100, 000 RPM

†.   *

Study on measuring the low torque on an air tool operating at 100,000 RPM class

Eun-Jong Kim and Soo-Yong Cho

Key Words: Air tool(   ), Axial-type rotor(   ), Torque-meter(   ), High RPM(RPM), Low torque(   )

Abstract

An experiment is conducted for measuring the performance of an air tool, which is operated at 100,000 RPM at the unloaded state with the low torque. An experimental apparatus is developed as the power absorption type dynamometer. Inlet static pressure, flow rate, RPM and force are measured simultaneously. Torque, output power and specific output power are obtained. Those experimental results are compared with the experimental results obtained on a commercial dynamometer. However, no commercial dynamometers are available for measuring the torque above 30,000RPM. In order to use the commercial dynamometer, a reduction gear is applied to the shaft of dynamometer. Torque and power obtained on the commercial dynamometer show 50% lower than those obtained on a power absorption type dynamometer, because the inertia force is added to the air tool rotor for the braking system. Moreover, the starting RPM on the commercial dynamometer is less than 40,000RPM. From the compared results, they show that the power absorption type dynamometer should be applied for measuring the performance of an air tool operating at low torque and high RPM.

1.   ,
,
.

.   6mm   .
,   ,
,   ,   ,

.

†
    E-mail : sycho@gsnu.ac.kr
    TEL : (055)751-6106   FAX : (055)757-5622
*   (   )

.

40,000RPM

.

100,000RPM

.

.

.

Holman(1)

Garshelis   (2)

.

.

4000RPM   . Garshelis   (3)

. Sobel   (4)

4

. Zabler   (5)

10Nm~60Nm

. Fleming(6)

3

Doebelin(7)

.

.

.

.

2.

2.1

.

T

.

$$\tau_{\max} = \frac{T\,r_o}{J} = \frac{Gr_o\theta}{L} \tag{1}$$

r_o J

. G

. L

.

x , y , z

45°

.

90° 45°

.

4

.
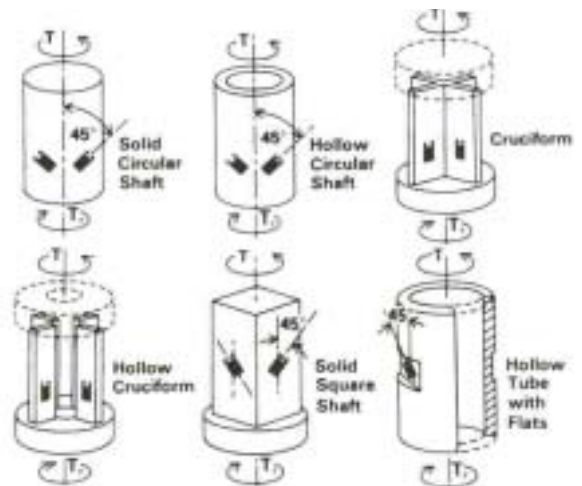
Fig. 1 Elastic bars for torque measurement(8)

.

.

(fillet effect) (trunnion)

.

.

.

.

. Fig,

1 .

.

2.2

.

.

.

.

. 2.4

.

.

2.3

.

.

.

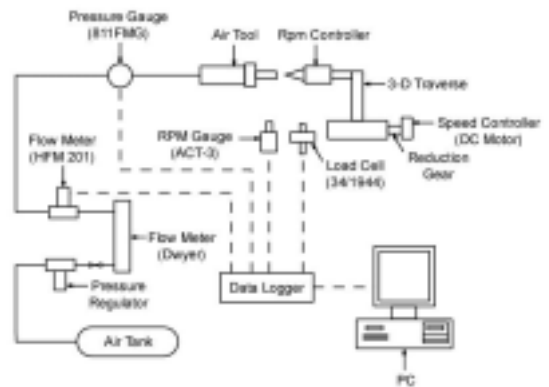$$P = wT \qquad (2)$$

.

(*P*:Watts) (:rad/sec)

.

.

.

.

Fig. 1 Schematic diagram of experimental utility

.

Table 1 Degree of accuracy and models for experimental utility

측정장치	모델	정밀도
	HFM201 Hastings Instruments	- 0.5% @%FS - 0~200l/min air
	34/1944-07 Sensotec	- ±0.02% - Max. 250gf
	ACT-3 Monarch	- ±0.0015% - Max. 100,000RPM
	811 FMG Sensotec	- 0.25% @%FS - 150psi gauge

.

8.75mm   .

.

. Fig. 2
                  . Table 1
                  .

                  .

                                              Lebow(8)

            70N.mm
      20,000RPM   .
   350N.mm
  20,000RPM   .

   20N.mm
100,000RPM   .

                  .
            Magatrol(9)

30,000RPM   .

                        .

      3.

Fig. 3
                              . Fig. 4
      RPM   .

      RPM
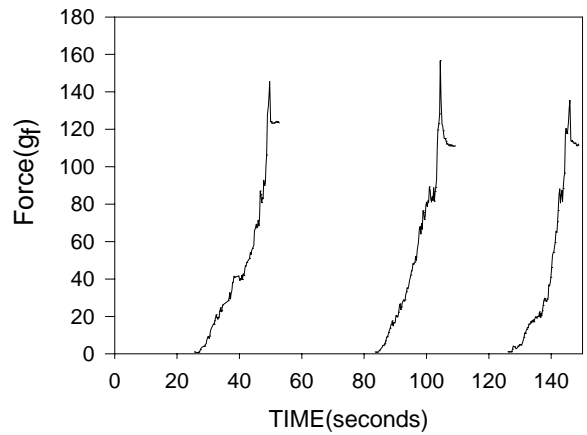   Fig. 5   .

Fig. 3 Variations in operating force on the rotor by controlling the contacting force
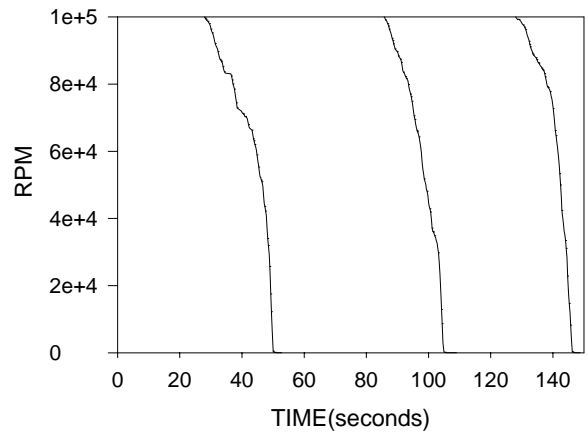

Fig. 4 Variations in RPM on the rotor by controlling the contacting force
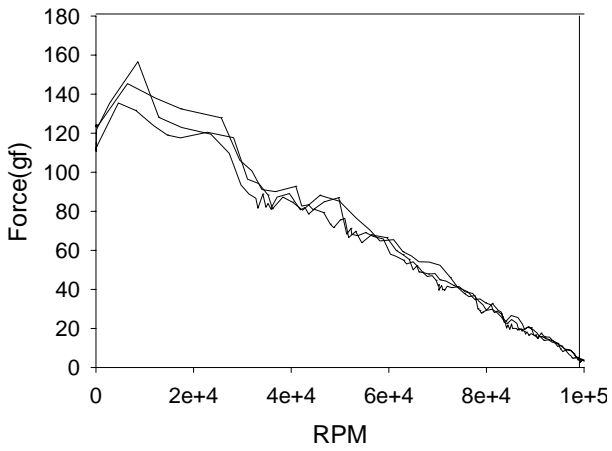
Fig. 5 Variations in operating forces with rotor RPM

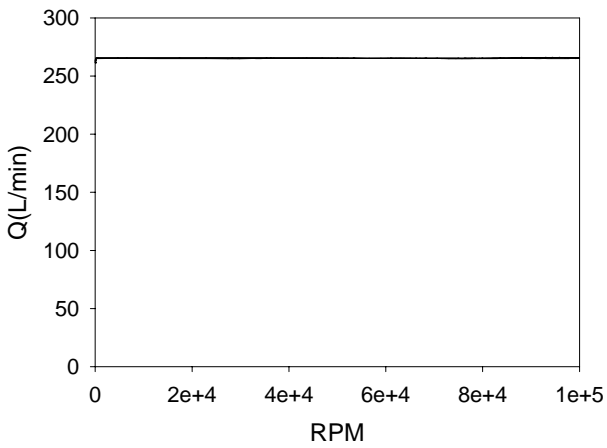**Fig. 6** Variations in flow rate with rotor RPM

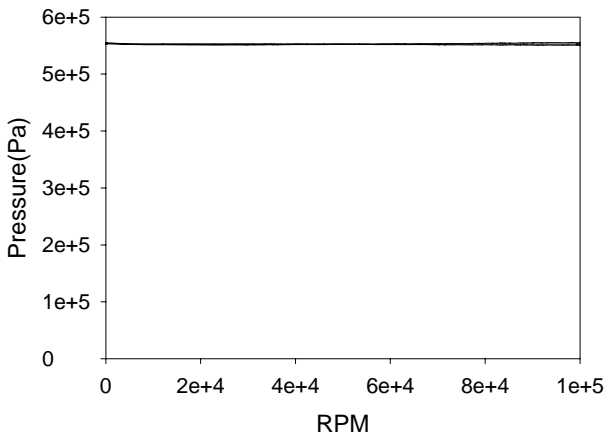**Fig. 7** Variations in inlet static pressure with rotor RPM

Fig. 6   7

.

.

.

Fig. 8   Fig. 3

(8.75mm)

.

.

.

.

40,0000RPM   .

40,000RPM

.

.

Fig. 9

.

(9)

.

50%

.

16

.

.

$$T = \frac{97.4 * P(Hp) * 750 * 9.8 * 10}{RPM * 16}$$ (3)

Fig. 10

.   50,000RPM

.

.

Fig. 8 Comparison with torques obtained on a commercial dynamometer

Fig. 9 Comparison with output powers obtained on a commercial dynamometer

Fig. 10 Variations in specific power with rotor RPM

4.

.

50,000

RPM

.

BK21

.

(1) Holman, J. P. 1994 ,"*Experimental Methods for Engineers,*" McGraw-Hill, pp.440 443.

(2) Garshelis, I. J, Christopher, R. C. and Fiegel W. S., 1995, "A Single Transducer for Non-Contact Measurement of the Power, Torque and Speed of Rotating Shaft," SAE 950536.

(3) Garshelis, I. J., Aleksonis, J. A., Jones. C. A. and Rotay, R. M, 1997, "Development of a Magnetoelastic Torque Transducer for Automotive Transmission Application," SAE 970605.

(4) Sobel, J. R., Jeremiasson, J., Wallin, C., 1996, "Instantaneous Crankshaft Torque Measurement in Cars," SAE960040.

(5) Zabler, E., Heintz, F., Dukart, A. and Krott, P., 1994, "A non Contact Strain Gage Torque Sensor for Automotive Servo Driven Steering Systems," SAE940629.

(6) Fleming, W. J., 1991, "Computer-Model Simulation Results for Three magnetostrictive Torque Sensor Designs," SAE910857.

(7) Doebelin, E.O.,1992, "Measurement Systems," McCraw-Hill Publishing Company, pp.410 433.

(8) Lebow, 1998, "Load Cell and Torque Sensor Handbook No. 710B," Lebow Products, Troy, Michigan, USA.

(9) Magtrol, 2000, "Torque-Speed-Power," catalogue, Buffalo, New York, USA.