Jet Engine Performance Degradation due to Droplet Nucleation and Water Ingestion

Thirty years ago, engineers interested in flow condensation worked on steam turbines. Since then, the subject has expanded and found application in several other parts of the turbomachinery world. For example, jet engine performance is adversely affected by heterogeneously nucleated droplets in the engine intake ducts, and also by the ingestion of the much larger droplets encountered in tropical rain storms. The latter have a major effect in the 'descent-idle' operating condition and in some cases cause 'flame-out'.

Nucleation in intakes is discussed in [1995] and includes some predictions of the atmospheric particle concentrations and humidity levels required to cause substantial water formation. These were later confirmed almost exactly by site measurements. The effect of tropical rain ingestion is discussed in [2007] with the focus on analytical methods for predicting the movement of water on rotating blades. This problem, well-known and often discussed qualitatively, has not yielded to analysis before.

Young JB. 1995. Condensation in jet engine intake ducts during stationary operation. *ASME. J. Eng. for Gas Turbines & Power*. 117: 227-236.

Williams JC, Young JB. 2007. Movement of deposited water on turbomachinery rotor blade surfaces. *ASME. J. Turbomachinery*. 129: 394-403.