Course Name: Design of Electric Motors

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Title: Effective Length Equations of the Machine Core with Different Stator and Rotor Lengths

Greetings to all. In the last lecture, we have started to analyze the performance parameters with respect to the magnetizing currents, right. So, to find the magnetic fields and other parameters like MMFs and flux densities at different parts of iron, we require the actual and effective length of the iron core, right. If the machine core having the different ducts for cooling purpose, then how to find the effective length of stator core and effective length of rotor core? Some empirical formulas we will discuss in this lecture. If we will see here, the effective length of a core is a combination of iron length plus the duct length that is nothing but le. The effective length of the core is a key parameter to solve the sizing equations where the D square l e term we have discussed, right and flux densities at the different parts of iron and the reluctance and MMFs and performance parameters and etcetera.

Now, how to calculate the effective length? There is no straight forward equations. Some empirical formulas depends upon the literatures and depends upon the experience with respect to the manufacturers. Some empirical formulas I will discuss in this lecture. We can see here, there is no ducts on the rotor side as well as stator side and I am also showing here one motor.

This is the stator and this is the rotor. There is no duct on the stator side. The core is complete iron. Here length of the core will be le. l e is nothing but length of iron into stacking factor I can consider, but with respect to the rotor here also there is no ducts.

That kind of structure I am showing at the left side and right side we can see large transmachine where the length of the core will be very high. This is the length of the core. Here we can see some ducts on the core here 1, 2, 3, 4, 5, 6 like that. Different ducts we can see on the stator core as well as rotor core. This is the rotor core and this is the stator core.

If like this ducts are there along with the iron, how to calculate the length of the stator core as well as rotor core? Let us consider the case 1 where stator and rotor having the same length, stator core having the length lis and rotor core having the length lir length of the iron with respect to the stator, length of the iron with respect to the rotor. An effective length of the core is equals to li plus 2 into lg, 2 into air gap length where length of iron li equals to li s equals to lir. As of now I have shown the rotor as well as stator core without any duct. For that le is equals to we have to calculate based on this equation.

Next with respect to the case 2, we will discuss.In case 2, stator length core length as well as rotor core length are slightly different. Then how to find the effective length of the core? The effective length of the core l e is equals to mean of those 2 cores. The stator core is different or rotor core is different. We have to do the mean length of the both cores is nothing but effective length of iron. Here the condition length of lis should be less than the effective length of the core less than the iron length of the stator plus 8 times the air gap length.

In this condition, the mean we have to consider. For this kind of situation, the effective length equation will be this one. Next the effective length of the core with respect to the same number of stacks and same number of ducts. We can see here 3 stacks we have shown here l 1, l 2, l 3 lengths and number of ducts n equals to 2, the like duct length will be l naught s. Length of the each duct at the stator side will be l naught s and length of the each duct at the rotor side will be l naught r.

So, with respect to these different stacks at the stator side as well as rotor sides having the same length and ducts length at the stator side l naught s and l naught r, the effective length equation will be like this empirical formula that is equals to length of iron plus 2 into length of air gap plus number of ducts into the mean of the ducts length l naught s plus l naught r by 2 into 5 by 5 plus duct length divided by air gap. Here also another term with respect to the rotor. Here length of iron is equals to the lengths of all stacks l 1 plus l 2 plus l 3 and so on up to l n plus 1. Here we can see both sides we have the ducts and the length of the each stack as well as length of the each duct is same. The next case where the rotor is cylindrical, rotor is smooth stator side only we have the ducts.

We can see here this is one duct second, third, fourth, five like that n number of ducts are there and rotor side we have the smooth surface there is no duct. In this situation in order to find the effective length of the core l e is equals to this one is l i plus 2 into l g plus n into l naught s into 5 divided by 5 plus l naught s divided by l g. Here length of iron is equals to sum of all stack lengths and here two ducts I have shown, but in the right side image we can see n number of ducts. Last case where the stator or rotor both consist of n number of ducts, but both are not aligned we can see in this image. Stator also consist of three stacks and rotor also consist of three stacks and two ducts.

The ducts length at the stator side will be l naught s and ducts length at the rotor side will be l naught r, but the lengths are not aligned misaligned here. Similarly here also whereas, in the other cases the ducts are aligned. In this type of condition the effective length of the core l e is equals to length of the iron plus 2 times the effective length of the air gap plus the number of ducts by 2 into l naught s into some constant value and l naught r into some constant value and l i is nothing, but effective length of iron. It is a sum of all stacks of the stator. So, these are the five different cases to find the effective length of core.

By utilizing this empirical formulas we can find the effective length of core. Once we know the effective length of the core we can utilize that l e value effective length of core value to find the sizing equations flux densities at the different parts and MMF and reluctance and etcetera. So, we will utilize these equations to find the effective length in the coming lectures. So, with this I am concluding this lecture. In this lecture we have discussed the empirical formulas to find the effective length of the core. Thank you.