Exponent®
Engineering & Scientific Consulting

Zach Owens, Ph.D., P.E.

Senior Managing Engineer | Thermal Sciences
Natick
+1-508-652-8512 | zowens@exponent.com

Professional Profile

Dr. Owens is a mechanical and aerospace engineer who specializes in performing failure analysis and providing design support for problems involving flow and thermal processes. This expertise has been applied to solving problems involving oil and gas, pipelines, drilling, flow assurance, refinery equipment, aircraft, satellites, turbines, consumer electronics, batteries, medical devices, appliances, construction practices, HVAC systems, power plant equipment, power lines and wildland fires. Dr. Owens' work often arises in the context of performing failure analysis for an industrial accident, but he also works proactively with industry to solve problems associated with new product or technology development. Dr. Owens has served as a designated expert and provided testimony on various commercial litigation matters.

Dr. Owens leads multidisciplinary teams leveraging both analytical modeling techniques as well as experimental methods. He has two decades of expertise in developing and using computational fluid dynamics (CFD) software and has applied this tool to a wide breadth of problems. He has specialized expertise in investigating detonations, explosions and overpressure events. This includes containment design for high pressure pneumatic and hydraulic testing. Dr. Owens also has extensive experience evaluating gas and liquid flows in piping systems. This includes evaluating failure mechanisms in these systems that may involve erosion, cavitation, and water hammer. He has also worked extensively on thermal management of electronic systems and mitigation of thermal runaway in battery packs.

Prior to Exponent Dr. Owens held research positions at Stanford University, the University of Virginia and NASA.

Academic Credentials & Professional Honors

Ph.D., Aeronautics and Astronautics, Stanford University, 2008

M.S., Aeronautics and Astronautics, Stanford University, 2004

B.S., Aerospace Engineering, University of Virginia, 2002

Sigma Gamma Tau Outstanding Aerospace Engineering Graduate, 2002

Louis T. Rader Chairperson's Award, 2001, 2002

Licenses and Certifications

Professional Engineer Mechanical, California, #36339

Fire Investigation 1A (Cause and Origin), California Office of State Fire Marshal

Professional Affiliations

Society of Petroleum Engineers (Board Member of New York New England Section 2017-2019)

American Institute of Aeronautics and Astronautics

Tau Beta Pi Engineering Honor Society

Publications

Publications, Conference Proceedings & Presentations

Davies W, Owens Z, Hur IY, Ajdari A, Nirankari Z, Datta D, Vytiniotis A, Levine M. Vibrational Assessment of Injection Well Tubing. SPE, AAPG, SEG: Carbon Capture, Utilization, and Storage. March 2024.

Brandvik PJ, Krause D, Leirvik F, Daling PS, Owens Z et al. Subsea Mechanical Dispersion a Possible New Option for the Oil Spill Response Toolbox?, IOSC International Oil Spill Conference Proceedings 2021.

Favero C, Owens Z, Fogler H. Conditions where asphaltene destabilization are not detected in the laboratory but could still lead to surface fouling, 16th Global Congress on Process Safety, Houston TX, August 17-20, 2020.

Owens Z. Casing failure due to heat checking – New modeling solutions for an old problem. Siemens On-demand webinar, April 15, 2020.

Owens Z, Smyth B, Ames N, Pye J, Hilbert L, Brooks B. Development of a Casing-Integrated Well Control Tool, Offshore Technology Conference, Houston, TX, May 2018.

Owens Z, Gilman L, Dunne R, McNulty J, Kemal A. Evaluation of breathable enclosures for thermal management of outdoor electronics. In Thermal and Thermomechanical Phenomena in Electronic Systems (ITherm), 2017 16th IEEE Intersociety Conference on 2017 May 30 (pp. 6-12). IEEE.

Simeoni A, Owens ZC, Christiansen EW, Kemal A, Gallagher M, Clark KL, Skowronski N, Mueller EV, Thomas JC, Santamaria S, Hadden RM. A preliminary study of wildland fire pattern indicator reliability following an experimental fire. Journal of Fire Sciences. 2017 Sep;35(5):359-78.

Simeoni A, Owens Z, Christiansen E, Kemal A. A study of wildland fire direction indicator reliability following two experimental fires, International Symposium on Fire Investigation Science & Technology, Scottsdale, AZ, September, 2016.

Owens Z, Gilman L, Rosen J, Kemal A. Investigation of variables affecting electrical arcing with applications in wildland fire investigations, 2015 Wildland Fire Litigation Conference, Monterey, CA, May 2015.

Owens ZC, Hanson RK. The influence of wall heat transfer, friction, and condensation on detonation tube performance. Combustion Science and Technology 2010; 182(8).

Owens ZC. Flowfield characterization and model development in detonation tubes. Ph.D. Thesis, Stanford University, February 2008.

Li H., Owens ZC, Davidson DF, Hanson RK. A simple reactive gas dynamic model for the computation of gas temperature and species concentrations behind reflected shock waves. International Journal of Chemical Kinetics 2008; 40(4).

Owens ZC, Hanson RK. Single-cycle unsteady nozzle phenomena in pulse detonation engines. Journal

of Propulsion and Power 2007; 23(2).

Owens Z, Hanson R. Preliminary investigation into the influence of transverse waves in PDE simulations. 21st International Colloquium on the Dynamics of Explosions and Reactive Systems (ICDERS), Poitiers, France, 2007.

Owens ZC, Mattison DW, Barbour EA, Morris CI, Hanson RK. PDE flowfield characterization and simulation validation using cesium-based velocimetry. Proceedings, Combustion Institute 2005; 30:2791-2798.

Owens Z, Hanson R. Unsteady nozzle design for pulse detonation engines. Oral presentation, 41st AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, Tucson, AZ, July 2005.

Barbour E, Mattison D, Owens Z, Hanson R, Morris C. A pulsed detonation tube with a converging-diverging nozzle. 43rd AIAA Aerospace Sciences Meeting, Reno, NV, January 2005.

Barbour E, Owens Z, Morris C, Hanson R. The impact of a converging-diverging nozzle on PDE performance and its associated flowfield. 42nd AIAA Aerospace Sciences Meeting, Reno, NV, January 2004.

Mattison D, Barbour E. Oehlschlaeger M, Owens Z, Hanson R. UV optical diagnostics for PDE applications. 39th AIAA/ASME/SAE/ASEE Joint Propulsion Conference, Huntsville, AL, July 2003.

Owens Z, Goyne C, Krauss R, McDaniel J. Assessment of particle seeder performance via direct flowfield sampling. Oral Presentation, 41st AIAA Aerospace Sciences Meeting, Reno, NV, January 2003.

Project Experience

Selected Project Experience

Oil Spill Investigation

Multiple large scale investigations involving oil spill release quantification, analysis of drilling and/or operational data, evaluation of well abandonment, evaluation of well control response and evaluation of well control safeguards, such as blow out preventer (BOP) systems.

Buried Pipeline Leak Investigation

This work involves evaluating leaks in gas, liquid and multiphase pipelines. Often these pipelines are buried but the analysis techniques can also be applied to above ground pipelines. These studies typically involve predicting the leak rate and sometimes also involve evaluating the expected timeline for product to daylight at the surface in the case of buried pipelines. These analyses can be used to inform leak timing which may have ramifications for insurance coverage or toxic tort litigation. My team has developed sophisticated, CFD-based modeling techniques to predict the release of product in the near-field of the leak site and account for the effects of detailed through-wall pipeline crack geometry, pipeline sleeves, as well as the potentially heterogenous nature of the soil/backfills surrounding the leak site.

Pipeline Explosion

Investigation of the rupture and subsequent explosion of a natural gas pipeline that became immersed in a fire started on an adjacent pipeline. This project involved analyzing how the adjacent fire contributed to the rupture and whether any remedial actions could have prevented the incident.

Aircraft Cabin Air Quality Investigation

Investigate allegations of adverse air quality in aircraft cabins. This work involved reviewing literature, previous studies and design documents, as well as inspecting aircraft and developing contaminant quantification models.

Hydroelectric Turbine Failure Analysis

In this work a simulation-based analysis is used to predict the location of cavitation erosion and its role in the deterioration of the materials used in the seal passages of a hydroelectric turbine. The analysis demonstrates that cavitation erosion is predicted in seal designs where damage is observed and not predicted in seal designs where similar damage is not observed.

Satellite Failure Investigation

After deployment of the satellite solar arrays in orbit our client observed damage that would limit their satellites intended lifespan. Anomalous audible cues recorded by microphones in the payload bay during ascent gave clues as to the source of the problem. Our analysis was able to triangulate the recorded acoustic signals and pinpoint the source of the problem.

Aerosol Transport Study

This study involved modeling the transport of an aerosolized disinfectant within indoor public spaces. Client needed to understand fraction of disinfectant that would reach intended surfaces as opposed to being convected away by typical HVAC currents or evaporate prior to reaching the intended surface. The computational fluid dynamics (CFD) methodology developed can be applied to many other aerosol transport problems, including COVID-19 transport.

Refinery Failure Investigation

Many different projects over the years dealing with fires and explosions as well as failure of piping, valves and flare systems.

Gas Turbine Failure Analysis

The fuels nozzles on gas turbines in a generating plant experienced recurring failures. After reviewing operating data and inspecting the failed gas turbine components it was determined that a combination of operating conditions and nozzle design were major contributing factors to the failures. In particular, one failure mode involved sustained flashback of the flame onto the nozzle tips which then caused coking of accumulated liquid hydrocarbon contaminants in a dead-ended fuel nozzle passage.

Failure Investigation of Campus Hot Water System

Shortly after a campus-wide utility upgrade involving the hot water distribution system wide spread failures were observed on the associated piping and valves. Our work showed that these failures were the result misoperation leading to cavitation in the piping rather than an inherent design deficiency.

High Pressure Testing Containment Evaluation

Developed a suite of software tools that have been used by a major aerospace manufacturer for over a decade to evaluate containment safety during high pressure component testing. For both hydraulic and pneumatic testing methodologies have been developed to determine shield sizing to prevent projectile penetration as well as to predict resulting overpressure loads on the containment.

Flow Assurance Research

Hired by oil and gas operator to construct a large-scale flow loop (4 inch diameter, 50 ft test section) and perform fundamental research on the behavior of high wax content oils. This work is the first known demonstration of measuring velocity profiles by using ultrasonic reflection from the un-dissolved wax content in oils. Ultimately this work is aimed at improving flow assurance for transport of waxy crude oils.

Engineering Analysis for Carbon Capture & Storage (CCS) Developments

As part of this work my team performed analysis to evaluate risks associated with erosion, vibration, and stress/fracture/fatigue in tubing intended for a CCS development in the North Sea.

Battery Pack Analysis

Oversaw experiments to characterize battery performance (thermal runaway, charge/discharge cycling) and performed modeling to improve heat management and minimize risk of cell-to-cell propagation during thermal runaway.

Thermal Management of Electronics

Client developed a grid-based internet connectivity device for underserved urban and suburban environments. Focus of our efforts was on device thermal management that needed to be accomplished under constraints imposed by the industrial design team, contract manufacturer, and PCB designers. This included optimizing solar load management, fin sizing, via placement and thermal interface materials selection.

Transmission Line Flashover Analysis

Developed analysis tools that an electric utility client will use to predict electric flashover risk on its transmission line assets. LIDAR surveys are used to characterize clearances between transmission lines and potential flashover targets. Models then predict flashover probability as a function of line operating parameters and weather conditions, including wind loads. This tool is used to mitigate wildland fire risk.

Oil Spill Response Technology Development

My team collaborated with partners at SINTEF and Oceaneering to develop a water-jet based mechanical dispersion technology to enhance droplet breakup in a subsea oil release. Smaller droplets have lower rising velocities, are more influence by oceanic turbulence and have a larger potential for natural biodegradation. This technology has advantages over conventional chemical dispersants in situations where local regulations limit chemical injection, application is ineffective or transport of large dispersant volumes is impractical.

Risk Mitigation of Heat Checking during Drilling

Increasingly, with directional drilling of non-vertical wells, the drillstring can move off center in the wellbore and contact the casing. This results in large, localized heat loads at the contact point leading to high temperatures that are subsequently quenched by cool drilling fluid. The result is the formation of thin martensite layer which is brittle and susceptible to cracking. This mechanism of failure lead to $100+ million in well remediation costs for our clients in the span of a few years. My work involved building a real-time analysis tool to model the underlying fluid, thermal and tribological phenomena allowing a prediction of the operational circumstances (RPM, side load, rate of penetration) during which this phenomena is expected to occur.

Blood Testing Device Development

Client objective was to do automated diagnostic tests on a very small blood volume. As a result of the small sample volume automated pipetting operations within the device needed to be optimized to

minimize any fluid losses. My work involved analyzing these operations to understand how capillary effects, evaporation, temperature and other variables would affect fluid losses.