

Fluid Flow Software vs. Spreadsheets for Piping System Design & Analysis

The traditional approach for sizing pipelines in fluid piping systems is done using spreadsheet programs such as Microsoft® Excel®. Spreadsheets provide a platform for organizing data and performing the single pipeline calculations for pipeline friction loss. If done correctly, spreadsheets can save time when performing single pipeline headloss calculations.

However, in order to sustain a competitive advantage in today's marketplace, it is critical that you consider new technology that provides a total system view of the piping system. A clear picture can be better obtained by incorporating the following features into a single fluid flow program:

- Visualization - using a piping schematic to show how the various items are connected.
- Calculations – integrating all fluid flow calculations into a single program.
- Communications – maintaining design control, and sharing results with members of the design team and clients.
- Access – providing access to electronic documents used to design, build, operate, and maintain fluid piping systems.

These features, along with a robust network calculation engine, provide a clearer picture of the piping system. This White Paper explores many of the advantages that fluid flow software such as Engineered Software's PIPE-FLO® has over spreadsheets for the

design, analysis, and troubleshooting of fluid piping systems.

Visualization of the Piping System

Fluid piping systems are made of pumps, tanks, components, controls, and interconnecting pipelines. A piping schematic drawing shows how the items in the system are connected. Piping schematic drawings, process flow diagrams or Piping & Instrument Drawings (P&ID) are often created with CAD software and become the primary design documents of the piping system. These drawings provide a system overview and are used for the life of the plant.

When calculating the pipeline headloss with a spreadsheet program, the names of the individual pipelines and the design data are taken off the CAD drawing and manually entered into the spreadsheet's columns and rows. This provides a satisfactory method to organize data and eliminates the need to re-enter the pipeline information each time single pipeline calculations are performed. However, the spreadsheet's row and column format does little to show how the pipelines are connected into a fluid piping system.

PIPE-FLO utilizes a piping schematic drawing interface (the FLO-Sheet) as the primary user interface. The piping schematic is created using PIPE-FLO's drawing tools, by inserting objects onto the FLO-Sheet and then entering the details for each object. For example when entering a pump on the FLO-Sheet, the pump's unique name is entered, along with the elevation and operating characteristics

After the various piping system objects are placed on the FLO-Sheet, the interconnecting pipelines are drawn and the pipeline data is entered. The data for the pipe material, valves, and process fluids are looked up in engineering data tables; this not only simplifies data entry, but also insures that the data is entered correctly.

Notes and call out boxes can be added to the FLO-Sheet to improve the presentation quality of the piping schematic drawing.

Finally, since the P&ID drawings are design documents often included in the projects document package PIPE-FLO can export the complete FLO-Sheet drawing to CAD software.

Integrated Calculations

A typical pipe sizing spreadsheet looks at only a single pipeline, calculating the headloss loss for a given flow rate. If the piping system consists of multiple pipelines in series, the total system headloss can be calculated using the spreadsheet's sum feature. If the system consists of branching pipelines it is difficult to set up the spreadsheet to calculate the proper flow rate for each branch. Piping systems consisting of multiple parallel paths are very difficult to setup using a spreadsheet. Separate spreadsheets need to be developed to evaluate pumps and control valves.

PIPE-FLO provides a complete solution for detailed network analysis calculations. The program uses the FLO-Sheet drawing to set up the equations needed to calculate the balanced flow rates. Using advanced hydraulic network analysis techniques, the program calculates the balanced flow rates and pressures for the system. Calculations can be performed for piping systems of any size, containing straight pipe segments, loops, and branches.

In addition to the headloss, a series of calculations must be performed for selecting pumps and control valves. These calculations include:

- Total Dynamic Head (TDH) required for pump selection
- Net Positive Suction Head (NPSH) for a pump
- Design point values needed to select the control valves

These calculations often require the use of different spreadsheets in which design information must be re-entered for each step.

PIPE-FLO calculates the effect that pumps, components, tanks and controls have on the operation of the piping system. As a result, the program provides information as to how the total system operates, including the pumps' TDH and NPSH as well as design points for control valves. All calculated results are displayed on the FLO-Sheet, providing the user with a clear picture of how the total piping system operates.

Engineering Data Tables

Most of the pipeline input data used in spreadsheet analysis comes from pipe, fluid and valve tables found in engineering handbooks. Often the design values have to be looked up in engineering handbooks and manually entered into the spreadsheet. This process must be repeated for each pipeline. Not only is this tedious, it is prone to error.

PIPE-FLO uses built in engineering data tables and looks up the necessary pipe, fluid, and valve data used by the program. There is no limit to the number of pipe, fluid, and valve engineering tables PIPEFLO supports. You can add to, modify, or delete engineering data tables to customize the program for your specific project needs.

PIPE-FLO contains an extensive library of critically reviewed fluid property data. The program ships with over 550 process chemicals and industrial fluids. PIPE-FLO has one of the most advanced fluid calculation modules on the market. With PIPE-FLO's unlimited fluid data specs, users can calculate fluid properties using the DIPPR, Polynomial or Yaws methods.

Pipe Specifications

Most piping systems are designed using client generated pipe specifications. This capability is difficult to incorporate into a spreadsheet.

PIPE-FLO incorporates pipe specifications in its workflow, providing project management with the ability to control the choices available to a user. For example, a pipe specification sets the pipe material and schedule, valve & fitting tables, pipeline sizing rules, and design limits.

To size a pipeline using PIPE-FLO, choose a pipe specification, then enter the designed flow rate. The pipe specification fixes the pipe material and schedule, and the program selects the best available pipe diameter using the sizing rules found in the pipe specification.

Pump and Valve Selection & Evaluation

A spreadsheet can be developed to evaluate pumps. The pump must be manually selected and the manufacturer's pump data must be entered prior to performing the evaluation.

One of PIPE-FLO's greatest advantages is the ability to select and evaluate a pump in the piping system. PIPE-FLO performs the sizing calculations and determines the pump's Total Dynamic Head and Net Positive Suction Head needed for pump selection.

Using manufacturer supplied Electronic Pump Catalogs PIPE-FLO selects the pumps meeting the system needs. The selected pump can then be placed into the piping system model. PIPE-FLO calculates the operation of the system based on the selected pumps operating curves.

PIPE-FLO also has the capability to add control valves to the system. When a control is inserted into the system, the program calculates the control valve's inlet pressure and differential pressure, along with the flow rate through the control. The program selects and evaluates control valves from manufacturers' catalogs.

Spreadsheet programs do not have the ability to select pumps and control valves because of the large volume of manufacturer data that must be entered to make the necessary equipment selection.

Communication Tool Between all Workgroups (From the Boardroom to the Plant Floor)

It is often difficult to communicate the piping system solutions and results to clients or various members of the design workgroups. Spreadsheets provide a tool to present raw data or single

pipeline calculations, but it is very difficult to understand and communicate a problem or solution when it is in the form of over 5-10 pages of spreadsheet calculations.

Using PIPE-FLO you can quickly and easily share your system operations in a way that allows others to understand and accept your solutions. The program gives you a detailed flow sheet view of the system, showing the interaction of pipelines, pumps, components, and controls. In addition, PIPE-FLO provides you with a simulation tool for system network calculations and a platform to quickly troubleshoot ‘what-if’ types of analysis. PIPE-FLO:

- Provides a visual representation of the system
- Demonstrates the impact of multiple design alternatives and solutions
- Allows others to understand, visualize, and accept the solution

Program Testing and Error Checking

Anytime a spreadsheet is developed internally, you must consider the cost of verifying and validating the calculated results. This can be a long and tedious operation depending on the spreadsheet design. Furthermore, whenever a change is made to the spreadsheet, this process must be repeated.

PIPE-FLO has gone through an extensive set of automated test scripts in our verification and validation process. The scripts test and exercise every feature of the program. The results are then compared against hand calculations, and any discrepancies that occur are resolved before PIPE-FLO’s release. A description of PIPE-FLO’s test plan can be found at the following Web address: <http://www.eng-software.com/technet/testing.htm>

Conclusion

Spreadsheets provide an excellent tool for organizing data and performing a variety of engineering calculations. To properly simulate the operation of piping systems, you need to employ a specialized fluid flow network analysis program such as Engineered Software’s PIPE-FLO program.