A Short Review and Development of Rope

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A Short Review and Development of Rope Brake Dynamometer for Measurement of Brake Power on Small Scale Engine

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ABSTRACT: Small-scale engines are very many fields of utilization. The measurement of brake power requires a tool that simple and easy in manufacturing. Dynamometer of rope brake is an equipment to measure the brake power produced by a rotating shaft. This study aims to review the use of rope brake dynamometer on small scale engines with an output power about 10 kW. The results of the review show the engine used with brake power in the range of 2.2 to 11 kW on the rotation between 400 to 4500 rpm, the diameter of drum was used in the range of 5.5 to 38 cm and the diameter of rope in the range of 0.45 to 1.6 cm. The results of the development are a rope brake dynamometer with a drum diameter of 10 and 20 cm with a rope diameter of 1 cm. The maximum of engine brake power is used at 4.02 kW.

KEYWORDS: Review, Development, Rope brake, Dynamometer, Brake Power, Engine

INTRODUCTION

The power generated by a rotating shaft needs to be measured to get the power that can be generated. The measuring instrument used is called a dynamometer. Brake power of rotating shaft is obtained after the resulted of torque value. One method used to measure torque is the method of absorption (torque of friction). A rope brake dynamometer uses mechanisms of absorption (friction torque), by using the principle of torque produced by engine equal to frictional torque caused by the rope [1]. The mechanism of working of the rope brake dynamometer is shown in figure 1. Before the drum rotates, the weight of the load is the same with the weight that reading in spring balance, after drum was rotated, a weight that reading in spring balance was reduced caused rope is pushed up by friction on the drum. So that the magnitude of the force due to friction that works towards the top is W-S.

The principle of torque and brake power calculation use a rope brake dynamometer as follows:

$$F_{\text{tangential of drum}} + S = W \quad (1)$$

$$F_{\text{tangential of drum}} = f_{\text{friction by rope}} = W - S \quad (2)$$

$$\text{Torque} = F_{\text{tangential of drum}} \cdot r_t = (W\text{-}S) \cdot r_t \quad (3)$$

$$\text{Brake Power} = 2\pi N(W\text{-}S)\, r_t / 60000 \text{ (kW)} \quad (4)$$

Where: r_t = Total of diameter (m) = $r_d + r_r$, N = Rotating of drum (rpm), W = Dead weight (N), is read on spring balance before shaft is rotated, S = Spring balance (N), is read on spring balance after shaft is rotated.

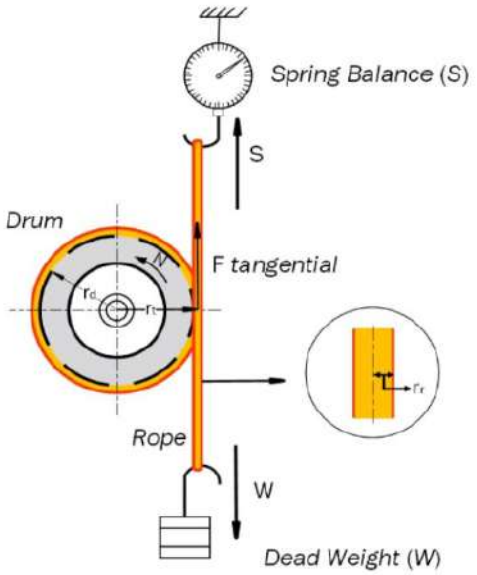


Figure 1. The principle of rope brake dynamometer

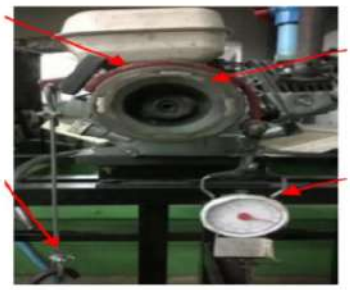
REVIEW OF MEASUREMENT OF BRAKE POWER USING ROPE BRAKE DYNAMOMETER

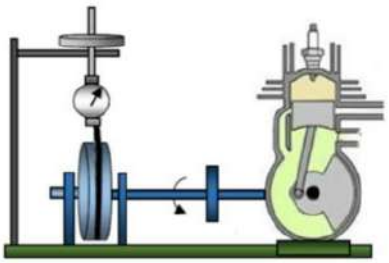
The development and application of rope brake dynamometer to measure torque and brake power have been conducted by several researchers [2-34]. Some papers also show an experimental set-up of the rope brake dynamometer model that is used as shown in Table 1.

Table 1. Rope Brake Dynamometer Model has been used on experimental by researcher

Engine Specification	Rotation and Brake Power was used on Experimental	Rope Brake Dynamometer System	References
-Brake Power of 3.5 Hp or 2,57 kW -Speed of 1500 rpm			[7]

-Brake Horse Power of 5 HP or 3.68 kW -Speed of 1500 rpm -Compression ratio of 16.5: 1	-Brake power of 4 kW		[12]
-Brake Power of 3.7 kW -Speed of 1500 RPM	-Brake Power of 400 – 1800 W -Speed of 1400 – 1600 RPM		[13]
-Brake Power 5 hp or 3.7 kW -Speed 1500 rpm -Compression Ratio 16: 1 -			[14]
-Speed 1500 rpm	-Brake Power: 1.97 kW		[15]

-Brake Power of 5 kW -Speed of 1500 RPM	-Brake Power of 0.2 – 2.5 kW -Speed of 1500 Rpm		[19]
-Brake Power of 2984 Watt -Speed of 3600 RPM -Compression Ratio of 7.5: 1	-Brake Power of 400 – 1600 watt -Speed of 1500 – 4500 RPM -Torque of 1 – 5.5 N.M		[21]
-Brake Power of 15.06 PS or 11 kW -Torque of 12.5 Nm			[22]
-Brake Power of 2.2 kW -Speed of 2650 RPM	-Brake Power of 2 kW		[25]

-Brake Power 5.2 kW -Speed 1500 RPM			[27]
-Brake Power of 5.8 kW -Speed of 3500 RPM	-Brake Power of 1.05 -1.35 kW		[33]
-Maximum Power 7 PS or 5.18 kW -Speed of 800 rpm -Maximum Torque of 7.5 Nm	-Brake power maximum of 0.9283 kW		[34]

TYPE OF ROPE BRAKE DYNOMETER COMMONLY USED

Based on the results of the review conducted, there are three models of rope brake dynamometers commonly used as shown in Table 1. These models are the configuration of I [12,13,19,22,25], the configuration of U [7,14,15,27,33,34] and the configuration of n [21] as shown in figure 2,3 and 4.

DEVELOPMENT OF ROPE BRAKE DYNAMOMETER

The development is carried out on two types of rope brake dynamometer namely: the configuration of I and configuration of U. Based on the results of the review shows the diameter of the drum can be used in the range of 5.5 cm to 38 cm [4,7,17-18,20,28,33] and the rope diameter of 0.45 cm to 1.6 cm [18, 28] for testing on the engine with brake power specifications of approximately of 10 kW. In this study, a rope brake dynamometer with a drum diameter of 10 cm and 20 cm with a rope diameter of 1 cm was developed to measure small scale engine with the specifications as follows [35-38]:

Table 2. The Engine Specifications

Parameter	Value
Maximum Power	5.5 HP or 4.02 kW

Speed	3600 RPM
Bore	6 cm
Stroke	4.2 cm
Capacity	163 CC
Number of Cylinder	1
Engine Type	4 strokes
Compression Ratio	8.5 :1
Fuel	Gasoline

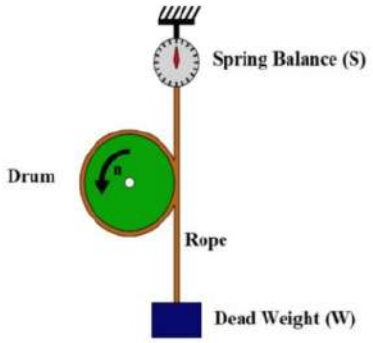


Figure 2. Rope Brake Dynamometer with I Configuration

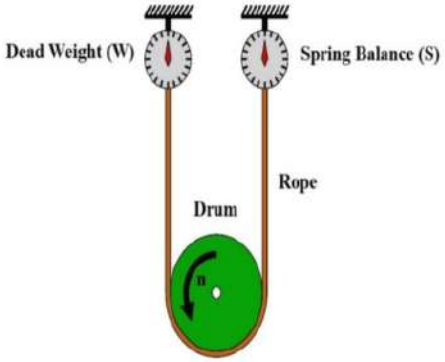


Figure 3. Rope Brake Dynamometer with U Configuration

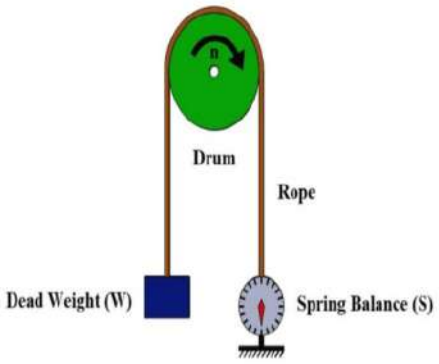


Figure 4. Rope Brake Dynamometer with n Configuration

Figure 5. The Development of U Configuration

Figure 6. The Development of I Configuration

CONCLUSION

The testing of brake power of small-scale engines with power about 10 kW using rope brake dynamometer is still very popular. The rotation speed range used is in the range of 400 to 4500 rpm. In general, there are three models of rope brake dynamometers, namely: configuration of I, configuration of U and configuration of n. The diameter of the drum that can be used in the range of 5.5 cm to 38 cm and the diameter of the rope in the range of 0.45 to 1.6 cm. The results of development are the diameter of drum of 10 and 20 cm with the diameter of the rope of 1 cm. The power of engine used is 4.02 kW.

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