APPLICATIONS IN THE MINING INDUSTRY

This note describes the application of the *FluidFlow3* software package to the design and simulation of mine pumping and gas flow systems including:

- Mine dewatering using submersible and end-suction centrifugal pumps.
- Bore farms using borehole pumps.
- Process flows using end-suction centrifugal and positive displacement pumps.
- Spray/sprinkler systems such as dust suppression and fixed fire protection.
- Potable water.
- Instrument and process air.
- Simulation of the performance of control valves, heat exchangers, orifice plates and almost any type of line equipment.
- Slurry Flow.
- Gas drainage.

*FluidFlow* can simulate the performance of multiple pumps in series, parallel or booster configuration. It is ideal for the investigation of existing systems prior to upgrade or extension and the design of new systems.

*FluidFlow* can simulate the flows of non-Newtonian/Non-settling liquids and settling slurries.

*FluidFlow* has applications at all stages of a mining project, viz:

**Conceptual Stage:** At this early stage estimates of pipe sizes and pumps are required. Possibly at this time equipment items on long lead-times need to be ordered. Using *FluidFlow*’s flowsheet representation of the pipe network, outline systems can be quickly developed with sufficient accuracy to make these types of decisions.

**Design Stage:** This is where the software would be used for the detailed design of the flow system - economically sizing pipes and control equipment, performing “what-if?” case studies, determining the performance of the system as pipes foul up over time. Precise modelling at this stage allows all associated design and equipment sizing to be performed accurately, viz electrical supply systems, control valves, etc.

**Commissioning Stage:** The actual performance of the system is compared to model results. De-bottlenecking occurs here.

**Operation Stage:** The pipe system model remains a valuable engineering resource as the project matures over time. It can be used for “tweaking” the system, or designing upgrades and improvements.

GENERAL PUMPING DESIGN

A typical mine dewatering system may involve multiple pumps, say submersible dewatering pumps supplying direct to tanks or reservoirs. For the processing plant the system may be a cooling water circuit supplying multiple facilities or the internal process flows within the facilities.

*FluidFlow* allows users to create a database of pump curves saving the following data:

- Pump name, model etc
- Capacity curve
- Efficiency curve
- NPSH curve
- Operating speed and impeller diameter
- Maximum and minimum speed and impeller diameter
- Maximum and minimum flow
Once the system model has been developed and the pump or pumps selected, the program will calculate flows and pressures throughout the system. The following can be performed:

- Pumps can be switched on and off.
- Pump speed and impeller diameter can be changed within the model and the affinity laws applied to the entered pump curve.
- The Hydraulics Institute correction for viscous fluids in end-suction centrifugal pumps can be applied.
- The Hydraulics Institute correction for solids content can be applied to end-suction centrifugal pumps delivering a settling or particulate slurry.

After calculation the software may generate the following warnings:

- Inadequate NPSH.
- Pump(s) operating outside set limits of minimum and maximum flow.
- Negative pressures or vapourisation of flow in the pipe system.

Full user-definable reports can be generated or results can be exported to Excel.

As well as pumps, FluidFlow can simulate the hydraulic performance of almost any type of line equipment including control valves, filters, heat exchangers, not0return valves, etc. The user–definable database includes pipes (materials, sizes, class), valves, controllers, sprinklers etc.

BORE FARMS

FluidFlow is ideal for the design, analysis and on-going monitoring of the performance of a borefarm.

The software allows the simulation of multiple bore pumps with pumps turned on/off to replicate operational conditions. Once the model has been constructed, it is simple to perform “what if?” calculations. Bore levels can be changed, different types of pipe and size investigated. FluidFlow's visual display of results and especially the instant display of pump curves and duty points provide the engineer with a 'snap shot' of how the system will perform under specified conditions.

PROCESS FLOWS

FluidFlow allows for the determination of heat change in fluid flow systems, viz heat loss/gain through pipes walls (lagged or unlagged), heat change at equipment items such as heat exchangers. Consequently, process flow systems involving heat exchangers can be simulated.

Other parts of the process system modelled by FluidFlow are instrument and process air supply and steam flow.

GAS DRAINAGE

FluidFlow's advanced compressible flow capability means that gas drainage systems can be modelled from goaf to ground level pumps. FluidFlow's database contains the thermo-physical properties of more than 1200 pure fluids including all coal mine gases such as methane, carbon dioxide etc. Gas mixtures can be created and saved in the database for subsequent use in a model.

SLURRY FLOWS

The FluidFlow Slurry Module is divided into two parts: non-Newtonian/non-settling liquids and settling slurries.

Non-Newtonian/non-settling liquids can be simulated using four different correlations, viz:

- Bingham plastic
- Power law
- Herschel-Bulkley
- Casson
Settling slurries can be simulated using one of five different simulations:

- Durand.
- WASP.
- Wilson-Addie-Selgren-Clift (WASC) following the method described in the book ‘Slurry Transport Using Centrifugal Pumps’.
- Selgren and Wilson Four Component Model based on the paper “Validation of a Four-Component Pipeline Friction-Loss Model”, by A Sellgren and KC Wilson.
- Correlation from ‘The Application of Liu Dezhong Formula in Slurry Piping Systems’.

For more information on slurry flow see our Slurry Flow brochure.

COST BENEFIT

In all fluid flow systems there are penalty costs arising from both over- and under-sizing the system. FluidFlow3 allows for the accurate sizing of equipment but also for appropriate stress-testing of the system. Performing “what-if” calculations brings justification to factors of safety built into the design and allowances for future expansion.

TYPICAL MINING PROJECTS

Accutech has used FluidFlow (or its predecessor Piping Systems FluidFlow) for the following mine-related fluid flow projects:

- **Ulan Coal Mines**: Simulation of multiple Pleuger and Emu pumps dewatering the decline by pumping vertically through boreholes to a discharge main on the surface and onwards to dams.

- **Springvale Coal**: Simulation of large numbers of air operated and traditional end-suction centrifugal pumps for dewatering by pumping along the decline to the surface. Simulation of mine compressed air supply.

- **Mount Whaleback Mine**: Simulation of multiple borehole and end-suction centrifugal pumps for the dewatering of the open cut.

- **Spinifex Ridge**: Water supply including simulation of large bore farms.

- **Beltana Coal Mines**: Blakefield South longwall goaf gas drainage system.