Vortex Shedding suppression of a circular cylinder by attaching cylindrical rings - measurements of velocity distribution behind the cylinder using particle image velocimetry

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Résumé ou extrait : Navy ships move through a complex environment. Thus, characterizing interactions between fluid and structure is essential during their design. One of the most common geometries used to study a cross flow is a uniform circular cylinder as it is encountered in many engineering applications. It is well known that cross flow generates vortex shedding which leads to unwanted effects such as vibration and aeroacoustic noise. More, shedding of vortices is believed to play a governing role in many features of the flow such as heat transfer. Numerous investigations were devoted to drag reduction and vortex shedding reduction on a circular cylinder. In the case of a rigid cylinder, the simplest control methods are passive control methods which consist in modifying the initial shape (macro-inhomogeneities) or the initial surface state of the cylinder (micro-inhomogeneities). In the framework of this study, we rather focus our interest on macroinhomogeneities of rigid cylinders. While Zdravkovich et al. (1981)[1] conducted experiments to suppress the vortex shedding from a circular cylinder by attaching 'tripping wires' (thin protuberances) on them, Owen & Bearman (2001)[2] investigated vortex suppression through three-dimensional surface modifications. First, they worked with a sinusoidal axis (one-directional modification) and then, by adding bumps on the cylinder (multi-directional modification but axially non-symmetric which means that the modifications depend on the flow direction). Lam et al. (2004)[3] and Zhang & Lee (2005)[4] also investigated drag reduction through threedimensional surface modifications. They worked with a cylinder with sinusoidal change in diameter (omnidirectional modification but changing pitch means to design a new cylinder and wavy shape production is complex). Finally, Nakamura & Igarashi (2004)[5] investigated vortex shedding behind a ring-attached cylinder. They worked on surface pressure and lift coefficient fluctuations and made smoke and PIV visualizations. In the wake of these investigations, Morton & Yarusevych (2014)[6] investigated vortex shedding behind a dual step cylinder which is very similar to the previous study that will be our starting point. The advantages of the ring-attached cylinder are its axial symmetry (omni-directional modification) and its simple geometry. The expected efficiency depends on several parameters such as the Reynolds number Re and the ratios of ring diameter D/d, ring width W/d and spanwise pitch P/d to the cylinder's diameter d. Previous studies give us an optimal configuration for Re 20 000 : D/d = 1,3, W/d = 1,0 and P/d = 3. In

this configuration, the fluctuating lift force was about 1/30 that of a 2D cylinder due to the suppression of periodic shedding and the reduction of spanwise correlation (Nakamura, 2011)[7]. The objective of the present study is to investigate different ring configurations by changing the spanwise pitch in order to explore the mechanism behind the vortex shedding suppression