Traced Streamlines Using Mixed Models

Norberto C. Vera Guzmán

nrbrt@geofisica.unam.mx

Instituto de Geofísica, UNAM

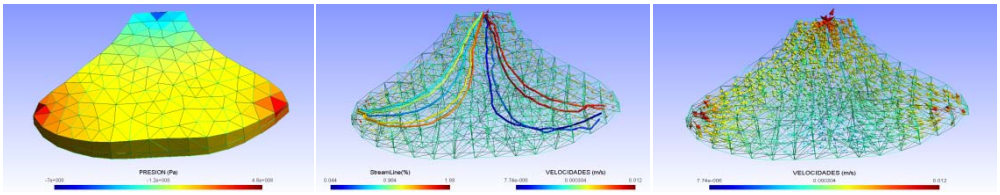
In this work we presents a way to use mixed models to draw streamlines in three-dimensional general geometry.

The methodology to follow is the next.

A mixed model (M) considering a general geometry in 3D is set up. In this mixed model approach we consider two fields unknown, velocity and pressure of fluid. The problem (M) is variational formulated in Hilbert spaces and reformulated in finite dimensional spaces, using a mixed finite element approximation. The resulting system to solve this problem consists of two coupled linear systems, one of them associated with the pressure and the other associated with the velocity field. From their solution, the velocity and pressure fields of the problem are obtained.

Once obtained the solution of the problem, we have the finite element coefficients and we can to calculated the fluid velocity and so, draw the streamlines in the follow way [2].

In each mesh element (a tetrahedral) without sinks or source, we take a initial point and we calculate the velocity on that point, one point over element face in which the velocity is incoming ($u.n<0$ if we consider the outer normal). The velocity is calculated in such a point and it is considered that this is kept constant inside the element and so a departure point is obtained in any of the remaining faces of the element, ie, we calculate the intersection of a line in 3D with one plane that represent additional faces of the tetrahedral. To continue the path of the line, we take the exit point as a starting point for the next element is taken and this operation is repeated. This procedure is repeated as many times as necessary until you find an element that has defined a source-sink. The entry and exit points of each element are joined with straight segments and they constitute a streamline.



[1] Sébastien F. Matringe, Mixed Finite Element Methods for Discretization and Streamline Tracing, Doctor of Philosophy Thesis, Stanford University, 2008.

[2] Norberto C. Vera-Guzmán, *Funciones Base Vectoriales para RTo en Triángulos y Tetrahedros*, Reportes Internos 2006-04, Diciembre del 2006, Instituto de Geofísica, UNAM.