Deltares

Enabling Delta Life

WANDA Newsletter

may 2010

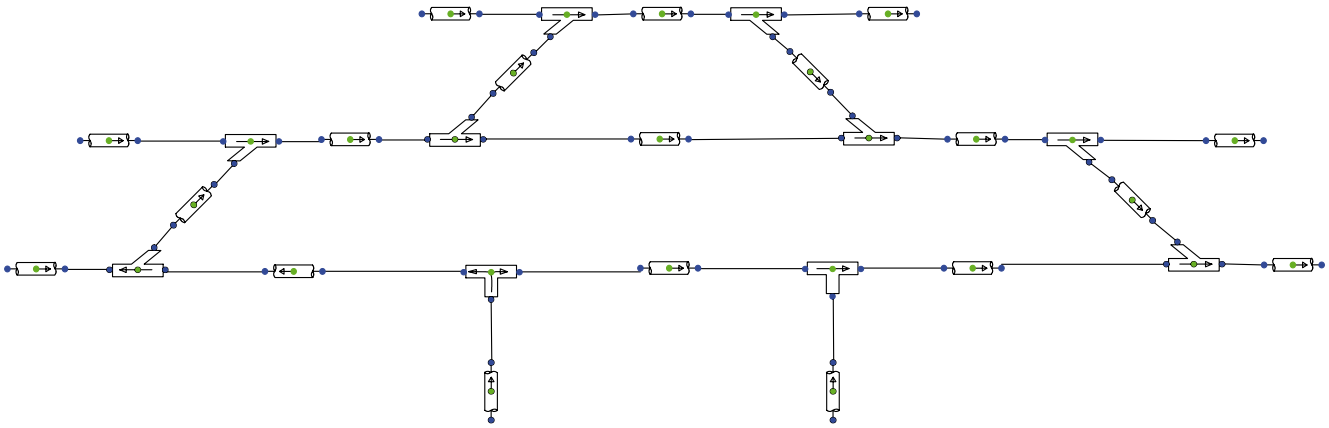
This newletter presents the latest developments in WANDA that have resulted in the next generation of WANDA software: WANDA 4. Not only the liquid applications have been extended, the new software also accomodates the calculation of gasses and heat transfer in pipeline systems.

Wanda User Conference 2010

On 4 March 2010 the annual Dutch WANDA user conference was organized at Deltares in Delft. On that day WANDA 4 was introduced. Several presentations about the architecture, new components and new possibilities proved WANDA 4 to be a versatile software package that now extends pipeline calculations from liquids (with or without temperature dependent properties) to gasses, with components varying from one up to four connection points. Communication possibilities between WANDA and applications or other software packages were demonstrated.
We thank all participants for their useful contributions. All presentations can be found on the WANDA wiki (http://wanda.deltares.nl). Below, the main new developments are summarized.

WANDA 4: GUI unchanged

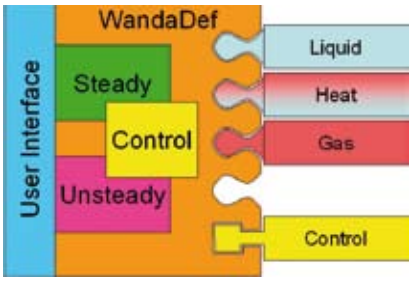
We have received many enthusiastic remarks about the WANDA 3 user interface, particularly about the powerful graphical capabilities, the convenient diagram builder, the broad scope of animation options and spreadsheet facilities, the ease of importing and exporting files. Since many users have indicated to be happy with the user interface, it has been left mostly unchanged in WANDA 4.



Example of a complex pipe geometry with T and Y junctions

WANDA 4 Architecture

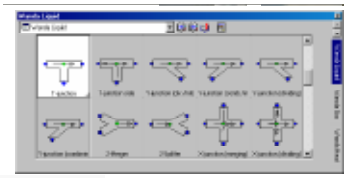
Where in WANDA 3 calculations are necessarily in terms of discharges and energy heads, WANDA 4 is much more versatile as a consequence of its architecture. The components (including the pipe) and nodes are outside of the core, such that WANDA is no longer restricted to calculating discharges and heads for liquids, but can calculate any set of quantities that define a full set of conservation laws. WANDA 4 gives access to new physical domains such as gas, heat and mechanics (e.g. rotating shafts, moving pistons). In the future several of these may be coupled together, giving rise to multi-physics domains that combine mechanical, hydro- and thermo-dynamical phenomena.



WANDA 4 Liquid: T, Y, and cross components

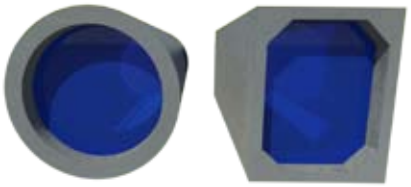
WANDA 4 Liquid shows the advantages of the new WANDA Architecture: three- and four-node components can be incorporated without changes to the core. The three-node components currently developed are the T- and Y-junctions, the four-node component is the cross-junction. With these new components it is possible to calculate merging and diverging flows, and to evaluate the energy losses due to these configurations. The user will no longer need to make manual calculations to evaluate loss coefficients and the final outputs of a pipeline network will have better results due to a more precise computation of the head drop in the junction.

3 and 4 node components



Important geometrical parameters, such as the ratio of areas and the angle between the legs of the junction have been taken in account. The loss coefficients are based on the equations in the Idelchik handbook. However, the loss characteristics can also be defined by the user.

Another advantage of the junction components is that it is now possible to evaluate the correct head drops in transient mode. Since the loss coefficients may change during the transient calculation (due to the fact that they depend on the discharge ratio between the side and combined branches) this is only possible when WANDA recalculates them over time.
In future we expect to develop more types of three-and four-node components.



WANDA 4 Liquid: "All-in-one" pipe

Another change to WANDA 4 Liquid is the integration and extension of waterhammer pipe components. The new pipe component replaces the 5 separate types used in WANDA 3. The following input properties are now operated by input choices:

Cross section type :	circle / rectangle
Friction model :	Darcy Weisbach (roughness or friction factor) / Chezy-Manning, Hazen-Williams
Extra losses :	low dependant value / table with xi-losses / table with L_equivalent
Calculation mode :	waterhammer / rigid column
Wave speed :	physical / user-specified
Geometry :	length / L-H profile, / XYZ coordinates / XYZ differential coordinates

The rectangular cross section affects both the hydraulic radius and the wave speed. It is also possible to calculate rectangular pipes with corner fillings.

WANDA 4 Liquid: slurry modelling

Apart from Newtonian fluids also slurries can be calculated; The Herschel-Bulkley rheological model has been built into the new “All-in-one” pipe. The friction factor is calculated based on the non-Newtonian properties of the fluid, such as yield stress and flow index. All known forms of non-Newtonian behaviour are incorporated in the friction model. As a result the slurry-model can be used for several applications, such as transport in the mining industry, paints and pastes, sludge handling from treatment plants, heavy oils, etc.

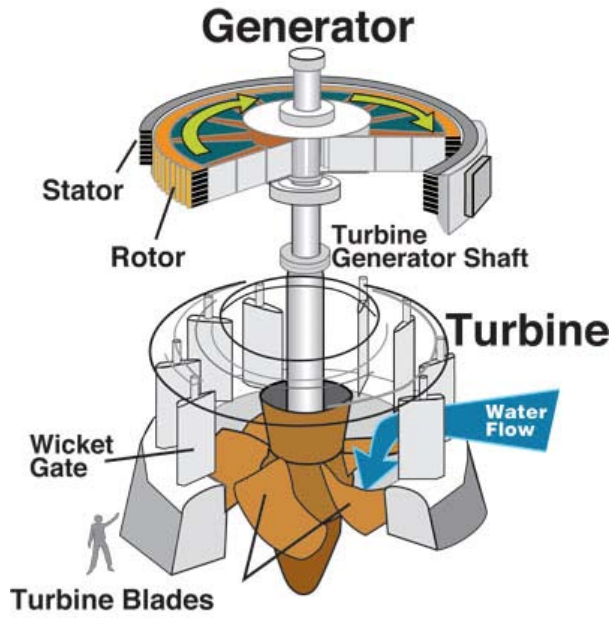
WANDA 4 Heat

WANDA 4 Heat makes it possible to calculate heat transfer and monitor the temperatures in a liquid system, making it an interesting module for urban district heating networks, oil industry and process industry. The calculations are no longer performed in terms of heads and discharges, but in terms of mass flow rates, pressures and temperatures. Whereas mass flow rates and pressures bear a strong resemblance to discharges and heads, the introduction of the temperature gives rise to a third primary variable. The temperature is determined by various heat fluxes, caused by transport due to the flow, heat generation by friction (the frictional losses are transformed into heat), heat loss to the surroundings and heat transferred by dedicated components (such as heat exchangers). As a consequence of the variation in temperature, fluid properties such as density, viscosity, vapour pressure and specific heat also vary, and these variations are calculated in WANDA 4 Heat. Heat loss through a pipe wall is calculated from the thermal conductivity of the pipe, the temperature difference of the fluid in the pipe (which depends on the location in the pipe) and the surrounding and the exposed area. Steady state calculations show the change of temperature along a pipe, together with the change of density. Transient calculations show that also waterhammering, including temperature dependent vapour pressure, can be simulated with WANDA 4 Heat.

Insulated pipes for district heating systems

WANDA 4 Gas

With WANDA 4 Gas the transient processes and phenomena of gas in pipeline systems can be simulated. The module can be applied to gas wells, pneumatic systems and air conditioning systems. The basis is formed by the several conservation laws (mass, momentum and energy) and the equation of state of the gas, allowing to calculate the pressures, temperatures, velocities and densities as the primary variables. Currently the ideal gas model (with the compressibility factor) is employed; in future real gas models will also be incorporated. Heat transport processes such as heat loss through the pipe wall are handled in a similar fashion as in WANDA 4 Heat. For gas valves choking flows can be calculated. Mach numbers and mass flows are shown in the output.



A Kaplan turbine

WANDA 4 Turbine component

Wanda 4 features a new turbine component for modelling hydropower systems. This new component models the dynamic behaviour of a reaction-type turbine for variations in blade angle, wicket gate position, electric power and flow. This new functionality enables engineers to solve new hydropower problems, such as load acceptance and load rejection scenarios.

WANDA 4 OpenMI compliant

WANDA 4 can be coupled to external programs. The WEC protocol allowed in WANDA 3 already the exchange of data sets between two programs by making use of shared memory. However, since two processes have to be run at the same time, they are slowed down noticeably. A better alternative has now become available by the "Open Modeling Interface" (OpenMI) standard. This interface allows models to exchange data with each other matching models with differing discretisation steps. OpenMI is a standard specially designed for coupling of numerical models, designed by organizations leading in water management (including Deltares, Wallingford software and DHI). For more information, please see http://www.openmi.org

WANDA 4 is now OpenMI compliant, such that it can be coupled to applications or other numerical models. A successful coupling between Wanda and SOBEK (a numerical program for integral simulation of processes in one dimension, i.e. in a river, an estuary, a canal or in a sewer network) has been accomplished as well as a coupling between Wanda and a programmable logic control unit to form a trainings simulator for operators in the process and water industry. In both cases the two programs perform well in speed.

WANDA User Conference in English

We would like to hear from our users whether they are interested in a two-day conference in English that focuses on applications of WANDA, such that users from abroad and the Netherlands get acquainted with each other and with the many fields in which WANDA is employed. If you are interested in participating in such a conference, please let us know by sending an email to wanda.support@deltares.nl

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