

Numerical investigation of the gas jet formation immediately after opening a champagne bottle

L. Wagner^{a,b}, S. Braun^b and B. Scheichl^{a,b}

This contribution presents the numerical simulation of the emissive behaviour of pressurized CO₂ gas inside a Champagne bottle in the first few milliseconds after the cork popping. The proposed flow configuration¹ assumes an ideal gas undergoing an axisymmetric adiabatic expansion and thereby propelling the cork, taken as a solid object, in the axial direction. The numerical solution of the Euler equations for each time step is typically found via Godunov's method, receiving the waves and corresponding fluctuations from a specifically modified HLLC-solver, all implemented inside the CLAWPACK software. Some issues concerning the shock capturing and its stability are discussed. The analysis mainly focuses on the dynamics of the Mach disk created between the cork and the bottle opening. The correct prediction of the isentropic change of state there demonstrates the reliability of the simulated transient behaviour of the flow. As an interesting finding, the actual state of the Mach disk appears to depend sensitively on the actual fluid-cork interaction. Furthermore, comparing the position of the Mach disk for a series of time steps reveals a high correlation between the results obtained through simulation and real experiment¹. In particular, the appearance of the shock wave after half a millisecond, its disintegration and even the proposed¹ retraction behaviour of the newly created second wave can all be observed in both cases. A refined model incorporating dry friction between the cork and the bottleneck is also addressed.

^a AC2T research GmbH, Wiener Neustadt, Austria.

^b Institute of Fluid Mechanics and Heat Transfer, TU Vienna, Austria.

¹ Liger-Belair et al, *Sci. Adv.* **5**, 1 (2019).

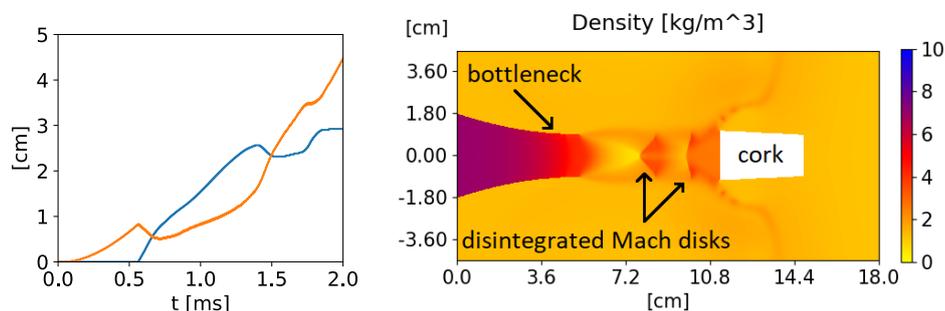


Figure 1: Left: distance between the Mach disk and the bottle opening (blue) and between the Mach disk and the cork (orange); right: density contour plot at 1.7ms after the popping.