Theoretical Prediction of Sound Attenuation in Acoustically Lined Annular Ducts in the Presence of Uniform Flow and Shear Flow

Sung-Hwan Ko

Citation: The Journal of the Acoustical Society of America **55**, 424 (1974); doi: 10.1121/1.3437335
View online: https://doi.org/10.1121/1.3437335
View Table of Contents: https://asa.scitation.org/toc/jas/55/2
Published by the Acoustical Society of America

WEDNESDAY, 31 OCTOBER 1973 GARDEN ROOM WEST, 2:00 P.M.

Session T. Noise V: Propagation of Sound from Ducts

EDWARD J. RICE, *Chairman*

NASA–Lewis Research Center, Cleveland, Ohio 44135

Contributed Papers (15 minutes)

2:00

T1. ***Abstract withdrawn.***

2:15

T2. Theoretical Prediction of Sound Attenuation in Acoustically Lined Annular Ducts in the Presence of Uniform Flow and Shear Flow.* SUNG-HWAN KO, *New London Laboratory, Naval Underwater Systems Center, New London, Connecticut 06320.*—An investigation is made of the sound attenuation in a lined annular duct in the presence of fluid flow. The eigenvalue equation in the presence of uniform flow is derived by matching the radial component of the particle displacement and acoustic pressure across a vortex sheet located an infinitesimally small distance from the facing sheet of an acoustic lining. The eigenvalue equation in the presence of shear flow is developed by matching the acoustic pressure and the radial component of the particle displacement at the interface between the regions of uniform flow and shear flow. Theoretical prediction of the sound attenuation spectrum is based on an acoustic energy flow in which the effect of the mean flow is taken into account. The results presented in this paper are limited to those which are typical to the geometry of an annular duct. Effects of mean flow Mach number, boundary layer refraction, and acoustic impedance on the sound attenuation for a given duct configuration are found to be similar to those in rectangular and circular duct problems.

* This work was originated while the author was with the Boeing Company, Seattle, Washington 98124.

2:30

T3. Laboratory Evaluation of Absorptive Silencer Performance. M. W. BLANCK, *Kodaras Acoustical Laboratories, Division of Electrical Testing Laboratories, Incorporated, Elmhurst, New York 11373.*—The recently published ASTM E477 "Laboratory Standard Method of Test for Duct Liner Materials and Prefabricated Silencers for Acoustical and Airflow Performance" provides a consensus procedure for the measurement of insertion loss, airflow-generated noise, and pressure drop of air conditioning silencers. Similar test procedures have been in use since 1966 that yielded reproducible test results between laboratories. Round-robin data indicated that there was a need for a single test method which would eliminate small variations in testing procedures between laboratories. As in most laboratory tests, the silencer is tested in a duct location not normally found in actual usage. The acoustical consultant or mechanical engineer should, therefore, be aware that the laboratory data are for optimum conditions. The insertion loss may vary in actual applications, owing to different duct configurations and duct impedances. Pressure drop will normally be higher because ideal silencer entrance and exit conditions are only found in a long straight duct configuration.

2:45

T4. Acoustical Characteristics of an Open-Ended Duct with Flow. UNO INGARD, *Departments of Physics and of Aeronautics and Astronautics and Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139.*—The acoustical characteristics of an open-ended, rigid-walled duct carrying flows with mean velocities up to half the speed of sound have been studied. The pressure reflection coefficients from the upstream and downstream ends of the duct have been measured, and the results have been used in the evaluation of the Green's function for the duct. The bandwidths of the duct resonances have been determined as a function of the Mach number, and it is demonstrated that the resonances practically disappear at sufficiently high Mach numbers. The steady-state pressure distribution in a duct from a source inside the duct is measured, as well as the response of the duct to an external sound source. The results are discussed in the light of calculated results. [This work was supported by the U.S. Navy (Office of Naval Research) by Contract N00014-67-A-0204-0019.]

3:00

T5. Space-Time Structure of Acoustic Propagation in Ducts in the Presence of Shear Flow. M. N. MIKHAIL AND A. N. ABDELHAMID, *Carleton University, Ottawa, Ontario, Canada K1S 5B6.*—The effects of shear flow on the modal phase velocity, the group velocity, and the cutoff frequencies of acoustic modes propagating in ducts are studied analytically. The convection effect of the shear flow is found to be equivalent to the convection effect of a uniform mean flow with some effective Mach number. Using the effective Mach number, the uniform mean flow dispersion relation can be generally used to