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Area of expertise

Flows with trapped vortices

Wings of the modern aircraft are thin and streamlined thus ensuring maximum aerodynamic efficiency. From structural viewpoint a thick wing would be more efficient in carrying the load. The tendency of increasing aircraft size shifts the weight of the design balance towards structural considerations. As a result, improving aerodynamics of thick wings is essential for further progress in aviation.

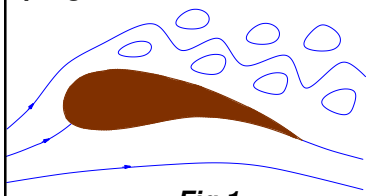

Fig.1

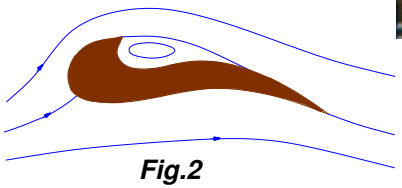

Fig.2

Trapping vortices is a technology for preventing vortex shedding and reducing drag in flows past bluff bodies. Large vortices forming in high-speed flows past bluff bodies tend to be shed downstream, with new vortices forming in their stead (Fig. 1). This leads to an increase in drag and unsteady loads on the body, and produces an unsteady wake. If the vortex is kept near the body at all times it is called trapped. Vortices can be trapped in vortex cells as in Fig. 2.

Prior to the final experiment of VortexCell2050 (FP6 project, 2005-2009) there had been only two reportedly successful implementations of the idea of trapped vortex, namely, the Kasper wing and the EKIP (Ecology and Progress) aircraft (Fig 3). Attempts to reproduce Kasper's results in a wind tunnel did not confirm Kasper's claims. The stories of the Kasper wing and EKIP are complicated, controversial, and involve much wider issues than trapped vortices. More can be found on the Web.

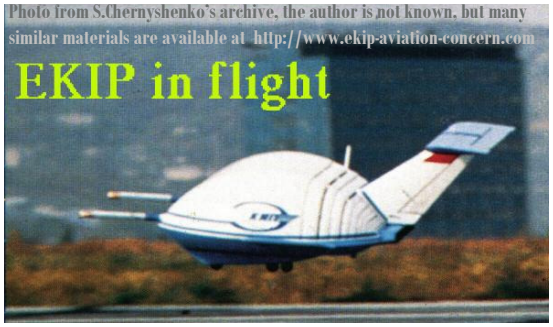

Fig.3 In Ekip large-scale separation was prevented by trapped vortices. Ekip, built in 1980th in Russia, became known as a flying saucer in the West. How flying saucers could be observed before 1980th remains a mystery ☺.

VortexCell2050 outcomes:

• A software tool for designing a flow past a thick airfoil with a trapped vortex assuming that this flow is stable, apart from small-scale turbulence, was developed.

• A methodology and software tools for designing a system of stabilisation of such a flow were developed.

• An airfoil with a trapped vortex and a stabilisation system for the High-Altitude Long Endurance aircraft was designed, built, tested and its performance was estimated.

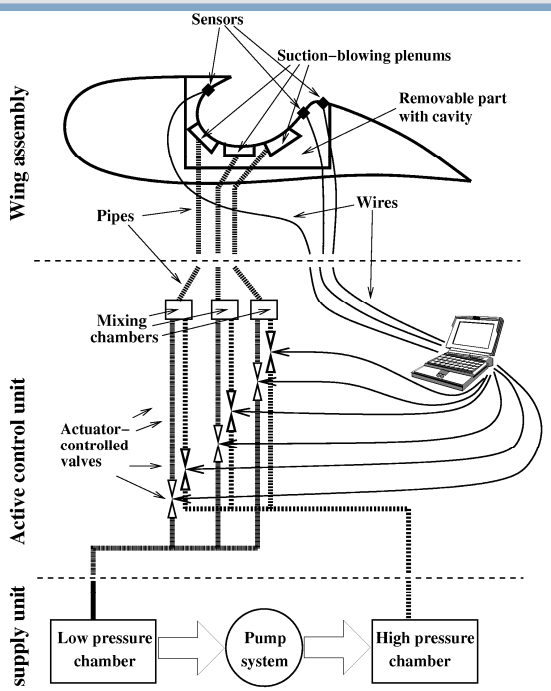

Fig.4. Stabilising the trapped-vortex flow is a challenge. Future work would aim at feedback control of such a flow.

More information:

S.I.Chernyshenko. VortexCell2050. Specific Targeted Research Project "Fundamentals of actively controlled flows with trapped vortices". Publishable executive summary. http://cordis.europa.eu/documents/documentlibrary/120142501EN6.pdf