Comments on Experimental Testing Results of 3kw GMI Generator

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3kw GMI Generator has been tested with 4 characteristics recorded:

a) No-load voltage characteristics,
b) Short-circuit characteristics (SCC),
c) Loading tests, and
d) Temperature rise test.

1. The test results of no-load voltage characteristics are shown as in Fig. 1.

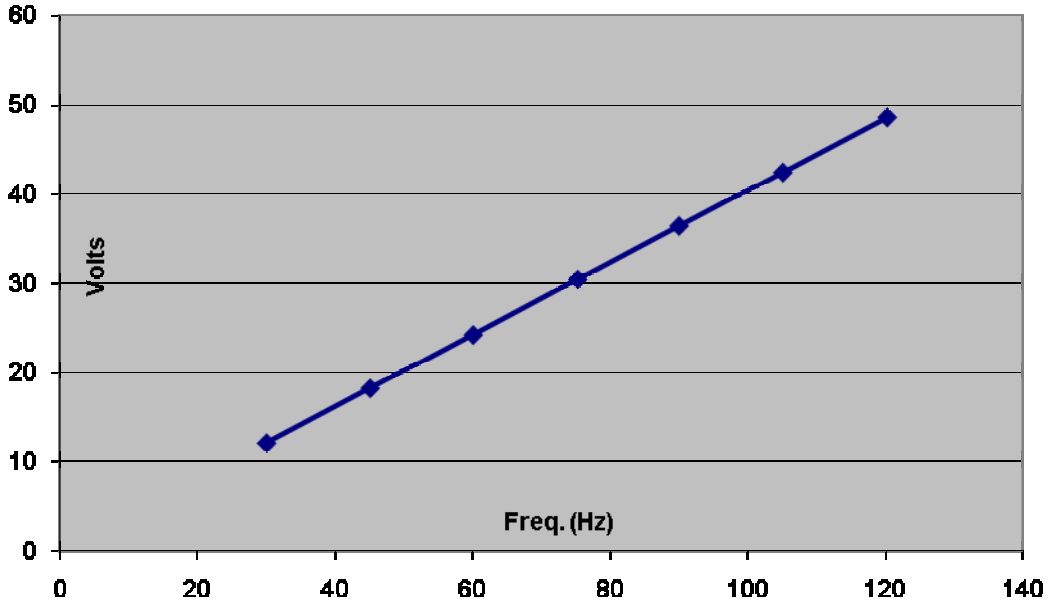

Fig. 1. No Load voltage characteristics of GMI 3 kw generator

As expected, the induced open circuit voltage increases linearly as the speed (frequency) increases. The tested results are an indication of the permanent magnet strength in the 3kw GMI generator design. It is shown that the results from the results are satisfactory.

2. The SCC test results are conducted in two operation points and the recorded voltage and currents are:

3. Loading tests are conducted in a speed range of 200-800 rpm in various loading conditions. In Figs 2 two loading conditions are selected to shown, one for rated load (3kw) and another overload (5kw) conditions.

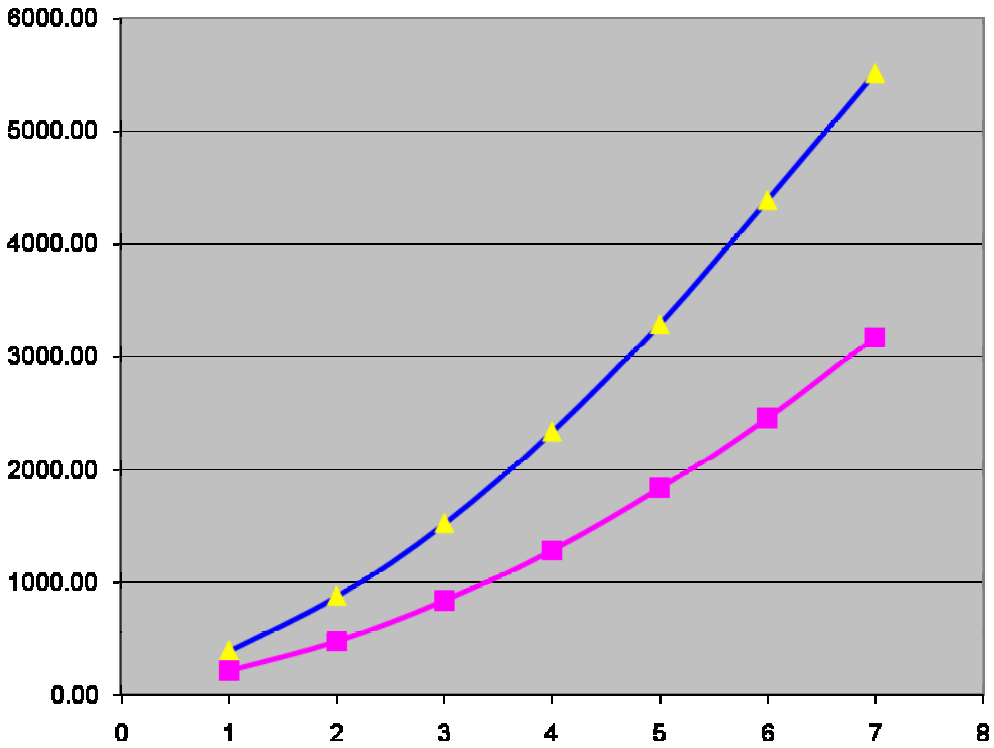

Fig. 2. Load-speed characteristics with load resistance of 1.34 and 0.565 ohms

In the tests, the generator speed has been increased from about 200 to 800 rpm while the load resistance kept nearly as one constant for one case (1.34 and 0.565 ohms). Since the generator voltage is linearly proportion to the speed, the generator power is nearly proportional to the square of the speed because $P = v^2/R$, just as shown in the figure. As indicated, the designed generator is capable of delivering 3kw real power. It is also shown that the generator is capable of being overloaded to 5.5 kw.

It is to be noted that whether the generator can continuously deliver the amount of power mentioned above depends on the cooling conditions of the generator. If the generator can continuously deliver the amount of power shown in the figure without overheating problem, then the generator's power capability is verified.

Also to be noted that in a real wind power generator situation, the power-speed curve will be different from what shown in Fig. 2 - the generator power is proportional to the cubic of the speed, instead of square of the speed.

4. Efficiency

For the two selected cases, the energy efficiency is shown below. As can be identified, the efficiency of the GMI generator is as high as at about 90% in the rated level and 82-83% whenever overloaded to 170% of the rated level. For a torque and current not very high, the GMI machine favors high speed over low speed operation. However, in the overloaded conditions with a very high torque and current, the efficiency in the high speed is lower than that in the low speed range. Overall, the energy efficiency of the GMI looks good. It is to be noted that for future GMI generator with larger capacity, the energy efficiency should be higher (95% or higher).

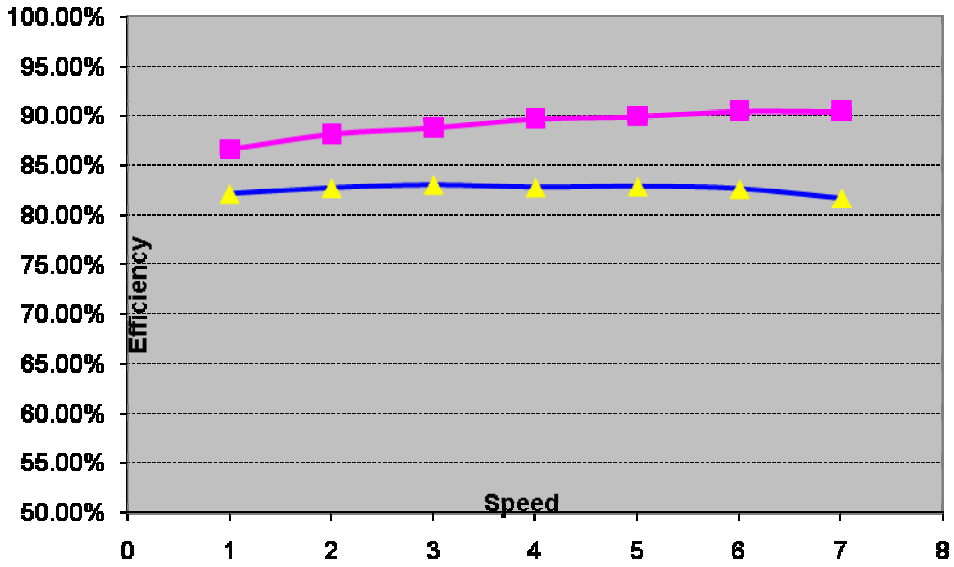

Fig. 3. Efficiency with load resistance of 1.34 and 0.565 ohms

5. Temperature rise

The temperature rise test is conducted at 600 rpm at the power level of 4.1-3.7 kw. The temperature rise test lasted about 15 minutes and the inner stator winding temperature rise curve is shown in Fig, 4. The temperature test is of significance because the results show the actual power capability of the GMI 3 kw generator. As an example shown in the figure, the inner winding temperature rises from 54 to 102 degrees for the tested 15 minutes. As indicated by the curve, the temperature will go higher if the test is allowed to last longer. The curve also indicates that the rising rate has already slowed down. It can be expected that the temperature curve eventually will level off.

In a standard temperature rise test for continuous operation for the rated conditions, people should allow the test to continue until the temperature is stabilized. At the moment of stabilized temperature rise, the heat generation and dissipation are balanced. The stabilized temperature is the one for real operation conditions.

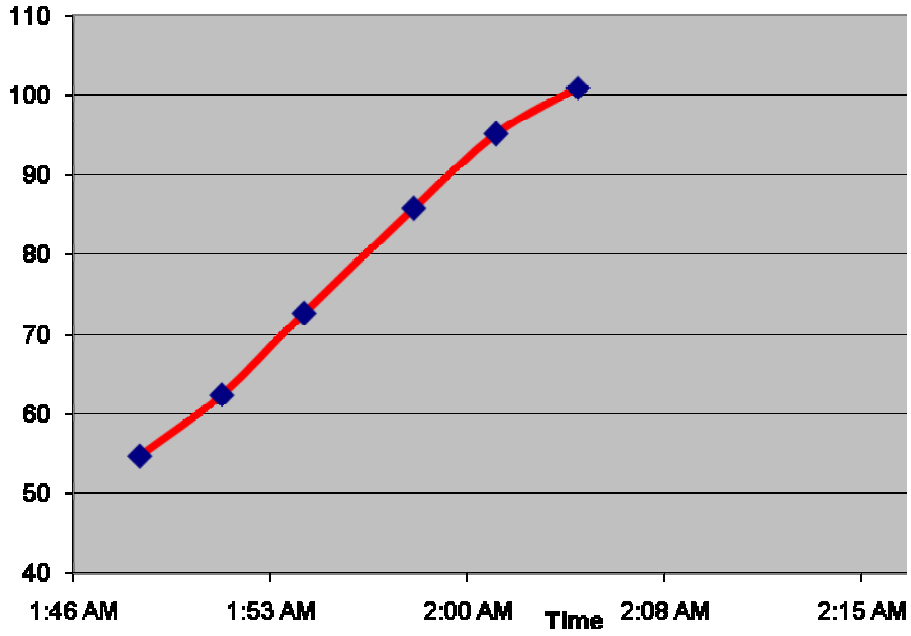

Fig. 4. Temperature rise curve