AIOLOS ENGINEERING – AERO-ACOUSTIC CAPABILITIES FOR TEST FACILITY DESIGN

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Résumé

Aiolos Engineering est un fournisseur d'installations d'essais aérodynamiques, climatiques, et acoustiques spécialisées desservant des clients à travers le monde. La majorité des installations d'essais conçu par Aiolos sont des souffleries. La plupart des souffleries ont des exigences relatives au contrôle de bruit, pour lesquels l'analyse et la conception est réalisée en interne. Aiolos conçoit aussi des installations uniques qui ne sont pas des souffleries, par exemple des chambres de bruit de forte intensité pour des essais sur des satellites.

Mots-clés: bruit, soufflerie, acoustique, résonateur, générateur de bruit

Abstract

Aiolos Engineering is a supplier of aerodynamic, climatic, and specialized acoustic test facilities for clients around the world. Most of these test facilities are wind tunnels though there are also unique non-wind tunnel facilities. Many of the wind tunnels have requirements for noise control, for which the analysis and design is performed in-house. Some unique non-wind tunnel facilities supplied by Aiolos include high-intensity noise chambers for satellite testing.

Keywords: Noise, wind tunnel, acoustic, resonator, noise generator

1 Introduction

Aiolos Engineering provides engineering design services, construction management, final testing verification, and turnkey supply of aerodynamic, climatic, and specialized acoustic test facilities for clients around the world. Most of these test facilities have their form as wind tunnels. Some non-wind tunnel configurations include large high-intensity noise chambers. [1]

2 Aeroacoustic Noise Control

Many of the wind tunnels designed by Aiolos incorporate some degree of acoustic control. The balancing of many competing influences usually requires low pressure loss noise attenuation methods such as acoustic turning vanes and treated duct sections upstream and downstream of the main fan. In addition, the impact of flow induced self-noise further restricts the options available. Aiolos performs the acoustic design to ensure proper integration with the aerodynamic circuit as well as to ensure suitability of the acoustic materials with the air temperature and moisture content range of the wind tunnel. An example is the University of Ontario Institute of Technology ACE Climatic Wind Tunnel located in Oshawa, in which the test section wind speed reaches 250 km/h, the air temperature is controlled from -40°C to +60°C, and the dew point varies from -40°C to saturated [2].

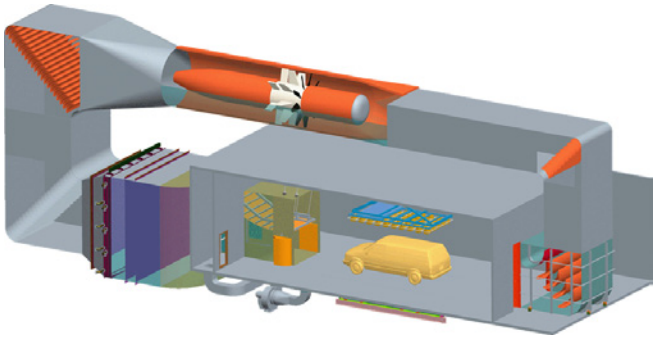

Figure 1: The University of Ontario Institute of Technology ACE Climatic Wind Tunnel
Acoustically Treated Turning Vanes and Fan Shown in Orange

Low-noise aerodynamic wind tunnels have driven additional design techniques. For the S2A automotive aeroacoustic wind tunnel [3] located outside of Paris, Aiolos used the following design features to meet the demanding aerodynamic and acoustic requirements:

- Double-sided foam-lined turning vanes, where the foam incorporates a thin smooth skin to provide a non-porous aerodynamic surface with near-transparent acoustic properties.
- A vented internal vane structure to avoid deformation and possible blow-out of the material due to pressure variations during wind speed ramping.
- A unique micro-pore floor surface to minimize the self-noise at the surface of the floor boundary layer suction system. This detail was in addition to the standard silencers applied both sides of the suction fan.

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– A membrane-absorber panel system for the plenum that surrounds the test section to provide the hemi-anechoic conditions for the test vehicle.

Additional low-noise facilities produced by Aiolos include a combined aerospace-acoustic research wind tunnel for the Agency for Defense Development in Taejon, Korea [1], the Hyundai Aero-Acoustic Wind Tunnel near Seoul, Korea [4], and an acoustic upgrade to the GM Aerodynamics Laboratory in Michigan.

Aiolos is also involved in the specification and integration of the acoustic instrumentation. In the case of the S2A, Aiolos oversaw the specification and procurement of the complete acoustic instrumentation package which included an in-vehicle acoustic holography set and an external Beamforming unit.

Besides the audible frequencies, Aiolos has developed extensive capabilities in the control of low-frequency pressure fluctuations [5]. Shear layers produced at open jet test sections induce pressure fluctuations that can couple with different resonant modes in the air circuit, primarily the closed-loop return air path but also the relatively large plenum. The frequencies are of the order of several Hertz to about 10 Hz. Resonator absorbers connected to the circuit have been developed at Aiolos to provide passive and broadband control of these low-frequency pressure fluctuations. They have been used on several recent climatic wind tunnels, including a set of 3 climatic wind tunnels for BMW [6] and two climatic wind tunnels for Daimler [7].

3 High-Intensity Noise Generation

Aiolos also designs test facilities that provide simulation of very high noise levels. An example of this is the very large Reverberant Acoustic Test Facility (RATF) at the Space Power Facility of NASA Glen Research Center's Plum Brook Station in Sandusky, Ohio. This test facility is used to simulate the acoustic environment that satellites and space vehicles experience on launch. Overall sound pressure levels of up to 163 dB are generated by a bank of noise generators in one wall of the test chamber (Figure 2).

The noise is produced by electrodynamic or hydraulically driven gaseous nitrogen modulators coupled to an acoustic horn with a suitable cut-off frequency. During the design phase of the RATF project Aiolos performed extensive testing to characterize the modulators in a reverberant chamber at the National Research Council of Canada [8]. Aiolos considered using supersonic jets for producing part of the noise spectrum required for the RATF. This idea was tested at the NRC [9].

Figure 2 : NASA Reverberant Acoustic Test Facility

Aiolos has also upgraded an existing high noise test facility. Changing test requirements for the Large European Acoustic Facility (LEAF) resulted in a design and supply contract for Aiolos to modify LEAF's noise generators to produce more high frequency noise [10]. LEAF is similar to RATF (but smaller) and is used for high noise tests on space vehicles.

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