Optimized Water Supply Network of Pipeline by Particle Swarm Optimization with the Increment of the Utilization of Pipe

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Abstract- The construction and maintenance of pipelines for water supply costs many millions of dollars every year. As funds for the development of new infrastructure become increasingly scarce, there is an increasing desire to achieve the highest level of effectiveness for each dollar spent. Traditionally, the design of water distribution networks has been based on experience. However, there is now a significant (and growing) body of literature devoted to optimization of pipe networks. The genetic algorithm technique is a relatively new optimization technique. In this paper we present a methodology for optimizing pipe networks using genetic algorithms and particle swarm optimization. In this thesis decision variables are coded as binary strings. We investigate a three-operator genetic algorithm comprising reproduction, crossover, and mutation. Results are compared with the techniques of complete enumeration and nonlinear programming. We apply the optimization techniques to a case study pipe network. The genetic algorithm technique finds the global optimum in relatively few evaluations compared to the size of the search space. The particle swarm optimization more improve the pipeline cost and relative cost by its global and local optimization

I. INTRODUCTION

The water distribution system is one of the significant prerequisites in urban and local financial improvement. For any organization managing the outline of the water distribution system, a monetary plan will be a target. Endeavors ought to be made to decrease the cost and vitality utilization of the distribution system through optimization in examination and plan. A water distribution organize that incorporates promoter draws mounted in the pipes, weight diminishing valves, and registration can be dissected by a few normal techniques, for example, Hardy Cross, direct hypothesis, and Newton-Raphson.

The most vital thought in planning and working a water distribution system is to fulfill shopper requests under a scope of amount and quality contemplations amid the whole lifetime for the normal stacking conditions. Additionally; a water distribution system must have the capacity to oblige unusual conditions, for example, softens up pipes, mechanical disappointment of pipes, valves, and control systems, control blackouts, glitch of storerooms and incorrect request projections. The likelihood of event of every one of these insufficiencies ought to be inspected to decide the general execution and in this way the unwavering quality of the system. By and large, unwavering quality is characterized as the likelihood that the system performs effectively inside indicated limits for a given timeframe in a predetermined domain. As it is characterized above, unwavering quality is the capacity of a system to give satisfactory level of administration to the shoppers, under both ordinary and unusual conditions. Notwithstanding, there is as yet not a helpful assessment for the dependability of water distribution systems.

Pipeline is the main sufficient and inexpensive mode of transportation of the hydrocarbons to land for processing and allocation. Wide-ranging business and engineering considerations go into the pipeline installation procedure. Offshore pipeline installation process has a proven track record. On the other hand, many technical challenges are encountered besides weather, water depth and installation vehicle potential and require to be addressed carefully during an installation process.

Types of pipeline are following:

- Rigid
- Flexible
- Composite

II. LITERATURE REVIEW

Zhang, Duo, et al. [1] explained the approach for sewage in-line control flow and clearly describes the free space usage of the pipes to reduce the overflow at the waste treatment plant. Basically, this work is done by using the hydraulic techniques and neural networks. Free space in the sewer system is identifying by using the detailed hydraulic model. The proposed method enhances the decision making and provides an effective response time for proposed control solution. Flow is forecasted by using the recurrent neural network. At last, the performances of the three models are compared and long-short-term memory has the capability for time series prediction[1] .Zhang, Haoran, et al. formulated a method which is based on the inverse hydraulic thermodynamics method and Particle Swarm Optimization. This work is done for leak detection and localization method in liquid pipelines. For numerical model continuity, momentum and energy equations are used. To analyze the virtual pipeline four types of algorithm are used. The parameters used for evaluation is accuracy, robustness, stability and false alarm rate. SIPSO algorithm is proposed and tested on two oil pipelines. This method estimates the location, coefficient and starting time of leakage[2].Matthews, John C., et al. worked on the pipeline installation and rehabilitation methods. This work is done to find out the optimum solution for the rehabilitation of multiple pipe segments. The proposed support system is divided into two parts. Firstly it selects the optimum method which solves the problem properly. The second part analysis the quality, time and cost of the project. In this work multiple pipe segment optimization and total cost reduction. This work also presents the optimal solution by evaluating the trenchless technology [3].

Fouial, Abdelouahid, et al. worked on the irrigation distribution network.to solve the problem of the hydraulic pipeline. The rehabilitation of these pipelines is a basic need for farmers to provide effective services. To provide the cost-effective strategy computer model is used which provides the effectiveness of decision making. An algorithm is used for automatic search of the best looping position in the network[4] .Wang, Hai, et al. described an optimization model which is used to achieve the lowest power consumption. This model is able to adapt the heat fluctuation load of renewable. By using proposed method substation branch reaches the minimum excess head. The output of the pumps is sensitive to heat load fluctuation of renewable. The variation of the total pump work is analyzed by sensitivity [5].

Wang, Peng, et al. formulated the fast method for hydraulic simulation of natural gas pipeline network which is based on divide-and-conquer approach. When the size of the pipe network is increased then computation burden and time is also increased. To solve this approach fast method firstly solved the variables of multi-pipeline interconnection nodes then it divides the network into independent pipelines and solves the equation of all pipelines. The performance evaluation is done on the SPS simulator. It shows that the computation time linearly depends on the number of pipelines in the network [6].Wang, Bohong, et al. MILP model is formulated for natural gas network design. This method determines the connection of pipelines and compressor stations. Piece-wise linearization method is also applied to this model. It solves the complicated problem of natural gas transmission network optimization. This method also reduces the construction cost [7].Su, Huai, et al. described a method which analyzes the reliability of the natural gas pipeline network. To solve the issue of uncertainty and complexity graph theory, thermal hydraulic simulation and stochastic processes are integrated. Unit states and network structure are the two factors on which supply capacity of pipeline network depends. A stochastic model is developed in this work which is based on the Markov model and graph theory [8].Valyukhov, S. G., et al. explained an approach for the design of the flow path of the main oil pump. The maximum energy of the pump is used to optimize the flow path. The proposed model is based on the hydrodynamics process and mathematically simulated on ANSYS system. This system is combined with non-linear programming system for effective results[9].Rahmanifard, et al. combined the Wattenbarger slab model and pseudo pressure model in net present value as the objective function. This work is based on the four variables that are HF stage, spacing, half-length and wellbore spacing. The objective function is optimized by combining the genetic algorithm, differential evolution and PSO algorithm. The computation time is reduced due to PSO. PSO has fastest convergence rate which provides the optimal solution[10].

III. PROPOSED ALGORITHM

Step1: In this step firstly initialize the pipes.
Step2: Perform the iteration and it is equal to 1+0.
Step3: Generate the cost by random function and objective function.
Step4: Check the value is optimized of not. If not repeat the step2 otherwise update the P_{id}.
Step5: Analysis the cost.

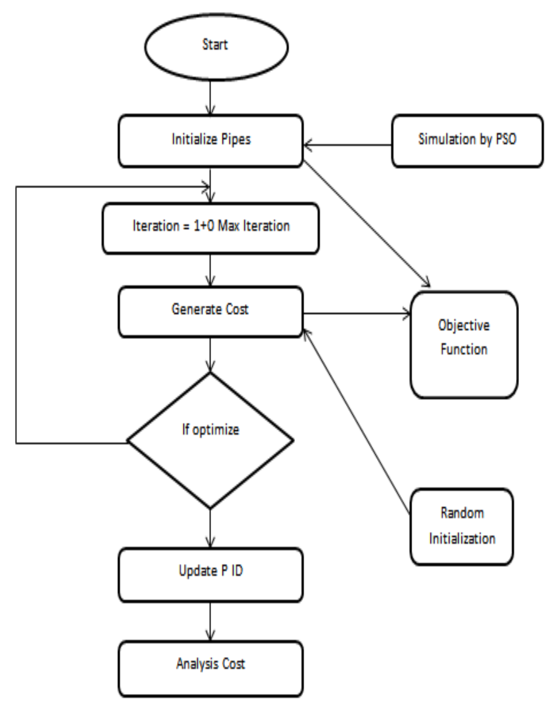

Fig.1: Flow chart of the proposed Methodology

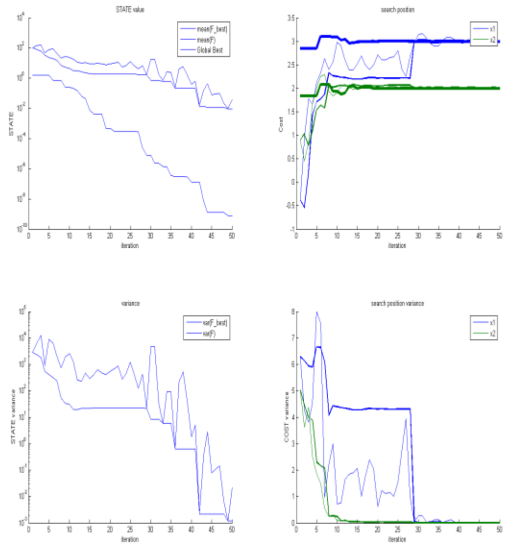

Fig.2: Graph of state value, Search Position, Variance and search position variance

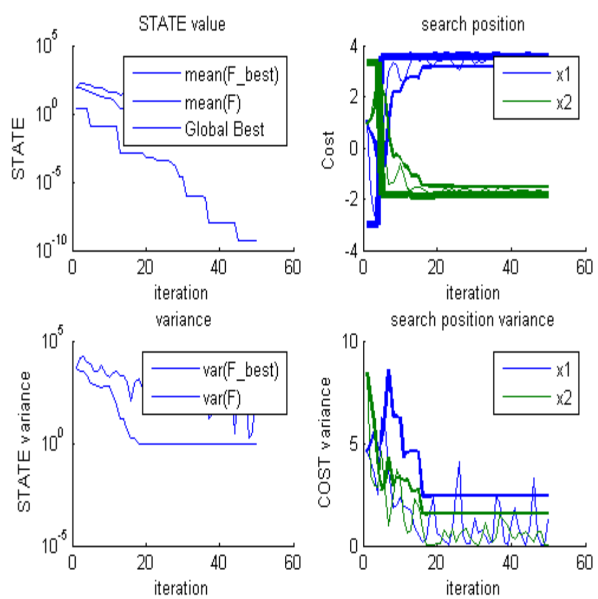

Fig.3: Graph of state value, Search Position, Iteration Variance and Iteration search position variance

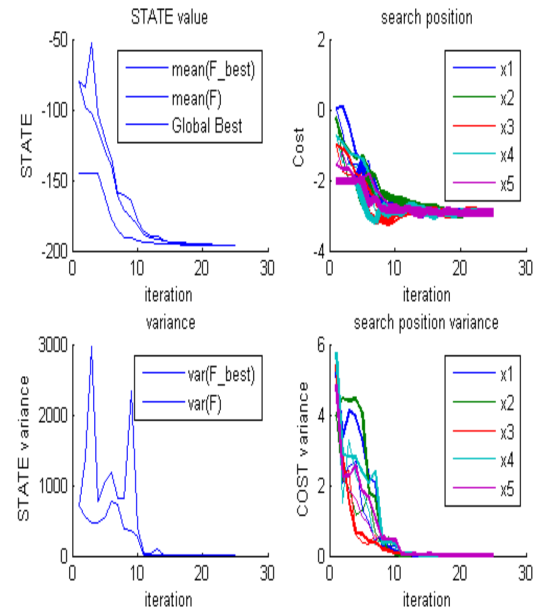

Fig.4: Graph of state value, Search Position, Iteration Variance and Iteration search position variance

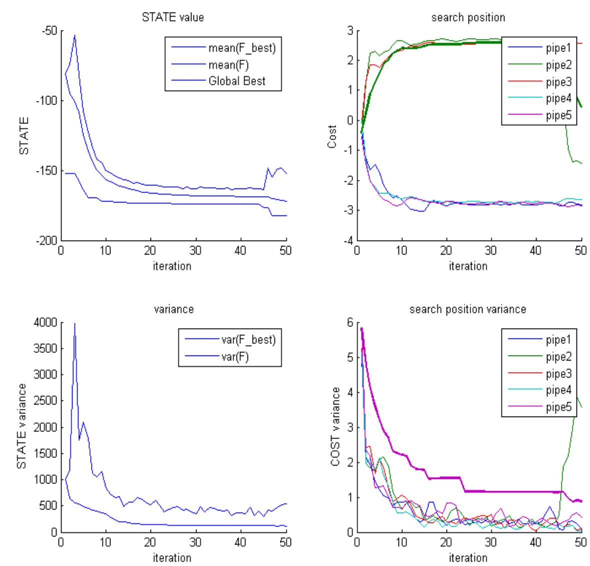

Fig.5: Graph of state value, Search Position, Variance and search position variance

IV. CONCLUSION

In this work, PSO used for code the pipe sizes which are available for selection as binary strings. Three operator particles swarm optimization is used in this work. The results come from the PSO approach is compared with both non-linear optimization and complete enumeration. Nonlinear optimization is an effective technique when applied to small network expansions such as for the case study network; however, the problem of rounding up and down of the continuous solution to discrete pipe sizes must be addressed. The nonlinear programming method only generates one solution. The PSO approach generates a whole class of alternative solutions close to the optimum. One of these alternative solutions may actually be preferred to the optimum solution based on other non-quantifiable measures. This is a major benefit of the genetic algorithm method. The genetic algorithm technique is in its infancy, and further developments should provide improvement in these search methods for practical problems.

V. REFERENCES

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