FROM THE SINGING TELEGRAPH WIRES TO THE TEMPERATURE CONTROL OF WAKES

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Vortex shedding from a bluff body is a classical problem as well as an exciting challenge for fluid mechanics. Since the time of Prof. Strouhal at the end of the 19^{th} century, the phenomenon has been frequently studied by several generations of researchers. This contribution introduces (1) the historical context of the milestone studies, (2) motivations and goals of the recent investigations, and (3) recent original results of research on the fluid dynamics and heat transfer of heated and cooled circular cylinders in the cross-flow, obtained mainly in the Institute of Thermomechanics.

Key words: *vortex shedding, Kármán vortex street, laminar flow, heated circular cylinder, heat transfer, effective temperature*

1. Introduction – the historical context

A reference of one of the first observations of wakes is usually dedicated to the most versatile genius of the Renaissance, Leonardo da Vinci (1452–1519). Usually mentioned is his drawing of St. Christopher at the river, where a vortex wake is shown behind his immersed stick (e.g. Zdravkovich [56]). Understandably, much older historical evidences that the human mind was always fascinated by fluid flows around and behind obstacles can be found – e.g. Nakayama et al. [34] referred rather seriously that patterns of an ancient Japan pottery (2500 BC) was created according to the von Kármán vortex street. To support this speculation, Nakayama et al. [34] made an observation of vortices behind a rock of river, laboratory visualization by means of the hydrogen bubbles method in water, and two-dimensional numerical simulation using the finite difference method.

Prof. Čeněk (Vincent) Strouhal (April 10, 1850 in Seč – January 23, 1922 in Prague) experimentally investigated the phenomenon of 'singing wires' (or the so-called audible tones, misleadingly called 'friction tones' at that time). He was the first who measured the wake frequency and found that the pitch of audible tones depends on velocity and diameter of the cylinders (wires) only – Strouhal [44] in 1878. He explained that the reason of the tones is air flowing around a cylindrical body generating alternating vortices. His original data were published in graphical form of the linear relationship between frequency (f) and velocity (U) with the diameter (D) as parameter, and he generalized the proportionality $f\,D/U =$ constant. Much later, this constant was called the *'Strouhal number'* by Bénard [4] in 1926. However, Bénard's suggestion was not accepted outside France until Kovasznay [24] (1949) and Roshko [39] (1952) adopted it in their works (written in English).

Since that time, flows around circular cylinders were studied by many investigators – see, e.g., an exhaustive monograph by Zdravkovich [56] where nearly one thousand relevant

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