

THE SONIC ASYNCHRONOUS MOTOR FOR VEHICLE APPLICATIONS

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ABSTRACT – Sonic propulsion systems are based on energy transfer using waves propagated in liquids. The major advantages of this process are low dissipation rates and high power density. In order to convert the sonic energy for propulsion goals, an asynchronous motor with liquid rotor was considered. Results of sonic-mechanical conversion processes analysis are presented in the paper. Two different size experimental models were build and analysed.

INTRODUCTION

Sonic motors are an important part of sonic transmissions. Their role is to convert the wave energy into mechanical rotational energy. The sonic – mechanical energy transfer has to be made using a piston. The solution for obtaining rotational movement can be made using liquid friction at rotor level or using a freewheel device, both principles being presented by Gogu Constantinescu (1), (2), (3) and allowing different practical solutions.

THE PRINCIPLE OF THE SONIC ASYNCHRONOUS MOTOR

The basic idea of the sonic system is to have a device that allows the motor to start having a coupled load. The principle developed by Gogu Constantinescu is presented in figure 1.

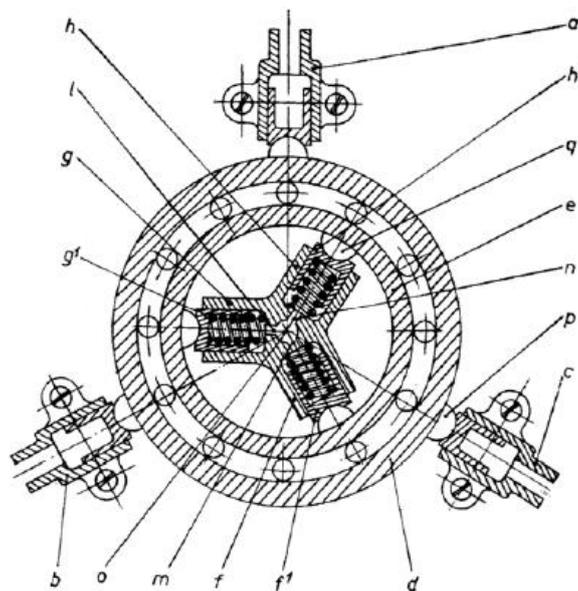


Fig.1: Working principle of the sonic asynchronous motor

The stator pistons a,b,c are uniformly distributed around its circumference. The pistons comprise the transmitter d, build from two rings separated by ball bearings fitted between the rings. The rotor is made by three cylinders displaced in a radial position. In the cylinders glide the pistons (f,g,h)¹, that are maintained in a neutral contact with the inner ring of the transmitter. The cylinders are connected with each other by small apertures n. The pistons of the stator are actuated by the pressure waves that arrive from the generator with a uniform phase shift. The pistons induce a planar combined with a rotational movement to the transmitter. The inner ring of the transmitter presses the pistons of the rotor that force the cylinders to rotate the main shaft of the rotor. The liquid in the rotor is pressed through the apertures from one cylinder to the other, generating a delay in transmitting the power from the stator to the rotor. This asynchronous running condition allows the motor to start having a load connected.

Another configuration is based on a linear piston – cylinder assembly, presented in figure 2, a structure that converts the wave energy into mechanical one. The piston drives a lever that via a freewheel transforms the alternative linear motion into rotational movement of the main shaft.

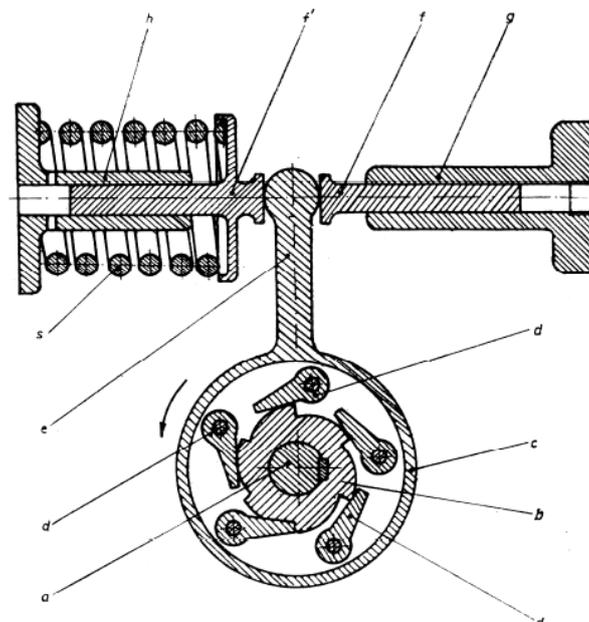


Fig.2. The linear piston – cylinder

THE SIMULATION MODEL

The mathematical model of the sonic motor was developed by Gogu Constantinescu. It's main equation of the output power is given by:

$$P = \frac{N}{2} SH^2$$

N is the number of phases, S the flow through the apertures, the perdittance of the apertures and H the pressure amplitude in the rotor. The influences of these three parameters are given in the graphs in figure 3. It can be observed that the flow in the rotor apertures have a major

effect on the power output. This fact relays on the hydraulic effort that has be done to press the liquid through the orifices. In other words, the orifice size of the rotor apertures allows how much power can be developed by the motor.

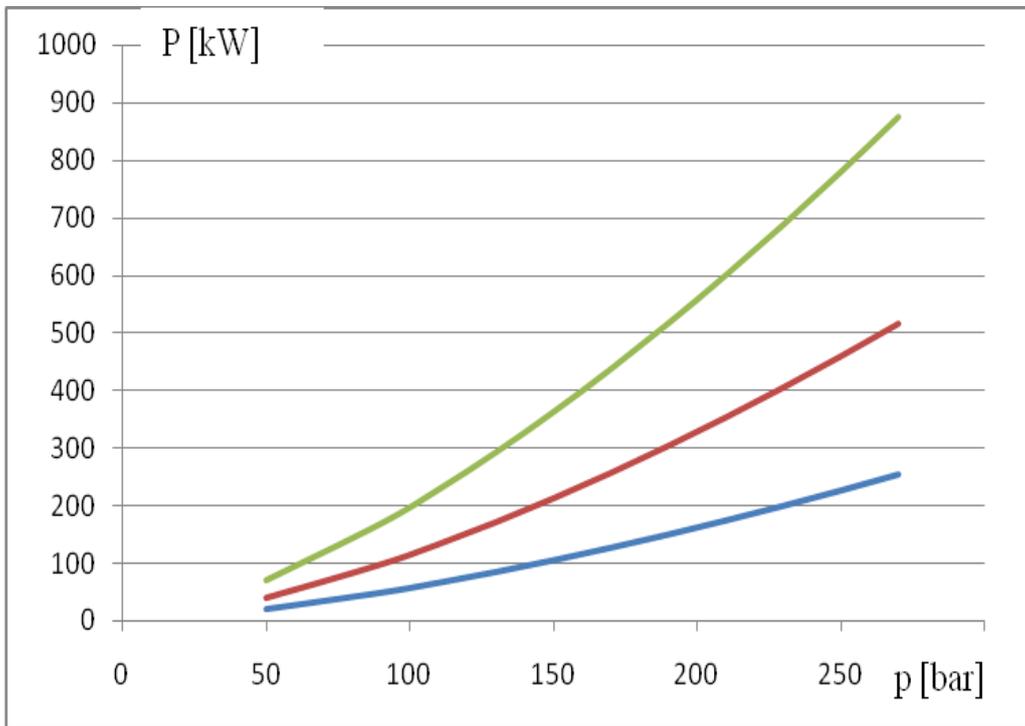


Fig.3. Theoretically available power for different pressure amplitudes with aperture diameter as parameter

A kinematic analysis of the rotor, considered simplified as a disc subject to alternative forces having a uniform distribution on the circumference of the disc, show that the resultant force has to be balanced (fig.4).

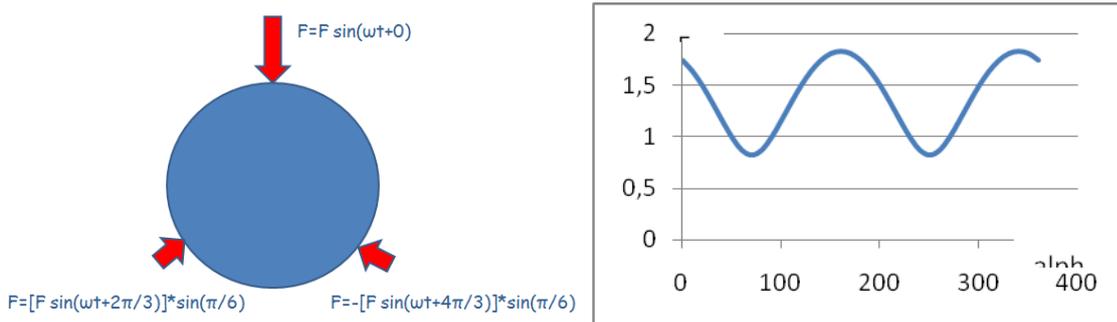


Fig.4. The mechanical model of the sonic asynchronous motor and the resultant rotor force

The multi-domain model of the freewheel asynchronous model is given in figure 5.

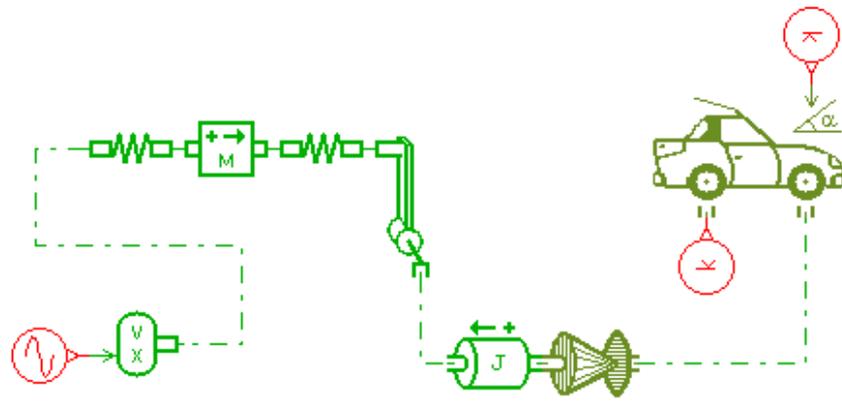


Fig.5. The multi-domain model of the freewheel asynchronous model

The influences on output torque of working frequency, stroke, lever length and phase numbers are synthesized in table 1.

Table 1

Parameter	Value			Figure
frequency	10 Hz	30 Hz	50 Hz	Fig.6
Piston stroke	10 mm	30 mm	50 mm	Fig.7
Lever length	50 mm	100 mm	200 mm	Fig.8

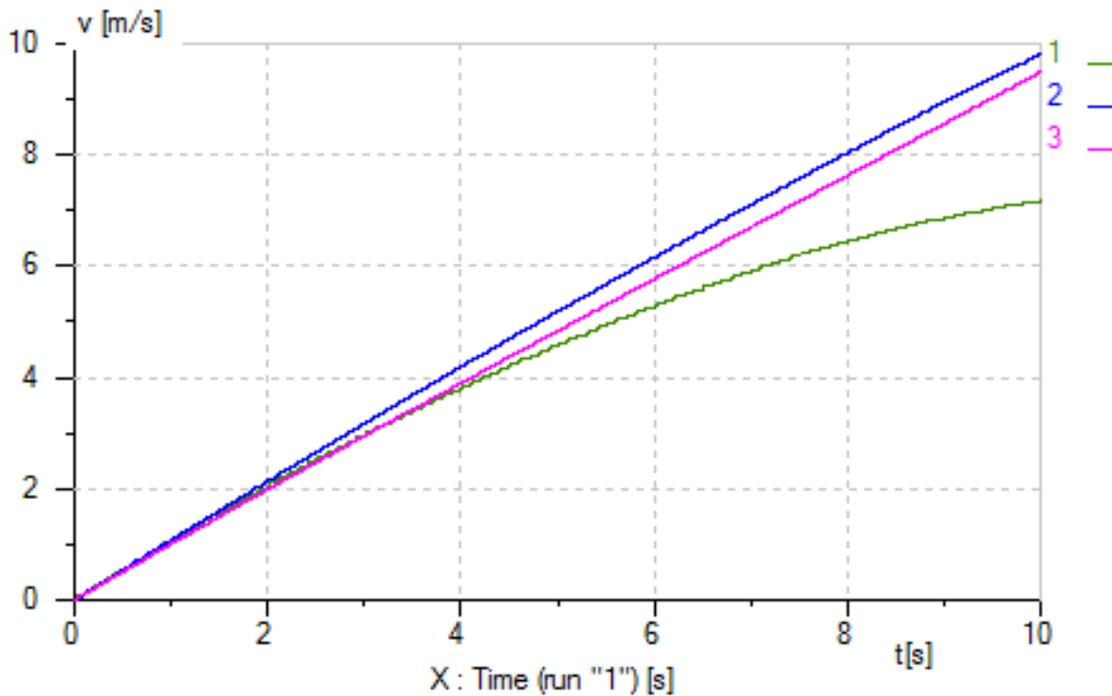


Fig.6.

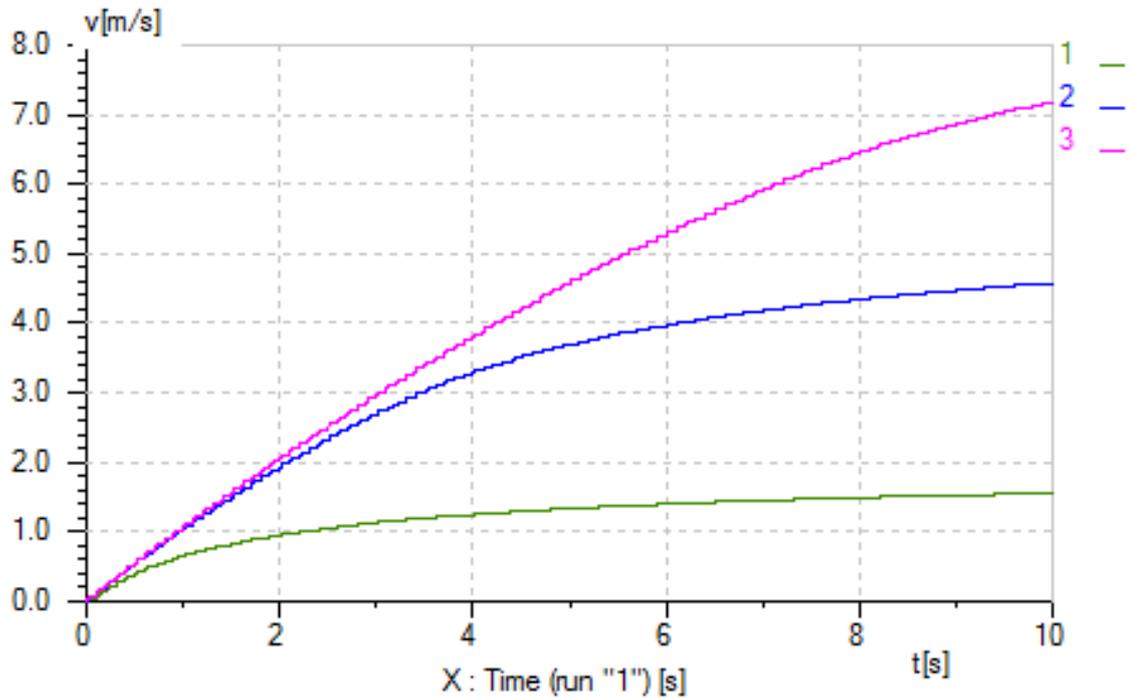


Fig.7.

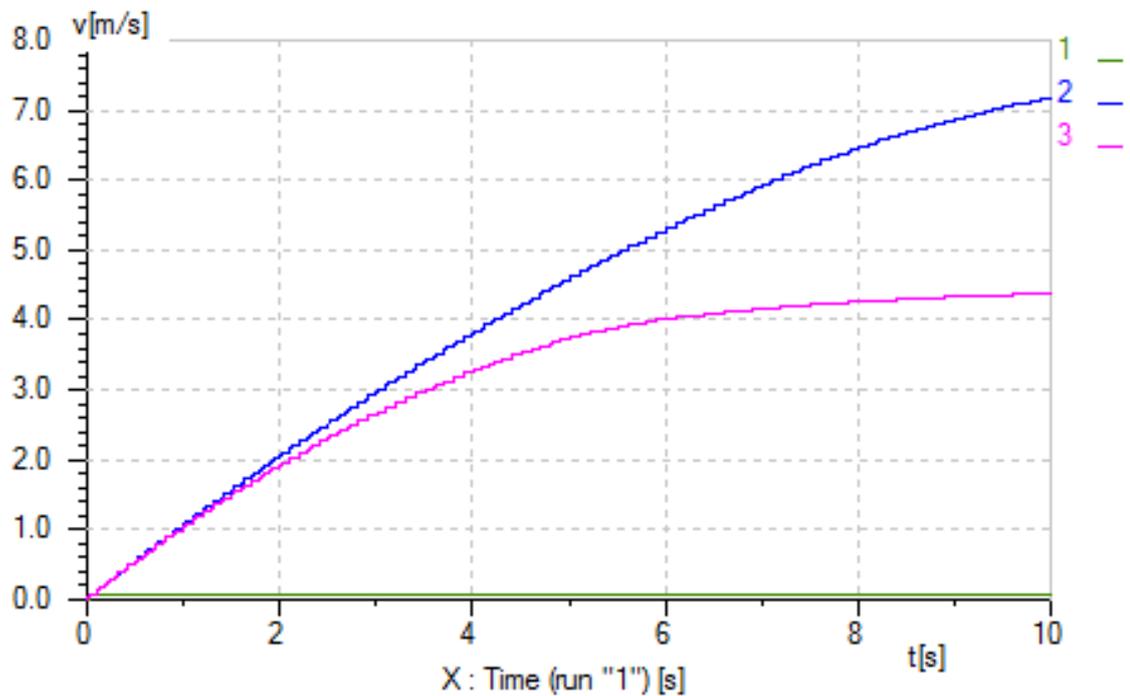


Fig.8.

THE EXPERIMENTAL MODEL

In order to identify the working principle of the sonic motors, experimental models were developed. The images are presented in figure for the liquid rotor solution 9at left side in the picture and the freewheel solution (a three cylinder configuration). Both motors can be coupled to the same shaft that can be loaded by a mechanical continuous adjustable break.



Fig.9.

As pointed out by the simulation, piston stroke with lever length have to be correlated in order to have a proper movement.

CONCLUSIONS

The paper analysis two principles of an asynchronous sonic motor. It was demonstrated that for acceptable dimensions and pressure amplitudes, significant power can be obtained by the solution with liquid rotor. Freewheel configurations must be designed paying attention to parameter correlation. Otherwise parameters that can improve performance have as result a contrary effect.

REFERENCES

- (1) Gogu Constantinescu, "Teoria sonicitatii" Editura Academiei Republicii Socialiste Romania Bucuresti, Pages 1-248, 1985;
- (2) Gogu Constantinescu, "Theory of wave Transmission", Price tos. 6d, Pages 1-209, 1922;
- (3) Pop Ioan I., "Tratat de Teoria Sonicitatii", Editura Performantica, Pages 1-609, 2006.