THE ESR EFFECT

EXTENDED SPEED RANGE — FOR DIRECT-DRIVE ENGINES (LYCOMING, CONTINENTAL…)

At E-PROPS, the term **"ESR effect"** refers to a fixed-pitch or ground-adjustable-pitch propeller whose behaviour is very close to that of a variable-pitch propeller — that is, **strong thrust throughout the aircraft's operating speed range at full throttle**.

This effect is not limited to geared engines: it applies just as much to propellers designed for **direct-drive engines** such as Lycoming and Continental. E-Props propellers for direct-drive installations – **ASCALON**, **CLARENT**, **VORPALINE** and **BELISANDRE** – are all designed to deliver this ESR effect.

> *Don't forget: what makes an aircraft take off, and what we are looking for, is not engine RPM – it is thrust.*

A very small RPM gap between the ground and cruise

The ESR effect produces a very small gap between the full-throttle RPM measured on the ground and the full-throttle RPM reached in cruise flight. Thanks to hollow profiles capable of generating more lift, the blades are never stalled – which provides a **very strong take-off thrust**, even though this quality cannot be measured from static thrust alone.

With an ESR-effect propeller, the full-throttle engine speed stays almost constant across the whole speed range. Beware, however: a propeller can be "constant-speed" without having the ESR effect, whereas a propeller with the ESR effect is necessarily constant-speed.

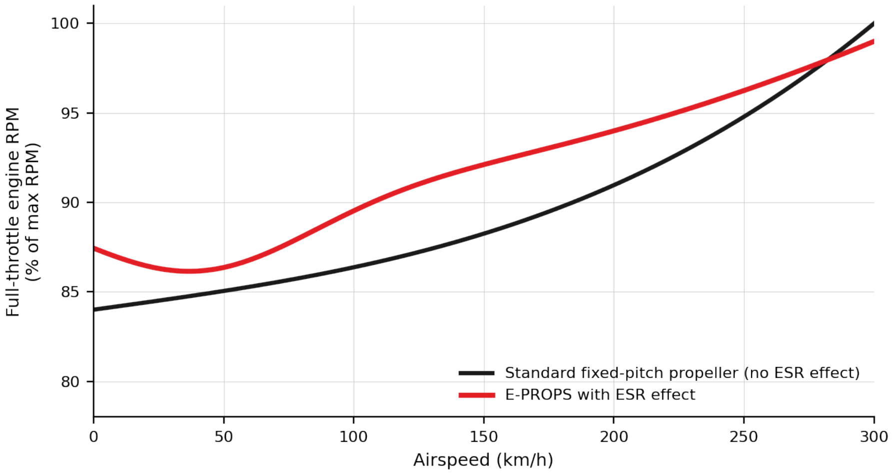
Illustrative example

Take a direct-drive engine such as a Lycoming O-360 (180 hp), with the propeller pitch set for maximum RPM in cruise:

- a propeller **without** the ESR effect can lose several hundred RPM at full throttle on the ground compared with cruise – and its thrust at take-off suffers accordingly;
- an E-PROPS propeller **with** the ESR effect keeps this gap very small, so the engine develops power close to its maximum from the very start of the take-off roll.

(figures given here are for illustration only, to show the order of magnitude of the phenomenon – they are not measured flight-test data for a specific installation)

This matters because, when trying to shorten an aircraft's take-off distance, the thrust available between roughly 40 and 80 km/h (22–43 kt) is what "consumes" most of the runway – far more than the thrust between 0 and 40 km/h, where the aircraft is still barely moving. Keeping the engine near its maximum RPM throughout this phase is exactly what the ESR effect achieves.



Conceptual comparison – full-throttle engine RPM vs. airspeed: an E-PROPS propeller with the ESR effect (red) stays close to its maximum RPM across the whole speed range, while a standard fixed-pitch propeller (black) shows a much wider gap between ground and cruise RPM.

How the ESR effect is obtained

From a technical point of view, several approaches exist to obtain an ESR effect:

- narrow chord with classic airfoil profiles;
- pitch reduction at low speed through blade deformation (difficult to achieve reliably);
- **narrow chord with special profiles**, designed to avoid blade stall – this is the approach used by E-PROPS.

Increasing the propeller diameter reduces the ESR effect; decreasing the number of blades restores it – the same design logic that applies to E-Props geared propellers applies here as well.

PENA Bilouis – Lycoming O-360 (180 hp) – 2-blade ASCALON ground-adjustable-pitch propeller, showing a strong ESR effect on a direct-drive installation.

Any questions about the ESR effect? Contact our design office: **helices@e-props.fr**