



## UL-Engines (2-stroke) fuel consumption

In case of complaints about "high fuel consumption" first of all has to be checked whether this is

- due to performance demand
- or
- due to a technical failure.

### 1) How much fuel is allowed for an engine if it is in good condition?

This mainly depends on the power output of the engine (=output requirement). This power requirement depends mainly on the aerodynamic quality of the aircraft (wire-based ultralight or streamlined experimental) and of the flight habits (high-speed flight, cruising, sportive flight).

#### 1.1) Example no. 1:

- performance demand  $P = 28 \text{ kW}/37,5 \text{ hp}$  (e.g. take-off power) ( $1 \text{ kW} = 1,341 \text{ hp}$ ,  $1 \text{ hp} = 0,746 \text{ kW}$ )
- specific consumption, e.g. BSFC =  $450 \text{ g/kWh} = 0,45 \text{ kg/kWh}$
- Fuel density  $\varphi$  (Rho) =  $0,73 \text{ kg/litre}$

This results in a consumption "B" of litres per hour:

$$B = \frac{P \cdot \text{BSFC}}{\varphi} = \frac{28 \cdot 0,45}{0,73} = 17,2 \text{ litres/h}$$

This "absolute" consumption refers to a continuous engine power supply of 28 kW (= 37,5 hp). This consumption will seem extremely high for an ultralight aircraft but is realistically possible.

In practice the consumption will be considerably less, as the engine is run at full throttle (= max. engine performance e.g. 28 kW) only for a few minutes, and after take-off flight, when cruising altitude is reached, one continues at cruising speed.



### 1.2) Example no. 2 (basic data as in example no. 1):

— 6 minutes for take-off and climb (full throttle) ..... = 1,7 litres

— 54 minutes at cruising speed at e.g. 15 kW (= 20,1 hp)

$$B = \frac{15 \cdot 0,45}{0,73} \cdot \frac{54}{60} \dots\dots\dots = \underline{8,3 \text{ litres}}$$

total 10,0 litres/hour

If the pilot, however, remains at "full throttle", the consumption will remain at 17 litres/hour.

In competition where minimum consumption is the criterion, consumption values of 4 to 6 litres/hour have been achieved. These values, however, must not be taken as a rule for common use, as these values are achieved by top-pilots under particular conditions.

#### Please note the following:

— Usual (common) specific consumption:

- fan-cooled 2-stroke-engines      480 to 530 g/kWh
- liquid-cooled 2-stroke-engines    400 to 460 g/kWh

— see ROTAX power/torque/consumption curves for each engine type with an "estimated" propeller as indicative values

— The power requirement increases considerably with increasing speed. This is shown in the following example:

### 1.3) Example no. 3:

15 kW for 60 km/h, however, already 35 kW for 80 km/h with the same air-craft i.e. the performance increases with the 3<sup>rd</sup> power of the speed.

$$\frac{P_2}{P_1} = \left(\frac{V_2}{V_1}\right)^3 \quad P_2 = P_1 \left(\frac{V_2}{V_1}\right)^3 = 15 \left(\frac{80}{60}\right)^3 = 35 \text{ kW}$$

and the consumption increases accordingly.

NOTE: Full throttle results in maximum power at "nominal r.p.m." but 3/4 or 1/2 of throttle position does not mean 3/4 or 1/2 power.

Depending on engine type,	3/4 throttle	means	95 % power
	1/2 throttle	means	80 % power
	1/4 throttle	means	50 % power

as approximate indicative values.



## 2) Possible mistakes causing high fuel consumption:

If a check as per para. 1) should result in considerably less consumption as measured in fact, the reasons may be the following:

- a) Intake- and exhaust-system does not correspond with original ROTAX configuration.
- b) air filter very dirty
- c) the propeller is not correctly matched to the engine
- d) carburettor float does not hold fuel level:
  - carburettor float valve is too wide open because of dirt
  - float level incorrectly adjusted
  - extreme vibrations (engine mounts, unbalanced propeller, inadequately suspended intake silencer) keep the float valve open
  - too high pressure in fuel system (max. 0,5 bar allowed, should be 0,3 bar).
  - carburettor float valve defective
  - bad carburettor vent (see Installation Instructions)
- e) Carburettor of a different engine type has been fitted or wrong jets have been installed.
- f) Incorrect carburettor jetting

## 3) Conclusion:

In any case a specialized technician has to find the reason for excessive fuel consumption. It is not allowed "just" to change carburettor jets.

The reflexions as per para. 1) are particularly important if a pilot has changed from a low performance craft to a more powerful aircraft.