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OPTIMIZATION OF FUEL CONSUMPTION IN COMPRESSOR STATIONS

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ABSTRACT

Natural gas passing through pipelines is transported via compressor stations which are installed in pipeline network systems. As the gas flows through the network, energy and pressure are lost due to both friction between the gas and the pipes' inner wall, and heat transfer between the gas and its environment. These stations are usually installed at above 60 miles away from intervals in order to overwhelm the pressure loss and typically consume about 3-5% of the transported gas. These facts make the problem of how to optimally operate the compressors driving the gas in a pipeline network is important. A model has been studied to minimize the consumed fuel and to stumble on suitable decision-making variables. This paper optimized non-linear mathematical relationships which are required to evaluate the steady, isothermal, one-dimensional and compressible flow pipelines. Genetic algorithms are used as the optimization methodology.. The optimization modeling aims to improve the fuel consumption in the compressor stations available in the network according to conditions of the transmissions.

Keywords: optimization, fuel consumption, compressor.

INTRODUCTION

(Flores 2003) extended a study by means of an extensive computational evaluation of the Generalized Reduced Gradient method to obtain fuel cost minimization problem.(Conrado Borraz 2010) shows minimizing fuel cost in gas transmission networks by dynamic programming and adaptive discretization. (David 1985) show Genetic algorithms were employed for the first time in 1985 for the optimization of the pipelines..(Fred Odom et al 1991) members of a solar turbine manufacturing corporation presented two diverse versions for modeling gas turbines which activate centrifugal compressors. (Samuel Andrus 1994) wielded the spread sheets for the first time to simulate the steady state gas transmitting pipes and network stipulating that the compressibility factor is constant for all the systems. The aforementioned methodology was executed once again by (Ian Cameron in 1999) from Trans Canada to examine both steady and transient flows in Excel software. (Chapman & Mohammad Abbaspour 2003) from Kansas varsity have made abundant perusals in the fuel optimization methodologies in compressor stations in the non-isothermal and transient conditions using compressors shafts velocities as a decision-making variable.

The Genetic Algorithms is used to obtained the optimization results and the relationship of objective function can be simplified to the following equation:

$$\min \sum_{i=1}^{n} FC\left(S_i\right) = \min \sum_{i=1}^{n} \frac{PWR_i}{\eta_{Di} \times HV}$$

Subject to:

$S_{\min} \le S \le S_{\max}$ where S_{min} minimum speed, S_{max} maximum speed

$surge \le \frac{Q}{S} \le stonewall$ *surge* is limit surge, *stonewall* limit stonewall

$\mathbf{H^L (Q) \le H \le H^U (Q)}$ **and** $\mathbf{Q^L \le Q \le Q^U}$

Table 1 shows the results before and after optimization process.

Table 1 - results before and after optimization

Station 1	Before optimization	After Optimization
1 st Comp. Speed	211.25 rev/s	205.14 rev/s
1 st Comp. Efficiency	81.21	81.01.
2 ed Comp. Speed	193.61 rev/s	188.62 rev/s
2 ed Comp. Efficiency	79.51	79.24
3 ed Comp. Speed	181.1 rev/s	179.3 rev/s
3 ed Comp. Efficiency	78.31	78.29

Station 2	Before Optimization	After Optimization
1 st Comp. Speed	211.25 rev/s	205 rev/s
1 st Comp. Efficiency	81.21	80.89
2 ed Comp. Speed	193.61 rev/s	187 rev/s
2 ed Comp. Efficiency	79.51	79.34
3 ed Comp. Speed	181.1 rev/s	179.05 rev/s
3 ed Comp. Efficiency	78.31	78.17

The Mass Flow Rate before optimization is 377.87 lbm/s and after optimization is 370.42lbm/s.

The Fuel Consumption before optimization is (186 lbm/s x103) and after optimization is (170.13 lbm/s x103).

CONCLUSIONS

Using modular programming techniques and Genetic Algorithm, the operational optimized points in fuel consumption were generated. The model was further applied to a case study and best operational points with the minimum rate of fuel consumption were established for a typical compressor station.

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