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 kW/37,5 hp (e.g. take-off power) (1 kW = 1,341 hp, 1 hp = 0,746 kW)

— specific consumption, e.g. BSFC = 450 g/kWh = 0,45 kg/kWh

— Fuel density φ (Rho) = 0,73 kg/litre

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

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

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.

BOMBARDIER - ROTAX
GESELLSCHAFT M.B.H. MOTORENFABRIK
A-4623 GUNSKIRCHEN — AUSTRIA
Telefon: (07246) 271-0*, Telefax: 43-7246-370
Telex: 25546 brgk a, Telegr.: Bombrotax Gunskirchen

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)

$$B = \frac{15 \;.\; 0.45}{0{,}73} \cdot \frac{54}{60} \;.....= 8.3 \text{ litres}$$

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 3rd power of the speed.

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

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.

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