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A Review on Design and Development of Eccentric Shaft for Cotton Ginning Machine

Amol Kurle[1]
M.Tech (CAD/CAM) Student,
Department of Mechanical Engineering
G.H. Raisoni College of Engineering,
Nagpur - 440016 (India)

Prof. L. P. Raut[2],
Assistant Professor,
Department of Mechanical Engineering,
G.H. Raisoni College of Engineering,
Nagpur - 440016 (India)

Abstract:

The present review provides brief information about the design of eccentric shaft for cotton ginning machine. The author suggest that, significant of eccentric shaft are as follows,

1. Due to the small eccentric distance in design of eccentric shaft; friction torque is very small, which result in small friction loss and high system efficiency.
2. The torque acted on motor increased as eccentric distance expanded which result in poor force condition and complicate structure.
3. Eccentric shaft are usually with features of small eccentric distance, thus its can only provide small displacement.
Eccentric shaft is the important element, which play the important role in ginning operation. These shafts provide an oscillatory motion or action to moving knives. Eccentric shaft is required in various industries according to their application. In traditional case, implementation of the proper selection of raw material, latest and advance methodologies is typical task.

Examination of parametric linkages reveals that eccentric shaft life is dependent on load acting on the eccentric shaft, its geometry, metallurgical properties and wear. Today in design and development of eccentric shaft by using the good quality of raw material that is alloy steel with composition of Fe (98.5%), Al (0.5%), C (0.5%), and Mo (0.5%) by using that composition the life of eccentric shaft is increases. latest and advance methodologies for ginning machine increases productivity and high quality of operation is possible.

1. Introduction

Ginning is the first mechanical process involved in processing cotton. Its primary objective is separating the fibres of cotton from the seed. Cotton ginning machine is use for preparing the raw or seed cotton for the cotton mills. The cotton gin has as its principle function. The conversion of a field crop into a salable commodity. The ginning operation is the bridge between cotton production and cotton manufacturing. But today's modern cotton gin is required to do much more. The cotton ginning machine converts mechanically harvested cotton in to a salable product.

The design and operation of cotton gins are usually oriented towards fibres production. In essence, the modern cotton gin enhances the value of the cotton removing objectionable foreign matter, while preserving as nearly as possible the inherent qualities of the fibres. Many component used in ginning machine such as, pinion gear, eccentric shaft , connecting housing, clutch pin, roll flange, crank shaft for jumbo ginning machine.

But eccentric shaft is one of the important components in ginning machine. Eccentric shaft is a circular or cam type disk solidly fixed to a rotating axel with its centre offset from that of the axel. Which plays the important role in ginning operation. These shafts provide an oscillatory motion or action to moving knives. Eccentric Shaft is widely appreciated for its features like corrosion resistant, long service, effective performance and reliability. Eccentric shaft is required in various industries according to their application. In traditional case, implementation of the proper selection of raw material, latest and advance methodologies is typical task.

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Examination of parametric linkages reveals that eccentric shaft life is depend on load acting on the eccentric shaft, its geometry, metallurgical properties and wear. Design and manufacture of eccentric shaft by using the good quality of raw material, latest and advance methodologies for ginning machine and increases productivity and high quality of operation is possible. Eccentric shaft provides a more strength and support bearings are placed closer to driving point as compared to crank shaft.

2.1 Working Principle

Zhao Weiwei et al [1] discuss complete design process related to role of eccentric shaft. The spindle of step motor is driven by magnetization, and then the eccentric shaft. In which integrated into the motor spindle, rotated in cycle with eccentric distance *e* as radius. Due to the small eccentric distance in design of eccentric shaft, friction torque between drive piston and cylinder is very small, which result in small friction loss and high system transmission efficiency [1].

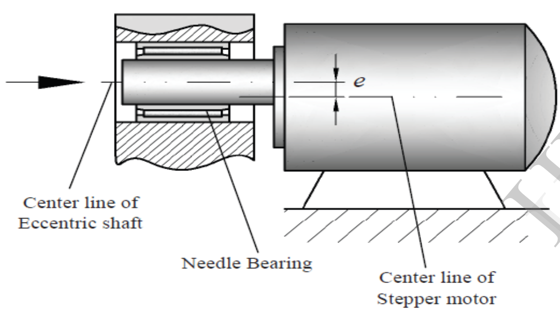

Fig.1 linear reciprocating motion device driven by eccentric shaft motor [1]

The needle bearing drives the driven piston moves up and down, the introduction of bearing is to reduce the friction between eccentric shaft and driven piston. When the driven piston moves downward, oil in under chamber flows into upper chamber through reflux hole on output piston, so pressure in
Two chambers are equal; the actual function of reflux hole is form an internal differential circuit. When remote transmission of power and motion needed, the method of mechanical drive is very complicate and poor flexibility.

2.2 Eccentric mechanism

Shun-Hung Tsai et al [2] discuss complete design process related to eccentric mechanism. A typical eccentric mechanism is shown in Fig. 2 .The eccentric plate is driven by the shaft, belt and pulley.

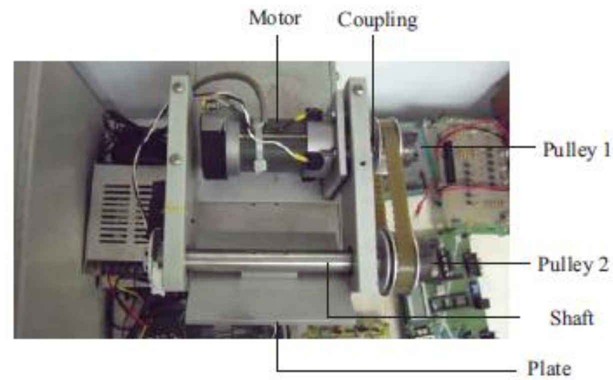

Fig. 2The typical eccentric mechanism [2]

An eccentric mechanism is used to test the tracking performance of our proposed controllers [2]. All the parameters of each part of the eccentric mechanism is shown
In Table 1

Machinery Part			
d_t	0.03885 (m)	d_{L1}	0.0146 (m)
d_{L2}	0.005 (m)	d_m	0.001 (m)
m_t	0.0978 (kg)	m_{L1}	0.0735 (kg)
m_{L2}	0.1095 (kg)	m_m	0.049 (kg)
d_a	0.08 (m)	d_b	0.0165 (m)
d_c	0.005 (m)		
Electronic Part			
R	3.3 (Ω)	K_e	0.0764 ($V \cdot sec/rad$)
K_t	0.0764 ($N \cdot m/A$)		

Table .1 parameter of the eccentric Mechanism [2]

A model reference T-S fuzzy tracking controller, hybrid structure of T-S tracking controller and model reference adaptive controller, for a nonlinear eccentric mechanism. To tackle this nonlinear system, motion control system can dramatically reduce the position and velocity tracking errors under different motion conditions.

2.3. Eccentricity-related Faults

Hamid A. Toliyat et al [3] suggested in his paper the eccentricity model used to simulate the effect of eccentricity fault and complete design process related to eccentricity faults. The winding function theory shows the effect of eccentricity fault on the motor inductances and the simulation is done using a non symmetric air-gap function. Eccentricity fault is the condition of unequal air-gap between the stator and rotor. It is called static air-gap eccentricity when the position of the minimal radial air-gap length is fixed in the space [3].

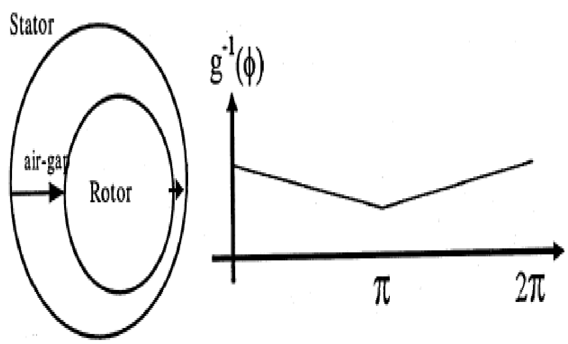

Fig.3 simplified model of linear dynamic eccentricity [3].

In case of dynamic eccentricity, the center of rotor is not at the center of rotation, so the position of minimum air-gap rotates with the rotor. In practice, an air-gap eccentricity of up to 10% is permissible. In order to simulate eccentricity fault, a heavy weight was attached to one side of a disk coupled to the shaft. All features are normalized to exclude the rotor speed and load in order to have comparable data for different conditions. Both static and dynamic eccentricities tend to exist in practice. The eccentricity model used to simulate the effect of eccentricity fault.

2.4. Vibration Control.

Wei-Ming Shen et al [4] discuss complete design process related to eccentric rotor. Speed regulation of a rigid rotor has been a straightforward process in case of control design. Even for an unbalanced rotor revolving in gravitational field, accurate speed control can be achieved by explicitly compensating the gravitational disturbances, or by a high-authority controller such as sliding-mode control. However, for an eccentric rotor with a flexible shaft, speed regulation becomes a challenging task, because the actuator is neither collocated with the output nor with the time-varying torque from gravity [4]. This is a practical issue since the shaft connecting a rotary member usually has certain degree of flexibility, which will limit the speed of operation and achievable accuracy if not properly addressed.

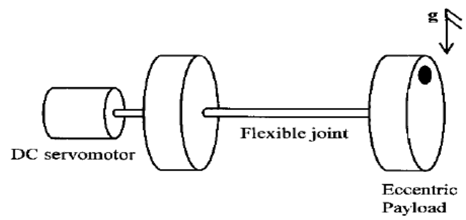

Fig4. The control plant [4].

2.4.1 Simulation and Experimental Results

The experimental system is shown in Fig. 5, where the disk on the right is mounted with unbalanced cylindrical masses to mimic an eccentric rotor. The dc servo motor with a rotary encoder is installed at the other end (the base). Note that the encoder on the right
is to record the motion of the payload for evaluation purpose; it does not provide feedback signals to the controller. Both numerical simulations and real-time
Experiments are conducted to evaluate the performance of the control system.

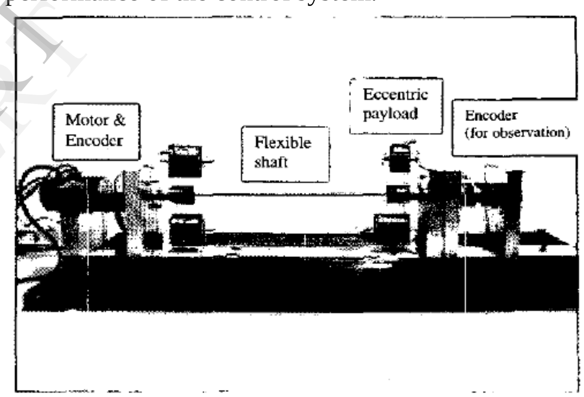

Fig5. The experimental set up. The encoder at the right end is to record the response of the payload for evaluation (not for
Feed back) [4].

2.5. Motor with eccentric connection to shaft

J. Junak et al [5] has carried out complete design process related to Motor with eccentric connection to shaft. The brushless type permanent magnet motor especially suitable for a pump in the anti-lock braking system (ABS). The pump due to eccentric connection on the shaft is characterized by a change of load torque over one turn of the shaft - as it is shown in Fig.6

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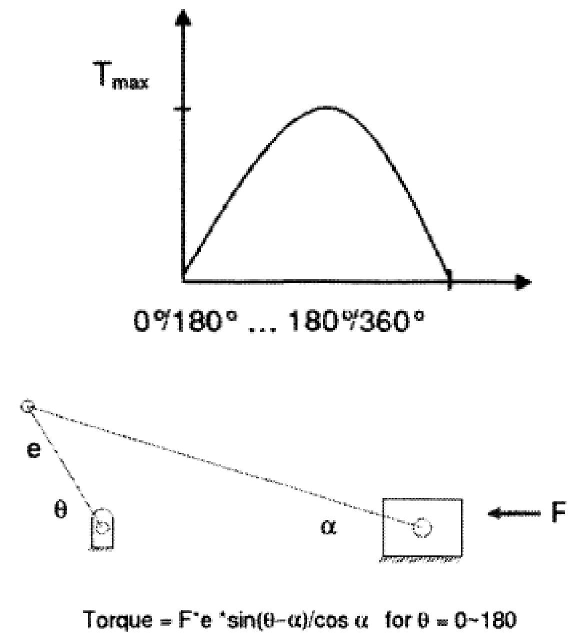

Fig6. Change of load torque over one turn of the shaft [6].

An instantaneous torque of the motor should be always higher than the torque of the load. For the standard brush type motors applied now in ABS systems the torque of the motor looks in comparison to the load torque as it is shown in Fig7.

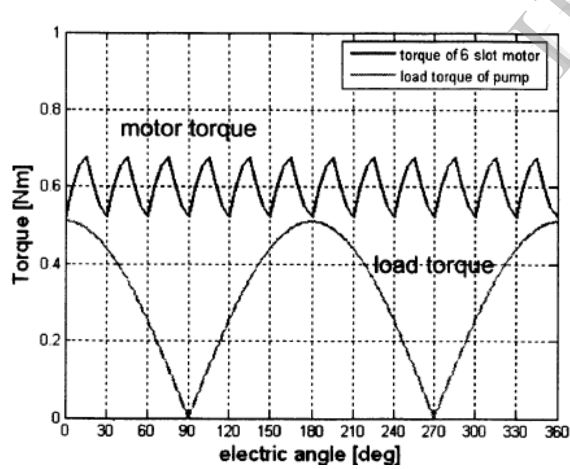

Fig7. Motor and load torque for a standard design with brushless (or brush) motor (result of simulation) [5].

In safe operation mode it is important to keep a minimum value of motor's torque always above the maximum load torque. Such solution has at least two drawbacks. First, the motor is oversized. The average value of motor's torque is much higher than average load torque. Second problem arises by low speed of the motor. Difference between motor's torque and load's torque changes within one turn of the motor.

For maximum load torque the motor delivers the torque only slightly higher than required value. In contrast for load torque equal to zero this difference in torque between load and motor is significant. It leads to ripples of speed especially within its low range. The speed ripples in turn generate additional noise in system. Such problems are already reported and it is strong demand from customers' side to reduce them. The waveform shown in Fig.7 is achieved by standard brush type motor. The similar waveforms appear for 3-phase brushless motors.

2.6. Eccentric Paddle Mechanism

Yi Sun et al [6] discuss complete design process related to Eccentric Paddle Mechanism .Several locomotion patterns exist for terrestrial and aquatic robots.

Among them, legged [10]-[12], wheeled [18], and paddling [13]–[17] are most common gaits. Generally, these three kinds of motion can be realized with rotational joints. So here the question arises as to whether it is possible to perform legged, wheeled and paddling gaits within one mechanism. We give a positive answer to this question by proposing the Eccentric paddle mechanism as shown in Fig.8.

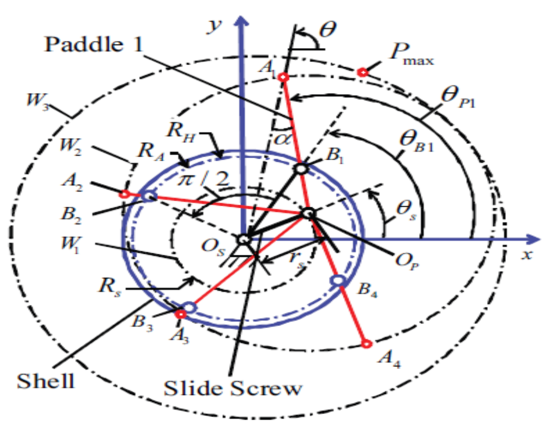

Fig8. Eccentric paddle unit with four paddles [6].

By using Eccentric paddle mechanism, a robot can perform legged and wheeled walking on land as well as aquatic paddling gaits in water [6].

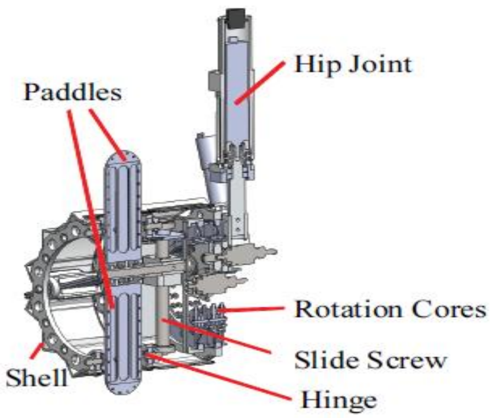

Fig9. Prototype design of the eccentric paddle module [6].

The above fig. shows the eccentric paddle mechanism. The outer surface of each paddle protruding from the shell will serve as the control surface during paddling motion and as the leg during legged walking. This novel design brings the proposed robot two following advantages. Firstly, by using Eccentric paddle mechanism, a robot can use the same locomotion mechanism both on land and in water. On land, paddles function as legs or wheels. In water, the protruded areas of paddles serve as control surfaces to gain thrust forces. Gait transitions are achieved intrinsically and simply by changing the position of paddle shaft. Secondly, the protruding and retracting behaviors of paddles are actively actuated. It brings the robot higher maneuverability than conventional legged or wheeled vehicles.

For example, by protruding its paddles the robot can pass through rough terrain with legged gait. When on even terrain, paddles can be retracted and shells roll as wheels. While swimming in water, the robot generates vector thrust by adjusting the direction and size of control surface.

2.7. Unbalancing Torque of Crankshaft

Guo Rui et al [7] carried out complete design process related to Unbalancing Torque of Crankshaft .The irregular shape work piece like crankshaft, the spindle system of the lathe can hardly operate in the desired constant rotating speed, because of gravitational unbalance torque arisen from the eccentric unbalance weight of the work piece. For this case, the gravitational unbalance torque may be caused by three reasons: journal unbalance, unbalance in crankpin and misalignment of journal.

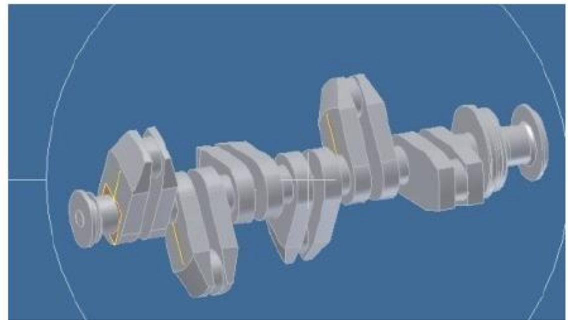

Fig10. 3-D modeling of 6 pins crankshaft [7].

In order to keep constant operation speed against the irregular unbalance torque, usually control motor is used in addition to main driving motor [7]. However the static pre-torque produced by the control motor is half the unbalance torque, so it may compensate at least half the unbalance torque of the work piece. The rotating speed changes or torsion vibrations of the main spindle may cause undesirable or bad effects on machining accuracy.

2.8. Adjustment and verification of air gap asymmetry

Thomas M. Wolbank et al [8] discuss complete design process related to Adjustment and verification of air gap asymmetry. The accurate measurement as well as adjustment of rotor eccentricity is quite challenging on a real machine as there are several possible sources of air gap asymmetry in an induction machine that finally end up in inherent static and dynamic eccentricity [8].

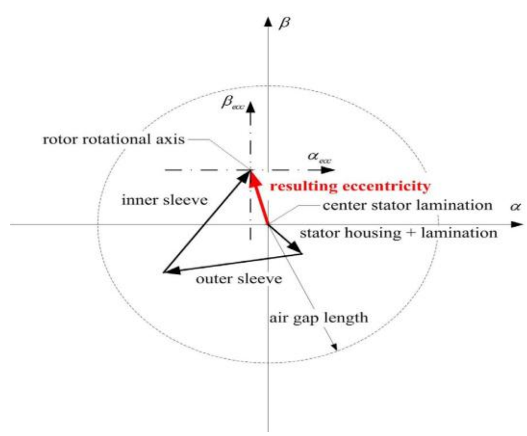

Fig11. Adjustment of static eccentricity considering asymmetries of the stator housing and lamination [8].

In Fig.11 the mechanical arrangement used for this investigation is depicted schematically in the stator fixed α, β-reference frame. The origin of the reference frame defines the center of the stator lamination. The dashed circle gives the overall air gap length between stator and rotor. For the machine considered this length is 450µm. The rotor is thus represented in the figure only by its center (denoted rotor rotational axis) with zero diameters. The distance from the rotational axis to the dashed circle gives the resulting air gap in the corresponding direction. Starting from the center of the complex plane the black Phase (denoted stator housing + lamination) defines the magnitude and position of the identified inherent eccentricity.

The end point of that phase is the starting point for the chosen arrangement using the two eccentric sleeves. Changing the angular orientation of the two sleeves it is thus possible to adjust the resulting eccentricity (red phase) to any magnitude as well as direction within the air gap length. It has to be stressed that the figure shows the geometrical position for one bearing housing only. Especially the phase of the inherent eccentricity (stator housing + lamination) generally has different magnitude and direction at both sides of the machine. Camera placed at different angular positions as well as on both sides of the shaft. For the calculation of magnitude and direction of the different phases in Fig.12 using data of the digital camera it is important to consider the fact that the measurement of the air gap length with the camera is done at a different axial position.

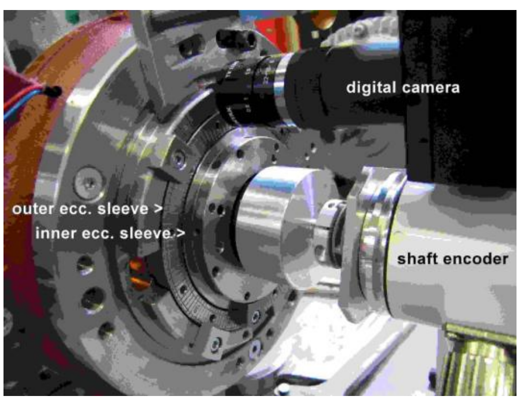

Fig.12 Modified bearing housing with eccentric sleeves and digital camera [8].

In Fig.12 the modified bearing housing with the two eccentric sleeves is shown together with the digital camera mounted. As already mentioned there are four possible positions to measure the air gap optically through holes in the housing. For the detection of the air gap length it is essential to realize a proper illumination inside the machine. Though the need for an illumination is obvious, its proper placing and tuning is tricky and has a strong influence on the magnitude of the air gap detected. It was found that a balanced illumination of both the foreground and the background (trough the air gap) leads to the best results.

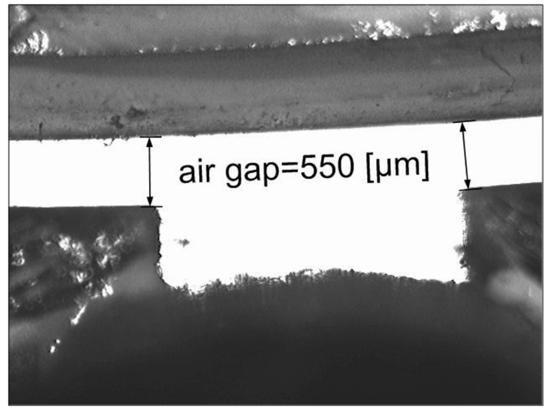

Fig. 13 local air gap length taken with the digital camera [8].

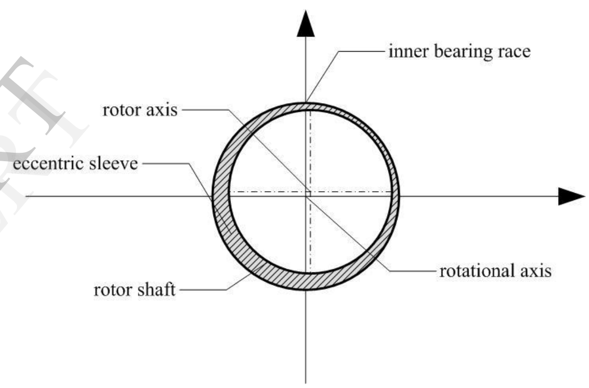

Fig14. Eccentric sleeve to adjust fixed dynamic eccentricity [8].

This single sleeve arrangement is depicted in Fig.14. In total four sets of these rings have been manufactured with eccentricity of zero, 50µm, 150µm and 250µm respectively. Each ring has a marker to indicate the direction of the eccentricity as shown in the picture. In order to investigate the properties of an induction machine reference to air gap asymmetry it is thus necessary to consider the above mentioned non-ideal properties of the whole mechanical setup. Tolerances in the manufacturing of the machine as well as the eccentric sleeves have to be identified.This time consuming procedure is necessary to deliver accurate and reliable measurement results. Taking into account the mentioned effects as well as measuring the air gap length at four different positions along the circumference at each side of the machine accuracy of a few ten µm can be reached. In addition to the measurement of the air gap length using the digital camera, two sets of laser sensors have been placed on each side of the machine to measure the shaft position.

Discussion and Conclusion

The paper reveals that due to the small eccentric distance in design of eccentric shaft; friction torque is very small, which result in small friction loss and high system efficiency [1]. The pump due to eccentric connection on the shaft is characterized by a change of load torque over one turn of the shaft [5]. The rotating speed of eccentric mass changes vibration of the main spindle may cause undesirable or bad effects on machine accuracy [7].

Eccentric Shaft is widely appreciated for its features like corrosion resistant, long service, effective performance and reliability. Proper design of eccentric shaft for cotton ginning machine reduced the vibration which ultimately make the noiseless and smooth in operation and there by enhanced the efficiency to achieve the quality of ginning operation.

References

1. Zhao Weiwei, Li Xin, Wang Mingdi, Zhong Kangmin, "Mechanical-Electronic-Hydraulic Integration Light Load Linear Reciprocating Motion Device Driven by Eccentric Shaft Motor", IEEE, 2011.

2. Shun-Hung Tsai, Chin-Sheng Chen, "Model Reference T-S Fuzzy Tracking Control in an Eccentric Mechanism," SICE Annual Conference 2010 August 18-21, 2010, the Grand Hotel, Taipei, Taiwan.

3. Masoud Hajiaghajani, Hamid A. Toliyat, M. S. Panahi ,"Advanced Fault Diagnosis of a DC Motor," IEEE Transactions on energy conversion, MARCH 2004.

4. Shang-Teh Wu, Wei-Ming Shen "Speed regulation of an eccentric rotor with a flexible joint' IEEE, September 2-4,2004.

5 J. Junak , G. Ombach, " The 2-pole brushless motor designed for a pump with eccentric connection to shaft in Anti-lock brake system (ABS)"

6. Yi Sun, Shugen Ma, and Xin Luo, "Design of an Eccentric Paddle Locomotion Mechanism for Amphibious Robots," *IEEE*, December 14-18, 2010.

7. Guo Rui, SungHyun Jang, KwangSeop Sim and YoungHyu Choi, "Torsional Vibration Analysis of a Geared Transmission System of a Large Scale Lathe under Gravitational Unbalancing Torque," IEEE, August 4-7, 2010.

8. Thomas M. Wolbank, Peter E. Macheiner, "Adjustment, measurement and on-line detection of air gap asymmetry in ac machines"