Failure analysis of multiphase flow corrosion–erosion with three-way injecting water pipe

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Abstract: Water injection is an essential component in a reaction effluent air cooler (REAC) system because its primary function is to dissolve the generated ammonium salt, which leads to deposition or blockage accidents. A damage incident in a three-way pipe made of carbon steel under the multiphase flow field was investigated. The failure analysis was performed by means of scanning electron microscope (SEM) inspection and computational fluid dynamics (CFD) simulation. CFD results show that a large velocity gradient exists near the area of 5–12*d* at the bottom of the main pipe. This gradient results in a region of low flow velocity, high wall shear stress, and high turbulent kinetic energy. The flow state becomes very chaotic, and the non-uniformity coefficient of velocity is high. The corrosive medium (NH_4Cl or H_2S) dissolving in water increases the causticity of fluid medium and aggravates the flow corrosion. The high risk area from the CFD simulation coincides with the breakage area of the three-way pipe on the spot. This failure incident is attributed to the flow corrosion–erosion.

Keywords: Air cooler system; Water injection; Pipe failure; CFD; Flow corrosion–erosion