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Drinking Water
Engineering and Science
Discussions

Interactive comment on "Pump schedules optimisation with pressure aspects in complex large-scale water distribution systems" *by* P. Skworcow et al.

Anonymous Referee #2

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GENERAL COMMENTS

1.Does the paper address relevant scientific questions within the scope of DWES?

YES!

2.Does the paper present novel concepts, ideas, tools, or data?

YES!

3.Are substantial conclusions reached?

YES!

4.Are the scientific methods and assumptions valid and clearly outlined?

YES!

5.Are the results sufficient to support the interpretations and conclusions?

Some results could be better explained and some are omitted (for example, concerning leakage levels).

6.Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)?

YES!

7.Do the authors give proper credit to related work and clearly indicate their own new/original contribution?

NO! There is no reference to other works about the same subject (with similar approaches or different ones).

8.Does the title clearly reflect the contents of the paper?

NO! In this tittle the words "pressure aspects" concern leakage, but this conclusion is not obvious.

9.Does the abstract provide a concise and complete summary?

YES!

10.Is the overall presentation well structured and clear?

YES!

11.Is the language fluent and precise?

YES!

12.Are mathematical formulae, symbols, abbreviations, and units correctly defined and used?

YES!

13.Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated?

NO!

14.Are the number and quality of references appropriate?

NO! References are almost reduced to author's previous works. In my opinion, it can be OK for a Conference paper, but a good journal paper should have some kind of state-of-the-art, even if a short one.

15.Is the amount and quality of supplementary material appropriate?

YES!

This paper is about water distribution network operation, namely pump schedules optimization, and this topic is of interest for the Drinking Water Engineering and Science readers. It presents a methodology to define pumping operation rules in order to minimize the total cost (both energy usage and leakage).

Although the methodology is quite well explained, there still remain some doubts.

1) In the automatic discretization, the first continuous optimization problem to be solved by GAMS/CONPT considers the number of pumps ON at each time step as decision variables. After rounding the continuous number of pumps ON to an integer number, the second continuous optimization problem to be solved by GAMS/CONPT considers the pump speed as decision variables. In the first problem the pump speed is also a decision variable or assumes a fixed value (for example, 100% of the nominal speed)?

2) The interactive discretization is a procedure involving GAMS/CONOPT solver (continuous solution), EPANET simulator (discrete solution) and an Excel spreadsheet

(match discrete and continuous solutions). The text mentions that "For small networks or a short time horizon (24 h) only few iterations are required", but nothing is said about the time it takes to obtain a final solution to be implemented. If we are dealing with real time operation of WDN this can be crucial.

3) It is well known that EPANET isn't adequate to calculate energy costs from variable speed pumps (it doesn't convert the pump efficiency when changing the pump speed). How did you manage it? Probably you used affinity laws to estimate the pump efficiency. However, affinity laws assume that efficiency remains constant, but in real world variable speed pumps similar operating points don't have similar efficiencies (efficiency reduces when reducing the pump speed). Did you take this in consideration?

4) Along the text nothing is mentioned about the leakage level obtained with the optimal pump scheduling, although this was a part of the objective function (minimize energy usage and leakage)? In terms of results, the only reference to leakage is "The automatic discretisation algorithm particularly struggled for scenarios with pressure dependent leakage; for these scenarios the interactive discretisation approach was employed".

SPECIFIC COMMENTS

Page 128, Line 12: "For pipes, tanks and pump stations standard equations based on the Hazen–Williams formula are used". I don't understand this sentence! What is the relationship between the Hazen-Williams formula and tanks and pump stations?

Page 130, Line 17: "Actual implementation of the control variables in the physical WDN depends on valve construction and is not considered here." The mentioned PRVs and FCVs are physically present in the network or are just an assumption to force the model to achieve a desired set of results (pressures and flows)? We know that real world WDN sometimes have "strange things" (for example, the case study has "...PRVs fed from booster pumps or a booster pump fed from a PRV"), but both PRVs and FCVs introduce head-losses, reducing the system global energy efficiency, and this seems a countersense when we are trying to minimize the energy costs.

Page 131, Equation 7: I don’t understand the need of that “10-14”.

Page 131, Equation 8: The objective function doesn′t include the power costs, and sometimes these can be quite expressive in the global energy cost.

Page 133, Line 7: “. . .so for example continuous “2.5 pump switched on for 2 h”, can be discretised as “3 pumps on for 1 h and then 2 pumps on for another hour”. This is correct if it is assumed that the pump flow does not depend on the number of pumps switched on (a simple mass balance equation), but when you have parallel pumps this is not quite true (unless you adjust the pumps speed to compensate). I guess this problem is subsequently solved by the procedure presented in Page 133, Line 23.

Page 136, Line 19: Did this conversion procedure produce a good match even when the flow in pipes was low (for example, when some pumps were OFF during the night)?

Page 136, Line 11: A screenshot of the case study WDN would help, even if it was a simple print screen of the EPANET model.

Page 137, Line 2: When using the Darcy-Weisbach formula, it is easy to replace a fixed opening TCV with a pipe of equivalent resistance (they both have the same exponent = 2), but with the Hazen-Williams formula that is not straightforward. How did you manage it?

Page 137, Line 4: Why did you replace the TCVs by FCVs? Was it to reduce the number of different control elements in the model or is it an imposition of the automatic model reduction algorithm applied?

Page 137, Line 6: I don’t understand the physical meaning of “A pipe to which an open-close control rule was assigned . . .”.

Page 137, Line 13: Table 1 refers 10 tanks in the original model and 9 in the reduced model, but section 5.1 refers 9 tanks in the WDN and section 5.2 refers that two of

them were merged into one (there should be 8 in the reduced model). There is some disagreement in these numbers.

Page 138, Line 2: I guess that this can be the answer to some of the previous questions.

Page 138, Line 18: “Subsequently, it was decided to extend the boundaries of the model and include an additional pump station and a tank.” Is this another case study (based on the original one), or these changes were necessary to attain good results with the methodology?

Page 138, Line 22: “Optimisation for 24 h horizon with 1 h timestep and for 7 days horizon with 2 h time-step took around 5 min and 1 h, respectively, on a standard office PC.” Do these execution times correspond to the methodology with automatic discretization?

Page 140, Line 13: Eliminate the “s” in “heuristics”.

Page 140, Line 19: Introduce an “a” in the middle of “for variety”.

Page 148, Figure 5: Looking at these results we can see that there are always 5 pups ON, and sometimes with a normalized speed of 0.7. Is this a limitation of the methodology (the number of the pumps ON is always the same)? At first look I would say that 4 pumps ON with higher normalized speed would do the same with a better efficiency.

Page 149, Figure 6: For the 7days horizon results, the low levels of the tanks at the middle of the week can be a consequence of the leakage (higher level increase the pressure and, consequently, leakage). If leakage was not considered, perhaps the solutions would lead to a “better use” of the tank capacity.

Interactive comment on Drink. Water Eng. Sci. Discuss., 7, 121, 2014.