PREFACE

Hydraulic transport of solids is considered economical and environment friendly as compared to rail and road transport. It is an advanced technology for conveying coal, ore, minerals, and disposal of solid waste. Liquid or gas movement through pipes is generally used in fluid distribution networks. The fluid in such cases is usually flow by pump. The friction is directly linked to the pressure drop and head loss during flow through pipes. The pressure drop is then used to regulate the pumping power requirement. A typical piping system comprises pipes of different diameters joined to each other by numerous fittings or elbows to route the fluid, valves to regulate the flow rate.

The design of a network is a complex engineering assignment. Due to a high number of options, the traditional technique, a trial-and-error based scheme, is generally not efficient. Consequently, optimization algorithms can be significant tools for this type of project. Many researchers have addressed this problem in a different ways during the past decades. Linear Programming (LP), Non-Linear Programming (NLP), Dynamic Programming (DP) Evolutionary Algorithms (EA) and Hybrid Optimization method proposed by different authors for optimizing of pipe network. Recently genetic algorithms have been applied in the problem of pipe network optimization.

Constrains are important parameters in optimization of pipe network design. A constraint is a certain condition to which the resolution of a system must fulfil. For practical reasons constraints are essential. The following types of boundary conditions are generally used: definite flow rates at the outlets, minimum pressure in any element of the network and the minimum allowable fluid velocity. The optimization technique must be competent to optimize within these specified constraints.

The cost of a pipe network consists of the capital investment and the cost involved operating the system over a period of times. Present study deals with optimization in pipe network design. The main objective in the optimization procedure is to minimize the cost subjected to the different constraints.

To design the pipelines and its allied facilities, designers need precise information regarding pressure drop, critical velocity of flow, concentration of slurry, etc. at the primary design phase. Also the engineers must know the critical velocity so that one can regulate the slurry flow to have a minimum pressure drop to ensure optimize operating cost. The slurry plug occurs due to solids accumulation during transport at low points of pipe network. To check this, the designers have to impose as concurrent criteria for transport, the consideration of turbulent flow and velocity above the fall velocity. This thesis presents efficient algorithms that provide optimal or near-optimal solutions for problems with non-linear objective functions. Here, an efficient numerical technique is developed and explored to an extent for an optimized pipe network design. Effort has been made in this thesis to exploit the computational capability of recent advanced numerical technique namely Genetic Algorithm (GA) in water and slurry flow modelling. The GA technique has applied to obtain an optimal design of a pipeline system for the distribution of liquids, based on criteria such as complying with the laws of preservation of mass and energy, volume of flow requirement at the points of consumption. GA has effectively resolved complex real-world problems where traditional search processes either failed or executed poorly.

Analysis and design of pipelines are based on parameters which include Reynolds number, concentration, viscosity, specific gravity, fall velocity, temperature of fluid and commercially available pipe diameters. The algorithms are coded with MATLAB and applied on test functions.

In this study, the accuracy of this technique is verified against an experimental investigation carried out for water distribution network system. Also, the present technique is used to find the optimum design for water pipe network used in literature by other authors. The results are compared with the existing solutions in literatures and shows promising results. Thereafter, with some modification in GA parameter, the technique is used for solid liquid (slurry) flow in pipe. The two cases have been discussed, one for slurry with fine particles size (40 micron) and other for coarser particle size considered as 0.1 millimetre. For fine particles, the flow is homogeneous and solids are in suspension and uniformly distributed around the horizontal axis of pipe and for coarser particle, the flow is heterogeneous and solid particles are tend to settle down at pipe bottom. However, the flow velocity must be above the critical velocity to keep the particle in suspension. For both the cases, the optimize technique within the framework of GA has been developed here to minimize the pressure drop, which is objective function, with constrained in the pipe network.

The proposed methodology can be viewed as a guideline to solve complex and labour intensive problem which leads to optimized pipe network design.