Effects of Steam-Assist on Industrial Flaring Emissions Control

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Background

Flaring takes place during the extraction and processing of hydrocarbons and involves burning off undesired gases in large open flames. Environmental studies suggest gas flaring is a major contributor to Arctic warming due to the presence of black carbon in the smoke created by flares.

Figure 1: North Dakota's largest natural gas plant [1]

Certain methods are used in industry to reduce the production of smoke. A common method, called "steam-assist," is believed to improve combustion efficiency and suppress smoke formation by adding steam to the flame.

Figure 2: Steam-assisted flare [2]

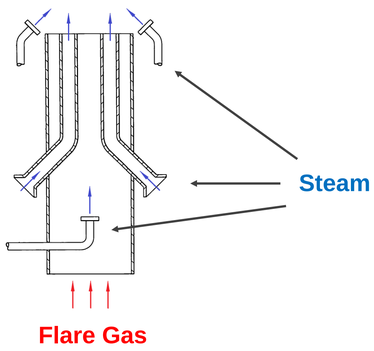

Figure 3: Steam-assisted flare section view

Objective

A study done by the TCEQ (Texas Commission on Environmental Quality) exposes the routine overuse of steam in industrial flaring [3]. Too much steam smothers the flame and allows waste gas to escape into the atmosphere unburned, inadvertently creating a serious climate forcing scenario. Therefore, the objective of this research is to develop a better understanding of the effect of steam on flare emissions.

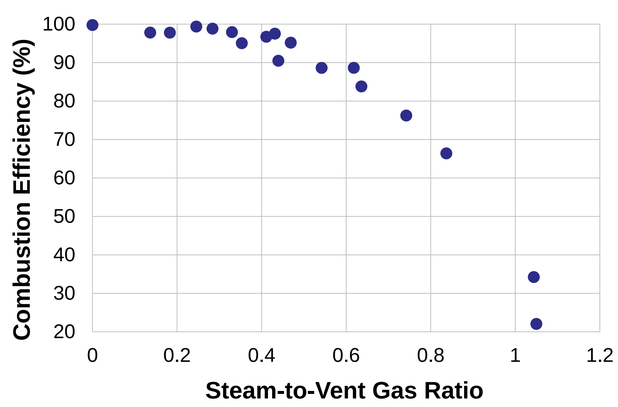

Figure 4: Combustion efficiency in relation to steam-assist [3]

Experimental Setup

Research on steam-assisted flaring has commenced at the University of Alberta with the construction of a one-inch diameter, one-foot high cylindrical burner. Steam-assist is simulated by sending steam to the burner tip either through an inner concentric tube or the annulus between the inner and outer tubes. Consideration will be given to the varying designs of industrial flare stacks by testing different inner tube diameters.

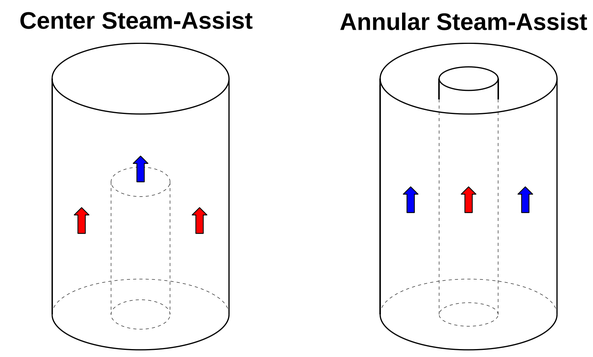

Figure 5: Steam-assist burner schematic

An electric steam generator is used to introduce steam to the combustion process. A differential pressure flowmeter will be used to control the mass of saturated or superheated steam sent to the flame.

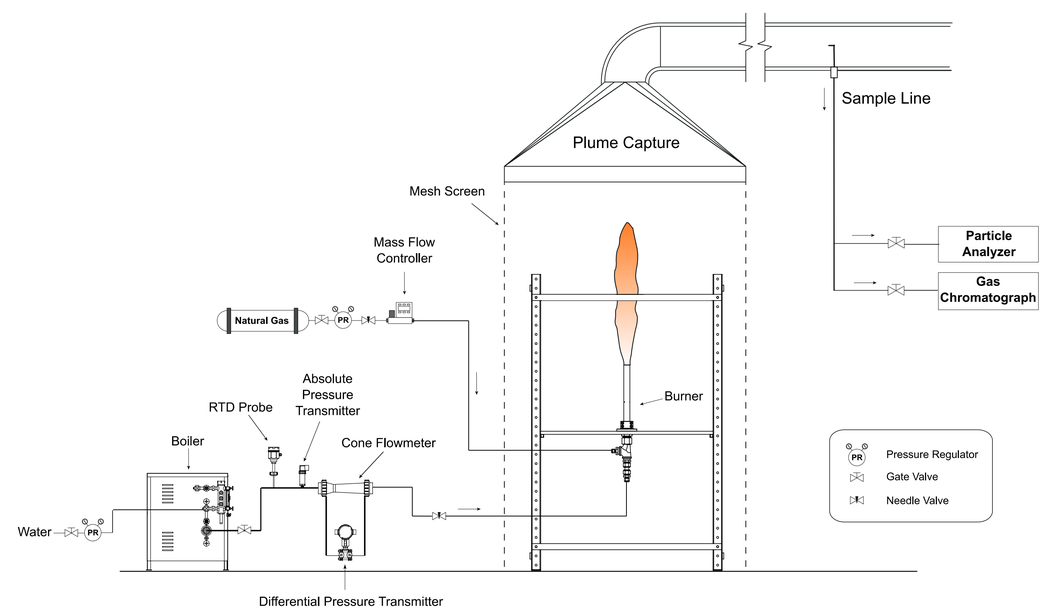

Figure 6: Lab-scale steam-assisted flare

Samples of the burner exhaust will be drawn and analyzed using a gas chromatograph to study the effect of steam on flame combustion efficiency.

Figure 7: Varying amounts of steam injected into the base of a natural gas flame

Conclusion

By investigating steam-assisted flaring practices through experimental research, models can be developed to quantify flare-generated pollution.

References

1. http://www.grandforksherald.com/news/business/3885801-north-dakotas-largest-natural-gas-plant-repairs-will-add-flaring
2. https://www.shutterstock.com/video/clip-5408876-stock-footage-oil-refinery-gas-flare.html
3. Allen, D. T., & Torres, V. M. (2011, August 1). *TCEQ 2010 Flare Study Final Report*