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No-moving-part fluidic oscillators

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Abstract

The subject of generating oscillatory motion in fluids operating without moving components is relatively less well known. However, the idea is not new first oscillators were patented fifty years ago - but were nearly forgotten until the recent surge of interest, stemming from their robustness, resistance to high temperature or radioactivity, long life, absence of external energy supply, and no need of maintenance. Applications were found in increasing heat and/or mass transfer (suppressing formation of the conduction layer held on surfaces by viscosity - however thin, the layer is the decisive factor in the transport phenomena), generation of hybrid-synthetic jets for separation control, and generation of small bubbles in water (the oscillation period setting the limits to bubble growth) using CO_2 to grow algae - for food and/or biofuels - and thus suppress the global warming. The self-excited oscillation is due to hydrodynamic instability. In some configurations there is an internal feedback, often rather difficult to identify and interpret. Easier to design is use of devices with amplifying properties (large response in the flow-field to a tiny input in a critical sensitive spot), providing them with a negative feedback that produces the de-stabilisation. The main causes of frustration encountered by potential users are:

1. difficult design of a flow-field having some sensitive spot,
2. the need of matching the oscillator properties to the driven load,
3. sometimes unpleasantly large overall hydraulic losses.

The search for possible ways towards decreasing the losses is one of the current development activities. Somewhat enigmatically, recent research indicates the pressure recovery taking place before the flow enters the diffusers, which are usually provided for the purpose. Another recent development direction, with the obvious aim at applications in microfluidics, is how to keeping the oscillation present in spite of the viscous damping at low Reynolds numbers.

About the author

Main research interests of Prof. Tesaȓ are shear flows (in particular wall jet and synthetic jet) and their applications in fluidics: control of fluid flows by devices having no moving parts. He is member of the team awarded in Great Britain the Moulton Medal for the best publication in chemical engineering in 2009. Prof. Tesaȓ is author of 3 textbooks for engineering students (in Czech language), 1 textbook in English, 1 monograph published in the U.S.A. and of over 380 papers and conference contributions (The total number of citations in the Citation Tracker of SCOPUS is 221). He is named as the inventor of more than 200 Patents, mostly on fluidic devices.

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