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Drinking Water Engineering and Science Discussions

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Interactive Comment

Interactive comment on "Hydraulic modelling of drinking water treatment plant operations" *by* G. I. M. Worm et al.

G. I. M. Worm et al.

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We would like to thank the referee for his or her comments. The referees questions (Q) have been replied to with answers (A).

Q: I found this paper highly confusing and poorly structured.

A: Major revisions have been made, including a more clear structure and a revised introduction. In general the focus of the paper will be more specific to the effects of interventions in a drinking water treatment plant and less on the drinking water treatment plant simulator. More attention will be paid to the objective of the study: the modelling of the effects of operational interventions on the hydraulics in a drinking water treatment plant.

Q: Section 2 describes the use of four different valve models to represent different types of hydraulic behaviour. Aside from this there is no further discussion of the hydraulic elements.

A: discussion on junctions, pipes and reservoirs was added.

Q: The description of the valve types is confusing. For example, we are told that a pressure sustaining valve (PSV) is defined as min(Hcalculated, Hspecified). However, there is no indication as to how the calculated head is reached. I assume that what is meant if that the *upstream* head is greater than the specified head then the PSV is regarded as throttling the valve to bring the downstream head into line with the specification.

A: If the referee states a PSV should be defined as the minimum value of Hcalculated and H specified, authors do not agree. Result of a PSV is Hspecified in the upstream junction if Hspecified exceeds H downstream. So, when the upstream head is greater than the specified head, the PSV is not throttling, as suggested, but fully open.

Q: The description of the throttle control valve suggests that the authors' are unfamiliar with the EPAnet modelling system. The head loss is defined as eta vˆ2 / 2 g; normally the parameter eta would be regarded as valve coefficient to relate the number of velocity heads (vˆ2 / 2 g) to the headloss. However, the authors describe eta as 'where the setting for the TCV is eta, which is constant for a valve with a fixed position.' While I can see what the authors mean it is a cumbersome approach that, as I wrote, indicates that the authors' are unfamiliar with the definition of eta.

A: The description of the valves properties has been improved, closer to the description given by Rosmann in (Rosmann, 2000). Page 157 line 16 till page 158 line 5 will be replaced by:

In the design of a drinking water treatment plant often hydraulic disconnections are added to prevent water from flowing in the opposite direction and to distribute water over lanes. For hydraulic disconnections in EPAnet the pressure sustaining valve (PSV)

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is used. A pressure sustaining valve (PSV) maintains a set pressure at the upstream point. EPANET computes in which of three different states the PSV is in: i) partially opened to maintain its pressure setting on its upstream side when the downstream pressure is below this value, ii) fully open if the downstream pressure is above the setting or iii) closed if the pressure on the downstream side exceeds the pressure on the upstream. A pressure breaker valve (PBV) forces a specified pressure loss to occur across the valve. Flow through the valve can be in either direction. PBVs are not true physical devices but can be used to model situations where a particular pressure drop is known to exist. A throttle control valve (TCV) simulates a partially closed valve by adjusting the minor head loss coefficient of the valve. The head loss over a TCV is calculated with

$$\Delta H = \xi \frac{v^2}{2 \cdot g}$$

Where ξ is the minor loss coefficient (-), v = is the velocity through the pipe (m/s) and g is the gravity constant (m/s^2). The relationship between opening degree and minor loss coefficient is often given by the valves' manufacturer. A general purpose valve (GPV) is used to represent a link where the user supplies a special flow - head loss relationship instead of following one of the standard hydraulic formulas, like the one mentioned above. The relationship can be linear or quadratic, as well as custom defined.

Q: When we proceed to the description of how the process models are represented by the various valve elements things get no better. A well is modelled with a linear relationship to the abstracted flow. What is the linear relationship? Headloss is linear with flow? The paper states that 'drawdown is linear to the abstracted flow.' Does this mean that water level (drawdown) decreases linearly with abstraction flow? There is no easy way of telling what is meant. The other process model descriptions are no better.

A: 3) The description of the well behaviour has been reformulated. Page 158 lines 12 and 13 will be replaced by

The water level of a freatic aquifer is modelled with a reservoir. Wells can be equipped

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with a submerged pump or can be part of a vacuum-gravity system to extract the water from the aquifer. Several wells can extract water from the same aquifer, so in a model several wells can be connected to the same reservoir. The well draw-down is modelled with a GPV if the relation between extracted flow and draw-down is known. Often the relation between abstraction and draw-down is linear, meaning the water level in the well decreases with the abstracted flow linearly (Moel et al., 2006). For each well a specific yield can be determined in [m^3/h] per [m] drawdown.

Q: When the validation of the model is discussed we are given large, detailed, flow-sheets of the hydraulic layout in EPAnet. This reproduces badly.

A: For reproduction of the model information is needed of the plant's layout and all its design parameters (pipe length and diameter, number and place of bends, pump curves, etc.). An export of the model in ASCII format can be easily produced and can be distributed under conditions of confidentiality. Authors hope and believe the validation shows that, using the element library and straight on modelling, EPAnet offers a good possibility to model the operation, hydraulically, of a drinking water treatment plant.

Q: It is not clear if the pump speeds in the wells were varied during validation, as well as calibration, to better match the measured flow values.

A: Page 162 line 3 to 5 are replaced by:

Since the speeds of the two speed controlled well pumps lacked in the dataset, the speeds of these pumps were set manually so that the yield of the well in the model equalled the yield in the historic data. After these iterations the model results for validation were captured.

Q: The graph of validation accuracy reports a commendably low MAE of 3.6%; but by eye data match is poor.

A: The poor eye data match in comparison to the other results are caused, most prob-

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ably, to the different scales used. The scales have been equalled, yielding updated Fig 2, 4 and 5.

Q: The other processes look to be a better fit, but with the sand filters having the calculated flow consistently greater than the measured flow.

A: The referee mentions the sand filters have the calculated flow consistently greater than the measured flow. This was further analysed by the authors. Obviously the pumps deliver more water than would be expected. Authors consider it's likely the formula used to calculate the pump speed (technical specification current frequency controller) is not accurate. For the percentage of the speed control 0% equals an electricity frequency of 13 Hz in stead of 15 Hz and 100% equals an electricity frequency of 56 in stead of 58 Hz. As can be seen in Figure 5 model results are more balanced and have a higher accuracy as well.

Several linguistic adjustments shall be made.

(Updated figures on next pages.)

Interactive comment on Drink. Water Eng. Sci. Discuss., 1, 155, 2008.

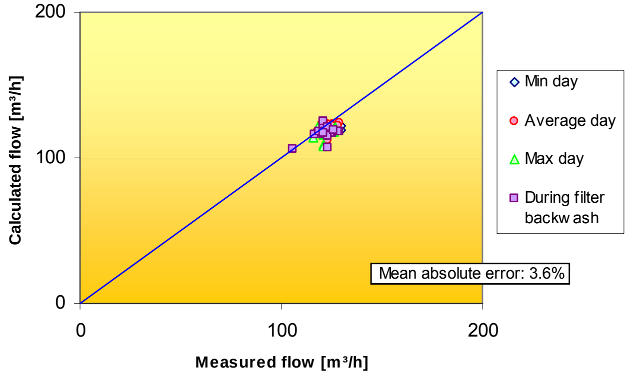

Fig. 2.

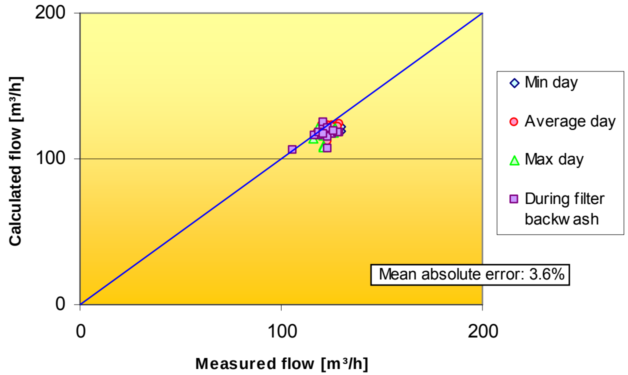

Fig. 4.

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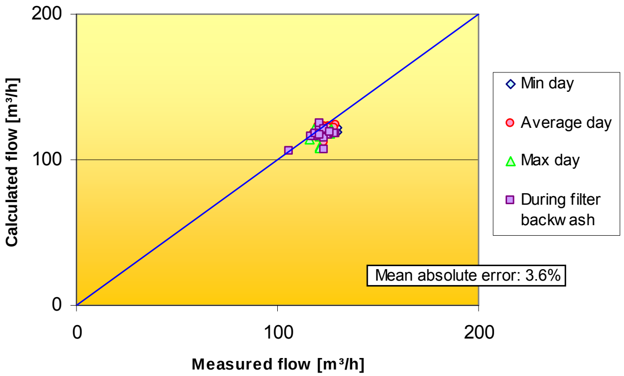

Fig. 5.