



Two-stroke vs. Wankel engines for UAVs: Which propulsion technology is most suitable for the respective mission profile?

Propulsion selection in UAV systems: a fundamental technical and strategic decision

The choice of propulsion system in the development of unmanned aerial systems is far more than a matter of design detail. For technical decision-makers, it directly influences flight duration, payload capacity, integration capabilities within the platform, reliability in the field, maintenance requirements, and long-term operating costs. Especially for UAVs designed for tactical operations, long-range missions, or sensor-based reconnaissance tasks, the engine is an essential system component rather than an exchangeable standard part.

In the field of UAV propulsion systems with internal combustion engines, the focus is on the classic two-stroke engine and the Wankel engine. Both technologies have their validity, both offer clear advantages in UAV applications, and both also come with technical limitations. The central question is therefore not which concept is fundamentally superior. The decisive factor is rather which engine concept delivers the better system response under the respective operating conditions. This is precisely where the actual technical evaluation begins.

Two different design principles with clearly distinct characteristics

The two-stroke engine is based on the classic reciprocal piston principle. Intake, compression, combustion, and exhaust are carried out in a very compact cycle consisting of just two strokes. This results in a simple mechanism with few parts, low design complexity, and a very favorable power-to-weight ratio. These characteristics explain why two-stroke engines have been established for many years in UAV applications, where robustness, scalability, and cost-effectiveness play a major role.

The Wankel engine, on the other hand, operates on a fundamentally different principle. Instead of an oscillating piston, a triangular rotor operates inside a specially shaped housing. The combustion processes occur continuously and overlap, resulting in very smooth power delivery. From the perspective of UAV development, this characteristic is particularly interesting in applications where smooth operation, compact integration, and a low-vibration system environment are critical.

It is particularly important for technical decision-makers not only to consider these differences at the level of the engine principle but also to understand their impact on the system. The construction of the engine directly influences the behavior of the entire platform, from vibration loads on the avionics and sensor quality to maintenance intervals and packaging issues in the aircraft.

Why two-stroke engines remain highly relevant in the UAV sector

Two-stroke engines are sometimes rushed to be classified as conventional or simple solutions in technological discourse. However, this perspective is too narrow when it comes to the UAV sector. Especially in many practical applications, their strength lies in a highly compelling combination of robustness, power density, cost-efficiency, and flexibility in integration.

A key advantage is their mechanical simplicity. The number of moving components is low compared to more complex engine designs. For UAV platforms, this means fewer potential sources of failure, lower maintenance requirements, and high overall operational robustness. This characteristic is particularly relevant in operational scenarios where UAVs are operated under field conditions, take off in remote



regions, or must be serviceable only to a limited extent. Where ease of maintenance and repairability are key factors, a two-stroke design can offer clear operational advantages.

This is complemented by an excellent power-to-weight ratio. In UAV systems, this is a key factor because every additional gram either reduces the payload or has a negative impact on range and flight time. Two-stroke engines enable high power density with relatively low system weight. This is particularly appealing to technical decision-makers when platforms are designed for maximum payload flexibility, short takeoff distances, or high-power reserves during critical flight phases. In tactical UAVs or high-volume systems, this characteristic can make a significant contribution to the overall efficiency of the design.

Another major advantage lies in cost-effectiveness. Two-stroke engines are generally less expensive to manufacture than more complex alternatives. This applies not only to the production of the engine itself but often also to the costs along the entire industrial value chain. This is a significant factor for programs with larger fleets, for applications with clear cost targets, or for platforms where a robust and functional propulsion system is more important than maximum technical refinement. Technical decision-makers consider not only unit costs but also the overall scalability of a program. Two-stroke engines offer clear advantages in this regard.

Operational flexibility should not be underestimated either. Since a traditional oil pan is not required, two-stroke engines can be operated regardless of their mounting orientation. This expands the design flexibility when integrating them into a wide variety of UAV layouts. For developers and system architects, this means fewer packaging constraints, greater freedom in design concepts, and, in some cases, reduced integration effort into existing platform architectures. This feature can be particularly valuable for platforms where available installation space is limited or where different configurations are to be implemented on a single base platform.

The technical strengths of the two-stroke engine in detail

From the perspective of technical decision-makers, it is worth taking a more detailed look at the advantages of the two-stroke engine. Its robustness is not only a result of simple mechanics but also a reflection of high functional tolerance in practical operation. A two-stroke engine often has an advantage in situations where the overall system must function reliably under changing climatic conditions, varying load conditions, or time-critical operational requirements.

The concept also offers clear advantages in terms of maintenance strategy. Systems with lower design complexity are typically easier to diagnose, quicker to repair, and easier to handle in the field. For operators who do not work exclusively in highly standardized maintenance environments, this can be a decisive factor.



Fig. 1: Sky Power International SP-110 FI TS two-stroke engine with fuel injection



Furthermore, the characteristics of the two-stroke engine make it attractive for applications where the priority is not on maximum acoustic or mechanical smoothness, but on predictable, reliable performance. For those looking for a robust, powerful, and cost-effective solution for tactical UAVs or standard platforms, the two-stroke engine often offers the more technologically sound overall package.

Of course, the limitations of this concept are well known. Fuel consumption tends to be higher, emissions are less favorable, and the increased vibrations and reduced smoothness of operation can also cause drawbacks on the system side. Especially with sensitive sensor technology, high-precision imaging, or particularly demanding ISR missions, this can lead to higher requirements for decoupling, structural design, and signal stability. This is precisely why engine selection always comes down to a matter of priorities.



Fig. 2: The Nimkii 42-S standard UAV platform from Sky Canoe in Canada uses a single-cylinder two-stroke SP-55 FI TS ROS engine as the power unit for its transport UAV

Why Wankel engines are particularly appealing for high-performance UAV platforms

Wankel engines address many requirements that are becoming increasingly important in the modern UAV market. Their greatest advantage lies in their exceptionally smooth operation. Since there are no reciprocating masses, they generate significantly less vibration than conventional piston engines. For UAVs equipped with optical, electro-optical, or other sensitive sensor systems, this is a significant advantage. The lower the vibration load on the platform, the more stable imaging, target tracking, surveying, or reconnaissance systems can operate. This characteristic is of strategic importance, particularly for ISR missions.

Equally important is the compact design. Wankel engines offer a very space-saving geometry combined with high power density. This facilitates integration into UAV platforms with tight packaging constraints and can give developers additional freedom in the overall design. For technical decision-makers, this means not only better engine integration but also potential advantages in terms of aerodynamics, center of gravity, and system architecture. Where installation space is limited or multiple subsystems must be tightly integrated, a Wankel engine can offer significant design advantages.

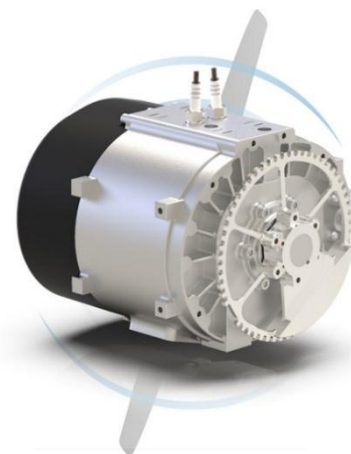


Fig. 3: Sky Power International SP-180 single-disc Wankel engine

Furthermore, less consideration needs to be given to cooling during integration planning. Unlike two-stroke engines, the Wankel engine does not require air cooling, as it is equipped with water and oil cooling. Another advantage is its smooth power delivery. Continuous combustion results in very smooth operation. This is not only important for comfort and noise reduction, but also directly influences flight performance and the mechanical stress on adjacent systems. Lower vibration levels can positively



impact the service life of components, improve control quality, and reduce the need for structural decoupling measures. This is a particularly compelling argument for platforms with sophisticated avionics or complex sensor payloads.

In addition, many Wankel engines can run on different fuels. This multi-fuel capability is particularly appealing in military or security-related applications, where logistical standardization and operational flexibility are high priorities. The ability to run on fuels such as gasoline, JP-8, or Jet A1 can simplify the supply chain and improve operational readiness under various conditions. For technical decision-makers who consider not only the platform but the entire operational system, this represents significant added value.

The specific advantages of the Wankel engine from a systems perspective

From a systems perspective, the Wankel engine excels particularly in applications with high technical demands for stability, precision, and integration. Its smooth operation not only reduces vibrations but also improves the conditions for high-quality sensor payloads. This can enhance image quality, stabilize target acquisition, and improve the overall performance of ISR or surveillance platforms.

The Wankel engine also demonstrates its strengths in terms of platform miniaturization and compact, high-performance architectures. When installation space and weight must be distributed with extreme precision, a compact engine with high power density offers a significant advantage. This is not just about the engine itself, but about the freedom to coordinate the fuel tank, electronics, cooling, payload, and structure more efficiently.

For technical decision-makers, it is also relevant that Wankel engines are frequently used in applications where the UAV is not primarily viewed as a cost-sensitive standard platform, but rather as a highly sophisticated flying system with clear requirements for range, signal quality, platform stability, and integration quality. In such applications, the added value of the Wankel principle is often systemic and cannot be assessed solely at the component level.

A direct comparison: Which technology is the better choice, and when?

A direct comparison paints a clear picture. Two-stroke engines excel particularly where a UAV powerplant needs to be robust, simple, cost-effective, and powerful while remaining lightweight. They are especially attractive for tactical UAVs, fleet applications, standardized platform programs, and mission profiles where ease of maintenance and cost-effectiveness play a major role. Their disadvantages in terms of smoothness and fuel consumption are well known, but in many applications, they are manageable or acceptable within the system.

Wankel engines, on the other hand, are primarily of interest for high-end, performance-oriented platforms. They are particularly suitable for long-range UAVs, ISR missions, and applications with sensitive sensor technology. Wherever vibrations must be minimized, installation space optimally utilized, and a high level of integration achieved, the Wankel principle can offer clear advantages. The higher technical demands in design and maintenance are often justified because the platform benefits from improved smoothness and system stability.

Strategic overview for technical decision-makers and UAV manufacturers

For technical decision-makers in development, product management, and system architecture, the key insight is: The choice of engine must not be made solely on the basis of individual performance metrics. Neither maximum simplicity nor maximum smoothness automatically lead to the best solution. What



SKYPOWER
INTERNATIONAL

matters is the interaction between mission profile, payload requirements, maintenance strategy, integration logic, production goals, and budget constraints.

Two-stroke engines are particularly compelling when robust and economical UAV systems with high production volumes, good power reserves, and ease of use are required. Wankel engines demonstrate their strengths when high platform quality, low-vibration operation, compact design, and high-quality sensor integration are the primary considerations. The technological future therefore increasingly lies not in a general preference for a single concept, but in a differentiated selection based on mission profile and, in the long term, also in hybrid architectures that can combine the advantages of both worlds.

It is not the engine itself that matters, but how well it fits into the overall system

For UAV manufacturers and technical decision-makers, the question of “two-stroke or Wankel?” ultimately comes down to system compatibility. The two-stroke engine stands out for its simplicity, robustness, cost-effective scalability, and excellent power-to-weight ratio. The Wankel engine, on the other hand, offers clear advantages in terms of smooth operation, compact integration, consistent power delivery, and performance on demanding platforms with sensitive payloads.

Anyone conducting a thorough evaluation of UAV propulsion systems should therefore not look for a universally best technology, but rather for the solution that delivers the greatest technical and operational impact within the specific mission profile. This is precisely where the true strength of a professional propulsion selection lies: not in comparing individual engine concepts in theory, but in their precise alignment with the mission, platform, and application. Engine manufacturers such as Sky Power International, which offer both types of engines in their product range, support UAV developers and manufacturers in selecting the right engine concept.

About Sky Power

Sky Power International is a leading manufacturer of 2-stroke combustion- and Wankel engines for UAS (Unmanned Aerial Systems) and hybrid applications. Besides in-house development and manufacturing, Sky Power International produces all engines in Germany. Custom adaptations, new developments and continuous performance improvements of the combustion engines are ongoing company objectives. More information: www.skypower.online

Do you have any question? Please contact us. Your contact:

Edward Weston-Davies

Program Management & Sales

+44 7398 256585

ewd@skypower.online