Computational Analysis of Power Fluidic™ Mixing Technology for Enhanced Chemical Cleaning Operations in High Level Waste Tanks at Savannah River Site

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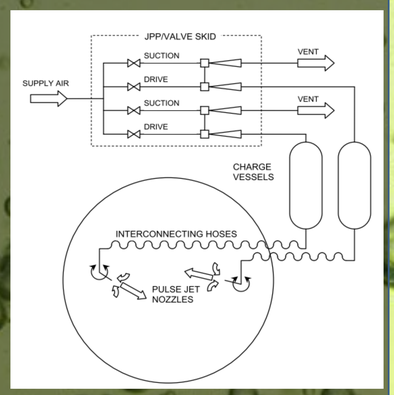
Project Overview: Chronicle of Events & Objective

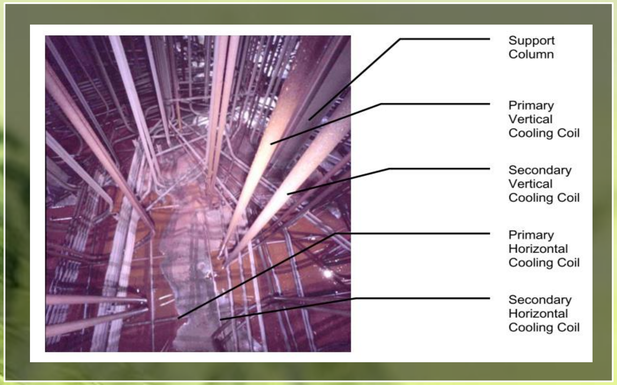
Savannah River Site (SRS) is a highly active facility with part of its operations being to manage and disposition approximately 36 million gallons of high activity liquid radioactive waste. The facility has 49 large shielded tanks. Twenty-nine (29) tanks are located in the H Area tank farm and 20 in the F Area tank farm. All SRS tanks are built of carbon steel, reinforced inside with concrete containment vaults. Many years after the construction of the SRS tanks in the 1950s, several of them were reaching their design life. In addition, several were suspected to have leaked waste material into the surrounding environment. Some tanks even formed flammable gases from the reactions which occurred in the tanks. As a result, it became crucial to find a method to remove the waste inside the obsolete tanks and close them in a safe and environmentally sound manner.

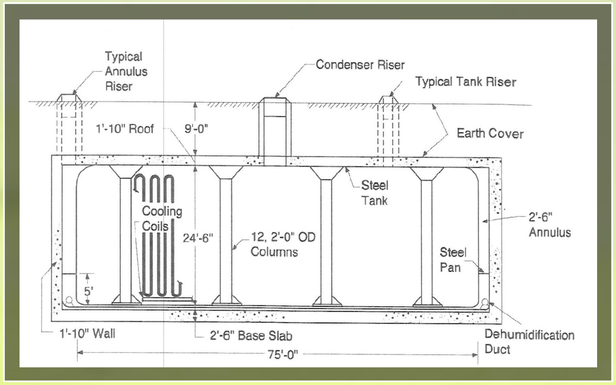
Savannah River Site is pursuing the use of a dilute-chemistry acid, which is used for the cleaning process at high level waste (HLW) tanks. The first intended tanks for the deployment of the Enhanced Chemical Cleaning (ECC) process are the Type I tanks in the SRS Area F tank farm. The purpose of the ECC process is to reduce the oxalate loading collected at the bottom the Type I tanks. The driving element behind the technology is the circulating acid, which promotes a fresh boundary for the chemical agent reaction. However, the low-liquid level environment and geometry seen inside the SRS tanks would pose a challenge in agitating the fluid. Being presented with this challenge, NuVision Engineering Inc. developed the Power Fluidic™ Pulse Jet Mixers (PJM), and demonstrated that this technology would be a viable option for implementing the ECC process.

Technology Development



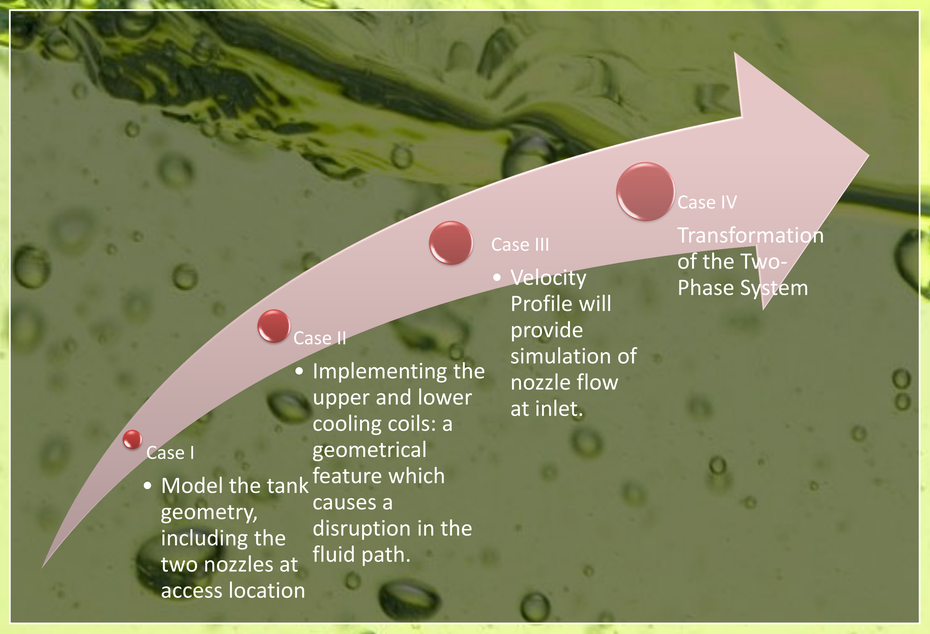
Internal Structure of Tank





The CFD process will include the need to enhance the discretization to better capture the tank features. The features that will be meshed in the process will be the 60-ft diameter tank itself, along with a system of nested cooling coils located within close proximity to the bottom of the tank and twelve concrete columns.

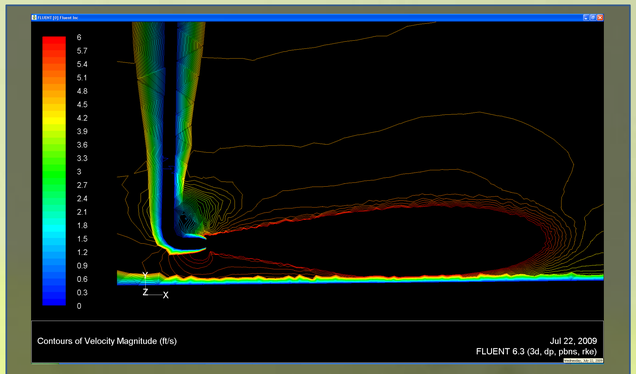
Plan of Execution



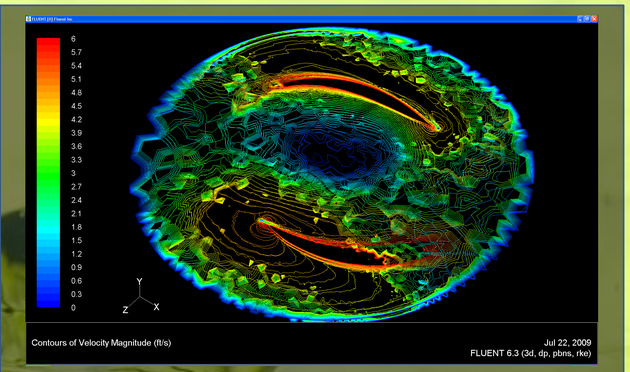
Reference

Test Report: "Demonstration of Power Fluidics™ Mixing Technology to Enhance Chemical Cleaning Operations in High Level Waste Tanks," NVE Document Number 2302-4-002.

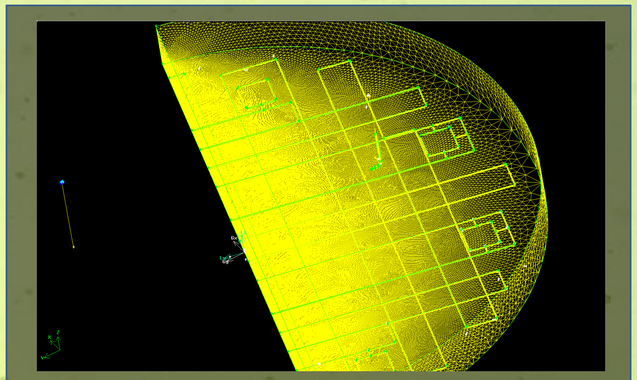
Preliminary Results



It is expected to see a convective circulation due to the positioning of the nozzles and the tank's geometry. From the contour plot we can examine the effectiveness of the flow pattern created by the nozzle. The contour plot provides a scale of the lower velocities, which are of more interest.



The examination of the plume provides an idea of the velocities we can expect to see at the outer bands of the plume. A contour plot of the velocity can assist with the analysis. The importance of the analysis is that it can provide us with an idea of whether the critical speeds can be reached at a certain distance from the nozzles.



Further analyses to include the obstruction are underway to determine whether the critical velocity can be reached in the tank.