1.0 INTRODUCTION

FluidFlow3 is a PC-based software package for the simulation of flow in complex pipe networks. Its calculation capabilities include:

- Pressure loss due to pipe friction
- Pressure loss due to pipeline fittings such as bends, valves and tees
- Pressure loss due to equipment items such as heat exchangers
- Pressure gain due boosters (pumps and fans)
- Changes in static elevation
- Heat change
- Combining fluids within a network

In any simulation, *FluidFlow3* solves for flows and pressures throughout the system taking into account static head changes, pressure losses and pressure rise due to pumps or boundary conditions. Fluid properties (density, viscosity, vapour pressure) are properly accounted for. Full heat change can be included for any pipe or equipment item.

FluidFlow3 is owned and developed by Flite Software Ltd.

2.0 CALCULATION METHODS

Pipe Friction Losses: Newtonian Liquids

Pipe friction loss calculation is determined using an expanded form of Darcy equation and the use of this equation implies that the liquid is Newtonian with a coefficient of dynamic viscosity that changes only with variation in temperature.

The friction factor in the Darcy equation is found from the Haaland equation (which gives a better than 2% agreement with the Colebrook White equation over the complete flow range). The friction factor is a function of pipe physical properties (internal diameter and absolute roughness) and the fluid properties (density, viscosity, flowrate). *FluidFlow3* detects laminar flow and uses an appropriate friction factor equation for this condition.

The Hazen-Williams equation is also available for water flows.

Pipe Friction Losses: Non-settling/non-Newtonian Liquids and Settling Slurries

The following correlations are provided:

Non-settling/non-Newtonian Liquids:

- Herxhel-Bulkley
- Power Law
- Bingham
- Casson

Settling Slurries

- Durand
- WASP
- Wilson-Addie-Selgren-Clift

Pipe Friction Losses: Gases

An expanded form of the Darcy equation is used taking into account expansion of the gas, temperature change and sonic (choked) conditions.

Pipeline Fittings' and Equipment Losses

Fittings' and equipment losses can only be determined from empirical data, either taken from published texts or supplied by manufacturers. *FluidFlow3* sources this data from the following well-established publications

1. Crane: "Flow of Fluids Through Valves, Fitting and. Pipes" Publication 410M.
2. Idelchick: "Handbook of Hydraulic Resistance", 3rd Edition, IE Idlechick, Pub Begelll House ISBN 1-56700-074-6
3. Miller: "Internal Flow Systems", 2nd Edition, DS Miller, Pub BHRA Information Services. ISBN 0-947711-77-5

Alternatively, the user can input data supplied by equipment manufacturers.

Heat Change

Heat change is calculated for the following conditions:

- Heat loss/gain through pipe walls (lagged or unlagged)
- Heat change at equipment items

Heat change for all components of a model (pipes and fittings) can be calculated on the basis of …

- Fixed temperature change – with the heat transfer determined
- Fixed transfer rate – with the temperature changed determined

In addition, for pipes, a heat transfer calculation may be specified, taking into account pipe wall and insulation thermal conductivity. A convection calculation is also performed based on ambient temperature, surface emissivity and wind speed.

3.0 QUALITY ASSURANCE

Flite Software Limited, the developers of the *FluidFlow3* software have over 20 years of experience in the development of fluid flow simulation software. *FluidFlow3* is the result of a development progress from early-days DOS programs to the current release, viz …

- *Flowmate* – a DOS-based pumping design program
- *Netmate* – a DOS-based pipe network analysis program
- *Piping Systems FluidFlow* – a Windows-based pipe network analysis program
- *FluidFlow3* – a fluid and process flow simulator

Flite carry out a number of quality checks on the calculation accuracy of their software. These checks are repeated prior to the release of any upgrade.

These Quality Assurance designs or files are delivered with the software and can be found in the folder *QA Compressible Flow* and *QA Incompressible Flow*. For incompressible (liquid) flow, approximately 100 models or designs are utilised in order to check either specific calculations (say head loss across a junction or heat change at a element) or the broader solution of a large network. Many of these designs are based on independent sources such as textbook examples and hand calculations.