



Faculty of Engineering
Department of Mechanical Engineering

**7th INTERNATIONAL SCIENTIFIC CONFERENCE ON
ADVANCES IN MECHANICAL ENGINEERING
(ISCAME 2019)
7-9 November, 2019 Debrecen, Hungary**

**CONFERENCE PROCEEDINGS
(BOOK OF EXTENDED ABSTRACTS)**

organized by
**Department of Mechanical Engineering
Faculty of Engineering, University of Debrecen
and
Working Commission in Mechanical Engineering
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**UNIVERSITY of
DEBRECEN**

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ADVANCES IN MECHANICAL ENGINEERING**

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SPATIAL ROTARY COMBUSTION ENGINE

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EVOLUTION OF ROTARY PISTON ENGINES

The evolution of rotary piston engines began at a distance and took place on two branches: from the screw compressor ancestors and from the progressive cavity pumps. The screw compressor branch is not analysed here because of the largely different build-up.

The progressive cavity pumps direction began in 1932 with the invention of the American inventor *Moineau* [1]. His design consisted of a rotor with two superimposed rotary motions, i.e. planetary motions, and a stationary chamber having an inner screw surface surrounding the rotor. *Moineau's* compact design induced the creation of several variants. The patented *Dudás motor* [2], unlike the previous designs, comprises continuously variable pitch screw surfaces, see Figure 1b. The goal of this analysis is to reveal its potential.

The famous construction (1951, see Figure 1a) of *Felix Wankel* [3], is a planar realization of the two rotary motion and the helical shape is missing. Under the name *Wankel engine* which in fact has so far represented the rotary piston engines alone, instead of the rotary piston and rotary chamber version the planetary piston version having stationary chamber suggested by *Hanns Dieter Paschke* [4] is known. All major car manufacturers have been experimenting with this design, but Mazda has got the furthest.

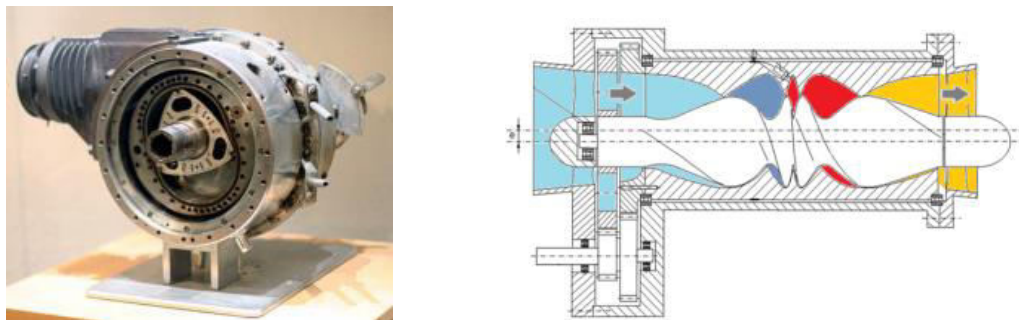


Figure 1 (a) Wankel-built DKM 54 clean rotary motor [3] and (b) the Dudás motor [2].

COMPARISON OF ADVANTAGES AND DISADVANTAGES OF PLANAR AND SPATIAL ROTARY PISTON INTERNAL COMBUSTION ENGINES

The advantage of rotary piston engines over alternative piston engines is their incredible smooth, quiet running and compact design. Due to their high rpm and very good power/weight ratio they are more suitable for racing cars. The main advantage of *Dudas engine* relatively to the *Wankel engine* is the **3 dimensional (3D) spatial construction** where the construction freedom in axial direction appears and allows parallel strokes and phases not only on different sides of the rotary piston but along the axis also. Additionally it makes possible optimizations through the thread pitch function.

Main Disadvantages The *Wankel engine* that has an extruded **planar (2D) construction** is similar to conventional two-stroke engines for flow control, where the openings are closed by the piston. The problem is similar, that is, the expanding gas is not completely burned when the spill gap opens. This causes fuel loss, power loss and environmental pollution. The very rapid cyclic temperature change at the rotor gaskets because of the constant temperature difference between the inlet and expansion sides of the housing imposes high demands on the material of the gasket. All these operational problems do not appear at first glance evaluating the brilliant geometric design. The lubrication with oil

injected into the suction cavity to lubricate the sliding edge and side seals results in high levels of pollutant and odor emissions.

Bearings Due to the eccentric shaft, *Wankel motors* usually have plain bearings, which are disadvantageous in operation due to mixed friction at start and stop. At the same time, dynamic loads are better tolerated. The *Dudás motor* without rotor friction is clearly fitted with ball bearings, which can be made of ceramic, do not restrict accessing very high speeds of up to 40,000 rpm at very high temperature.

Efficiency In terms of efficiency, the *Wankel engine* can be said to have a crank drive loss of about 1% and a 10% loss due to the fact that the compression ratio cannot be set to the required level. All these problems do not exist with the *Dudás engine* because it contains only rotating moving parts, the compression and expansion ratios are independently adjustable over a wide range, the sucked compressed mixture and the expanding working gas are completely separated. Even after-ignition can be used at any location in the expansion chamber. This great degree of freedom results from the fact that the construction is not planar (2D) but spatial (3D) in relation to the *Wankel engine*. However, the drawback of the *Dudás engine* is that it is longer in size, which requires dimensioning of the rotor deflection, and the manufacture of the shaped rotor and especially of the split chamber is demanding and complex, i.e. expensive. This justifies, among other things, the production of these parts from ceramics, which eliminates the need for cooling and heat loss.

Compactness, power/volume ratio The *Wankel engine* is more compact. The *Dudás engine* is less compact due to the larger length. With the better power/weight ratio, this engine boasts four longitudinal phases that are doubled on both sides of the rotor, when three strokes works at one time on the three sides of the rotor in the *Wankel engine*.

Engine Parts Since the gaskets appear as separate elements, the amount of parts of the *Wankel engine* may be larger.

Engine Assembling and Maintainability Assembling is partly related to the number of parts and affects the maintainability. To piece together the *Wankel engine* is easier. The *Dudás engine* requires more precision in assembly.

Engine Failure Probability The failure probability of a *Dudás engine* is clearly smaller, since the piston and rotary chamber are only rotating, there is not even contact, the main problem occurs with gears and bearings. The final version of the engine should be made of ceramic. Zirconium-based industrial gears and bearings can already be purchased. On the other side the *Wankel engine* needs frequent replacement of the edge seals.

CONCLUSION

The article analyzed the advantages and disadvantages of 2D *Wankel* and 3D *Dudás* rotary piston internal combustion engines. Opposite to advantageous compactness of *Wankel engine*, the exhaust imperfections, exhaust gas mixing with the intake mixture, and the high oil consumption due to the lubrication requirements can be mentioned. The full ceramic design would increase the chances of a *Dudás engine*, taking advantage of the friction-free operation, but it would require the development of a fuel component that does not generate harmful combustion products against to the gap sealing operation. In addition, one of the perspectives of converting hydrocarbons into motion energy, due to the extremely high operating temperatures and the extremely high speeds resulting from the design, is the motor that only rotates.

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