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Implementation of appropriate particle dynamics in CFD for wet compression

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Compressor is a very important part of power producing gas turbine system. Compressor compresses air before the combustion chamber. During a hot summer day, air is heated and expanded, for which compressor load is increased. When compressor load is increased, the power production is decreased. There are a few ways to minimize the power reduction, one of which is to spray water before the compressor bell mouth. Due to the presence of water particle, air gets more saturated and its temperature keeps dropping, which results in power enhancement. The presence of water particle introduces a number of physics, e.g. evaporation of water particles, coalescence and break-up of droplets, drag force and heat transfer between the air and water particles, erosion in the compressor blades due to water particles etc. Discrete particle method is used to model the wet compression, which treats air as the main fluid and water particle as the discrete phase. Lagrangian method is applied to characterize the discrete phase, where each particle is tracked individually. Evaporation of water particles is governed by the saturation temperature and pressure relationship, which is supported by most of the commercial CFD software. Coalescence can be modeled in many different ways and some of the renowned models are built-in in most of the CFD software. Taylor analogy breakup method is used to model the breakup of the droplets. Drag force and heat transfer are modeled by the response time (Time taken by the water particle to match the velocity of air) of water droplet. Regarding erosion, most of the CFD software has built-in solid particle erosion model, which are little different from the liquid particle. User defined function needs to be developed to model the appropriate model. This purpose of this presentation is to demonstrate the above mentioned droplet dynamics in CFD software.

Biography

Jobaidur Rahman Khan finished his undergraduate degree in 1996 from Bangladesh University of Engineering and Technology with the major in Mechanical Engineering. Then he worked in industry for two years and then came to USA in 1998 for Graduate study. He finished his MS in Mechanical Engineering from University of New Orleans, Louisiana in 2001. He worked in industry for another two years and continued his Doctoral study in Mechanical Engineering in the same university. He started his research on Wet Compression since 2003. During his Doctoral research, he published half a dozen of conference papers, of which one of the papers was awarded the best paper in ASME Turbo Expo Conference in 2011. He finished his PhD in 2008, where he started his Post-doctoral research and started working as Adjunct Professor in the University of New Orleans. He started working in Georgia Southern University in Statesboro from 2012, where he worked for a year and then started working in University of Buffalo (State University of New York, SUNY Buffalo) as Teaching Assistant Professor. He is still continuing his research on alternate energy.

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