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This thesis details work performed towards the completion of a Masters of Science in Mechanical Engineering. Two topics are discussed towards the study of shock driven multiphase hydrodynamic instabilities. The first topic, expanded upon in chapter 2, covers design work for the body of the Missouri shock tube experimental facility. The shock tube facility is a device which creates shock waves by mechanically releasing high pressure gas into a low pressure region. This shock wave travels through the tube and interacts with an interface created through the pairing of multiphase and/or multispecies components. It was found that the maximum allowable Mach number in Air is 2.75, when considering both safety of the user and the facility itself. The second topic, considered in chapters 3 and 4, investigates the shock driven multiphase instability through the use of two multiphysics codes developed at Lawrence Livermore National Laboratory and Los Alamos National Laboratory called Ares and FLAG respectively. In these simulations a shock wave with the Mach number 1.5 and an effective system Atwood number of 0.11 are considered. This Atwood number is created by considering the effective density field created by the presence of the multiphase components, initialized as spherical particles. In both chapters this instability is compared to the traditional shock driven single phase multi-density hydrodynamic instability, termed the Richtmyer-Meshkov instability (RMI), created to be an equivalent approximation through the use of mass averaging the particle properties to create an effective gas. Chapter 3 explores the parameters involved in the multiphase instability, highlighting that by increasing the particle size noticeable morphological differences occur between the RMI and the multiphase instability due to the decrease in circulation deposition. Chapter 4 continues the comparison, with the inclusion of particle evaporation. It was found that evaporation showed a slight increase in circulation over the non-evaporating particle case, with both these cases still exhibiting less circulation than the RMI equivalent. A reshock study was also performed due to the nature of evaporation to change the particle effects and post-shock scalar fields. This studied showed that the inclusion and then increase in evaporation changed the post-shock conditions such that the reshocked system would then exhibit more circulation deposition than the previous limiting case, the RMI equivalent. It was also found that the reshock morphology of the multiphase instability differed from the traditional RMI with increasing similarity due to increasing evaporation.