Geophysical Research Abstracts
Vol. 13, EGU2011-12030, 2011
EGU General Assembly 2011

Modeling of the near-field distribution of pollutants from a multi-port coastal outfall

Tatyana Lyubimova (1), Yanina Parshakova (1), Natalya Shumilova (1), Shengping Luo (2), and Bernard Roux (2)

(1) Institute of Continuous Media Mechanics UB RAS, Computational Fluid Dynamics Laboratory, Perm, Russian Federation (lubimova@psu.ru), (2) Laboratoire Mécanique, Modélisation et Procédés Propres/UMR 6181 CNRS, Marseille, France (broux@l3mgp.l3m.univ-mrs.fr)

The sea is often considered as the ultimate sink of most pollution, due to its huge volume and assimilating capacities, and the coastal waters, because of their intermediate position between deep seas and human activities, is acting as a buffer zone. During the past years, the interest in environmental issues in general, and in the conservation of the water quality in coastal regions, in particular, has steadily increased. In the present paper the nearfield dilution of an industrial effluent discharged by a multiport outfall is considered. The study is aimed to understand the environmental risk of the discharged effluent to pollute the seabed sediments, even in the case of a buoyant effluent (i.e. less dense than the receiving marine water). Indeed, these bottom sediments could accumulate the pollution during several months, and suddenly migrate in response to storm-driven currents for example. In addition, the movable bottom sediments can accumulate, due to alternate semi-diurnal tidal currents, below the diffuser and obstruct the interval between the pipe and the sea bottom.

One of the goals of our study is to analyze the distribution of pollutants in the bottom boundary layer (BBL) which may be defined as the layer adjacent to the seabed in which the flow is affected by processes occurring at the boundary and in which strong gradients of physical, chemical, and biological properties may occur. In thickness it extends to a height of a few meters above the seabed. The present work concerns the BBL dynamics in the nearfield of a multiport ocean outfall with submerged buoyant jets discharging vertically at a short distance above the seabed into a flowing ambient with a current speed up to 0.6m/s. It concerns the risk of pollution of sea bottom sediments by an industrial effluent emitted by an outfall, even in the case of buoyant effluent. So, special attention is devoted to the problem of interaction between the effluent plume and the sea bottom. The aim is to determine the conditions for a bottom attachment (Coanda attachment), in terms of ambient flow characteristics and discharge characteristics.

We consider a multiport diffuser involving a few hundred discharge jets spaced every 5m along the pipe. Two main configurations are considered: when the interval under the diffuser (which is surelevated from the seabed of 0.5m) is empty or filled by removable bottom sediments. The first case corresponds to the “nominal” configuration, the second one would simulate the risk of sediment accumulation under the diffuser due to alternate semi-diurnal tidal currents (the pipe behaving as a barrier). To analyze the effect of the ambient BBL dynamics we consider two types of vertical profile for the steady ambient current: constant in y and logarithmic increase; where the constants are extracted from experimental data. We study the pollutant transport in the three-dimensional stationary nonisothermal turbulent flow of viscous incompressible fluid. Numerical modeling is conducted with the help of the commercial software package Fluent 6.3.26, by using model for turbulent flows.

We also consider a situation where the ambient current is time-dependent, with a coastal current parallel to the shoreline and driven by a semi-diurnal tide. This ambient current is assumed to be perpendicular to the outfall and sinusoidal in time. The results concerning the temporal evolution of pollutant concentration at different distances from the seabed are obtained for both cases (without and with blockage).