Dynamometer: Use and Application

By:

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Self Learning

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Introduction:

As a part of the CWC Generator Team, we have been tasked with creating a small-scale wind turbine generator that will be used by NAU's Collegiate Wind Competition (CWC) Team. Our 66% build deliverable will be test results on the CWC Generator Team's commercial generators. To do this, we were given the previous CWC team's dynamometer (dyno) as a test bench. After rebuilding the majority of the dyno, with some modifications still in process, we will have to learn how to use it as a test bench. Acting as head Test Engineer in the CWC Generator Team, my self learning assignment is on the different uses and applications of dynamometers. This will help my understanding of the dynamometer as a test bench for our generators.

Research:

The term "dynamometer" extends far beyond the test bench we have been working on for the past six months. Dynamometers come in all different shapes, sizes, applications, and data output. They are primarily made to read force and provide specific output data. Most modern dynamometers are used to test motors and engines where they absorb the power from the engine and output data on the torque and power [1]. From this they can determine efficiency losses, thermal performance, and wear on the engine over time [3]. Others are more simple, like grip strength sensors, that purely measure the inflicted forces.

The data visualization can also vary depending on the application. For motors and engines, the data output is used to find power and efficiency curves that describe the behavior of the motor. This can be displayed in 3D plots or heat maps representing power or efficiency based on both the torque and speed of that motor, like the ones shown below in Figures 1 and 2. This format of visualization helps understanding the ranges of performance and efficiency that the motor operates within.

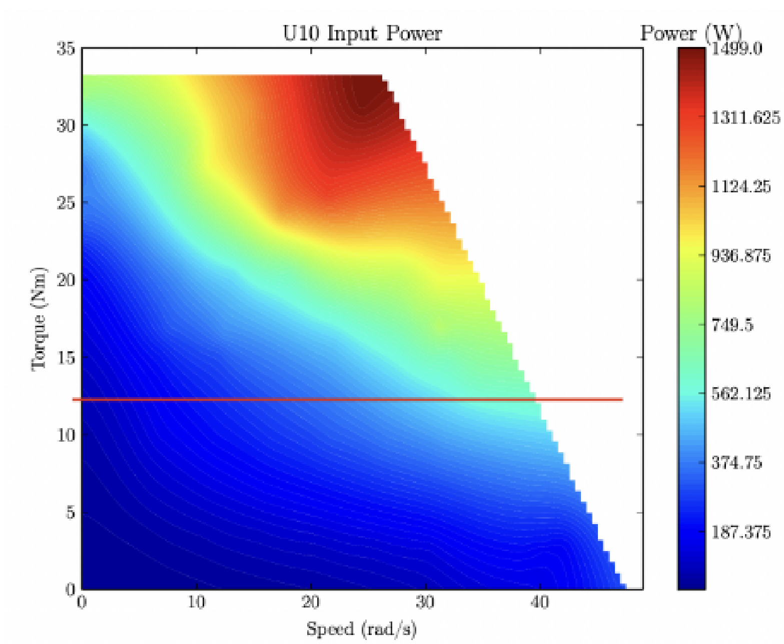

Figure 1: Torque/Speed/Power Map of a U10 Motor [2]

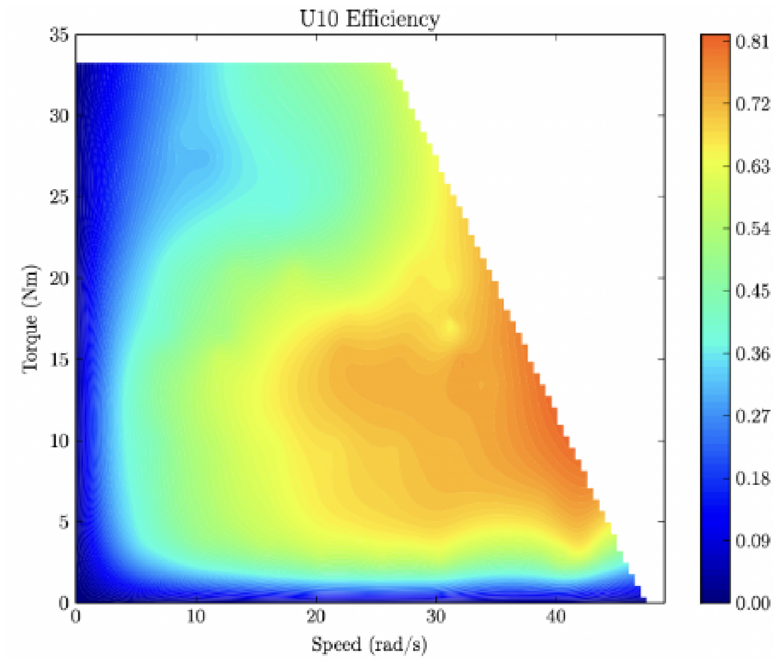

Figure 2: Torque/Speed/Efficiency Map of a U10 Motor [2]

To generate the characteristic maps like the ones shown above, existing test procedures are used to get these results. The three main testing methods are steady-state, sweep, and transient tests [4]. When doing a steady state test on a motor, the rpm of the motor is kept consistent. With a steady rpm, braking torque is increased over time on the dynamometer. To do a sweep test on a motor, the dyno braking torque is set constant while the rpm of the motor is swept from a specified minimum to a specified maximum. The transient test changes the rpm of the motor often and abruptly. The transient test is often used to determine modern engine emissions.

Application:

Considering dynamometers used for motors and dynamometers used for generators are parallels of one another, I will create a testing procedure applicable to our dyno setup. The inputs and outputs are different between motors and generators, so these parameters need to be set before the procedures are developed. Our dyno is a modified torque transducer dynamometer to get the right data from small-scale generators. Once modifications are complete, the dyno will be set up to provide data on the torque, rpm, voltage, and current of the generator. When testing our generators, we will be using a variable load machine to set the resistance of the generator to a particular value. This will mean the voltage and current will be variable, allowing for 3D visualization of the generator in 3D plots or heat maps like Figures 1 and 2. The efficiency and power of the generator will be the primary values we evaluate. Multiple tests at different resistances will be done to fully characterize the generator. In particular, the Kv rating of the generator will be found by applying an open circuit during testing. This will allow us to compare the results of the generators to the customer requirements we have, to date, been trying to fulfill through our predictions and design efforts.

Generator Testing Procedure		
Test Type	**Procedure**	**Output**
Steady State	Constant rpm supplied by the motor on the dyno, increasing resistance applied from the variable load.	Stall torque and the power/efficiency versus torque curves
Sweep	Increase rpm from naught to maximum slowly enough to be quasistatic.	Kv rating, efficiency and power curves.
Transient	Increase and decrease rpm between the operating ranges of the generator, equivalent to the 3 m/s cut-in and 25 m/s cut-out wind speeds.	Efficiency and power during more realistic working conditions.

Conclusion:

In conclusion, I have developed a better understanding of the wide range of tools referred to as "dynamometers" and their uses. Especially the modified torque transducer dynamometer in our possession. The kind of data collected is also clearer, aiding my understanding of what we are trying to achieve by putting our generators on the dynamometer. The test processes and data visualization is now clear, helping me to create a new test procedure applicable to our dyno. Doing this self learning assignment, I am now more confident in my ability to utilize the dyno during our testing phase.

References

[1] G. M. Smith, “A Comprehensive Guide to Dynamometers”:, *Data Acquisition | Test and Measurement Solutions*, Aug. 14, 2024. https://dewesoft.com/blog/dynamometers-guide

[2] A. Mehrotra, “A Brief, Informal Introduction to Motor Testing,” Apr. 2022. https://evt.mit.edu/textbooks/Dynos_for_Dummies.pdf (accessed Sep. 12, 2025)

[3] “Dynamometer: What Is It? How Does It Work? Types, Uses,” *www.iqsdirectory.com*. https://www.iqsdirectory.com/articles/dynamometers.html

[4] “Dynamometer - types, working principle and power measurement basics - Mechanical Engineering,” *Mechanical Engineering*, Dec. 24, 2018. https://mechanical-engineering.com/dynamometer/