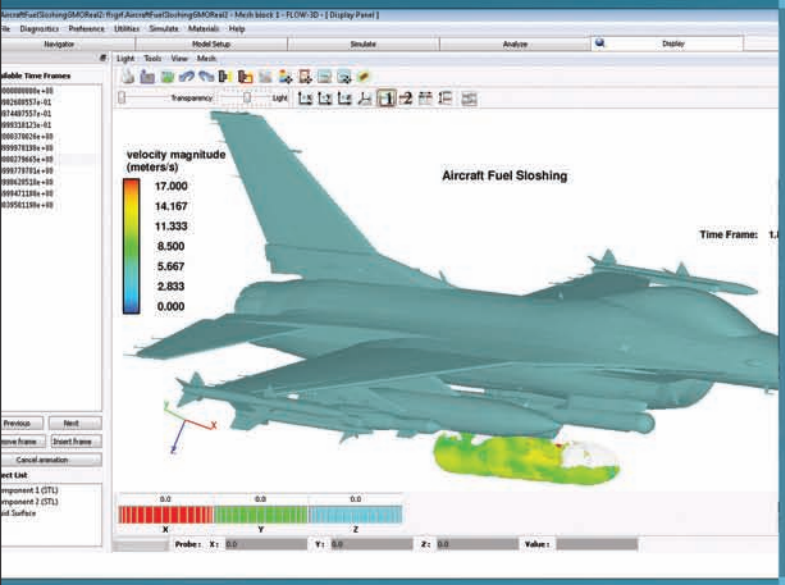
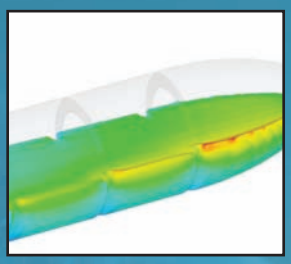
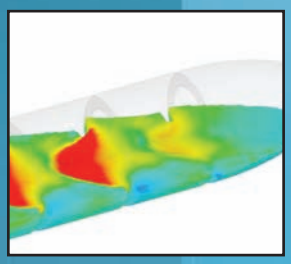
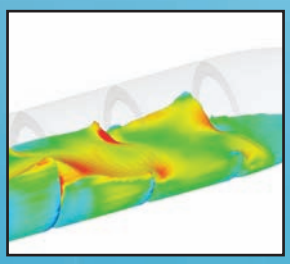
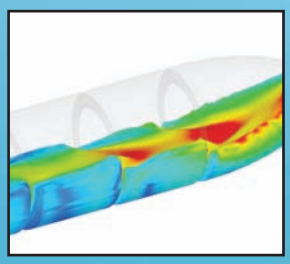


FLOW-3D

Powerful computational fluid dynamics software for accurate flow modeling

AEROSPACE

Easy-to-use CFD software to optimize the design and operation of your aerospace projects

- **Accurately simulate fuel slosh and acquisition in low-g environments**
- **Model ullage pressurization using non-condensable gas**
- **Identify viable designs quickly using efficient numerical methods**
- **Decrease the number of design iterations**
- **Improve time to manufacturing and quality certification**

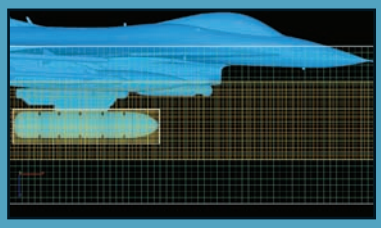
FLOW Science

1980 - 2010

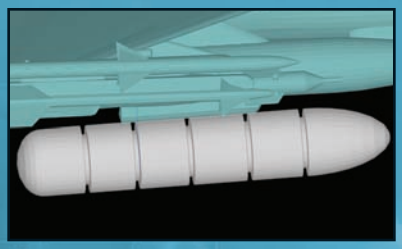
Improving the world through accurate flow modeling

Advanced Modeling Features

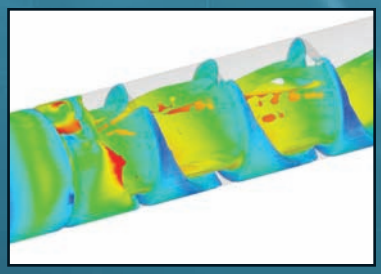
***FLOW-3D*'s advanced features make it easy to use and provide highly-accurate results.**



Multi-Block meshing adds even more flexibility and efficiency to problem setup.



***FLOW-3D*'s FAVOR™ method makes accurate representation of complex geometries simple.**



***FLOW-3D*'s TruVOF technique provides accurate representation of fuel sloshing and fluid breakup.**

FLOW-3D
from
FLOW Science
www.flow3d.com

FLOW-3D: Exceptional Accuracy

Why Choose FLOW-3D?

FLOW-3D is a powerful CFD modeling tool that gives engineers valuable insight into many physical flow processes. With special capabilities for accurately predicting free-surface flows, ***FLOW-3D*** is the ideal software to use for aerospace applications including, sloshing dynamics, cryogenics, nozzle flows, PMDs, cavitation and electric charge distribution.

Our strengths:

Accuracy is crucial for any simulation software. ***FLOW-3D*** provides meaningful results and has a proven reputation for accuracy in the many industries Flow Science supports.

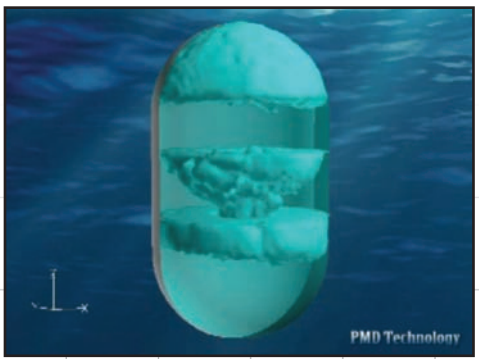
Meshing can be the most unwieldy part of setting up a simulation. The free gridding approach in ***FLOW-3D*** allows users to change the mesh grids independent of the geometry. ***FLOW-3D***'s FAVOR™ method allows users to accurately simulate flow profiles around complex geometries and save significant time in setting up a simulation.

Meshing controls allow users to optimize their mesh for the best combination of accuracy and speed. Multi-Block meshing provides this ability. Multiple mesh blocks of varying degrees of resolution enables users to capture regions requiring detail with a high degree of accuracy and keep other regions more coarse for a faster calculation time.

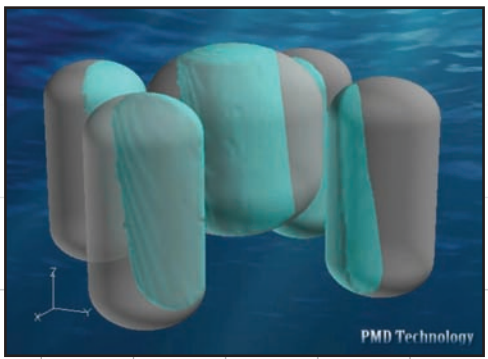
Speed is critical in going from design to production. ***FLOW-3D***'s unstructured memory allocation and implicit advection scheme gives users faster computational times without loss in accuracy.

Propellant Management Devices (PMDs)

FLOW-3D enables designers of spacecrafts to simulate real-world orbit maneuvers and design PMDs with a high degree of confidence. ***FLOW-3D*** provides users with well-validated physical models of surface tension and wall adhesion, free-surface advection and non-inertial reference frames.



Vapor bubble migration in a baffled tank subject to a short engine firing.



Simulation of fuel sloshing in a nutation 5-tank configuration at mid-range spin rate.

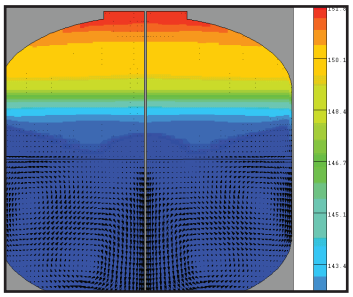
Results courtesy of PMD Technology. Post-processed by Fieldview.

More Precise Simulation

Simulate a wide variety of aerospace applications with FLOW-3D's all-inclusive package:

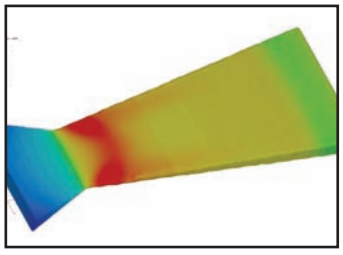
Cryogenics

Cryogenic propellants are used in space exploration programs. The high cost and limited opportunities for microgravity experiments have motivated the use of simulation to evaluate the effects of acceleration on pressure control thermodynamics. Tanks containing cryogenic liquids such as liquid hydrogen, oxygen, methane and nitrogen tetroxide can have ullage gas regions consisting of each liquid's vapor or a mixture of vapor with a second gas that is non-condensable at tank temperatures such as gaseous helium. Heat enters each tank's fluids through the tank walls and attached plumbing. ***FLOW-3D*** is used to simulate the pressurization of such tanks to verify controls designs.



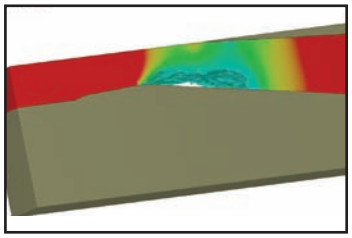
Nozzle flows

FLOW-3D has a powerful compressible flow capability across a variety of aerospace applications, including supersonic flows. In this example, ***FLOW-3D*** is used to simulate a Laval nozzle to control the flow of helium. The simulation captures the reflection and forward compression shock waves very well. As expected, flow chokes at the nozzle throat in about 1.5 milli-seconds as the flow becomes sonic. The flow accelerates to a supersonic velocity of Mach 4 at the divergent outlet.



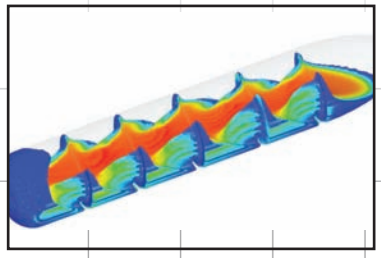
Cavitation

FLOW-3D can be used to simulate the nucleation, growth and collapse of vapor bubbles in a liquid. In this example of 3D convergent-divergent flow, water experiences a decrease in pressure in the nozzle that is below the vapor pressure of the water. Vapor cavities are seen to grow downstream of the nozzle, but then collapse once the exit pressure recovers.



Electric charge distribution

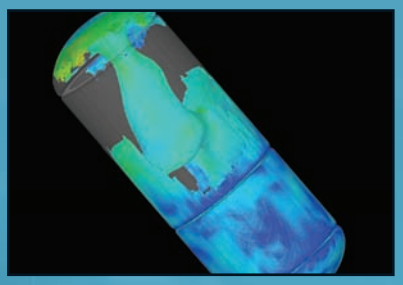
Sloshing of aircraft fuel in-flight or during refueling, generates electric charge causing the fuel-vapor mixture at the interface to become conductive. Analysis of transient electric potential and field distribution helps to identify optimum discharge locations on the fuel tank. This simulation using ***FLOW-3D*** demonstrates the fuel behavior inside an aircraft fuel tank while it accelerates through a turn in a series of yaw, pitch and roll motion.



Sloshing Dynamics

Spacecraft

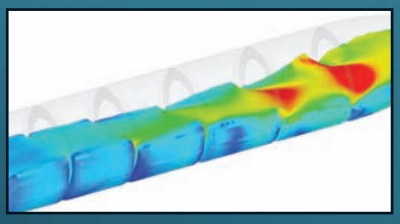
Knowledge of the motion of propellants in the fuel tanks of spacecraft is essential to understanding various aspects of their operation and performance. Propellant motion impacts such propulsion functions as expulsion of liquid, venting of gases, and pressurization. *FLOW-3D* helps create quality design and control motions.



Liquid fluorine tank under low gravity coast during launch.

Aircraft

Fuel sloshing within each compartment of an aircraft fuel tank is crucial in optimized placement of baffles and analyzing the volume of fuel retained in each compartment. Pressure forces on the fuel tank are also important through sloshing to determine the structural integrity of the tank material and construction. With *FLOW-3D* you can quickly mesh and simulate new design varations.



Transient velocity magnitude contours of sloshing in aircraft fuel tank through a turn under acceleration.

FLOW-3D

from

FLOW Science

www.flow3d.com

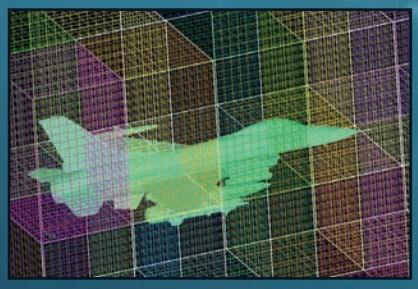
FLOW-3D MP

FLOW-3D/MP v4.0: High Performance Computing

***FLOW-3D*/MP v4.0 is the latest distributed-memory version of *FLOW-3D* and allows for larger simulations to be run and results obtained more quickly than with the serial version. Simulation runtimes can be reduced by 3-4x on 8 processors. *FLOW-3D*/MP is available on both Linux and Windows Compute Cluster.**

Automatic Decomposition Tool

***FLOW-3D*/MP v4.0 now includes an Automatic Decomposition Tool (ADT) making meshing easier than ever. ADT automatically finds the most efficient way of dividing the domain into multiple mesh blocks. This feature saves users time setting up their simulations, and obtains more computational efficiency than before.**



ADT decomposes the domain for balanced processor loads.

FLOW-3D from FLOW Science

www.flow3d.com

An All-Inclusive Application

From Model Setup to Simulation to Detailed Results Analysis

FLOW-3D includes all the functionality you need in one simple-to-use application, driven by an intuitive graphical user interface. Users can easily set up a model and quickly mesh it through its graphical model builder, screen out model incompatibilities and configuration errors, and perform detailed analysis through extensive post-processing capabilities.

Dedicated Support

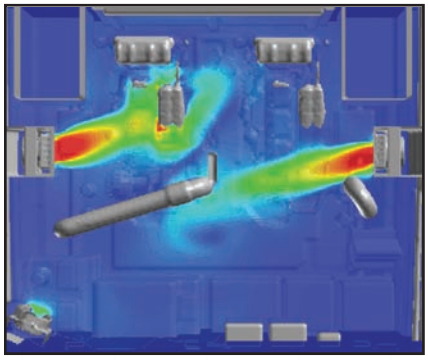
The professionals at Flow Science work closely with customers to understand their needs and ensure the software continuously meets their real-world challenges. Flow Science offers valuable training to help customers maximize their use of ***FLOW-3D***. Most importantly, Flow Science engineers provide accessible, responsive technical support.

Flow Science, Inc.

For 30 years, Flow Science has been an innovator in flow modeling software, serving a global clientele of business, government and academic institutions.

Call **505-982-0088** or email **sales@flow3d.com** for more information about how ***FLOW-3D*** can enhance the reliability and quality of your aerospace designs and help you reduce overall costs.

Engine Compartment Ventilation



Ventilation of engine compartments, especially where heat generation can affect both performance and comfort, can be crucial in aerospace designs. ***FLOW-3D*** has been used to improve the efficiency of cooling systems and maintain a specified temperature in the interior compartments and a maximum internal average temperature.

FLOW Science 1980 2010 30 YEARS FLOW-3D

Flow Science, Inc.
683 Harkle Road, Suite A
Santa Fe, NM 87505
sales@flow3d.com · www.flow3d.com
505-982-0088