

Horsepower Correction Formulae

RATIONALE

ARP2B has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE:

This document discusses formulae considered applicable to aircraft engines having integral supercharging without aftercooling, and using gasoline introduced at the entrance to the supercharger or directly into the cylinders. Such engines are normally designated as single and two speed engines. Correction formulae for engines having two stage or exhaust turbo supercharging will not be discussed. Corrections for engines having a high degree of integral supercharging will be discussed in general terms only and no specific formulae will be presented.

The correction formulae and methods listed are empirical and subject to error due to conditions beyond the scope of known corrections. Usage has indicated, however, that the correction formulae listed will provide a satisfactory approximation of power output under standard conditions.

2. REFERENCES:

There are no referenced publications specified herein.

3. GENERAL:

For simplicity, the formulae or discussion will be presented under two sections:

Section A - Formulae applicable to unsupercharged engines and to engines having a low degree of supercharging, i.e., less than 500 ft/s impeller tip speed at normal rated speed.

Section B - Items for which corrections are desired for engines having a high degree of supercharging, i.e., greater than 500 ft/s. Such corrections will be based upon data obtained on the particular type engine.

NOTE: The value of 500 ft/s is arbitrary and permits inclusion of unsupercharged engines and engines having a low degree of supercharging in the same class since the effect of the supercharger pressure ratio upon correction factors for engines with a low degree of supercharging is almost negligible.

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4. FORMULAE:

SECTION A - UNSUPERCHARGED ENGINES OF LESS THAN 500 FT/S TIP SPEED

1. Part Throttle Horsepower Correction Formulae

Applicable to operation at constant manifold pressure and constant speed regardless of degree of supercharging. For correction at constant speed and fixed throttle, the formulae under Section 3 A-1 should be used.

Case I

$$HP_s = HP_i \sqrt{\frac{460 + t_{ci}}{460 + t_{cs}}}$$

where:

- HP_s = Corrected HP at standard carburetor air temperature
- HP_i = Observed brake HP at observed carburetor air temperature
- t_{ci} = Observed carburetor air temperature, °F
- t_{cs} = Standard carburetor air temperature, °F (60 °F at sea level)

Case II - For air cooled engines only

$$HP_s = HP_i \sqrt{\frac{460 + t_{ci}}{460 + t_{cs}}} \sqrt{\frac{460 + t_i}{460 + t_s}}$$

where:

- t_i = Observed cooling air temperature = °F
- t_s = Standard cooling air temperature - °F (60 °F at sea level)

NOTES: The cooling correction formula is applicable only to similar cooling installations, i.e., installations having generally similar air flow conditions. For even this type of installation, it is necessary that since cylinder air temperature will vary with cooling air temperature, any controlled cooling, such as control of cooling air pressure, will preclude the use of a correction factor of this nature.

When the correction factor in the preceding formulae exceeds 5%, Indicated Horsepower may be substituted for Observed Brake Horsepower for more precise results. All definitions remain the same with the addition of FHP (Friction Horsepower at the observed condition). Therefore the formulae become

$$HP_s = \left[(HP_i + FHP) \times \sqrt{\frac{460 + t_{ci}}{460 + t_{cs}}} - FHP \right]$$

2. Full Throttle Horse Power Correction Formulae

Applicable to engines having no supercharging or supercharging less than 500 ft/s impeller tip speed at normal rated engine speed.

Case I

$$HP_s = HP_i \sqrt{\frac{460 + t_{ci}}{460 + t_{cs}}} \times \frac{B_s}{P_{ci} + B_i - p_v}$$

where:

HP_s = Corrected full throttle horsepower at standard carburetor air temperature and pressure

HP_i = Observed Brake Horsepower at observed carburetor air temperature

P_{ci} = Observed static carburetor scoop pressure in inches Hg relative to atmospheric pressure

B_s = Standard Barometric Pressure (29.92 in Hg at sea level)

B_i = Observed Barometric Pressure - in Hg

p_v = Observed vapor pressure - in Hg

t_{ci} = Observed carburetor air temperature - °F

t_{cs} = Standard carburetor air temperature - °F (60 °F at sea level)

Case II - For air cooled engines only

$$HP_s = HP_i \sqrt{\frac{460 + t_{ci}}{460 + t_{cs}}} \sqrt{\frac{460 + t_i}{460 + t_s}} \times \frac{B_s}{P_{ci} + B_i - p_v}$$

where:

t_i = Observed cooling air temperature, °F

t_s = Standard cooling air temperature, °F (60 °F at sea level)

NOTES: The cooling correction formula is applicable only to similar cooling installations, i.e., installations having generally similar air flow conditions. For even this type of installation, it is necessary that since cylinder air temperature will vary with cooling air temperature any controlled cooling, such as control of cooling air pressure, will preclude the use of a correction factor of this nature.

When the correction factor in the preceding formulae exceeds 5%, Indicated Horsepower may be substituted for Observed Brake Horsepower for more precise results. All definitions remain the same with the addition of FHP (Friction Horsepower at the observed condition). Therefore the formulae become

$$HP_s = \left[(HP_i + FHP) \times \sqrt{\frac{460 + t_{ci}}{460 + t_{cs}}} \times \frac{B_s}{P_{ci} + B_i - p_v} \right] - FHP$$