Design, Development and Analysis of Power Drive System for Calcination Drum: A Review

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***Abstract*: The objective of this paper to present the recent development in the field solid waste management and power drive system for calcination drum. Power drive is main part of a system. It transmits the power from main source to machine components. In most of mechanical machines gear trains are used as a power drive because of its higher efficiency. It transmits the torque with the help of friction wheels. In this work main aim is to give a power to calcination drum to rotate with required speed. Electric motor is used as a main source of power and torque produced by it is to be transmitted to calcination drum using a designed power drive. Hence design of power drive for this calcination drum system is done.**

Introduction

Solid waste refers to the refuse, the solid and semi solid waste matters of a community except the night soil. Solid waste contains organic as well as inorganic matters. As per Municipal solid waste Management and Handling rules-2000, solid waste management is in the obligatory function of urban local bodies, but in actual practice the solid waste management is given the last priority and the duties are either not performed or poorly performed consequently the city has to face numerable problems related to environment and sanitation. The solid waste management approach in India is extremely inefficient, using old and obsolete system technology for storage collection processing, treatment and disposal. Hence by taking into ill effects due to improper disposal of wastes due to which the atmosphere becomes ugly and unhygienic different methods for recycling are used. Composting is one of the method which is the biological decomposition of biodegradable solid waste under controlled predominantly aerobic conditions to a state that is sufficiently stable for nuisance-free storage and handling and is satisfactorily matured for safe use in agriculture. To perform this process, it is necessary that the wastes should be bifurcated into degradable and non-degradable ones. This can be done by the specially designed equipment named Calcination Drum.

It is simple cylindrical drum containing an inlet from where waste materials are fed and outlet from where the waste in the form of fine particles are send to further processing. Inside the drum there are perforated screens and blades which accomplish this task. The drum is rotated by means of 4 rollers rolling along guide ring and external ring gear meshing with a pinion. The guide ring is welded on the drum. When drum is in rotating condition due to unbalanced of solid waste mass tumbling inside the drum the failure of shaft and bearing of roller assembly takes place also some cracks are seen on guide ring. This problem can be solved by designing the roller assembly and guide ring such that it can withstand loads without failure.

Any organic waste from urban and rural areas and industries is a resource due to its ability to get degraded, resulting in energy generation.

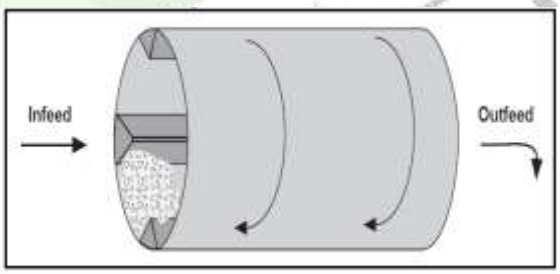

Figure no.1 Rotating Drum

Calcination drum plays very important role in bifurcating the degradable and non-degradable wastes and helps in forming the mixture of waste which is required for formation of methane. Waste materials are renewable source of energy which will not diminish as that of fossil fuels.

Literature view

2.1 Solid Waste Management

Today we face problems related to solid waste management. Vijay Kumar and Dr R. K. Pandit have [1] discussed about problems of solid waste management in Indian cities and the sources from which these solid wastes are generated. The land filling practice in most Indian cities is one of the most unscientific and unhygienic practices with serious environmental implications. Also works on case studies for large cities regarding ingredients of waste generated and also the problems regarding storage of solid waste as the system of keeping the bio degradable and non Bio degradable waste separately. Solid waste management; its sources and different separation methods are available. Gaurav K. Singh, Kunal Gupta, and Shashank Chaudhary[2] have studied on sources and methods like handpicking is a long-used form of separation of a few components of solid wastes in which a conveyor moves

the solid waste pass by a group of workers who pick up the designated components by hand. This method of separation is costly and only a few bulky components, such as bundled newspapers and cardboard, can be separated. A mechanized material recovery method utilizes shearers that break open the bag sand liberate cans and bottles Trammel screens separate cans, glass and other inorganic material. The organic material is shredded and passed through air classifiers, which separate the components desired for recovery of fibers for paper making or for producing refuse derived fuel Magnetic and electromechanical systems separate ferrous and non ferrous metals.

And electromechanical systems separate ferrous and non ferrous metals. The volume of municipal solid waste is greatly reduced by incineration, conversion processes or resource recovery. Tom L. Richard [3] search on the various technologies and options currently available for preprocessing Municipal Solid Waste. The steps involved in composting of municipal solid wastes are collection, contaminant separation, sizing and mixing, and biological decomposition. He describes different devices like trammel, eddy current separator, air classification etc used to carry out separation of wastes according to their sizes. Also describes other devices like hammer mill, shear shredders and rotating drum which are used for size reduction of solid waste particles in order to enhance the composting rates.

In composting systems there are three objectives for materials separation: 1) Recover recyclable or combustible materials as marketable by-products, 2) Reduce the levels of visible inert materials (e.g., plastics and glass), and 3) Reduce the levels of chemical contaminants (e.g., heavy metals and HHW).

In evaluating a system design, several criteria stand out as particularly important to these physical processing steps, including cost (capital, operations and maintenance), market specifications for compost and recyclable by-products, and the flexibility of the system to respond to a changing MSW feedstock.

2.2 Rotary kilns (Drum)

Rotary kilns used in industries for different application like cement industries, for drying purpose etc. Heng Long Li and Panos Papalambros[4] have focused on the optimal design of ride rings for Industrial Rotary Kilns. In this article they have represented the type of modeling analysis and subsequent solution, suitable for design problems which must be solved many times with parameter changes larger than those handled with usual sensitivity analysis. They give brief description regarding the typical construction of Rotary Kilns or Calcination Drums which are used in cement processing industries. Also represents the bending stress distribution and pressure distribution with the help of diagrams. Theoretical and experimental research on STRESSES of a kiln ring which is done by Ziga Alma, Hadžikadunić Fuad,Vukojević Nedjeljko [5] .The stresses in the riding ring of cement rotary kiln are discussed from both theoretical and experimental approach.These stresses are alternating in nature and are caused by forces acting on the ring and by thermal gradients. The most significant stresses are caused by Hertzian contact pressure between the ring and supporting roller.

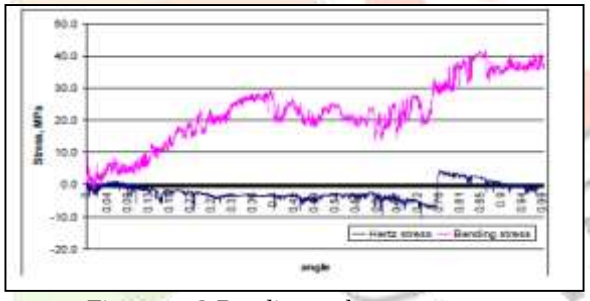

Figure no.2 Bending and contact stress

This figure shows that when no contact on the edge of ring is achieved, bending moment in those fibers will have different bending stress distribution.

Their highest value is not on the surface but slightly below it. These stresses are responsible for subsurface cracking and pitting damage of kiln ring and roller.(See fig. no. 3)

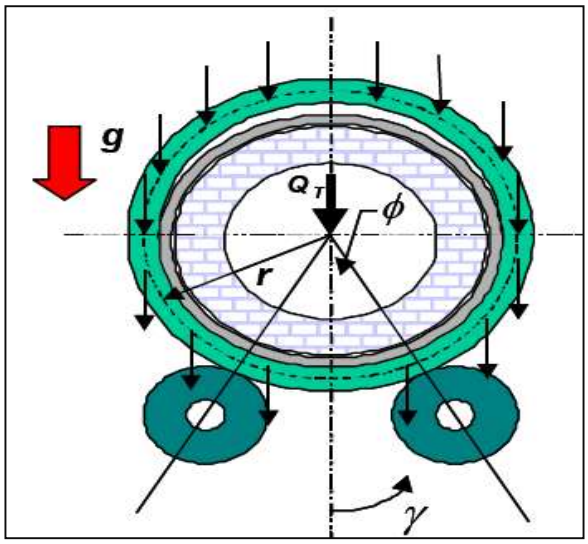

Figure no.3 Ring and Roller

In the ring, the bending stress and stress due to temperature gradient along the section height also exists. Theoretical value of stresses will be compared with experimental ones, obtained for the most loaded, middle ring in Cement factory in Kakanj.

Sumesh Krishnan [6] in his article 'Achieving Mechanical Stability of Rotary Kiln by FEM' have focused on kiln alignment, kiln geometry analysis etc. It was shown that an FEA model could be used to simulate contact between two bodies accurately by verification of contact stresses between two cylinders in contact and comparison with the Hertzian equations. Correct Mechanical Balance can be concluded as an optimum state of the forces and stresses distribution acting on kiln carrying system and the shell. The essential factors which determine this distribution are kiln geometry (ovality) and mutual relations between rotation axes of kiln and support rollers (dynamic relations).The analyses of the circumferential stresses and the contact stresses are implemented in the FE code ANSYS. Subsequently, the required tangential friction stress is obtained in terms of the rolling and sliding contact area condition. This study can be used to solve a fundamental contact problem similar to the roller. Concept of contact stress analysis of Rotary Kilns described by Vidyadhar Deshpande and Arvind Dhekhane [7]. Contact stress analysis of kiln tyre is presented. Contact stress plays key role in pitting of tyre.

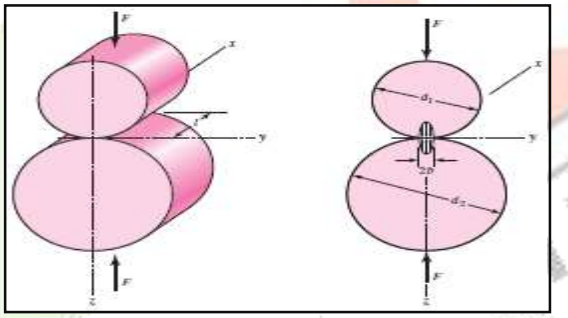

Figure no.4 Contact stress distribution

Contact stress distribution shown in fig. no.4. In some cases, contact stress cause cracks in tyre. Highest value of contact stress is not on the surface but slightly below. Tyre is supported by rollers, contact pattern arrangement of tyre and roller is similar to two cylinders in contact and axes are parallel. Load on tyre is calculated considering kiln is simply supported. Contact stress analysis is performed using analytical and finite element simulation. Kiln is considered as simply supported beam. Kiln reactions are calculated by using STAAD soft ware. There is no much more difference in reactions at three tyres but maximum reaction is at third tyre. Contact stress is calculated by using hertz theory and FEM method.

U.Ethrog and B.Shmutter [8] investigated for determining the deformation of rotary kiln. Deformations of a rotary kiln of a cement plant were determined by a special photogrammetric method. The uninterrupted rotations of kiln stops only once in several years for maintenance purposes which causes continuous changes in the deformations of the foundations and the shell of the kiln and prevents determining coordinates of points on the kiln in a ground system by common methods of analytical photogrammetry. The deformations of the kiln were then determined by analyzing the shapes of those curves. The accuracy of deformations so obtained was within the range of 2-4 mm. The method is advantageous in two additional respectsFault diagnosis for supporting rollers of the rotary kiln find out by Kai Zheng, Yun Zhang, Chen Zha, Tianliang Li [9] using the dynamic model and empirical mode decomposition. Fault diagnosis for the rotary kiln's supporting rollers has important engineering significance in that it can help to reduce equipment maintenance cost and economic loss resulting from production suspension of the rotary kiln. To achieve the above-mentioned purposes, it is of great importance to study the dynamic model and identify the fault features of the supporting rollers.

Figure no.5 Rotary kiln in a cement plant of China.

It includes the analysis was made on the impact of the rotary kiln crank on the supporting roller sand the dynamic model was established. Also the numerical simulation analysis was done.

2.3 Gear

Gear is one of the most reliable power transmission systems in modern industry, operates at various speeds and loads. Breakage of gear tooth is a serious issue. Gear manufactured with alternate material can compensate this problem. With the advent of composite materials, it has been possible to reduce the weight of the spur gear without any reduction in the load carrying capacity. Tanuj Srivastava, Sushovan Ghosh, Rohit Ghosh , Dr.Rabindra Nath Barman [10]have work on Design and Manufacturing of Spur gear Tooth which New Approach Towards Composites. They investigate the stresses in the spur gear tooth within the desirable limits to obtain a practical understanding for the theoretical ideas associated with composite materials. Most importantly the new design method has proposed to manufacture the tip of the gear tooth separately with composites in contrast to use of composites for the entire tooth. It has been observed that a substantial decreasing trend toward the deformation values for composite applications with a negligible increase in maximum stress.

Also Pravin B. Sonawan, P.G.Damle [11] works on Static Structural analysis of gear tooth. Spur gears are the most common means of transmitting power in the modern mechanical world. They vary from tiny size used in the watches to the large gears used in marine speed reducers; bridge lifting mechanism and railroad turn table drivers. The four major failure modes in gear systems are tooth bending fatigue, contact fatigue, surface wear and scoring.

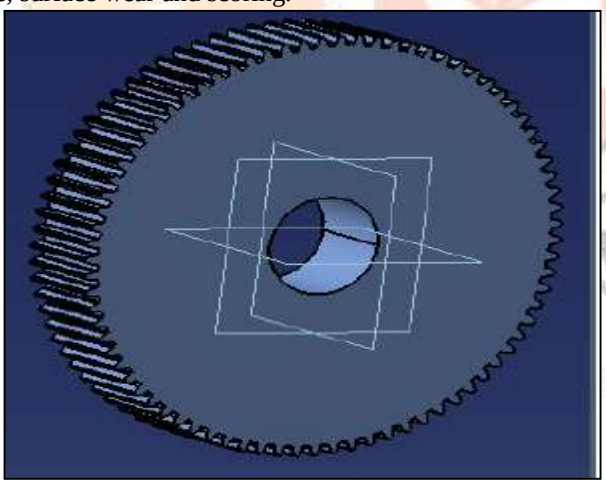

Figure no.6- 3D Model of Gear.

Tooth breakage is clearly the worst case of damage, since the gear could have seriously hampered operating condition.

Spur gears are very useful in numerous applications. Current methods of calculating gear contact stresses use Hertz's equations and Lewis Equation which were originally derived for contact between two cylinders. To enable the investigation of contact problems with FEM, the stiffness relationship between the two contact areas is usually established. The results of the three dimensional FEM analysis from ANSYS are presented. Finite Element Method can be used for bending stress analysis in a pair of gear. Seok-Chul Hwang, Jin-Hwan Lee, Dong-Hyung Lee, Seung-Ho Han, Kwon-Hee Lee[12] have works on Contact stress analysis for a pair of mating gears. Contact stress analyses for spur and helical gears are performed between two gear teeth at different contact positions during rotation. Two examples of spur and helical gears are presented to investigate the respective variations of the contact stress in a pair of mating gears with the contact position.

Jotram Patel, Gopal Sahu, Prakash Kumar Sen[13] have presented work on A STUDY ON COMMON FAILURE OF GEARS. Different types of failure detection and analyzing technique which is used to reduce this failure from gears. The basic reasons of gear failure misalignment of gear, spalling , pitting etc, follow the reason of gear failure. Gears generally fail when the working stress exceeds the maximum permissible stress. The gears generally fail when tooth stress exceed the safe limit. Wear and cracking

is also cause of failure of gear. Adhesive and abrasive wear are important modes of wear. Abrasive wear occurs when a surface is cut away by abrasive particles.
Cracking starts with small stress raisers quite in the root of a gear. This causes unsuspected overloads with a high sliding speed which raises the temperature of the hardened case.

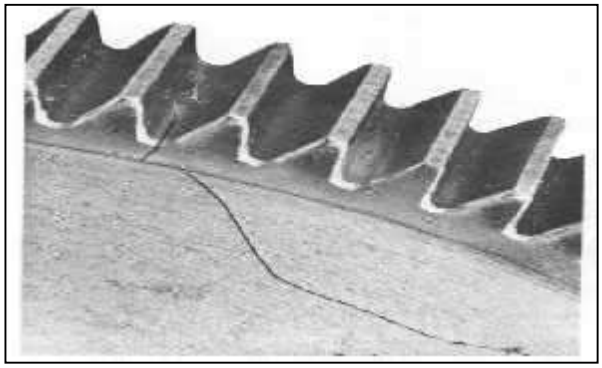

Figure no.7 failure by cracking

Also they work on the preventing the gear tooth failure.
Shaft is important term in power drive system. Sometimes shaft failure occurs in industry. In this study, the failure modes of the shaft of the rotary draw bending machine are inspected. Failure analysis and fatigue life of a shaft of a rotary draw bending machine which is investigated by B. Engel, Sara Salman Hassan Al-Maeeni.Shaft [14] failure modes are analyzed in detail. Modelling of shaft is shown in fig. no. 10. Spectro analysis test is performed to determine the chemical composition and mechanical properties of the shaft material and it is found that the shaft material is C 15 Pb.

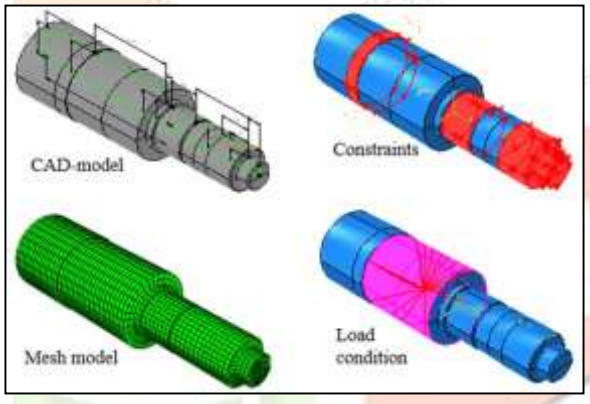

Figure no.8 Shaft modelling

From the surface roughness and hardness measurements, it can be deduced that the surface failure occurred due to the friction and wear on the mating surfaces. Forces, torques, and stresses are calculated by using an analytical approach and ABAQUS software. Both methods show that the stresses and deflections are nearly same and in the admissible range

2.4 Methane Production

Glenn E. Johnson, Louis M. Kunka, William A. Decker, and A. J. Forney [15] have addressed that waste materials of all types are ever increasing so that waste disposal is one of the largest problems facing an ecology-minded society of today. This paper describes the equipment used and the test methods for producing methane. Tests were carried out with different kinds of wastes results based on the amount of methane produced from different types of wastes were discussed.

Conclusion

Calcination drum, which produces useful energy from the wet waste garbage by rotating and mixing chemicals. For more capacity rotating calcination drum is made approximately 1.5 meters. Rotating calcination drum is very important and tedious task which can be accomplished by powerful power drive system. In this paper designing of the power drive system which includes rotary kiln, gear, shaft, key also different methods of producing methane. The Government and local authorities are working with their partners to promote source separation, achieve higher percentages of recycling and produce high quality compost from organic.
The analysis of contact stress between tyre and roller, Kiln reactions are calculated by using STAAD software. Also, Experimental determination of contact and bending stress didn't give correct values because the existing clearance between outer fibres of ring and roller surface. The numerical simulation result indicated that when there is kiln crank, there will have a kiln harmonics (RH) in the vibration signal. It was shown that an FEA model could be used to simulate contact between two bodies accurately.
This study presents the change in the contact stress of spur and helical gears in relation to the contact position. According to the analysis, the design that considers the contact stress is stricter than the AGMA standard.

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