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EFFICIENT BLDC MOTOR FOR MIXER AND GRINDER

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Abstract - *In this paper we are going to discuss about the implementation of BLDC motor for the residential mixer and grinder in place of universal motor. Brushless electric direct current (BLDC) motors also known as electronic commutated motor and powered by dc power via an inverter or switching devices which produce ac power output. In the future energy shortage will be the one of the main problem. So we must replace the traditional equipments with the new energy efficient technology. Residential devices are one of the key area for energy conservation because they are used daily basis. Every home is equipped with the mixer and grinder for the shaking, mixing, grinding, chopping etc.*

Key Words: BLDC-Brushless DC Motor, Universal Motor, Conventional Mixer, Energy Savings, Fossile Fuels

1. INTRODUCTION

Now a day, the usage of energy efficient appliance is occupying the market to deal with the problem of increasing energy demand, thus fossil fuel scarcity. Many home appliances employed with the induction motor and universal motor because it takes very high current at start can cause of voltage sag. It will cause malfunctioning of other appliances in home. Universal motor having commutator brush assembly, cause sparking and increase chances of maintenance results in reduction of life span. Fine speed control is difficult as the tapped windings are provided at stator. The mixers with universal motor are difficult to use with UPS system because of high starting current. All the above problems can be eliminated by use of BLDC motor for mixer grinder.[1]

BLDC motors are very small in size, and available in fraction power ratings. BLDC is capable of give the easy speed-torque control required for mixer. Electronic commutation increases the efficiency and reliability of operation. Some of the applications required the lower speed for mixing it can be achieved by this motor. Efficiency verses torque characteristics is nearly flat. Energy saving can be achieved at any torque and speed. These advantages makes possible to use the BLDC Motor for mixer grinder.[2]

2. NEED OF SYSTEM

A study by Berkeley National Laboratories calculates that 33% of energy savings could be achieved when AC appliances are replaced with high-efficiency DC appliance. In a system with DC sources, and DC appliances, energy saving of 47% could be achieved. Universal motor employed in mixers can work on DC supply, but it is very inefficient because of mechanical commutator and brushes. In addition, it draws high starting current. So in place of universal motor, BLDC (Brushless Direct Current Motor) is used in mixer-grinder, it saves abundant energy.[3]

3. WHY BLDC?

The brushes in conventional D.C motors wear out over the time and may cause sparking. This is illustrated in the Fig.1. As a result the conventional D.C motors require occasional maintenance. Controlling the brush sparking in them is also a difficult affair. Thus the brushed D.C motor should never be used for operations that demand long life and reliability. For this reason and the other reasons listed in the introduction, BLDC motors are used in most of the modern devices. Efficiency of a BLDC motor is typically around 85-90%, whereas the conventional brushed motors are only 75-80% efficient. BLDC motors are also suitable for high speed applications (10000 rpm or above). The BLDC motors are also well known for their better speed control.[4]

4. SPECIFICATIONS OF MOTOR

Motor has the 3000 rpm speed at full load. According to the requirement of load it can vary by using speed regulator provided with controller of motor. On load the slightly change in speed with respect to the standard speed. BLDC has good speed regulation. Motor has 60 Watt power and operated at 24V dc supply. It draws 3A current.

Table -1: Motor Details

Sr. No	Parameter	Value
1	Power	60W
2	Voltage	24V
3	Current	3A
4	Sensor	Hall
5	Number of Phases	3
6	Number of poles	6
7	Number of stator slots	9
8	Stator OD (mm)	65
9	Length(mm)	108

5. BLOCK DIAGRAM

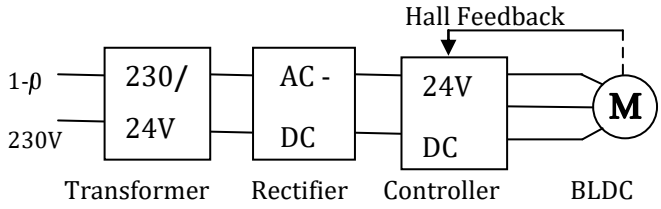

Fig.1 Block Diagram

In the home single phase 230V supply is available, but the motor needs 24V DC supply for operation. First need to step down the voltage to 24V AC, for this operation 230/24V, 3A transformer is connected to supply mains. After that AC to DC conversion is done by bridge rectifier unit. The rectifier gives the 24V DC at output. Then this 24V DC is given to the input to the controller which drives the motor.

6. SPEED CONTROL

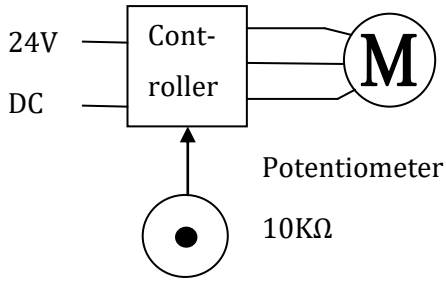

Fig.2 Speed Control

The speed of the BLDC motor can be controlled by different methods like input voltage control, PWM control. We preferred the first one i.e. Stator Voltage control. In this method we used the 10KΩ potentiometer to vary the input voltage to the controller. As we know the speed is directly proportional to the input supply voltage. Due to fine change in the resistance of the potentiometer we get fine variation in speed as per requirement. Permanent-magnet excited brushless DC motors are becoming increasingly attractive in a large number of applications due to performance advantages such as reduced size and cost, reduced torque ripples, increased torque-current ratio, low noises, high efficiency, reduced maintenance and good control characteristics over a wide range in torque–speed plan.

Table -2: Load Tests on Universal Motor

Sr. No	Load Quantity	Speed Setting	Input Power (W)
1	No Load	1	243
2	No Load	2	264
3	No Load	3	285
4	1	1	445
5	1	2	466
6	1	3	490

Table 2 represents a sample of mixing material with half liter water poured in it. The mixer under test has a 500 W motor. With reference to Table II, we can be seen that no load power loss is around 215 W - 280 W. By increasing in load, speed of the motor reduces as seen during test. This causes reduction in the iron loss as well as friction and windage losses. But the copper loss increases considerably with load. Therefore, it can be said that in any load condition, mixer has a power loss of nearly a half of mixer rating so efficiency is 50%. It can be seen that the power needs for chopping is proportional to the quantity of material or load. So the efficiency of the motor is proportional to load.[5]

7. DESIGN CHOICE OF MOTOR

BLDC motor has three varieties, namely surface mounted PM, inset PM and interior PM (IPM) motor. Applications like mixers which required high speed, IPM BLDC motor is considered more suitable because it has good speed-torque characteristics compared to surface and inset PM motor. In surface and inset PM BLDC motors, magnets are retained only with adhesives and they tend to fly off due to centrifugal force. Therefore, IPM BLDC motor is considered.[6]

In IPM motors, there is an inherent problem of flux leakage between poles inside the rotor. With higher number of poles, it is possible to design the motor with lower flux leakage. Six or higher number of poles is suggested for this purpose. With higher number of poles, the required thickness of rotor and stator yoke reduces in inverse proportion. This reduces motor size and cost. However, at high speed, higher number of poles results in high commutation frequency, causing higher switching loss and iron loss. Therefore, number of poles is fixed at 6. In order to keep the motor cost low, ferrite magnets are considered in the design. Flux concentration can be effectively done with 6 poles. Well-known spoke type and a new consequent pole IPM motor proposed in are considered.[7]

In order to reduce cogging torque and minimize the need for skewing of poles, fractional-slot design is considered. The number of slots is fixed at 9, which gives slots per pole as 1.5. With this slots per pole, the winding pitch is 1 slot pitch. Therefore, the winding has shortest end turns. Shorter end turns result in lesser copper loss and lesser requirement of copper wire. Non-salient permanent magnet motors have two types of torque acting on the rotor; the excitation and the cogging torque. Excitation torque is generated due to the interaction of the winding current and the permanent magnet field, whereas the cogging torque is due to the interaction of the stator tooth and the permanent magnet. The uniform air gap single-phase PM BLDC motors have coincident zero torque positions of excitation and cogging torques which makes them inherently not self starting. Asymmetric air gap is introduced to shift the zero position of the cogging torque from that of the excitation torque making them self starting.[8]

Table -3: Comparison with Existing System

Sr.No	Feature	BLDC Motor	Universal Motor
1.	Commutation	Electronic commutation based on rotor position information	Mechanical brushes and commutator
2.	Efficiency	High	Moderate
3.	Thermal performance	Better	Good
4.	Maintenance	Little/None	Periodic
5.	Speed/Torque Characteristics	Flat	Moderately flat
6.	Speed Range	High	High
7.	Lifetime	Long	Short

8. FUTURE SCOPE

In future all the AC appliances replaced by the DC appliances because in the DC appliances the power loss is low as compare to the AC appliances so BLDC motor can be used in Mixer-Grinder. Also the use of PV (Photovoltaic) cells goes on increasing, so the mixer with BLDC motor can directly operate on DC supply without any converting devices and also the energy saving is achieved by use of energy efficient BLDC motor. This is a main reason of representing this paper.

9. CONCLUSION

In this project, in order to provide an efficient alternative to universal motor in a mixer-grinder, design of a low cost ferrite magnet based BLDC motor is carried out. It is found that, iron and copper losses are just 5.2%. BLDC motor can operate with DC input supply and because of efficient design, it consumes far less power than universal motor. Thus, it is suitable for operation with the DC distribution system. In addition, its size is smaller than universal motor.

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