MEDIUM VOLTAGE APPLICATIONS IN TRANSPORTATION

THE STUDY OF BRUSHLESS DC MOTOR

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ABSTRACT: The brushless DC motor is a simple and robust machine, which has found application over a wide power and speed ranges. Brushless DC (BLDC) motor drives are continually gaining popularity in motion control application.

The advantages of BLDC motor are

- Less power consumption
- Small in size
- High torque to weight ratio..

Brushless DC motor found applications in

- Transportation

•Heating

•Ventilation

In green ships, the BLDC motor can be employed and research is going on to implement the BLDC motor on board...The new era of ships (GREEN SHIPS) which consumes less power and less threat to environment i.e. emission less we will introduce this BLDC motor which will run successfully in less battery power.

KEYWORDS:

•Introduction (Advantages)

•Construction and working principle

•Applications of BLDC onboard vessels

•Can BLDC be a trend setter in energy conservation

INTRODUCTION:

Brushless Direct Current (BLDC) motors are one of the motor types rapidly gaining popularity. BLDC motors are used in industries such as Appliances, Automotive, Aerospace, Consumer, Medical, Industrial Automation Equipment and Instrumentation. As the name implies, BLDC motors do not use brushes for commutation; instead, they are electronically commutated. BLDC motors have many advantages over brushed DC motors and induction motors. A few of these are:

- Better speed versus torque characteristics
- High dynamic response
- High efficiency
- Long operating life
- Noiseless operation
- Higher speed ranges

In addition, the ratio of torque delivered to the size of the motor is higher, making it useful in applications where space and weight are critical factors. In addition to this BLDC also has lots of advantages over AC induction motor, which are specified as follows:

•Operations at all speed

•Better dynamic characteristics

•No special starter circuit required

•A controller is required to keep the motor running and the same can be used for variable speed control, and a controller can be a system or computer.

•No slip is experienced between stator and rotor frequencies

This is controlled by a computer or a micro control unit which manages acceleration, control speed and fine-tune efficiency.

OPERATION AND WORKING PRINCIPLE:

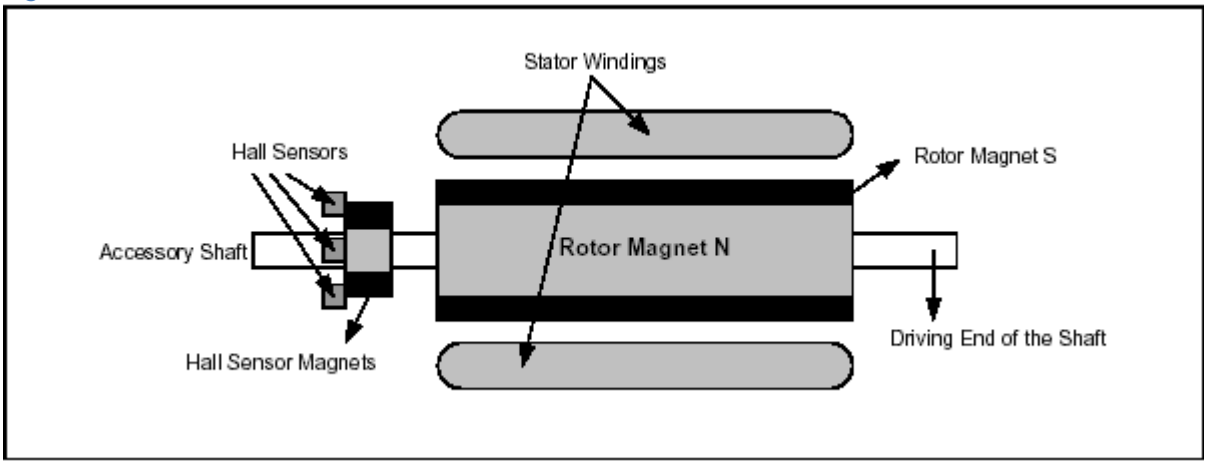
BLDC motors are a type of synchronous motor. This means the magnetic field generated by the

stator and the magnetic field is generated by the rotor which rotates at the same frequency. The

stator of a BLDC motor consists of stacked steel laminations with windings placed in the slots

that are axially cut along the inner periphery. Traditionally, the stator resembles that of an Induction motor; however, the windings are distributed in a different manner. Most BLDC motors have three stator windings connected in star fashion. Each of these windings are constructed with numerous coils interconnected to form a winding. One or more coils are placed in the slots and they are interconnected to make a winding. Each of these windings is distributed over the stator periphery to form an even numbers of poles. There are two types of stator windings variants: trapezoidal and sinusoidal motors. The **rotor** is made of permanent magnet and can vary from two to eight pole pairs with alternate North (N) and South (S) poles. Based on the required magnetic field density in the rotor, the proper magnetic material is chosen to make the rotor. Unlike a brushed DC motor, the commutation of a BLDC motor is controlled electronically. To rotate the BLDC motor, the stator windings should be energized in a sequence. It is important to know the rotor position in order to understand which winding will be energized following the energizing sequence. Rotor position is sensed using Hall effect sensors embedded into the stator. Most BLDC motors have three **Hall sensors** embedded into the stator on the non-driving end of the motor. Whenever the rotor magnetic poles pass near the Hall sensors, they give a high or low signal, indicating the N or S pole is passing near the sensors. Based on the combination of these three Hall sensor signals, the exact sequence of commutation can be determined.

Figure



APPLICATIONS OF BLDC ON BOARD VESSELS:

Brushless DC motors produce no sparks making them an excellent choice for below deck and above deck applications. Starter motors, Bilge pumps, Winches, hoists, Bow thrusters, Trolling motors and auxiliary power units are few applications of BLDC.

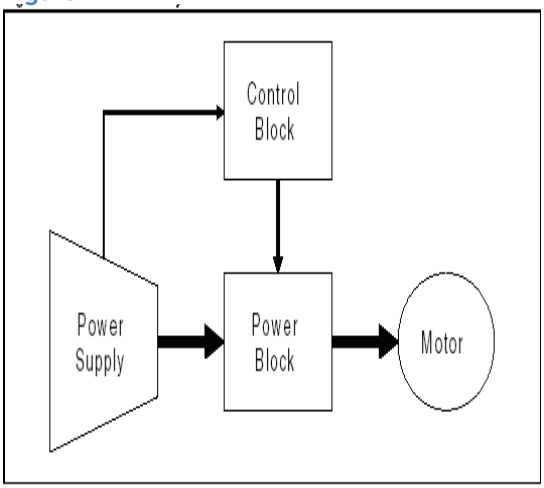
Starter motors are simple motors used to drive engines unless the required power is not obtained. So the BLDC is the best option to be used as this because of its speed variation control. BLDC as bow thrusters is the best that can ever be thought of by any person. The new motors are the ultimate in efficiency, operating with only 200 amps on the ship's batteries, resulting in less heat, which eliminates early thermal shut down. Conventional motors can consume up to 600 amps with fast heat buildup and early thruster shut down, sometimes at critical moments. Increase the efficiency even further. Another design to fit by switching from AC to DC motors will result in up to double the thrust and the motor and thruster sizes remain the same. Brushless DC motors can be controlled proportionally allowing the application of only the necessary thrust for efficient, safe and gentle docking; or full on if the conditions dictate. As waterways become even more congested and slip tighter, proportional thrusters will give you the advantage.

Figure

Wesmar bow thruster test facility is designed to measure the thrust of a particular design in a laboratory setting under all operative conditions. The effect of propellor pitch, number and design of blades, blade clearance, RPM and leg configuration can be measured and minute improvements made.

Again BLDC has found its action in an efficient way in the hoisting of davits and winches. This is because of the fact that when something is being lifted it being lifted by the force of normal motors can cause sudden jerks in the winches hence damaging the parts and cargo, etc. But this can be removed if we use the BLDC. Again the rate at which we want is achieved and suppose we are lifting the life raft with crew on board we reduce the risk of their lives.

Figure



The above diagram shows the use of a BLDC in a motor control application. This application is very vital if used in the bilge pumps and as auxiliaries both in propulsion and in power units. The basic disadvantage of the BLDC is it requires a controller to operate the systems, but with the advent of the computers this can be handled very easily as the controls will be controlled by the computer and anything if goes wrong will be notified by the alarms fitted to the system. BLDC can be used as a gas compressor. The gas compressors presently used on board ships are star delta type induction motor. This motor takes a large startup current to start for which we use the star windings, then this is transferred to delta winding after the required level of current is reached. Thus making the refrigeration system of the gas carriers a large unit and complicated one. Thus a BLDC unit may work best as the refrigeration unit on gas compressors.
But anything going wrong in the BLDC operation is less because these motors has been used successfully on board the space shuttles and crafts designed by NASA where the motors have survived the deadly environment of the space, mars, moon and that too for 7 years. As the vessel goes to the dry dock in every 5 years, on average that gives us ample cost effectiveness. Indeed the initial installation cost is high but this is compensated with maintenance free as sea is safer than space and thus making our BLDC unit a partner for lifetime.
All BLDC motors are used with permanent magnets which take a large space, but when we use it with electromagnets all ambiguity from it can be removed. Yet another motor which is competitive to permanent magnet D.C. brushless, A.C. servo, A.C. inverter, D.C. brush type, D.C. shunt and stepping motors to a limited degree. This product can be best described as a Brushless DC Motor without Permanent Magnets. The drive is nearly the same as any other brushless D.C. drive. This is the one which is going to create an impact on board ships cause as everybody thinks bigger the DC volt bigger the equipment. But with the advent of Electromagnet Brushless DC Motors all preconceptions are erased. Equipments are safer, smoother and cost friendly and overall joy all the way to the owners, crew and everyone associated with it.

CAN A BLDC BE A TREND SETTER IN ENERGY CONSERVATION?

During the latter half of the last century there has been lot of concern about the depletion of fossil fuel, global warming and need for energy conservation. One of the largest consumers of

energy is “electric motor” and that too induction motors. Energy efficiency improvements in prime movers of these applications can lead to high-energy saving/conservation. The potential is much huger if ASDs (adjustable speed drives) are used.

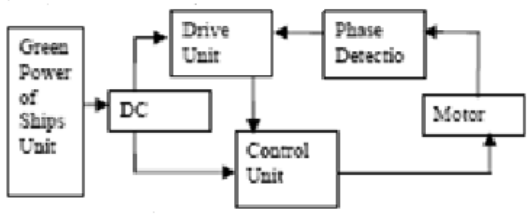
Since the 1990s, every industry has been increasingly impacted by various regulations mandating greater energy-efficiency and reduced environmental emissions demands for lower energy costs, betters performance, reduced acoustic noise and more convenience features. Most, if not all, of these requirements, as it turns out can be met by the use of **electronically driven motors (BLDC)**. This has lead to development of various newer types of electronically controlled motors of which the most promising have been the following.

1.DC brushless drive (BLDC),
2.Switched Reluctance Drive (SRM).
3.Controlled Induction Motor (CIM) or ac variable frequency drive (AC VFD).

Currently, manufacturers in Europe, Japan and Asia are favoring the use of BLDC motors for refrigerator and air-conditioner compressor because of their higher efficiency (in comparison to AC induction motors) and their lower motor and EMD costs. In Japan, BLDC inverter drives are displacing AC VFD for air-conditioner compressor applications as well.

A clear trend is emerging in today’s major industry for lower energy, high efficiency motors. Electronically driven motors, the majority of which will be the BLDC type and will soon replace induction motor and variable-speed universal motor drive designs.

Figure



In recent years yachts and green power technology are greatly enhanced, plus the appreciation of environmental protection and leisure tourism from society, the research and development of green power ships possesses great economic benefits, and there are many advanced countries engaged in this relevant development. However in order to combine the green power with ship building, BLDC Motor plays an important role. Because the DC Motor's contact-less rectifier structure does not produce any commutation division wear, and the motors can be encapsulated with watertight method, it has more advantages than the traditional DC motors. BLDC Motor will become a major trend of the green power ships application.

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