CHAPTER VI
CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE WORK

6.1 Conclusions

1. There are certain limitations to be accounted for when applying the GAS code or LIQUID code to specific applications. The GAS code has been implemented for a single phase and single component at steady state isothermal flow. If the program is forced to extend network analysis into multi-components or non-isothermal flow, it is recommended to use the mean effective fluid properties such as the average of compressibility factor, temperature, viscosity, density etc. The LIQUID code has been developed for network analysis and design to simulate steady state operation. When the flow is unsteady-state, the averages of fluid properties are likely to represent better property values.

2. The program is developed herein as a general purpose steady-state simulator of a single phase fluid network. There are three advantages in the use of the program to determine pressures and flow rates under given conditions. First, the most popular solution method used to solve the non-linear system of equations is Newton-Raphson iteration. The algorithm immediately treats the nodal pressures as decision variables in complicated network systems which are computed repeatedly until the values from any two successive steps converge (i.e., differ by a value less than or equal to a specified tolerance). Second, there is a bandwidth process module to fasten computing procedures for large scale networks. The bandwidth given in the

topological representation of the network analysis has to be in order with increasing numeration as i = 1, 2, 3, 4, ..., n (n = number of nodes). Third, the program can easily deal with the extension to multiple n-node networks, since it has the ability to use the minimum computer memory created in FORTRAN Power Station Version 1.0 for analyzing large complex pipeline network.

3. The observation from the program testing is that the LIQUID code has good results and strong consistency with the conventional theory of water network analysis calibrated by the PICCOLO model when the nodal pressures have converged. This leads to a reliable steady-state model. On the other hand, the GAS code does not receive the same accuracy according to the results obtaining from TGNET code.

4. The influence for the assumption of neglecting kinetic energy change in the algorithm applied in GAS code can be accepted for very long pipelines, compared to changes in pressures.

5. The GAS network model is designed for the computation of pipeline pressure drop at isothermal flow, which is rarely encountered in practice because the system generally behaves dynamically with the variations of temperature. In such case, the use of average temperature is satisfactory. In addition, the algorithm considers a pipeline as a single section with uniform slope. For the general case, the profile must be divided into a number of sections of nearly uniform slope for the purpose of pipeline calculations.

6.2 Recommendations for Future Work

1. For gas transmission systems, the flow is normally transient, because the variation of several variables affect the system such as flow rates, pressure drop, withdrawal or supply rates, etc. Therefore, the program should include a transient analyses, so that it will consider the accumulation term that exists from time to time. The current development of steady-state flow analysis is only valid for isothermal pipeline or a short pipeline in the case of temperature variation.

2. The special case utilized in the program is considered for terminal node with specified injection or withdrawal rates. The further improvement and extension of its capabilities should include more applications such as steady flow in open channels, air flow in ducts etc.

3. The program herein concerns a single component fluid network at steady state. Future work that appears to be of great interest is the development of network analysis for multi phase flow.

4. The main computation aspects for a set of simultaneous linear equations with a banded matrix implemented by Gaussian elimination method with column pivoting strategy in the program should be modified to accelerate calculation procedures, convergence, and consistency of the algorithm.