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A Unified Metric for Water and Energy Loss Studies

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ABSTRACT

The IWA water loss approach has had significant benefits; with it, one can assess and quantity of water loss within a supply or distribution system. The associated metrics allow different systems to be compared and critiqued and for single systems, whether deteriorating or being upgraded, to be tracked over time. Given the generally poor state of water supply infrastructure, the growth of urban areas and the pressure on resources, all these benefits are not only welcome but urgently needed. The harvest associated with the low hanging fruit associated with this approach has certainly begun but just as certainly has not yet peaked. Water supply was taken for granted for far too long for these issues to be rapidly resolved or addressed.

However, the work to be described in this paper can be viewed as a logical and justified next step in the evolution of system behaviour and performance assessment. The next step that is proposed here is to more explicitly add the dimension of energy to the system assessment toolkit. More specifically, if system head is plotted a two dimensional graph with demand or water supply as the other axis, the product of the two terms (a rectangle from the plotted demand and head with the origin as the opposite corner) has the dimension and physical interpretation as an energy measure. This energy requirement can be high either if the demand is high, the pressure is high, or if both are moderate. Certainly the IWA framework explicitly identifies pressure management for it leakage management benefits, but the current work seeks to go much further than this.

For in fact, the product of head and flow are a direct expense for the system, one that magnifies for any of a number of critical factors. Certainly having excessive leakage, or excessive demand for any reason, is to be avoided. Moreover, pressure should be limited not only because of the usual benefits of leakage reduction and increasing the longevity of pipes, but for the direct reason that energy must be paid for directly, both financially and environmentally. But the ideal strategy in one system might be pressure management, and in another it might well be to replace or overhaul the pumping system. To effectively entertain the respective benefits of both approaches, a combined metric is needed. What is proposed here is the combined energy and water conservation goals has a beautifully simple but potent advice of making the enclosed energy rectangle, when scaled for energy supply efficiently, as small as possible. The ratio between the ideal energy rectangle, that is the energy with the best available head and minimum required head at perfect efficiency, to the current energy use because a measure of the energy effectiveness of the system.

Such an approach is shown to comprehensibly include the current IWA advice (fix obvious leaks, repair breaks quickly, control pressures, etc.) but it also includes a range of new strategies: maintain pumps, watch the system operating point, use reservoirs creatively, control transient pressures and reduce head losses wherever possible. The overall approach will be illustrated through specific practical and simulation examples.

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