The XXXVI International School of Hydraulics, 23-26 May 2017, Jachranka, Poland

DENSITY CURRENTS: THEORY AND EXPERIMENTAL RESULTS

M. FRANCA[1]

[1] Laboratory of Hydraulic Constructions, Swiss Federal Institute of Technology of Lausanne
EPFL, CH-1015 Lausanne, Switzerland
email: mario.franca@epfl.ch

ABSTRACT

Density or gravity currents are geophysical flows driven by density differences between two contacting fluids caused by temperature gradients, dissolved substances or particles in suspension. The either natural or anthropogenic occurrence of gravity currents is of great engineering relevance as it is often related to human and environmental safety. Pollutant spillage and outflows from desalinization plants or industrial cooling systems provoke density currents resulting from differences in both temperature and salinity of water. Turbidity currents forming during flood events when waters with high concentration of sediment plunge into lakes and reservoirs, or turbidity currents triggered by landslide events, can travel for long distances in water bodies destroying deep water installations such as submarine cable and pipelines. Additionally, sediments deposited by turbidity currents have negative impact on the sustainability of reservoirs by clogging bottom outlets and intakes, and by reducing reservoir storage. Sedimentary basins caused by turbidity currents form some of the world's most important hydrocarbon reservoirs, and the topography of ocean and sea floors is shaped by large-scale gravity currents. Moreover, buoyancy-driven flows play a key role in the horizontal and vertical distribution of fresh water, oxygen, nutrients, pollutants and carbon throughout lakes ecosystems. Density currents are observed in industrial water clarifiers as well, compromising their operations. In this seminar, theoretical concepts on the fundamental physics of gravity flows, and particularly on classification, anatomy, basic variables and parameters, are given. Further, shallow water equations for mass and momentum conservations describing this density flows are derived and discussed. Experimental results regarding lock-exchange type of currents, triggered by the release of different volumes of brine water and for different buoyancies, are presented. Kinematics, temporal varying entrainment and mixing, and dynamics of the head of the current, are discussed. Further research needs will be pointed at the end of the presentation.