Minimization of Fuel Consumption of Natural Gas Compressor Stations with Similar and Dissimilar Turbo-Compressor Units

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Abstract

The present paper is concerned with the minimization of fuel consumption of natural gas compressor stations (CSs). The optimization methods used in this paper consist of a simple and fast heuristic approach (which assumes equal utilizations for all running turbo-compressor (TC) units), Genetic Algorithm (GA), and Exhaustive Search method (ES). In the first case study, a CS with similar TC units located along the third Iranian gas transmission pipeline, and in the second case study, the same CS but with the assumption of having dissimilar TC units was investigated. The results, obtained for specified rate of natural gas passing through the CS (150 million standard cubic meters per day, MMSCMD), and specified CS inlet and outlet pressures (5.45 MPa and 6.89 MPa, respectively), showed that for the CS with similar TC units, all the applied optimization approaches resulted in the same solution with the fuel consumption rate of 3.620 kg/s. By contrast, for the CS with dissimilar TC units, GA and ES attained lower fuel consumption rate (3.738 kg/s) compared to that obtained by the heuristic method (3.753 kg/s). As a result, the assumption made by the heuristic approach (equal utilizations for all running units) was accurate for the CS with similar units, but it led to suboptimal solution for the CS with dissimilar units. The sensitivity analysis of the optimal fuel consumption rate to the CS important

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operating parameters showed that any increase in the CS flow rate or in the CS discharge pressure, as well as any reduction in the CS suction pressure resulted in an increase in the optimal fuel consumption rate. The variations of the CS flow rate, suction pressure, and discharge pressure within the ranges of 100-200 MMSCMD, 5.03-5.86 MPa and 6.48-7.31 MPa, respectively, caused the optimal fuel consumption rate to vary within the ranges of 2.430-4.836 kg/s, 4.587-2.869 kg/s and 3.099-4.115 kg/s in the first case study, and within the ranges of 2.430-5.152 kg/s, 4.690-2.978 kg/s and 3.225-4.251 kg/s in the second case study.

Keywords: Natural gas compressor station; Optimization; Fuel consumption; Genetic Algorithm