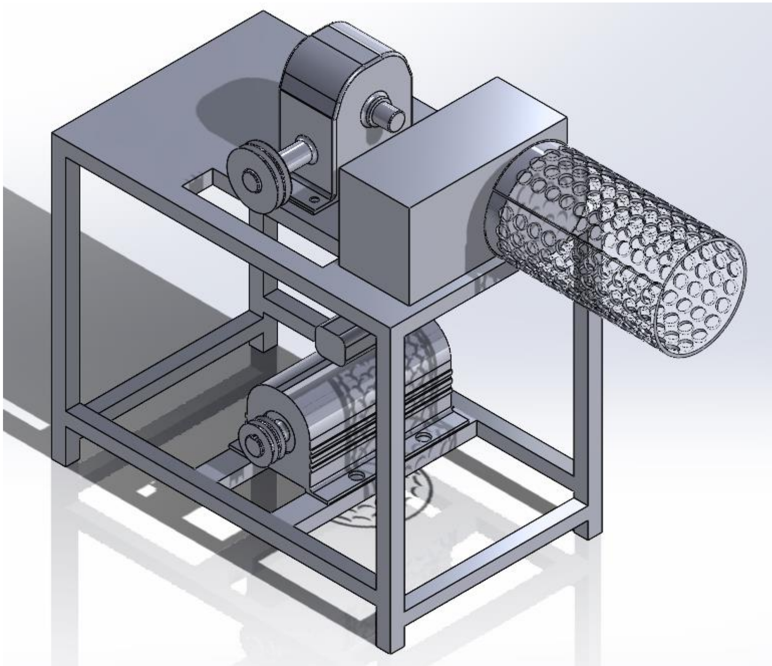
GEARBOX



DIE



STRUCTURE



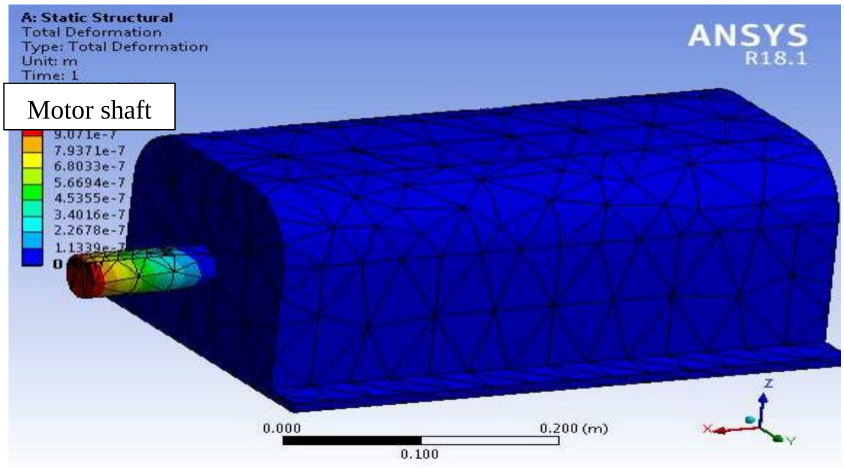
Assembly

VI. ANALYSIS

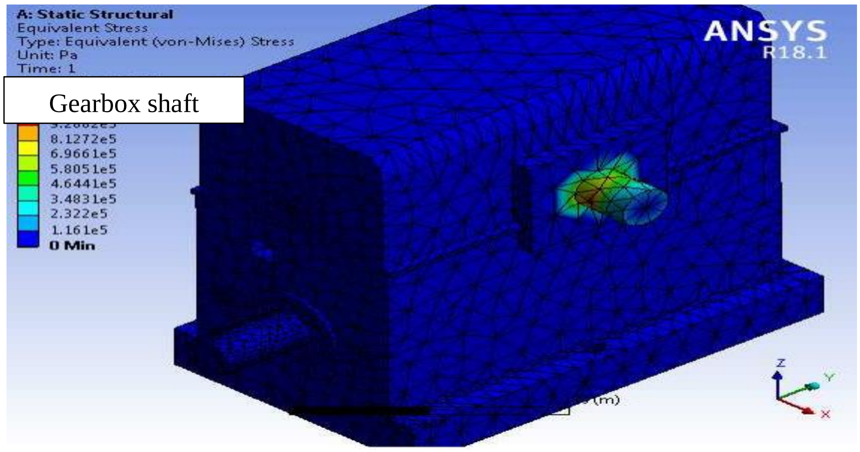
ANSYS is general-purpose finite element analysis (FEA) software package. Finite Element Analysis is a numerical method of deconstructing a complex system into very small pieces (of user-designated size) called elements. The software Implements equations that govern the behaviour of these elements and solves them all; creating a comprehensive explanation of how the system acts as a whole. These results then can be presented in tabulated, or graphical forms. This type of analysis is typically used for the design and optimization of a system far too complex to analyse by hand. Systems that may fit into this category are too complex due to their geometry, scale, or governing equations.

Static Analysis

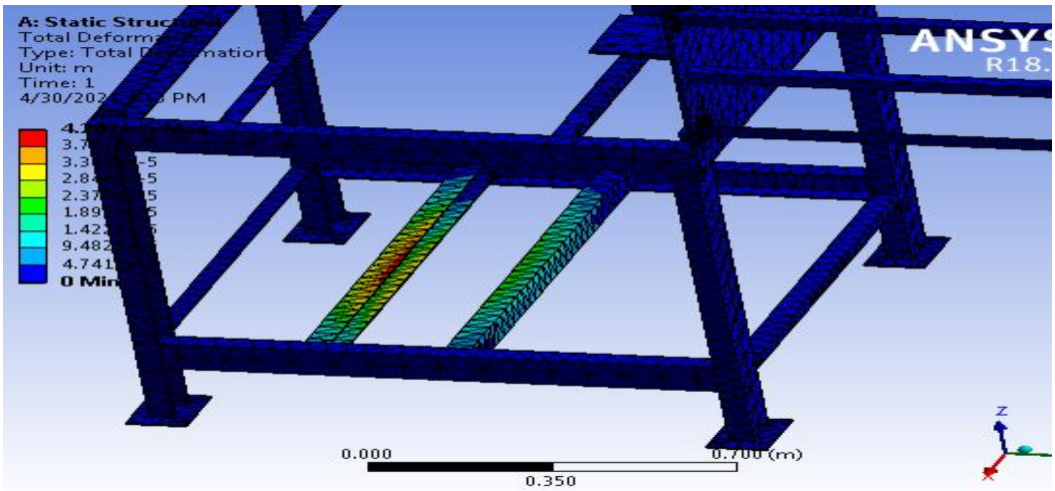
Used to determine displacements, stresses, etc. under static loading conditions. ANSYS can compute both linear and nonlinear static analyses. Nonlinearities can include plasticity, stress stiffening, large deflection, large strain, hyper elasticity, contact surfaces, and creep.



ANALYSIS OF MOTOR



ANALYSIS OF GEARBOX



ANALYSIS OF STRUCTURE

VII. CONCLUSION

It plays a vital role in processing of raw ingredients to get the homogeneous mixture of fertilizer as well as it can help to prepare the fertilization very fast and in less time without aid of human being. The outcomes of the project are,

- Take less time for preparation
- Easy to operate.
- Easy maintenance.
- Increase the machine life
- We compared the theoretical design data with the simulation software like ANSYS. After comparing the data, the actual and theoretical data was differed with 0.5% error. So, it is good for design perspective. The theoretical design was safe. In theoretical calculation, we cannot take the environmental conditions and we consider some assumptions, but in actual simulation it takes some standards for validation of theoretical inputs. This will result in error between actual and theoretical calculations.

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