

Jet Diffusion Flame Suppression Using Water Sprays—An Interim Report

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Abstract—The feasibility of using water sprays for the control of offshore oil/gas well blowout fires has been addressed. Considering the sheer scale of the problem, knowledge from a fundamental viewpoint is going to be required in order to extrapolate laboratory-sized flame studies up to full scale. Available data and appropriate literature concerned with the application of water sprays as a jet diffusion flame suppression/extinguishment agent have been reviewed. Small pneumatic atomizing nozzles using H₂ gas, both as the flame source as well as the atomizing driver, have been used to scale high momentum jet flames and to study the effect of water on the flame. Thermodynamic equilibrium was shown to be an effective guide in interpreting the results. The effect of flame temperature reduction due to water sprays has been observed to correlate with a single spray parameter—the median drop diameter. Directions for further study have been indicated.

Key words: Blowout fires; fire suppression; flame temperature; offshore well fires; water sprays; well fires.

INTRODUCTION

The object of this work is to study the interaction of water droplet sprays with high momentum jet flames in order to elucidate the physio-chemical mechanisms responsible for flame suppression/extinguishment. The study will provide the basis for estimating the feasibility of using water sprays for offshore oil/gas well blowout fire protection. Due to the sheer scale of the problem manifested in the large quantities of gas involved in blowout fires, it will be impossible to extrapolate or scale upward, with any degree of certainty, the results and conclusions of laboratory-scale experiments without this fundamental understanding of the participating mechanisms.

In the final analysis, the feasibility of the concept will depend on whether the amount of water deemed necessary for suppression/extinguishment is within the pumping power of the off-shore facility. A tacit assumption prevailing here is the existence of a virtually limitless supply of water (and pumping power) as opposed to some stored chemical inhibitor which would perhaps provide a more effective suppression action initially but might prove to be deficient in the circumstances of re-ignition or lack of total extinguishment. From engineering considerations of scale the variable chosen here to represent the amount of water is the ratio of the mass flow rate of water to that of the gas, $\dot{m}_{\text{H}_2\text{O}}/\dot{m}_{\text{gas}}$. The feasibility of the approach will depend strongly on how reasonable (as yet undefined) this ratio turns out to be.

The following table gives an estimate of the scale in terms of fire size attainable in various laboratories contrasted to the expected size of full scale blowout fires.

Also shown is the equivalent expected order of gas flow in millions of cubic feet per day. It is conceivable then to reach, with experiment, to within one order of magnitude of full scale. Information garnered at each lower scale where more