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Hydrolink

MODELING POLLUTANT EMISSIONS IN STAGNANT ENVIRONMENTS

BY PANAYOTIS C. YANNOPOULOS

Modeling pollutant emissions in stagnant environments has long been an important research area for the design and evaluation of disposal systems of wastewater in water bodies, or air pollutants in the atmosphere. This article gives an overview of the development of the Advanced Integral Model (AIM) for groups of interacting buoyant jets met in pollutant disposal systems. AIM's advantages include the low computer memory usage and the direct problem solution with acceptable accuracy, mostly of second order for cases that model assumptions are valid.

Interacting buoyant jet flows occur in many anthropogenic phenomena (disposal of wastewater, thermal effluent or brine discharges in water bodies, emissions of air pollutants or heat and moisture in the atmosphere, as well as plumes over humans due to temperature differences between bodies and surroundings). Some natural phenomena (density currents in lakes, sea and atmosphere, as well as gas escapes from earth faults, volcano eruptions etc.) may also form interacting buoyant jet flows.

The integral method is a popular procedure for solving the problems of interacting buoyant jets. For a single turbulent buoyant jet, plane or round, second order solutions can be obtained for the mean flow and mixing properties [1, 2, 3]. The solution of interacting buoyant jets is more difficult, because of the complicated flow and mixing fields. However, in the case of two adjacent vertical buoyant jets, a solution can be obtained by applying the Entrainment Restriction Approach (ERA) and, when the group consists of any number of closely located jets or plumes of arbitrary form, the Superposition Method (SM) can be used [4, 5]. The SM may be applied either to interacting jets, due to the conservation of momentum and buoyancy fluxes [6, 7, 8], or to interacting plumes, due to the conservation of kinetic energy and buoyancy fluxes [8, 9]. The case of a group of closely located interacting plumes includes also the plumes originated from areal sources, which are considered as composed by an infinite number of infinitesimal point or line sources (Figure 1) and, thus, the SM is successfully applied [9]. The validity of this method stems from the proof of the linear behavior of the partial differential equations of both the total kinetic energy of the mean flow, expressed in terms of the cubic power of the mean axial velocity, and the tracer and/or buoyancy conservation, expressed in terms of their mean fluxes in the main flow direction. Regarding jet-like flows, the linear behavior has also been proved for the partial differential equation of momentum, in terms of the squared mean axial velocity, under Reichardt's hypothesis [10]. Thus, the well-known solutions for point or line plumes or jets can be superimposed to synthesize the composite flow and mixing fields, without needing a core model or invoking the assumption of a virtual origin of the plume or jet.

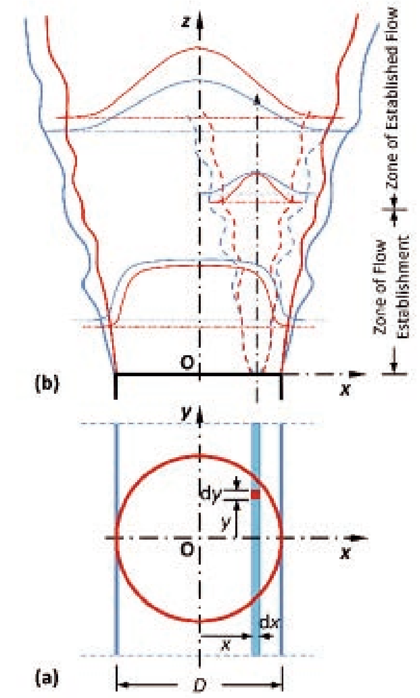

Figure 1. Actual plane and round buoyant jet composed by infinitesimal line/point plumes/jets: (a) Source plan view; (b) longitudinal cross-section

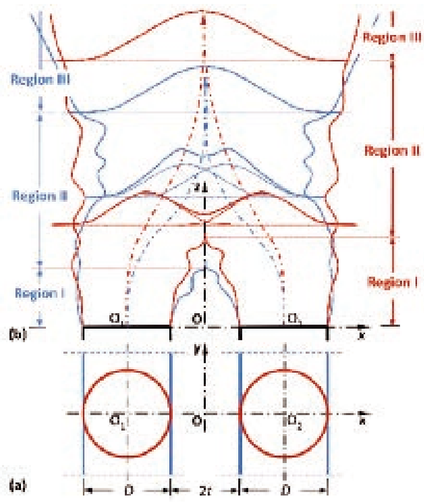

Figure 2. Interacting plane or round buoyant jets: (a) Sources plan view; (b) longitudinal cross-section

AIM is developed to tackle arbitrary groups of buoyant jets that are interacting with each other. Before merging (Region I of Figure 2b), AIM employs the potential flow theory, assuming that the centerline of each buoyant jet consists of sinks, which entrain fluid causing a secondary flow (dynamic interaction) [11, 12, 13]. This flow interacts with the flow of each buoyant jet of the group causing reciprocal reattachment of all buoyant jets of the group, as shown in Figure 2a and b. During buoyant jet merging (Region II of Figure 2b), AIM takes into account the merging process by both the dynamic interaction and composite velocity and concentration profiles. These profiles are constructed by superimposing the conserved local fluxes of momentum and buoyancy for jet-like flows and of kinetic energy and buoyancy for plume-like flows [8, 9, 14, 15]. In Region III of Figure 2b, AIM takes into consideration the merger effect by employing the aforementioned composite profiles. A comparison of the results of AIM with experimental data has been presented in a recent publication[9].

This method can be used for the analysis of multiple buoyant jet flows in the design of multiport diffusers in water bodies, or in the

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atmosphere and/or for the evaluation of their efficiency. It may be also used to evaluate the performance of other software that simulates such flows. ■

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A CALL TO ALL IAHR MEMBERS TO VOTE ON OUR REVISED CONSTITUTION AND BYLAWS

Dear IAHR Colleagues,

Firstly many thanks from the Secretariat and Executive Committee - many thanks to you for your feedback over the years and to the Task Force members who have put hundreds of hours into researching and developing the revisions to our Constitution and Bylaws.

On behalf of the IAHR Council, we are pleased to submit for your review and approval a revised Constitution and Bylaws. This has been a 3-year endeavour and has sought input from YPNs in different regions, Technical Committees (twice) and Regional Divisions (twice) as well as past members of Council and our Institute Members.

The objectives are simple:

1. Ensure IAHR can be nimble and responsive to members needs and initiatives
2. Link the IAHR activities, actions and members more directly to leadership decisions
3. Enhance the attractiveness of IAHR to early career researchers and engineers.
4. Resolve inconsistencies or previously adopted changes that have not been formally included in the Bylaws and Constitutions that have arisen over the past few decades.

The full text of the proposed Constitution and Bylaws can be accessed online click here

In order to facilitate your review, the main changes are summarised below:

1. The President serves one 2-year term and one 2-year term as past president (rather than the current 2x2-yr terms).
2. The Council will be expanded to included chairs of Technical Committees (TCs) , chairs of Working Groups and Journal Editors. Regional Divisions will continue to be represented on Council.
3. The Council will meet every 2 years (at the World Congress) but it is expected that there will be Task Forces and other activities structured between Council meetings. The Council may also convene on-line meetings as necessary. The Council will also include one YPN member from each Region with IAHR support to participate.
4. The creativity and innovation of IAHR will be driven by Council. The more operational 'Business of IAHR' will be entrusted to the Executive Committee with a responsibility of reporting to Council regularly.
5. Vice-Presidents and Presidents will be elected as normal IAHR practice
6. These changes would take effect in 2021
7. There is no change to Technical Committees, Regional Divisions, YPNs or Working Groups.

On behalf of the many contributors, we invite you to indicate your approval of these changes via the option that is included in the electronic ballot for the IAHR Elections: The ballot shall be available to you by email and shall open from July 4th to September 4th. The results of the ballot shall be announced on September 5th.

For more information about IAHR governance, we invite you to visit www.iahr.org and click on about -> governance. If you have any questions, please do not hesitate to contact Elsa Incio at elsa.incio@iahr.org

Thank you for your attention to this matter that is critically important to the future of our Association.

Peter Goodwin
President

Tom Soo
Executive Director