Assignment #3- Recip Engine Propeller Performance

1. A reciprocating engine for a light aircraft has the following mechanical characteristics:

bore = 11.1 cm stroke = 9.84 cm

number of pistons = 4 compression ratio = 6.75  
engine mechanical efficiency  propeller efficiency 

The fuel-air ratio is 0.06 by mass, and the pressure and temperature in the intake manifold are 1 atm and 285 K respectively.

**Using the same procedure as demonstrated in class, calculate the power available from this engine-propeller combination at an engine speed of 2800 RPM**. You may use the same values for γ, *c*v, and *q*fuel that we used in the class example (1.4, 720 J/(kg K), 4.29 × 107 J/kg respectively). Provide your work, and also fill in the blanks in the spreadsheet below.

1. Calculate the effective pressure, *pe*, for the engine in Problem 1 using an Excel spread sheet.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| no. cylinders, *N* |  | no units | ambient pressure |  | ATM |
| stroke *s* |  | m | ambient temp |  | K |
| bore *b* |  | m | fuel/air ratio | 0.06 | (by mass) |
| Compression ratio (*CR*) |  | no units | mechanical |  | no units |
| displacement *d* |  | m3 | propulsion |  | no units |
| RPM | 2800 | rev/min | *q*fuel | 4.29E+07 | J/kg |
| (gamma) | 1.4 | no units | *c*v | 720 | J/kg K |
| *Calculations* |  |  |  |  |  |
| *Piston/Cylinder dimensions & volumes* | |  | notes |  |  |
| *x* |  | m | distance, cyl top to piston top |  |  |
| *V*2 = *b*2/4(*x*+*s*) |  | m3 | volume of area above piston, BDC |  |  |
| *V*3 = *V*2/CR |  | m3 | volume of area above piston, TDC |  |  |
| *Compression Stroke calculations* |  |  |  |  |  |
| *p*2 = *p*1 |  | atm | input pressure |  |  |
| *p*3 = *p*2 CR |  | atm | pressure, end of compression stroke |  |  |
| *T*2 = *T*1 |  | K | input temperature |  |  |
| *T*3 = *T*2 CR(-1) |  | K | temperature, end of compression stroke |  |  |
| *W*compression stroke |  | J | includes ATM/Pa conversion |  |  |
| *Power Stroke calculations* |  |  | (remember, *V*4 = *V*3 and *V*5 = *V*2) |  |  |
| *q* = *q*fuel\*(fuel/air)/[1+(fuel/air)] |  | J/kg | of mixed fuel & air |  |  |
| *T*4 = *q*/*c*v + *T*3 |  | K | temp of gases after ignition |  |  |
| *p*4 = *p*3 (*T*4/*T*3) |  | atm | from *PV* = *RT*, *V* = const. |  |  |
| *p*5 |  | atm | pressure, end of power stroke |  |  |
| *W*power stroke |  | J | includes ATM-Pa conversion |  |  |
| *Total Power Calculation* |  |  |  |  |  |
| Net thermodynamic work / cycle |  | J | = *W*power - *W*compression |  |  |
| PA=Thrust Power Available (W) |  | watts | = prop\*mech\*RPM\*N\*W/120 |  |  |
| PA=*Thrust Power Available (HP)* |  | *HP* | = above / 746 W/HP |  |  |
| *Mean pressure pe* |  | *ATM* | = Power\*120/mech/prop/RPM/d/101325 |  |  |

3. Expand problem 2 and plot the engine OTTO cycle (P,atm vs. Volume) and Pe.