An Overview on the use of the Ffowcs Williams-Hawkings equation for the hydroacoustic analysis of marine propellers MARINE 2019

S. Ianniello[†], C. Testa[†]

[†] Institute of Marine Engineering (INM)
CNR - National Research Council
Via di Vallerano, 00128 Rome, Italy
Email: sandro.ianniello@cnr.it – claudio.testa@cnr.it

ABSTRACT

Since the last 70s, the integral formulations solving the Ffowcs Williams-Hawkings equation [1] represent a standard approach for the prediction of noise generated by a body moving in a fluid flow and, in particular, the aeroacoustic analysis of aeronautical propellers and helicopter rotors.
In the last years, this methodology is being applied to naval sector too, in the attempt of providing the shipbilding industry with effective predictive tools, which to fulfill the more and more stringent regulations on underwater noise emission with. These applications have revealed some interesting and somehow unexpected aspects in the generating noise mechanisms related to a marine propeller and a deep difference between the aero- and hydro-acoustic behavior of analogous devices [2].
The paper offers an overview on the use of the Acoustic Analogy for the assessment of noise from a marine propeller. At first, the attention is focused on the significant and generical differences between the acoustic behavior of rotating blades, operating in air and water; subsequently, many interesting aspects and practical applications are proposed, as the role played by the different source terms, the nature of the well known *end-cap problem* in the porous formulation, the insidious "acoustic" effects of the boundary conditions of the fluid dynamic solver, some possible strategies to evaluate the noise induced by a blade *sheet* cavitation and the assessment of scattering phenomena.
A lot of numerical results, mainly concerning a standard, multi-bladed marine propeller at different operating conditions, will be presented, by avoiding as much as possible any mathematical detail on the adopted, integral formulations and focusing the attention of the significant capabilities, the reliability and the effectiveness of the computational approach.

REFERENCES

[1] J. E. Ffowcs Williams and D. L. Hawkings, "Sound generationby turbulence and surfaces in arbitrary motion", *Phil. Trans. Royal Society*, A264, pp. 321–342, (1969).

[2] S. Ianniello, "The Ffowcs Williams-Hawkings equation for hydroacoustic analysis of rotating blades. Part 1. The rotpole", *Journal of Fluid Mechanics*, 797, pp. 345–388, (2016).