How to measure and reduce the water meters' park inefficiency

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Why to measure the water meters' park inefficiency?

For everybody, the reason why the water meters' park inefficiency needs to be measured and reduced is because it generates a financial loss. But this is not the only reason.

Another reason is the proper evaluation of the real losses. Because how are they measured ? They are not. They are calculated. They are the result of:

+ System Input Volume

- minus the metered consumption,

- minus the estimations, through customers surveys, of the un-metered billed and unbilled consumption, of the unauthorized consumption and of the data handling errors,

- minus the estimation, through on-site testing, of the customer metering inaccuracies.

But the level of uncertainty on these estimations is generally high, which is quite problematic with the metering inaccuracies as it usually represents a significant portion of the losses.

So finally, all the very costly actions on the network are motivated by a calculation which has a high uncertainty.

Why was it not measured?

The current methods to assess the inefficiency of a water meters' park are simple:

1/ replacement of a relatively large quantity of water meters with new ones (5,000 - 10,000),

2/ installation on a small scale (50 - 200) of new water meters in series with existing ones.

The difference over the months between the new total invoicing and the previous one is considered as the inefficiency of the installed park.

For the total a positive or a negative result is always found, but the individual differences are fluctuating between positive, negative and zero values. Without the ability to understand why there are those variations (and especially the negative and zero values which are reflecting the existence of other circumstances), the extrapolation from the samples to the full meter park is hazardous.

These variations are due to the fact that these methods measure a combination of two phenomenons that can have reverse impacts: the way the water is consumed which can be with a narrow or a large dynamic (if there is a leakage for example) and the ageing of the meters, which may show under or over-measurements according to the brand and the age of the installed meter.

In term of water meters replacement policy, the major consequence of these methods is that the only alternative that exists is "change all" or "nothing".

The reason why experts had to use these simple methods is because the modelization of the water meters ageing laws and the algorithms to calculate them were not existing. It is only recently that this subject has been analyzed to create the adequate tools.

Different approaches according to the type of consumption?

A water meters' park is constituted of residential meters and of commercial and industrial meters.

In residential applications, the way the water is consumed is influenced by a very limited number of criteria (number of persons, roof tank...), so by making an adequate selection of samples, we can use statistics to extrapolate on the full population.

On the contrary, for the commercial and industrial meters, there are usually much more criteria influencing the profile of the consumption and there is a limited number of similar appliances to perform representative sampling. So, individual analysis is preferred and as they are in a relatively small number but invoicing a large amounts of water, their inefficiency should be kept minimal by performing every one or two years.

For the residential meters, as the measurement of the loss of efficiency will rely on statistics, a proper methodology has to be followed.

Residential water meters' park inefficiency: modelisation and statistics

In order to have the calculations with the lowest uncertainty, the modelisation must take into account the influent criteria affecting the accuracy of a water meter as identified by the water meters expert:

- brand and mark of the meter,

- age,

- consumption,

- agressivity of the site where the meter has been installed.

The second point, which is crucial, is that the ultimate goal is not the loss of accuracy of the meters but the loss of efficiency of the meters.

What is the difference?

Accuracy is what is obtained when a meter is tested on a test bench. According to the tested flow rates, the meter gives its answer in term of which percentage of the volume it can measure.

To present the efficiency, the pattern of consumption must be first explained.

As a meter has an accuracy depending on flow rate, it is important to look at the consumption of a user by representing it according ranges of flow rates and indicating for each range the proportion of water which is passing. By doing this, it gives a weight for each flow rate interval. This chart is called the pattern of consumption.
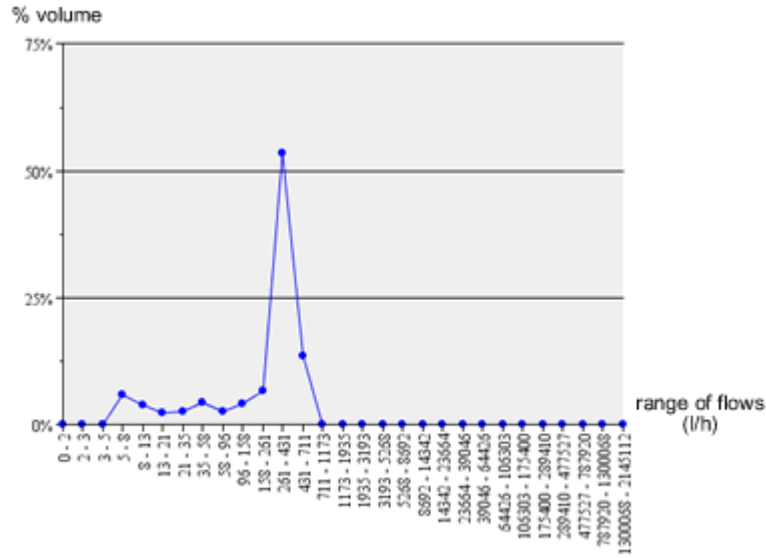
Figure 1.1 Pattern of consumption of a residential consumer

The efficiency corresponds to what the meter can measure when it sees a certain pattern of consumption. It is the "multiplication" of the accuracy curve by the pattern of consumption.

Hence, the methodology to study the efficiency of a residential meter park is as follow:

Consumers	Meters
1. Segmentation	1. Segmentation
2. Sampling	2. Modelling of the ageing laws
3. Statistics	3. Sampling
4. Patterns of consumption	4. Statistics
	5. Ageing laws

By combining the Patterns of consumption with the Ageing laws, we can calculate the evolution in time of the water meters park efficiency according the influent criteria.
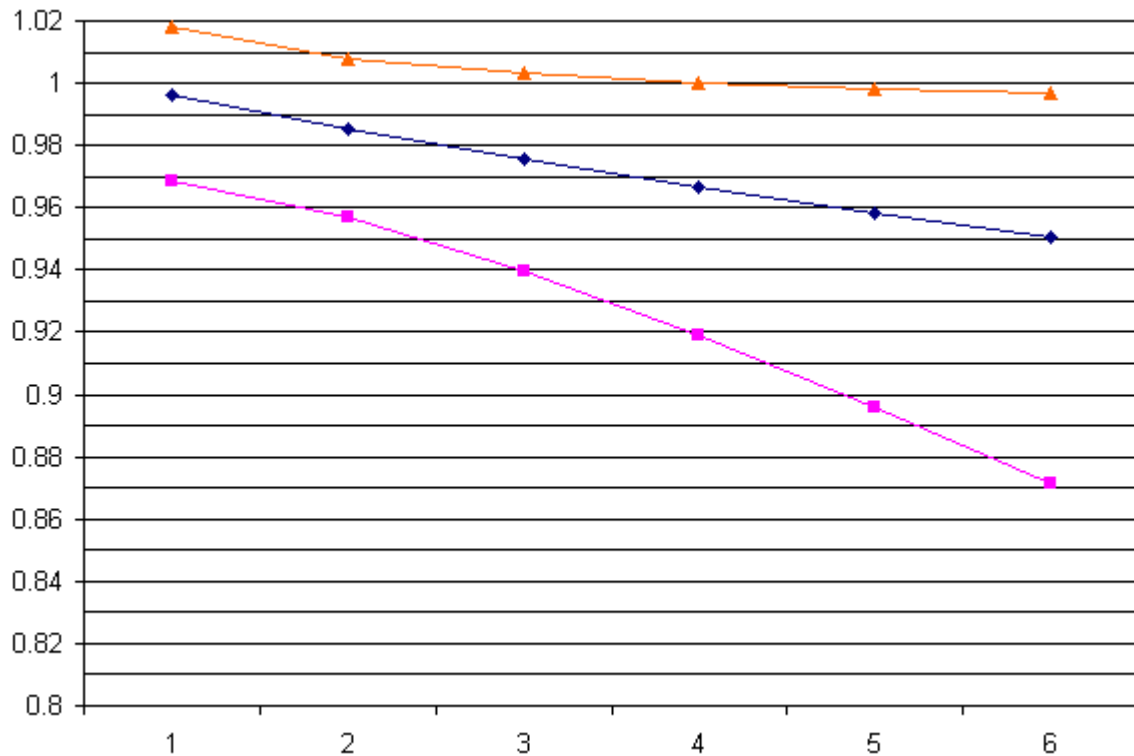
Figure 1.2 Evolution in time of the water meters' park efficiency

The above chart shows the evolution in time of the efficiency (blue curve in the middle) with the confidence interval at 95%. For example, at the 6th year of installation, the efficiency is 95%. So, if 180 m3 per year are passing through the meter only 171 m3 are registered and invoiced.

Then with this individualized information, the calculations for the water balance are much more accurate and decisions can be much easily justified.

Same, with this information the water meters' park can be optimized in order to change only the ones that need to be changed.

Rules like total cost of decision (purchase of the product + net present values of the consequences of the decision: losses in invoicing) can be used to determine the optimum replacement period for each meter.