

PIEZOELECTRIC–STRUCTURAL–FLUIDS ANALYSIS FOR AN INK-JET PRINTER NOZZLE

Michael Tooley, Chris Wolfe

ANSYS

ABSTRACT

A common design for an ink-jet printer nozzle incorporates a piezo-electric material that is used to squeeze a structure surrounding an ink cavity. The resulting increase in fluid pressure forces ink droplets out of the nozzle. A well-designed ink jet nozzle should produce a consistent stream of ink droplets at the applied voltage profile frequency. The success of nozzle is dependent on the many design parameters that can affect the droplet shape, frequency and volume, including:

- nozzle shape and hole diameter
- piezo-electric and nozzle material properties
- applied voltage magnitude
- frequency and profile shape
- ink viscosity, surface tension and wall adhesion angles

The response of the piezo-electric material, structure and fluid pressure in the ink cavity are interdependent and their simultaneous impact on the droplet physics must be accounted for. Using multiphysics analysis, the ink droplet shape, volume and ejection velocity can be predicted.

Such a simulation has been carried out using ANSYS Workbench. A voltage profile is applied to the piezo-electric body, producing displacements that are transferred to the attached nozzle. Both the piezo-electric body and nozzle are modeled in ANSYS Mechanical. The fluid cavity inside the nozzle is modeled using ANSYS Fluent.

The structural displacements are transferred to the nozzle walls in Fluent via the system coupling component in ANSYS Workbench. The resulting pressure change in the ink cavity drives the flow simulation with the fluid forces coupled back to the structure simulation through system coupling to produce a two-way FSI response. In Fluent, the VOF approach is used to capture the free-surface shape of the ink droplet as it is released into the surrounding air outside the nozzle. Surface tension and wall adhesion effects are included. Results from the simulation demonstrate the ability of multiphysics simulation to accurately predict the transient behavior and characteristics of droplets being ejected from the nozzle.