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AERONAUTICAL RECOMMENDED PRACTICE

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HORSEPOWER CORRECTION FORMULAE

I FOREWORD

These formulae are 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.

II 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./sec. 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./sec. Such corrections will be based upon data obtained on the particular type engine.

Note: The value of 500 ft./sec. 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.

III FORMULAE

SECTION A - UNSUPERCHARGED ENGINES OR LESS THAN 500 FT/SEC 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 III 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 $HP_s = \left[(HP_i + FHP) \sqrt{\frac{460 + t_{ci}}{460 + t_{cs}}} - FHP\right]$

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2. Full Throttle Horse Power Correction Formulae

Applicable to engines having no supercharging or supercharging less than 500 feet per second impeller tip speed at normal rated engine speed.

Case I

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

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

HP_i = Observed Brake Horsepower at observed carburetor air temperature

Pci = Observed static carburetor scoop pressure in inches Hg. relative to atmospheric pressure.

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

B_i = Observed Barometric Pressure - inches Hg.

p_v = Observed vapor pressure - inches 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

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

Where t_i = Observed cooling air temperature, °F.

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

Notes: The cooling correction formulae 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 $HP_s = \left[(HP_i + FHP) \sqrt{\frac{460 + t_{ci}}{460 + t_{cs}}} \times \frac{B_s}{Pci + B_i - p_v}\right] - FHP$

SECTION B - ENGINES HAVING A HIGH DEGREE OF INTEGRAL SUPERCHARGING

The use of simplified formulae for engines coming under this category is not satisfactory since the error involved in making the assumption may be greater than the correction factor thus determined. The nature of the correction formulae will also be dependent upon the nature of the engine, and actual data are generally required to permit an intelligent application of correction formulae. In dealing with engines having a high degree of supercharging, it is considered necessary that corrections be applicable for the following items when engine data or adequate empirical formulae are available, and that the points of reference, i.e., standard conditions, be firmly established.

1. The standard pressure at the inlet to the air throttle or carburetor shall be zero inches static pressure above standard atmosphere, and a correction shall be applied for the effect of variation in inlet pressure upon the full throttle manifold pressure and also for the resulting effect of change in full throttle manifold pressure upon full throttle horsepower.

2. The standard air inlet temperature shall be standard atmospheric temperature. A correction shall be applied for the effect of inlet temperature upon full throttle horsepower. A correction shall also be applied for the effect of inlet temperature upon full throttle manifold pressure and for the resulting effect of this manifold pressure change upon full throttle horsepower.

3. The engine RPM shall be maintained at desired values, otherwise a correction may be made for the effect of change in engine RPM upon full throttle horsepower and full throttle manifold pressure. An additional correction for the effect of this manifold pressure change upon full throttle horsepower shall then be made.