THE PARALLEL SONIC RESONATOR AS TRANSMISSION OPTIMIZATION SOLUTION FOR SONIC PROPULSION SYSTEMS

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ABSTRACT – The parallel sonic resonator as transmission optimization solution for sonic propulsion systems.

Sonic propulsion systems are an alternative solution to hydraulic hybrid solutions. Based on energy transfer using waves propagated in liquids, sonic propulsion systems receive the advantages of this way to transfer energy. Low dissipation rates and due to this fact, the possibility to generate dynamical phenomena, that are associated with high energy concentrations. One of these phenomena is resonance generated in the oscillation system, liquid, trapped in a pipe. The paper presents results of analysing a sonic parallel resonance system. The parallel structure refers to the parallel connection of a sonic capacity (given volume for a given type of liquid) and impedance (oscillating mass) Parameters that influence resonance development are studied using a multidomain simulation model, in order to have an image of the possibilities of controlling resonance in order to adapt frequency to the running conditions of the vehicle.

INTRODUCTION

Sonic systems are based on transmitting energy using wave propagated in a liquid. As an oscillating process, wave propagation is influenced by low dissipation rates, allowing, due to this fact, intensive dynamical phenomena, like resonance. To resonance contribute the accumulating and inertial phenomena associated with the time-dependent processes. A solution for generating resonance in a sonic system is the parallel coupling of a sonic inertia and a sonic capacity.

THE SONIC PARALLEL SYSTEM

The sonic parallel system is based on a sonic generator, a capacity and an inertia, the latter being coupled in parallel. The whole circuit can be designed as a one phase (figure 1) or two phase circuit (figure 2).

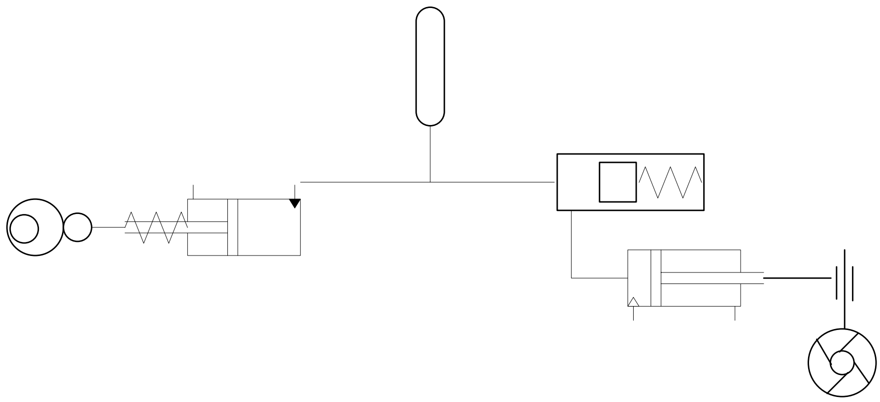


Fig.1 The single phase parallel resonance circuit

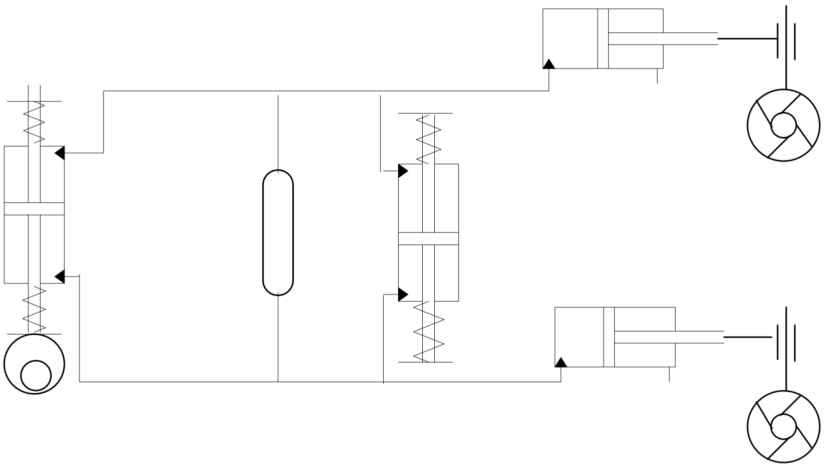


Fig.2. The double phase parallel resonance circuit

The sonic circuit acts as an oscillating system exposed to a periodic external force. In this case dynamical phenomena are present, e.g. resonance. The friction parameters induce a nonlinear effect.

A first analytical model adapted after the founder of the sonic science, Gogu Constantinescu (1), (2), (3) show that high pressure amplitudes are obtainable for resonance conditions. The physical meaning of this condition, an equilibrium non-dissipative balance of accumulating and inertial effects that allow an easy accumulation of energy in the system.

In figure 3 is plotted the pressure amplitude as a function of inertia mass, for three diameters of the generators piston: 5, 10, and 15 mm.

It can be observed that different conditions for resonance are influenced by the design parameters. The best technical solution must have a broad dependence on the specified condition. Under this circumstances, small deviation of optimal parameter value, allow the development of resonance.

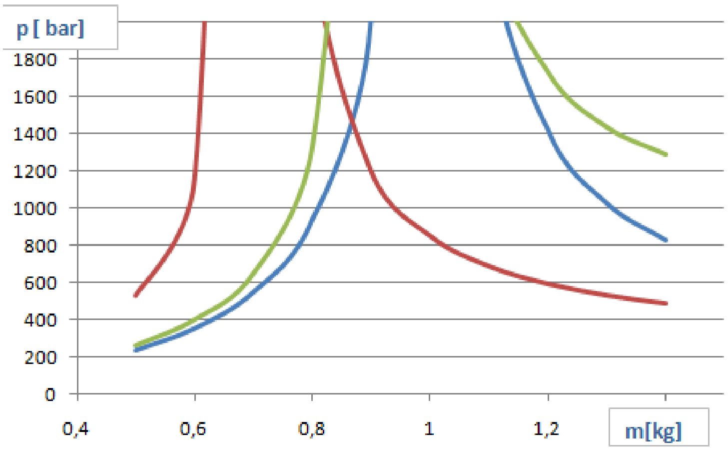


Fig. 3. Development of resonance using an analytical model

THE SIMULATION MODEL OF THE RESONANCE CIRCUIT

In order to identify the mechanism of resonance development, a more complex model using a multi-domain software was developed. Its structure is presented in figure 4.

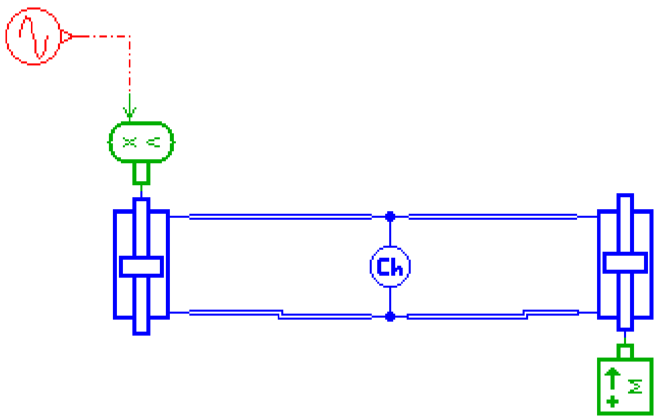


Fig. 4. The multidomain model of the resonance circuit

Four cases of resonance conditions were considered. The main parameters are given in table 1.

Table 1

generator working frequency	Hz	14,62	40	23,89	46,26
mass of inertia	kg	1	0,5	1,5	0,1
volume of capacity	cm^3	1570	3532	392,5	1570

Before analysing the influence of parameters, a pressure plot is given in figure 5 for a time interval of 100 s. It can be observed an almost linear development of the pressure in the system under resonance conditions.

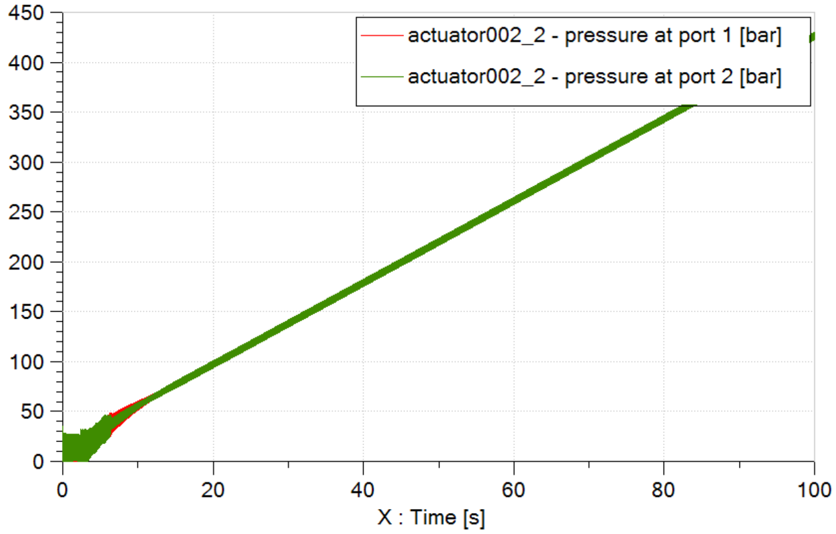


Fig.5. Pressure development under resonance in the actuating cylinder of the inertia

A narrow view of this graph is given in figure 6, where it can be noticed that wave amplitude doesn't develop similar in both working spaces of the inertia cylinder.

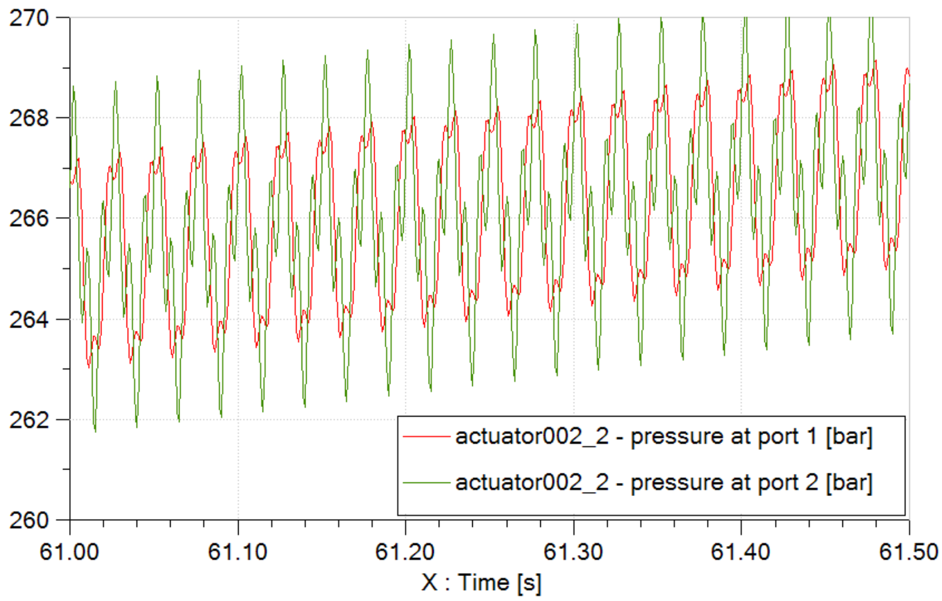
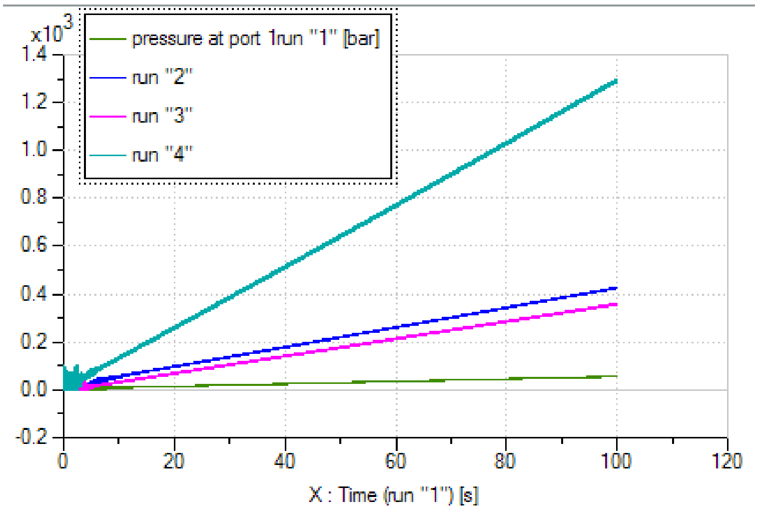


Fig.6. Pressure development under resonance in the actuating cylinder of the inertia - detail



The resonance conditions for the parameters synthesised in table 1, presented in figure 7 by the pressure in the actuation cylinder of the inertia, show that there it is a significant difference between the way how resonance is developed among the set of parameters that meet resonance conditions.

Fig. 7.

CONCLUSIONS

The results of the paper show that for small geometrical parameters it is possible to assure resonance conditions that are associated with important pressure amplitudes. It was also demonstrated that their it is an important difference of pressure amplitude among the resonance conditions.

BIOGRAPHY

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