

18000 Watt Engine Thrust Level Analysis for Three Different Thrust Levels

Of note: We suggest please also read the sfc (Specific Fuel Consumption) discussion in the following pages of this document

Thrust level One: this is the excess power transition protocol. Vertical thrust at take off is 110% of take off weight

Take off wt (drone + 80lb payload + 60lb fuel) = 294lbs 110% of 294 lbs is 323.4 lbs

323.4 lbs for four props prop thrust = 80.85 lbs = 359.63 Newtons

Prop Specifics from Javaprop is (for static thrust, airspeed = 0) 2588 rpm needing 44.07 Nm torque

Thrust Level Two: the drone needs to hover via VTOL so the pilot can do some maneuvering of the drone to get it properly set up for landing.

Vertical thrust needed is drone take off wt = 294lbs 294lbs divided for 4 props is 73.5 lbs/prop or 326.94 Newtons/prop

Prop Specifics from Javaprop (again airspeed is zero, this is static thrust)

rpm 2468 and torque is 40.06 Nm

Thrust level Three: this is the thrust to overcome drag for fixed wing flying at 6000ft altitude and 60mph drone wt is 294lbs

Drag is 35.01 lbs this is 8.75 lbs/prop for 4 props or 38.92 Newtons/prop and 88ft/sec = 60mph = 26.82 meters/sec

from Javaprop at 25.11 m/sec rpm is 1681 rpm and torque is 9.621 Nm per prop

from Javaprop at 27.94 m/sec rpm is 1827 rpm and torque is 10.45 Nm per prop

18000 Watt Engine Thrust Level Analysis for Three Different Thrust Levels

SFC discussion. The abbreviation sfc has many uses in the aviation area.

One form of sfc is lbs fuel used is: for a particular aviation engine lbs of fuel used per hour per delivered horsepower

We are not using this definition of sfc.

Another definition of sfc is simply lbs of fuel used by the engine per hour, this is the sfc we are using. This sfc can be used by the pilot of the flying device to establish, based on how many lbs of fuel are still available for use in the currently flying device, and noting the sfc of the current flying configuration, the pilot can have an answer to this question:

How many more minutes can this flying device continue to keep flying in this flying configuration before it runs out of fuel?

We base our sfc calculations on first establishing: What propeller thrust level are we using? This is the overall thrust needed by the flying device. Since our drone has 4 propellers, then we divide this overall thrust by 4 to get the thrust required per propeller.

We go to the Javaprop output to establish for this prop to give this thrust at this airspeed for the flying device, what rpm and torque values are needed by the prop?

Since the props are spun by hydraulic motors we need to convert rpm and torque into values that pertain to a hydraulic motor. (referring to physical parameters of the specific motor) Motor rpm is determined by Liters/minute (L/min) of hydraulic fluid flowing through the motor and torque delivered by the motor is determined by what hydraulic fluid pressure lbs/ square inch (psi) is needed by the motor for it to create the torque that is required.

We know the surface area and the stroke length of the hyd fluid pump of the engine. This allows us to establish the volume output of one stroke (one beat) of the engine as Liters. The beats per minute (bpm) of the motor establishes the volume rate of flow (L/min) of the hyd pump of the motor, or if we know what L/min we want, then we can calculate what bpm we need for the engine. Of note: there are two engines (to mitigate resonance issues since these engines are pulsating), thus for the L/min we need we should divide this by 2 for the two engines. And since we have 4 props, the total L/min needed would be the prop L/min needed times 4.

18000 Watt Engine Thrust Level Analysis for Three Different Thrust Levels

We can multiply the surface area of the pump piston x the psi needed for the pump hyd fluid output to give us the force we need to push on the hyd pump piston.

The combustion piston supplies (via a rod between the combustion piston and the hyd pump piston) the force that pushes on the hyd pump piston. Thus, knowing the surface area of the combustion piston, we can calculate how much force needs to be applied to the combustion piston.

Of note, we are using an inertial based free piston design, this allows us to keep the max temperature inside the combustion chamber at 380 deg. Thus, our force calculation for the combustion piston includes simply force of pushing by the combustion piston on the hyd pump piston, plus an additional amount of force on the combustion piston to accelerate it so that the tungsten block attached to the combustion piston can (by inertia based action) this tungsten block can also give a pushing force to the combustion piston assembly.

The force given to the combustion piston comes from pressure (psi) of the gases inside the combustion chamber. These gases consist of air (80% nitrogen, 20% oxygen) and the gas products of combustion. We elevate the gas pressure from its starting level of 20 atm up to the pressure needed by heating the air and the gases of combustion. We follow the normal ideal gas law $PV=nRT$ to calculate what is going on with these gases.

The heating of these gases arises from heat supplied by combustion of the fuel. Using $PV=nRT$ we can calculate: What is the increase in gases temperature that we need so we get the psi from these gases, the psi that we need? We can take this change of temperature of these gases and (using the specific heat capacity of these gases) we can establish: How many calories of heating do we need?

We can use the calories of combustion of the fuel to establish the calories released by combustion per gram of fuel combusted. This allows us to establish the grams of fuel needed to get the gases psi that we need.

If we take the grams of fuel needed per one stroke (one beat) times the beats per minute (bpm) we will get the grams of fuel needed per minute. This times 60 is grams fuel/hr and can be converted to lbs fuel/hr

Google Ai is happy to do these calcs for you at the detail level you want. You may just request: What is the sfc for this overall drone prop thrust level, or you can also request Google Ai to show you details of all the calculation steps that Google Ai used.