Re: Induction motor winding questions (clarification)

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- *From*: "Paul E. Schoen" <pstech@xxxxxxxxx>

- *Date*: Sat, 16 Jul 2005 00:51:01 −0400

I appreciate the comments and they raise valid points. However, the suggestions to use reduction gearing miss the objective, and I want to use an induction design rather than a PM rotor. What I am trying to accomplish is to make an inexpensive, rugged, and simple motor with maximum horsepower for a given frame size. I would like to use a standard frame for simplicity of mounting and coupling to sprockets and chains or other means to obtain the desired speed range. I want to make the basic motor with the slowest speed possible (at 60 Hz), which means maximizing the number of poles. I will then use PWM techniques to raise the frequency to a multiple of 60 Hz, to a maximum determined by the highest safe speed of the motor, as well as any limitations of the magnetic material. So far, the motors I have taken apart have 24 or 36 slots, and that appears to limit the number of poles to 8 or 12, but my experiments and analysis so far indicate that there may be problems with those numbers, so 4 or 6 poles may be a more reasonable limit.

I have tried to come up with various winding schemes, but it appears that when poles are closer together, the windings interfere with each other due to overlap and cancellation of effective number of turns. I'm not sure I am doing this correctly, but for each pole piece, I do a vector addition of the currents in the windings of the adjacent slots. Ideally, if all the windings (assume 4 in one slot and 4 out the other slot) are the same polarity (A), the total effective turns would be 8A. However, if the slots have overlapped windings from another polarity, the total effective turns will be less. The vector addition shows that crowding poles so close that adjacent pole pieces have a polarity 60 degrees apart (which creates a 12 pole motor with 36 slots), the effective winding is reduced to 1/4 of the ideal. I have not done all of the calculations, but the 2 pole and 4 pole designs should be close to ideal, but the 6 pole is probably reduced to about 50%, and it drops to 25% for 12 pole. This closely correlates to what I have seen on the size and weight of motors with slower speeds at the same HP. However, for some very large motors, this effect is much less, which indicates that they must have many more poles and will not have the same problems with overlap.

My conclusion is that I should probably use no more than 6 poles for a 36 slot stator. This will probably give me only a 50 % increase in HP when I run it at 3x (180 Hz), and perhaps three times rated HP if I dare run it at 7200 RPM. I may be able to find some commercially available motors with 48 or even 72 slots in the lower HP types I am looking at (up to 5 HP).

If any of you have any old motors you may wish to give (or sell) to me, it may help with my experimentation. I will of course pay for any reasonable shipping and handling. You could first remove the copper windings and sell them for scrap and reduce the weight. I have some new motors I will be stripping and rewinding, but I'd rather play with an old junker.

BTW, one of these motors is a three phase 1 HP unit which runs at 850 RPM, which implies 8 poles. However, it has a 36 slot stator, so I assume it is wound with considerable overlap and a 50% reduction of the torque it would have with 2 or 4 poles. Interestingly, it is the same size and weight as a 2 HP motor rated 3450 RPM.

"Paul E. Schoen" <pstech@xxxxxxxxx> wrote in message
news:11d9jr3ddc109a9@xxxxxxxxxxxxxxxxxxxx
> I am experimenting with various schemes to rewind AC induction motors to
> change their characteristics for special purposes. I have successfully
> rewound several single phase motors for three phase, and I have changed
> their speed by varying the number of poles. I am winding them with much
> heavier wire than originally used for the 120 and 240 VAC machines, as I
> want to use them for low voltage battery powered applications.
>
< Snip − details of experimental motors>
>
> The purpose of this long discussion is to solicit ideas and
recommendations
> so that I can design a practical, efficient, high torque, low speed motor
to
> run on about 6 to 12 VAC at 60 Hz, and be capable of running up to 3600
RPM
> (or higher) by means of a V/Hz PWM drive.

<Snip − winding schemes>

> Paul E. Schoen, President
> P S Technology, Inc.
> www.pstech−inc.com
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- ***Follow−Ups***:
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    - ◊ *From:* colin
  - ♦ ***Re: Induction motor winding questions (clarification)***
    - ◊ *From:* Rich Grise

- ***References***:
  - ***Induction motor winding questions***
    - *From:* Paul E. Schoen

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