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**SAE J1342 AUG89**

**Method for  
Determining Power  
Consumption of  
Engine Cooling Fan-  
Drive Systems**

SAE Recommended Practice  
Revised August 1989

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Ø METHOD FOR DETERMINING POWER CONSUMPTION  
OF ENGINE COOLING FAN-DRIVE SYSTEMS

1. SCOPE:

The technique outlined in this SAE Recommended Practice was developed as part of an overall program for determining and evaluating fuel consumption of heavy-duty trucks and buses.

It is recommended that the specific operating conditions be carefully reviewed on the basis of actual installation data. Cooling requirements are affected by all heat exchangers that are cooled by the fan-drive system. These may include radiators, condensers, charge air coolers or oil coolers.

Because of the variation in size, shape, configuration, and mountings available in cooling fans and fan-drive systems, specific test devices have not been included.

Using known power/speed relationships for a given fan, this procedure can be used to calculate the fan-drive systems power consumption for engine cooling systems using fixed-ratio, speed modulating, and on-off fan drives. This power consumption may then be used in determining engine net power per SAE J1349. For fan power/speed relationships, refer to SAE J1339.

2. PURPOSE:

The purpose of this SAE Recommended Practice is to provide a recommended method for determining and comparing the power consumption of fan drives over a variety of operating conditions. The resulting power consumption data is useful in predicting the fuel consumption of engines using these fan drives and in comparing one fan drive to another on the basis of power consumption. There is no known comparable ISO specification.

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### 3. METHOD OF PRESENTING TEST DATA:

To evaluate the power requirement differential between the fixed-ratio fan drive and a speed-modulating or on-off fan drive, the following formula will be utilized for all duty cycle conditions. Typical curves are shown in Fig. 1.

To evaluate the power:

$$\text{Total Power: } (N_1 - N_o) (N_o^2)(K) + (N_o^3)(K) + P_1$$

Where:

- $(N_1 - N_o)(N_o^2)(K)$  = Slip/drag power  
 $(N_o^3)(K)$  = Fan power  
 $N_1$  = Input speed  
 $N_o$  = Fan output speed  
 $K$  = Fan constant  
 $P_1$  = Power loss associated with the fan-drive system minus the fan and clutch but including belts, pulleys, and pulley bearings.

Fan output speed ( $N_o$ ) can be determined from curves such as those presented in Figs. 2 and 3. Curves as shown in Fig. 2 shall be provided by the fan-drive manufacturer. Curves as shown in Fig. 3 would normally be derived by the fan-drive user.

"K" fan constant is obtained by dividing fan power by the (fan speed)<sup>3</sup> required to consume that power.

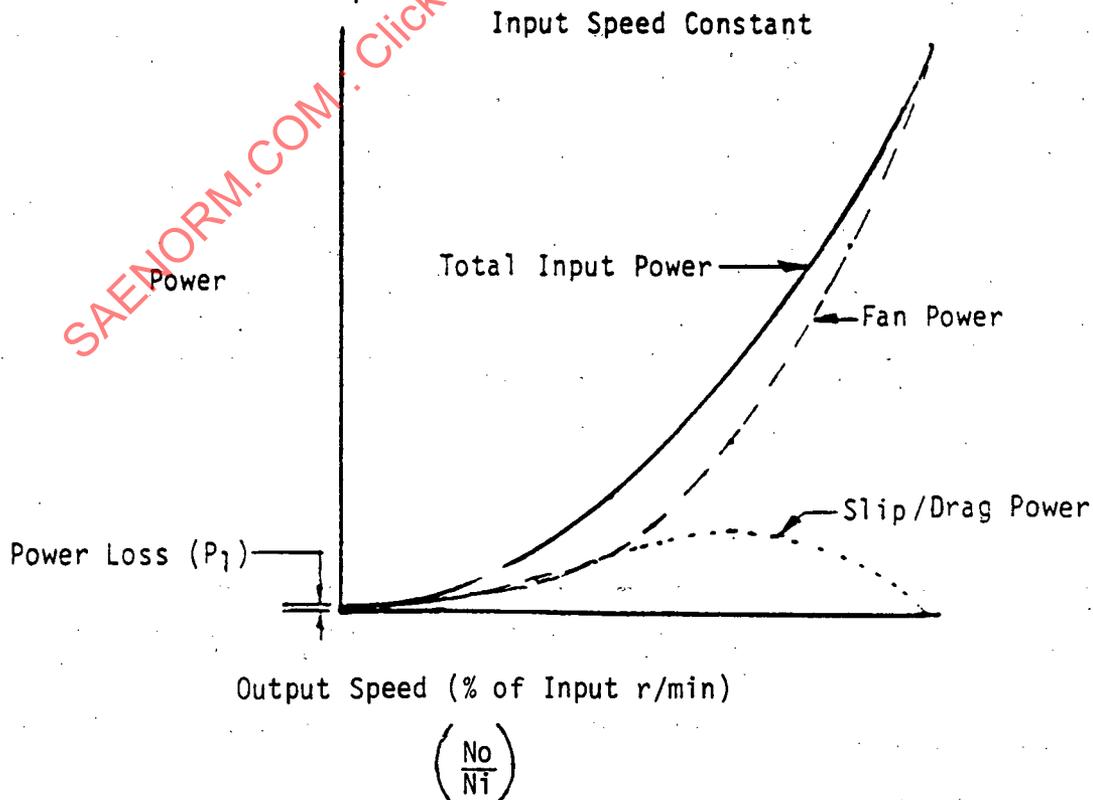


FIGURE 1 - Power versus Output Speed (% of Input r/min)

#### 4. PROCEDURE FOR ANALYZING VARIOUS TYPES OF FAN-DRIVE SYSTEMS:

##### 4.1 The section 3 method applied to the on-off fan drive is as follows:

When operating conditions do not require fan-drive actuation, fan-output speed ( $N_o$ ) will fall on line G-H (Fig. 2), or may be 0 rpm ( $N_o=0$ ), depending on the particular fan clutch being analyzed.

When operating conditions require fan-drive actuation, fan-output speed ( $N_o$ ) will fall along line A-B of Fig. 2. Given a specific input speed ( $N_i$ ), the output speed ( $N_o$ ) can be determined from line A-B of Fig. 3.

##### 4.2 The section 3 method applied to viscous fan drives is as follows:

When operating conditions do not require fan-drive actuation, fan-output speed ( $N_o$ ) will fall on line E-F of Fig. 2.

When operating conditions require fan-drive actuation, fan-output speed ( $N_o$ ) will fall on line C-D of Fig. 2. Given the percent cooling required from the fan at a specific input speed ( $N_i$ ), the output speed ( $N_o$ ) can be determined from line C-D of Fig. 3.

##### 4.3 The Section 3 method applied to speed-modulating fan drives is as follows:

When operating conditions do not require fan-drive actuation, fan-output speed ( $N_o$ ) will fall on line E-F of Fig. 2.

When operating conditions require fan-drive actuation, fan-output speed ( $N_o$ ) will fall within the boundaries of ABFE, Fig. 2. Given the percent cooling required from the fan at a specific input speed ( $N_i$ ), the output speed ( $N_o$ ) can be determined from line E-F of Fig. 3.

#### 5. SUMMARY:

After the total power requirement of any fan-drive system has been determined, it can then be compared to the power requirement of a fixed ratio fan-drive system to determine the power difference at any operating point. Total power difference can be estimated by summing the various operating point differences in proportion to the respective time at each point in the duty cycle of the vehicle.

The phi ( $\emptyset$ ) symbol is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. If the symbol is next to the report title, it indicates a complete revision of the report.

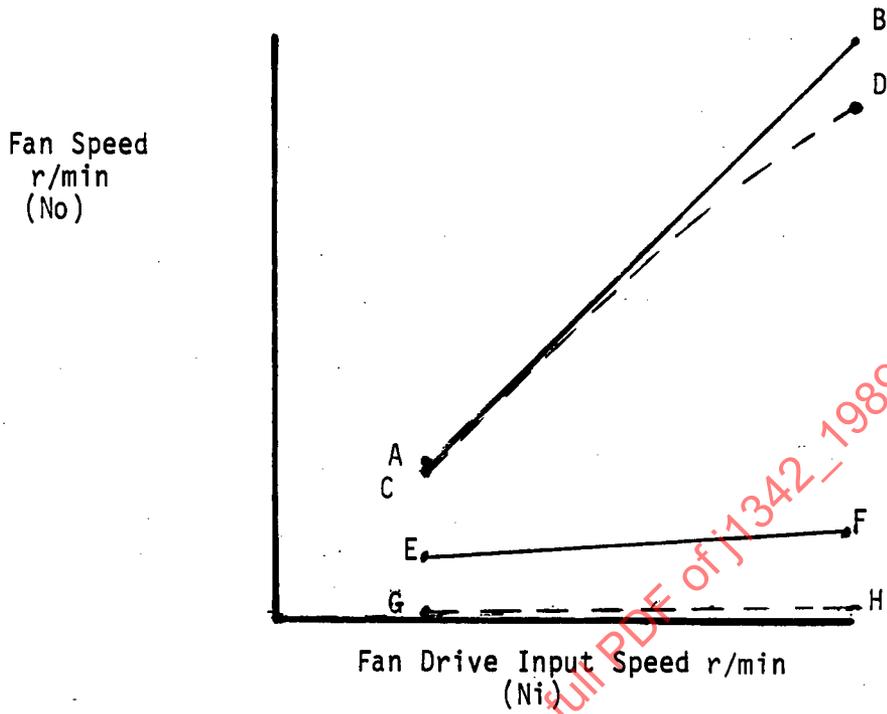


FIGURE 2 - Fan Speed Versus Fan-Drive Input Speed

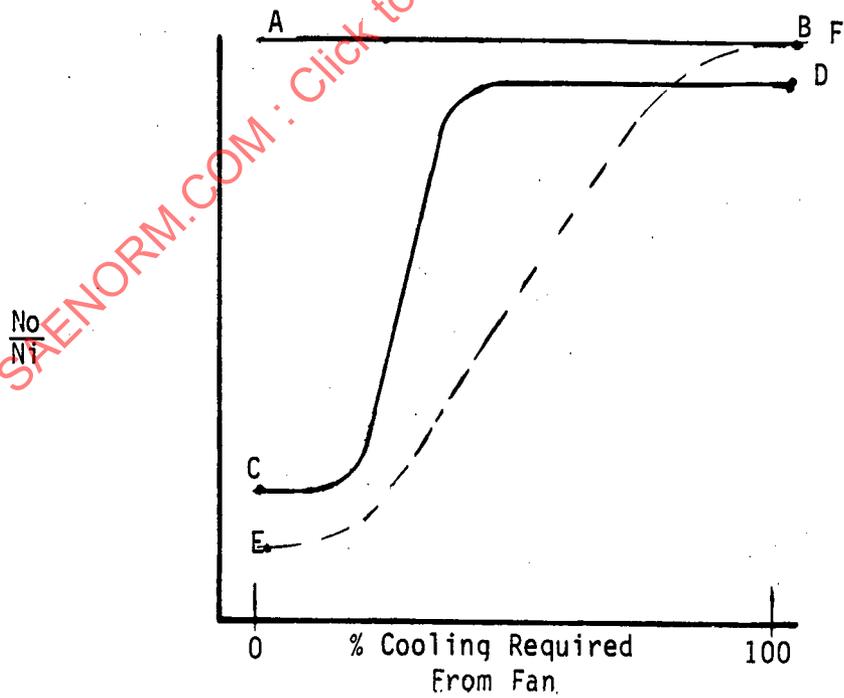


FIGURE 3 -  $\frac{N_o}{N_1}$  Versus % Cooling Required

RATIONALE:

Not applicable.

RELATIONSHIP OF SAE STANDARD TO ISO STANDARD:

Not applicable.

REFERENCE SECTION:

SAE J1339 MAY83, Test Method for Measuring Power Consumption of Trucks and Bus Engine Fans

SAE J1349 JUN85, Engine Power Test Code--Spark Ignition and Diesel

APPLICATION:

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