Double Fed Induction Generator

Pre Lab

In this pre lab, we will learn how to read the nameplate of machines as well as learning the background of machines. You should read this pre lab and complete it before you go to the lab.

DC Machine Nameplate

H.P.	R.P.M	F.L.AMPS.	VOLTS
2.5	1750	10.3	230
MODEL NO		MYD-M8-1BE	
SERIAL NO	6-140871-1	M8	FRAME
TYPE	M=1251E0	1.0	SERVICE FACTOR
ENCLOSURE	D.P.	0.58	FIELD AMPS
℃ RISE	40	230	FIELD VOLTS
TIME DUTY	CONT	6207	BEARING SHAFT END
AMB℃		6207	BEARING FRONT END

V_a=230V I_h=10.3A

P=2.5HP=2.5*746W/HP=1865W

V_f=230V If=0.58A

Pin=V_a*I_{fl}=230*10.3=2369W

P_f=V_f*I_f=230*0.58=133.3W

Pin-P_f=2369-133.4=2235.6W> 1865W

2235.6-1865=370.6W

This 370.6W is the losses of power. It cover the power of copper, brushes and windage or friction.

DFIG Machine Nameplate

HP	F.L.R P M	VOLTS
2.5	1690	208

MODEL	MHD-254R-2BWA	FRAME	254
F.L.AMP.	8.0	CYCLE 60	PH 3
TYPE	GW-599	TEMP.RISE	40°C
R.VOLTS	274	R.AMP.	4.3
BRG.D.E	6207	TIME DUTY	CONT
BRG.O.E.	6207-RS	ENCLOS	O.P.
SERIAL SR		6-140871-11	

Pre Lab Calculations

	Voltage	1.446	Current	1.457
2		2.05		2.07
3		3.039		3.071
4		4.09		4.05
5		5.03		5.01

doubly	5.48	5.48/0.019=288	0.019
	10.48	10.48/0.035=299	0.035
	0.225	0.225/0.539=0.42	0.539
	0.181	0.181/0.434=0.42	0.434
More turns than the second	2.272	2.272/2.021=1.1	2.021

		2	

Instrument

DC machine :

A DC machine is an electromechanical energy alteration device. The working principle of a DC machine is when electric current flows through a coil within a magnetic field, and then the magnetic force generates a torque which rotates the dc motor. The DC machines are classified into two types such as DC generator as well as DC motor. The main function of the DC generator is to convert mechanical power to DC electrical power, whereas a DC motor converts DC power to mechanical power. The AC motor is frequently used in the industrial applications for altering electrical energy to mechanical energy.

Brushes

Brushes in the DC machine gather the current from commutator and supplies it to exterior load. Brushes wear with time to inspect frequently. The materials used in brushes are graphite otherwise carbon which is in rectangular form.

Field Windings

The windings are wounded in the region of pole core & named as field coil. Whenever current is supplied through field winding then it electromagnetics the poles which generate required flux. The material used for field windings is copper.

Pole and Pole Core

The pole of the DC machine is an electromagnet and the field winding is winding among pole. Whenever field winding is energized then the pole gives magnetic flux. The materials used for this are cast steel, cast iron otherwise pole core. It can be built with the annealed steel laminations for reducing the power drop because of the eddy currents.

Armature Core

Armature core includes the huge number of slots within its edge. Armature conductor is located in these slots. It provides the low-reluctance path toward the flux generated with field winding. The materials used in this core are permeability low-reluctance materials like iron otherwise cast. The lamination is used to decrease the loss because of the eddy current.

Armature Winding

The armature winding can be formed by interconnecting the armature conductor. Whenever an armature winding is turned with the help of prime mover then the voltage, as well as magnetic flux, gets induced within it. This winding is allied to an exterior circuit. The materials used for this winding are conducting material like copper.

Test Table

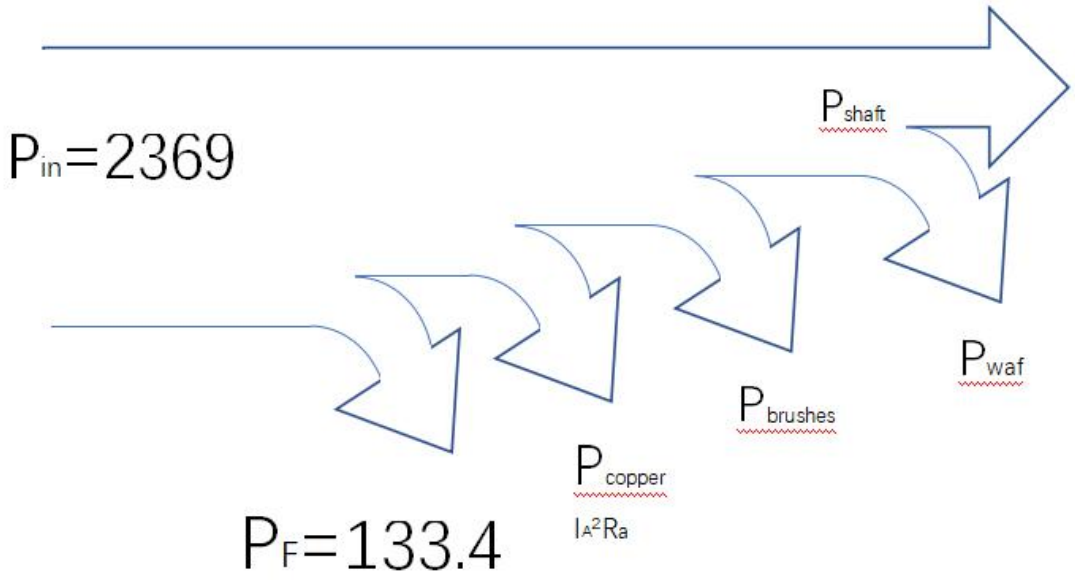
Load Bank

Supply Circuit

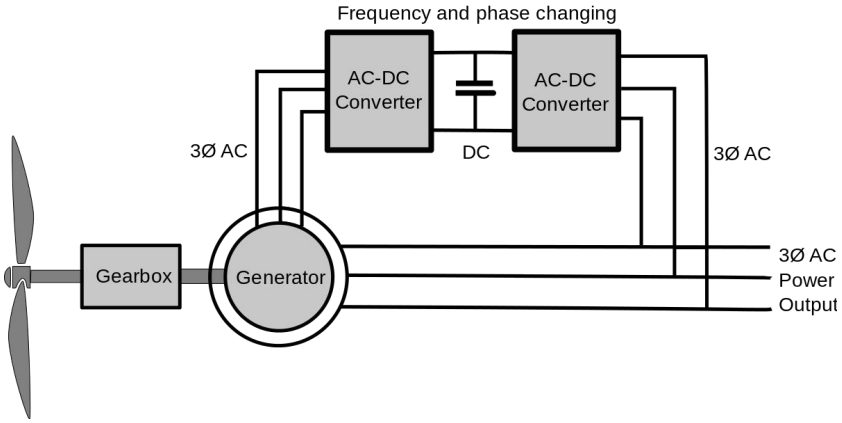
Power Supply

Background

Doubly-fed induction generators (DFIGs) are by far the most widely used type of doubly-fed electric machine, and are one of the most common types of generator used to produce electricity in wind turbines. Doubly-fed induction generators have a number of advantages over other types of generators when used in wind turbines. They allow the amplitude and frequency of their output voltages to be maintained at a constant value, no matter the velocity of the wind blowing on the wind turbine rotor. Also, they have the ability to control the power factor. Other advantage, generation of electrical power at lower wind speeds. Lastly, they optimize the amount of power generated as a function of the wind available up to the nominal output power of the wind turbine generator.



Theory of DFIG



Objectives

The objectives of this experiment are to investigate the operation of double fed induction generator

(1) We need to know the relationship between Wm, fs and fr. We can use Ws-Wr=Wm and 300 rpm = 10 Hz to verify it. We also need to know how to change the frequency for the machine.

(2)We need to know the direction for rotation then know the relationship with Wm, fs and fr. If the rotation of speed is negative for this machine, the frequency of the rotor is bigger than the frequency of the stator. We also can make the rotor as 3 phase. Therefore, the frequency of rotor can be 60 Hz. We can calculate the frequency of stator.

Apparatus

1) 2 test tables

2) DC motor

3) 2 DC power supply

4) DFIG

5) Three phase variac

6) Tachometer

7) 3 Multimeters

Procedure

1) Connect the first DC power supplier to the field on the DC motor.

2) Connect the second DC power supplier to the left side of the test table. The right side of the first test table should be connected to the armature.

3) On the DFIG side, connect the three phase variac to the second test table.

4) Connect the stator side of the DFIG in delta configuration.

5) Connect the variac to the test table.

6) The variac should be connected in Y connection as shown in the diagram.

7) Connect the variac to the power supply.

8) Use 120VAC and connect it to the variac to vary the voltage on the DFIG.

9) Once you finish all the connections, ask your instructor for final check.

10) Turn on the power from the grid.

11) Firstly, we use power to adjust the field current to 0.29A.

12) Adjust the power for armature to change the voltage. You can notice the change of the speed in the machine.

13) Use the speed measurement strobe and the power supply to adjust the DC machine to 1800 RPM.

14) Once the DC machine is up to speed, (1800 rpm) inform your instructor that you are ready to energize the DFIG. There should be very little noise when the breaker for the DFIG is closed.

15) Adjust the speed from 1370RPM to 1800RPM and record field current, and frequency. You can find the relationship between speed, frequency of stator and frequency of rotor.

16) De-energize the DFIG and slowly power down the DC machine with the power supply.

17) Once the machine set has come to a complete stop, de-energize your station’s power and put away your cables.

Data Table

Fs	RPM	Stator(60Hz)	rotor
		60	
		60	
		60	
		60	

Questions

1. If the frequency of rotor is constant at 60Hz, then the frequency of stator is larger than 60Hz. What can we do if I want the frequency of stator to be less than 60Hz?

2. If the stator and rotor sequence both positive. The rotor's frequency is greater than stator's frequency. According to the formula the frequency of DFIG is negative. What happened for this situation?

3. Do we have other ways to change the rotation speed for machine?

4. How is it possible to vary the rotor speed of a doubly-fed induction generator while the amplitude and frequency of the ac power network to which the generator is connected remains constant?

5. Consider a doubly-fed induction generator having four magnetic poles. The generator supplies power to a 60 Hz ac power network. Knowing that a prime mover makes the generator rotate at a speed of 1530 r/min, calculate the frequency of the ac currents that need to be fed into the generator rotor windings so that the generator is synchronized with the ac power network?

Summary

In this experiment we change the rotation speed by increasing the armature voltage. We can see that the electrical frequency of the rotor is changing as the rotation speed changes. However, the frequency in the stator does not change. When we convert the

rotational speed to the frequency we can verify the previous formula based on these data. (Ws-Wr=Wm).

Conclusion

A DFIG machine can generate power from both the stator and the rotor. DFIG has a converter on the rotor side that control the frequency and keep it at a constant value which makes it more efficient than the single fed induction generator where we cannot get any power from the rotor. DFIGs have only entered into use, but it will be used a lot in the future due to almost exclusively to the advent of wind power technologies for electricity generation.