Course Name: Design of Electric Motors

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Title: Name Plate Details and Datasheets of Induction Motor

Greetings to all, this lecture onwards we will discuss the actual design of induction machine. As of now we have discussed the sizing equations and different standards and generalized procedure for designing of any type of electrical machine right. We will consider the analysis with respect to the induction machine and then followed by switched reluctance machine we will discuss. So, before going to the design first I will explain about the name plate details. If we will see here this is a simple induction machine small writing of 225 watt each and every machine will consist of some name plate ok. That name plate consist of power, efficiency, which type of standards we are utilizing and what is the voltage rating and frequency all those type of details will be there.

First we will see and we will understand the induction machine name plate and after that we will start the induction machine details and design. So, in this lecture we will discuss only name plate details as well as data sheets of the induction machine ok. Here we can see that the name plate details of a three phase induction machine. First we can see here type of a machine and then which type of standards we are utilizing here.

The type of motor is three phase induction motor and type of standards REF IS 1261 1520 0011 this type of stand reference number and then IEC 60034 21 is the standard. IEC 60034 standard there designed this machine and then IEC I E 2 is the efficiency class ok. We have discussed the different type of efficiency classes right I E 1, I E 2, I E 3, I E 4 like that anyhow we will see again different type of efficiency classes in the next slides and FR represents the frame size. Frame size I E 1132 M is the frame size we can observe here ok. This is the frame size ok.

Then RPM of the machine is 1440 RPM that means 60 RPM is the slip speed and actual speed is 1440 RPM synchronous speed is 1500 RPM and type of connection of the winding is delta we can see here that one and duty of the machine is S 1. S 1 is nothing, but continuously operated machine there are different type of duties are there with

respect to the standards like S 1 to S 8 different type of duties will be there. Let us say if you are designing a induction machine for a duty of S 1 then we have to design for continuous load requirement and S 2, S 3 different type of duties will be there. First we will see the duty of a machine. If you are designing a machine for S 1 duty then the machine will operate continuously to drive the load.

The motor works at the constant load enough time to reach the temperature equilibrium that means continuously we are operating the machine and S 2 means short time duty we are operating that machine only for shorter intervals. Similarly S 3, S 4, S 5, S 6, S 7, S 8 these are the different type of standard duties for electrical machines depends upon the application aspect we have to utilize the different type of duties and we have to design accordingly. Here we can see continuous operation with electric braking that is S 7 duty continuous operation with periodic changes in load and speeds. If you are changing the loads continuously and if you are changing the speeds periodically then we have to design a machine for duty of S 8. Similarly, if we will see the efficiency class type of a class.

IE 4 is the super premium efficiency, IE 3 is the premium efficiency, IE 2 is the higher efficiency and IE 1 is the standard one that means efficiency of the standard machine is somewhat lesser as compared to the IE 2 and similarly IE 2 is less than the IE 3, IE 3 is less than IE 4. So, if you want higher efficiency greater than 90 percent then we have to go ahead with the IE 4 machines. The NEMA standards NEMA premium will give the higher efficiency and NEMA energy efficient will give the slightly lesser efficiency as compared to the NEMA premium standard. In the right side plot we can see the efficiencies with respect to the different type of classes and different efficiency numbers. For a given power rating for example, 30 kilowatt, here 30 kilowatt if I will take it, the efficiency with respect to the IE 4 class is greater than 95 or it is equals to exactly 96 percent and IE 3 standard machine is equals to 83 percent and IE 2 standard machine is equals to 91 percent, IE 1 standard machine is 90 percent.

Similarly, if I consider a operating point at this particular point that is 0.75 kilowatt, approximately it is equals to 1 HP, 1 HP machine if I will consider then the efficiencies with respect to the different classes we can see here. The next thing is voltage, we can see here voltage of a machine is mentioned here 415 volts and frequency is 50 hertz, hertz is mentioned here and current rating is 10.8 milliampere and IC 416 that is the cooling standard with respect to the NEMA standards IC 416. We will see what kind of cooling standards are there.

Already we have discussed the standards with respect to the all machines, but for cooling standards with respect to the particular IC 416 we can see here. This is IC 01 standard where open type of machine will be there fan mounted on the shaft open called means drip proof machine and IC 410, IC 411, IC 416 this is the type of cooling standard we are

utilizing where the enclosed machine like the machine will be enclosed in this manner. We can observe here the both sides enclosures will be there, there is no open space and this inside that particular enclosure there will be a small fan on the shaft. If we will remove the enclosure and if we will fix one fan here and if we will fix the again enclosure then this type of IC 416 standard we can realize it. We can observe how the airflow is there in this image.

In this image we can observe how the airflow will be there with respect to the direction and similarly IC 416 are standard and where external motorized radial fan will be integrated with the motor. Here fan is integrated to make the cooling mechanism and IC 611 standard we can see here where enclosed machine and heat exchanger is fitted on the machine and two separate air circuits air circuits and shaft mounted fans etcetera. These are the different type of standards we are utilizing for cooling mechanism. Next thing is power factor we can see here power factor on the name plate PF is not represents the power factor that is 0.81 and next efficiency is 87.7 percent. Then power rating of the machine is represented here 5.5 kilowatt. So, what represents the power rating and then INS is nothing but insulation standards or insulation class that is class F. Then A degree Celsius means ambient temperature what is the operating ambient temperature is nothing but 50 degree Celsius and then WT represents the weight of that particular machine is 66 kg. Now, we will discuss about the what is IP 65 here IP 65 or IP 55 here one thing is protection with respect to the dust and water some standard IP 55 is mentioned.

IP 55 or IP 65 what is it mean means how the protection with respect to the dust and water it will react response the machine response. So, if the IP is the standard example rating I am presenting here 6 represents the with respect to the solids 0 means no protection and 1 means the protection against the solid object greater than the 550 mm such as hand. And similarly 2 represents the solids greater than the 12 mm and then 3 represents the solids protection against the solid object greater than the 2.5 mm with respect to the dust how the machine is protected. This first integer or first digit will represents the with respect to the solids protection and second digit represents the with respect to the water we can see here solids representation 0 means no protection and 1 means protection against the 50 mm object 12 mm object for 2 and 2.5 mm object for 3 and 1 mm object is 4 and dust protected completely protected means 5 and dust tightly and there is no increase of dust completely protected means 6 5 and 6 will be better ways to protect the machine this first digit represents. And second digit represents the protection with respect to the water there is no protection means that is 0 if the protection is there vertical dripping water limited liquid entry only that is digit 1 or standard 1 we can say similarly 15 degrees and 16 degree 60 degrees. If full of liquid entry is there then the machine will damage the machine will be protected up to digit 5 the digit standard 5 is nothing but protected against the jets of water from all directions limited liquid entry only. If the huge water is enter inside the machine we cannot protect it only

limited liquid entry whether it can be water or any other liquids then only we can protect the machine. Other insulation classes we can see here the insulation class B class A and class F and class H and operating temperatures at ambient temperature we can see here permissible insulation temperatures at 40 degrees of ambient temperature for class F 155 degree Celsius.

This machine is designed for class F and this IP standard is nothing but 55 5 5 means it will be protected with respect to the solid particles greater than 1 mm are completely protected that is 5 and here 5 means limited liquid entry only protection is there with respect to all directions of the liquid entry. The next left out ratings will be MTG 33 motor mounting arrangements MTG is nothing but motor mounting arrangement B 3 class here we can see MTG is nothing but B 3 is mentioned that is the class for motor mounting arrangement with respect to the NEMA standards or IEC standards we can find this thing how the machine is arranged whether it is wall mount or foot mount or roof mounted like that. The next parameter is bearing information here we can see DE and NDE, DE is nothing but drive end and NDE is nothing but non drive end. For example, if you will see the machine here the machine here one side where it is connected to the other load or other type of machine is the drive end non drive end is this one. So, the bearings which are used at the non drive end and the bearings which are used at the drive end are represented in the data sheet.

We can see here that standard DE is 620 8C 32Z and non drive end 620 8032Z. We will see the different standards now. Motor mounting arrangements we can see here this is the foot mount foot mounted motors IM 1001 B 3 this type of standard is utilized for this type of machine. Here MTG B 3 is mentioned right B 3 means where foot mounted is there B 6 means foot mounted vertically left side and B 7 means right side mounted with respect to the base like different classes are there B 8 V 5 and V 6 etcetera. Similarly, planche mounted motors different type of structure and same way we can see some standards with respect to the foot plus planche mounted motors or roof mounted or wall mounted etcetera.

So, these are the standards with respect to the mounting arrangements. So, with this we have completed the name plate details of an induction machine how to read the name plate. Now, we will discuss about the data sheets of an induction machine as of now we have discussed the name plate details right. Name plate details is nothing, but short form of the data sheets in data sheet also we will find the same details like number of phases and rated output power rated voltage and rated current and speed frequency and cooling standards and what type of protection we are utilizing it and reference standard these are the different details. The main thing what we have to study from the data sheet is efficiency at different percentage of loads for this particular machine efficiency is not varying with respect to the percentage of load and rated torque also we can observe here rated torque is 36 Newton meter and power factors also we can see here with respect to

the different percentage of load how the power factor is varying and terminal box data also given total number of terminals are 6 and terminal size is M 5 and maximum cable section is this one and bearing data also given here with non drive end as well as non drive end these are the things we have discussed in the name plate details itself.

The other than the name plate details what we will see here is the ratio of starting current to the rated current 100 percent voltage if you are applying then 6 times the starting current will be there with respect to the rated current and if 80 percent of the voltage if you are applying 4.5 times the rated current. For example, rated current is 10 amperes then if you will apply the 80 percent of the voltage at starting time we will see 45 amperes. Similarly starting torque to the rated torque ratios we can see here 100 percent of the voltage the starting torque is 2.3 times higher than the rated torque.

These numbers we can observe in with respect to the performance curves also that I will show you after sometime and here we can see the voltage variation and frequency variation allowable frequency variation as per the standards voltage variation plus or minus 10 percent and frequency variation plus or minus 5 percent and breakdown torque ratio torque to rated torque ratios we can observe here. 2.8 is the ratio with respect to the breakdown torque to rated torque at 100 percent of the voltage. 1.17 is the ratio with respect to the 80 percent of the voltage for breakdown torque to rated torque.

That means, we can see here the breakdown torque to the rated torque ratio is 2.8 for 100 percentage of the voltage. That means, if rated voltage if you are applying for that condition we can get the breakdown torque 2.8 into rated torque. If rated torque is mentioned 36 Newton meter, then this 36 into 2.8 times we will see the breakdown torque that is the meaning of this one at 100 percent of the rated voltage. We can observe the same numbers in the performance curves also. The performance curve with respect to the percentage of load on the x axis side and efficiency and power factor on the y axis side by varying the percentage of load 50, 60, 70 up to 100 percent. What is the efficiency as well as power factor we can observe here. The green color one represents the efficiency and blue color one represents the power factor.

The power factor at lower power rating is very less and at the rated power factor is very high and similarly efficiency is almost same with respect to the percentage of change in output power. Here we can see the rated current waveform in this curve. If we will change the percentage of load 50 to 100 percent and then current is increased from this point to this particular point. At starting point we are seeing 6 amperes for the 50 percent of rated power at rated power the current will be 10 amperes. Similarly the other curves are torque versus speed.

The speed at the rated operating speed we will see some particular torque may be in this region it will be stable right at this particular points the machine will be stable right. So,

associated speeds and associated torques we can find other than that thing what is the breakdown torques or peak torques or pull up torques and then starting torques we can observe in this figure. With respect to the 80 percent of the voltage as well as 100 percent of the voltage different torques we can observe. The one more main thing is with respect to the current how much time the machine will withstand. If you are operating at the rated current machine will withstand for longer time there is no limit if you are operating just near to the rated current or less than the rated current we can see it is going up to infinite time kind of thing.

This one this particular point and then if you will operate the machine at six times the rated current this is the rated current one six times if you will take it for example, 10 ampere is the rated current then 60 ampere we are pumping inside the machine then it will withstand only for 10 seconds with respect to this particular point. These are the different standards for casing and design footprints of a machine. So, from data sheets we can get the performance characteristics as well as name plate details with respect to voltage currents and efficiency standards and bearing standards cooling mechanism and other things. Similarly, if you will observe the other manufacturers for the same design same output power the torque speed characteristics and other things may not be same. One example I will take what is the peak torque? Peak torque or starting torque I will consider.

So, the maximum torque to rated torque ratio is 2.8 and locked rotor torque is 1.7 with respect to the c mains it is 2.8 and 1.7 it is same. That means, both designers have done for the same efficiency and same thing and efficiencies we will observe once whether it is same or not efficiency also we can see efficiency is coming around the 88 percent or 89 percent which is slightly higher than the c mains manufacturer one that is 87 percent right here we are getting almost 90 percent. So, with respect to the different manufacturers the dimensions as well as operating conditions will vary the person who will working for higher efficiencies different dimensions the person who is working for different requirement the efficiencies may be different. The torque is matching in this two data sheets, but efficiency here we can see 88.4 percent here efficiency is 87 percent. So, difference in some operating points or performance parameters will be there and remaining curves and data will be same.

Here the efficiency current and power factor with respect to the per unit rated power is mentioned here. In this waveform speed versus torque is mentioned torque is represented with respect to the rated torque T s by T n is the rated torque. So, starting torque we can get it 1.7 and breakdown or peak torque we can get it almost 2.8 and the dotted line represents the current. Similarly speed versus starting time we can observe how the speed will rise with respect to the time 0.06 seconds it will reach the rated rpm and how current is coming down also we can observe in this image. So, initially current will be almost 6 times the rated current greater than 60 ampere is flowing the current curve.

Once the speed is picking up thus current is slowly coming down and it reach to the no load current value or rated current value if it is load is there. And here withstanding times with respect to the current magnitudes we can observe if the current magnitude is 800 percent that means, 8 times the rated value then it will withstand only for 3 seconds.

If greater than 3 seconds if will pump the 8 times the rated current then machine will damage. Similarly other manufacturer WG for the same power rating we can see the efficiencies. Efficiency is almost 89.6 percent that means, premium efficiency product line we can observe directly at the title itself IEC standard 3. If IEC 4, IE 4 if will go then the efficiencies will be further higher. For the ABB and Siemens this standard may be different. We can find the IEC efficiency standard in ABB as well as Siemens also. For WEG standard or vague standard it is IE 3 and remaining values and remaining parameters will be same and performance curves we can see in the same data sheet. Withstanding time with respect to the currents and similarly power factor with respect to the rated output efficiency versus rated output all these curves we can study from the data sheet. The main purpose of the data sheet is to represent the actual machine details other than the geometry how to meet the required torque and speed for a given power rating.

With this I am concluding this lecture. In this lecture we have discussed the name plate details as well as data sheet details of a machine induction machine. In the next lecture we will start doing the analysis with respect to the design. Thank you.