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Evaluation of a New Approach for Estimating the Amount of Flared Gas and Emission Estimation of Particulate Matters from Flaring of a Gas Process Plant

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Introduction

According to World Health Organization (WHO) definition, black carbon and the soot resulted from incomplete combustion of fossil fuels are considered as particulate materials [1]. Carbonated particulate materials especially aromatic compounds are highly hazardous for human health and possibly carcinogenic [2]. The flare system is used in oil and gas refineries to burn organic materials in waste gas compound in the time of starting up, overhaul, repairmen and process stops. Flare is an open air combustion system to prevent the release of explosive and toxic gases to the atmosphere through converting them to water and carbon dioxide. Iran is the greatest country of the world considering the amount of natural gas resources and is the third country of the world considering flaring waste gases. According to the estimation of World Bank, more than 16.4 billion m3 of gas is being flared in Iran every year. In this study, the flowrate of the flare gas is estimated using steady-state modelling and continuous scanning of the flare network once every 10 minutes by reverse engineering method and based on the flow equations for determining the size of control valves for compressible fluids according to ANSI/ ISA-75.01.01 standard method [3].

Materials and Methods

In order to estimate the particulate materials emission from the flare system according to the protocol suggested by US EPA, the online monitoring devices are needed to measure the flow rate and composition of the gas sent to the flare; however, due to technical limitations of using online devices, the gas flow rate is

in this research with a method which is developed based upon ANSI/ISA-75.01.01 standard of American National Standard Institute (ANSI) and control valves handbook [3,4]. Therefore, using steady-state modelling and continuous scanning of the flare network in 10-minute intervals, the amount of gas passing from the control valves on the lines leading to the flare, composition and the source of the flare gas are simulated and the amount of total particulate materials emission from the flare is predicted.

Results and Discussion

Flare gas flowrate determination

Table 1 shows the characteristics of one of the control valves which are led to the flare network in gas sweetening unit as an example.

Analyzing 8567 recorded data by the flowmeter for gas flowrate and comparing with predicted data by the model at the same time period for the same process line showed that the relative error for the method is ±21% which is acceptable in industrial scale (Figure 1).

The analyses conducted on the results of the model and validation of composition and flowrate prediction data with field measurements show that the proposed model is accurate enough in estimation of composition and flowrate of the flare gas.

Table 1: flowrate changes vs opening percentage for the valve PV1010081.

Flowrate (kg/h)	Opening Percentage	Opening Situation
20790	83.37	Maximum
18900	75.48	Normal
6930	25.49	Minimum

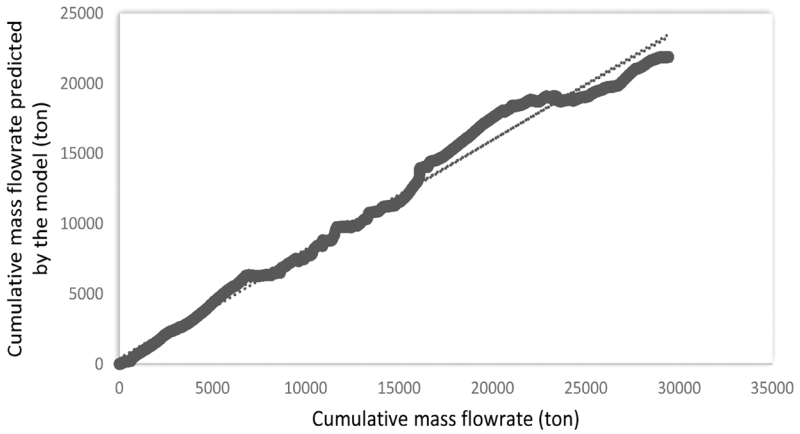

Figure 1: The comparison between cumulative mass flowrate predicted by the model and actual cumulative mass flowrate for 8567 field data.

Conclusions

Burning waste gases in natural gas refineries is one of the main reasons of particulate materials such as soot and aromatic compounds emission to the atmosphere. The activities of more than 60 flares of gas refineries and petrochemical complexes in PSEEZ in Bushehr province, Iran, has made this area one of the most polluted zones of Iran regarding the concentration of PM in the air. Therefore, permanent monitoring of flare networks in the refineries is necessary and has a significant role in managing pollution emission from the flare. The already-existing methods of flare's pollution emission monitoring are not generally possible and not capable of accurate determination of the amount of emission due to process complications. Therefore, it is tried in this research to propose a model for estimating the flowrate and composition of the flare gas and to determine the amount of contaminant emission and the types of contamination using the equations of control valves. The importance of the model proposed in this research is not only no new complicated and expensive devices of measurement are needed, but also, only, through checking the control valves and using fluid mechanical correlations, the amount of PM emission from the flare will be possible. Determination of sources and shares of each unit from the flare gas makes it possible to decide better about the flare gas recovery in order to minimize the contaminants emission; moreover, the determination enables the operator to have a better control and management on production and emission of waste gases in the whole refinery.

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