A Study on High Precision Torque and Rotation Speed Measurement Technology

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1. Introduction

Because the performance of the power-carrying rotor is defined as the output divided by the input, axial power requires measurement of torque and number of turns. Generally, when measuring the performance of electric motors, turbines, engines, transmissions, gearboxes, coupling, hydraulic pumps and motors, etc., measurements shall be made using a torque and rotary measurement device.

In this study, the characteristics of large interline noise in existing torque meters were analyzed, the noise filter ring by hardware filter was first performed to measure high precision torque, and the second was cut-off noise filtering by software. In the end, small differences of torque were tested and effects were compared using a digital pulse transmission torque meter that could fundamentally block line-to-line noise.

2. Testing apparatus and test results

Companies are focusing their efforts on improving performance to ensure the competitiveness of their products. However, the use of similar high-end facilities and programmed production processes does not result in significant performance differences than those produced by competitors. Therefore, high precision measurements are required to determine differences in minor performance improvements. Also, if the size of the input and output power of the product to be measured is very similar, such as the loss of friction in a single gear row or lubrication surface, it may not be possible to determine if the error of the measuring instrument is large. Measurements of the torque meter previously used were not reproduced when repeated measurements were made due to loud inter-line noise, and the output was higher than the input, resulting in more than 100% efficiency. Thus, it was not possible to measure efficiency if the power loss in the case of three pinions being entered in one gear as shown in Figure 1 was very small.

To solve this problem, the noise in the low-frequency and high-frequency bands was filtered by the hardware filter to achieve a more stable result, as shown in Figure 2. In addition, the measurement results were obtained using cut-off noise filtering methods by software, considering the physical characteristics of the test specimen and the test device that cannot change the torque rapidly due to the large inertia of the test specimen and test device, as shown in Figure 3. However, the existing torque transfer method uses a very small capacity, mV, in AC Transformer manner, which is seriously affected by line noise coming from the surrounding area as shown in Figure 4. Thus, as shown in Figure 5, a digital pulse transmission torque meter was developed to prevent noise between wires, enabling accurate measurement, and improving reliability in performance evaluation.

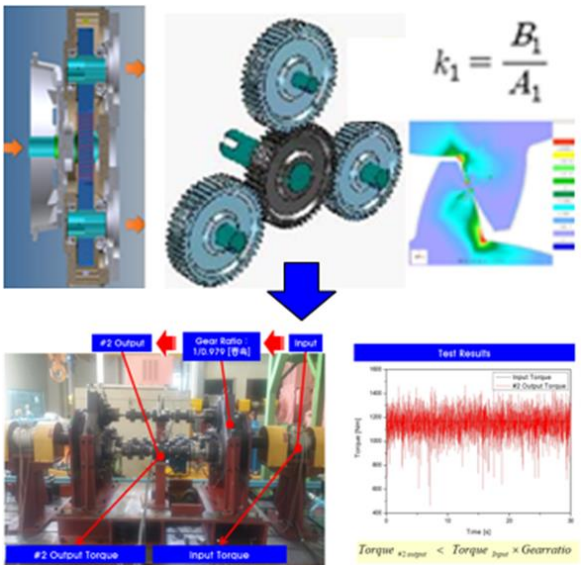

Fig. 1 PTO gearbox with very small friction loss and torque measurement results for performance test

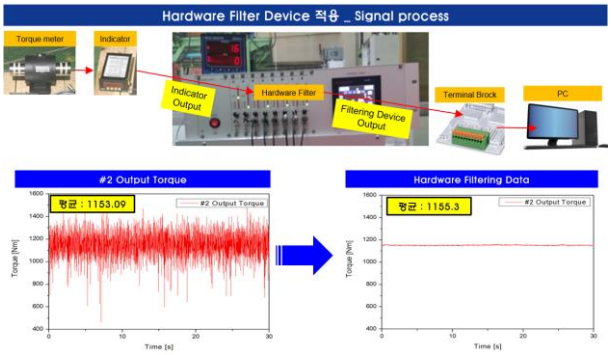

Fig. 2 Hardware filter unit and torque filtering data using high & low pass filter

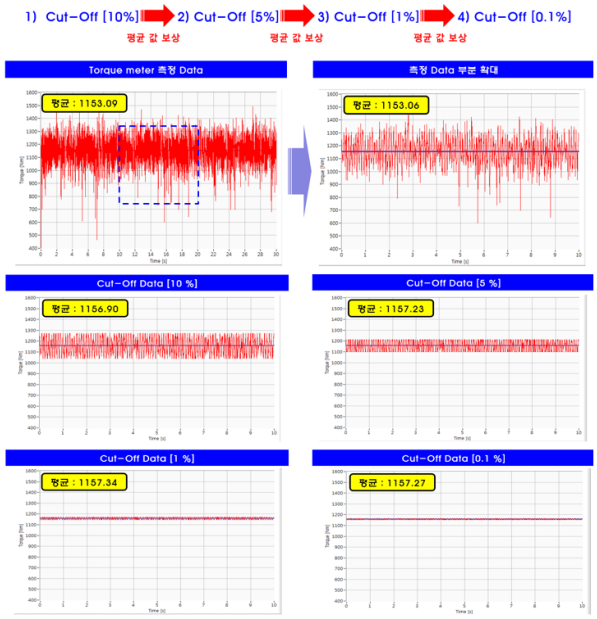

Fig. 3 Torque Measurement Data Noise Cut-off Software Filtering Results

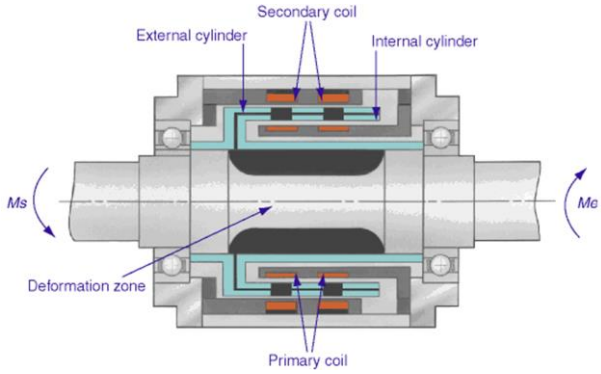

Fig. 4 Torque meter cross-sectional view of conventional transformer type analog

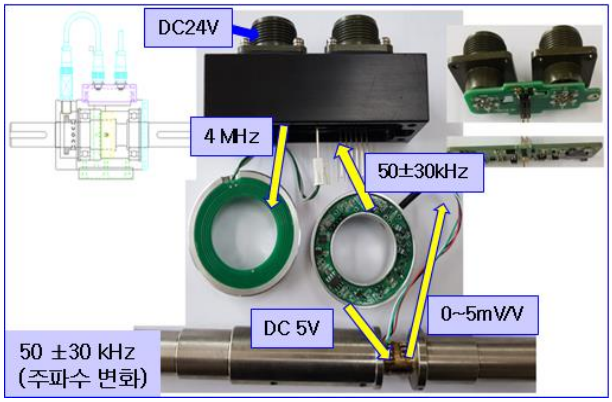

Fig. 5 Torque meter decomposition picture with newly developed digital frequency transmission

In Figure 6, the results of a comparative test between a torque meter with an existing analog transmission and a torque meter with a newly developed digital frequency transmission show that the measurement of a torque meter with a digital frequency transmission is excellent.

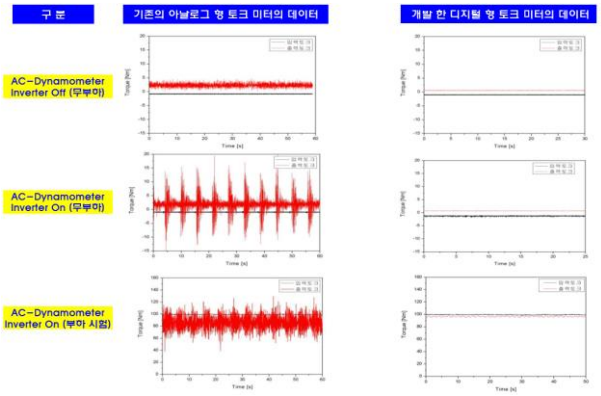

Fig. 6 Test results comparing the torque meter with the analogue transmission and the torque meter with the digital frequency transmission

3. Conclusion

1) Most of the torque meters currently in use have analog data transmission format, which is very vulnerable to noise.

⇒ Amplify mv/v by approx. 100 to 500x with v

2) Consideration and blocking of interline noise (AC Dynamometer) of testing apparatus that is much larger than calibration uncertainty is important.

3) To identify a small amount of high precision torque, a torque meter is suitable for digital type CAN communication that is strong for inter-line noise.

Acknowledgment

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