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Interactive comment on

“Corrosion control using hydroxide and bicarbonate alkalising agents in water drinking processes”

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We appreciate the valuable and interesting comments and suggestions received, as are contributions to the continuation of our research in the field of treatment and distribution of drinking water. The authors of the paper review each of the comments and observations and then present our response to them:

1. You focus too much on the water quality indices. I feel that these are not adequate for a proper prediction of corrosion control in the drinking water distribution system. They only provide a very simplified picture, whereas in actual practice corrosion control should be based on thorough research on the actual corrosion of the actual piping materials and the actual water quality, including such aspects as biofilm control, etc.

Indeed there are several methods of monitoring and measuring the process of stabilizing the pH in Distribution Water Systems (DWS), which can be direct or indirect; the first as options include physical inspection, microscopic and macroscopic observation in the internal pipe (which provides a diagnosis of the degree of corrosion or fouling by not carried out good stabilization of the pH), chemical analysis (presents information on the type or cause of corrosion or fouling) and microscopic techniques such as X-ray and infrared. Indirect methods include hydraulic testing, recording and reporting of complaints from consumers and indices that predict the behavior of water in the WDS.

The main limitation of the direct methods are the high costs required for evaluation, while indirect methods offer cheaper alternatives. For developing countries, the indexes are one of the methods available to control corrosion and are a routinely method in the operation of treatment plants.

In DWA as large as the city of Cali, corrosion is a complex problem and its management should include controls water quality that can be performed both in drinking water treatment plants (among which included the application of indexes), and studies of the condition of the walls of its components, such as pipes, fittings and tanks. Additionally, given the characteristics of the water used (average temperature, low alkalinity and hardness, as well as medium pH) should be analyzed considering local conditions, which are the chemicals most appropriate to modify the pH and alkalinity in each case. One aspect that was verified in relation to the use of indexes is that although the drinking water supply companies in the country generally perform the pH stabilization by applying the Saturation Langelier Index (SLI), is not suitable or advisable to use one but consider various aspects related to both the tendency toward precipitation of CaCO₃ as the type of pipe, mainly in WDS where you have different conditions on these two aspects.

In the study presented, the emphasis was basically on the pH stabilization process drinking water treatment plant that is where the process is performed as the last step of treatment; however, the choice of analysis of the biofilm in the distribution network, which influences the pH variation in the SDA, is an indicator which is complemented by the application of stabilization indexes. In this

regard, the working group has already made some related characterization of biofilm in different sections of the WDS and in different pipe materials system, results are being prepared for publication and were developed in conjunction with the company that handle the WDS in the city. Other studies that are to continue performing in the WDS is the analysis of other aspects such as records and reporting of user complaints in conjunction with the application of indexes, which provide a preventive analysis of pH stabilization can contribute to process control in water drinking treatment plants. It also intends to continue to make deeper observations on the state of the walls of the components of the WDS and riders physical models, including biofilm formation.

2. You focus too much on creating conditions that form protective CaCO₃ layers. This may lead to problems with scaling in the network and the household plumbing systems and many complaints from customers on hardness, scaling and turbidity. In actual practice it seems much wiser to not use ca-containing chemicals and only use a small dose of NaOH or Na₂CO₃ to increase the pH and alkalinity somewhat. This will in most cases limit corrosion and prevent scaling.

Regarding this aspect, this article analyze different types of alkalizing for the treated water from the Cauca River (hydrated lime, sodium hydroxide, sodium bicarbonate and sodium carbonate) and shown the advantages and disadvantages of each product, but there are not recommendation or indication restricted for a single type of product, because in each case, the selection criteria may be different (ie: costs, access, etc.). The comment made on the application of NaOH and Na₂CO₃ to increase pH and alkalinity can be seen in Figures 2 and 3 of the article confirming increasing pH; however, the doses is different when using sodium carbonate, since larger amounts are required compared to strong bases (sodium hydroxide and hydrated lime) and achieve precipitation conditions obtain the film of calcium carbonate; this analysis is also discussed in the article after Table 4.

The results shown that for the studied water it is possible to use any of the alkalizing evaluated, except for bicarbonate because it failed to exceed more than 8.3 pH units that is the maximum range that reaches into the carbonate system. We believe that for each WDS is advisable to define the most appropriate strategy because some authors argue that reach saturation pH (or no more than 0.2 to 0.5 of its value) prevents excessive calcium incrustation in pipes, or the water is aggressive if the value is smaller; Furthermore, some authors have found that increasing the alkalinity increases the presence of corrosion products of some types of materials, so advise against using products that increase the pH sufficiently but not alkalinity as may occur with the use of NaOH.

3. You do not use the available PHREEQC-software, which would allow you to make all the chemical calculations exactly and to calculate the chemical equilibrium with respect to CaCO₃ (refer to the DWES paper 6(2) 115-124, 2013 in your references).

Aunque se revisó información respecto al software mencionado, en este trabajo se usaron los índices cualitativos que se podían calcular con los análisis físico-químicos comunes que se realizan en la PTAP y solo se pudo determinar uno cuantitativo que fue el PPCC, el cual también se calcula con un software pero al no disponer del mismo, se diseñó una hoja de excel para obtener las condiciones de equilibrio presentando como limitación un proceso iterativo de ensayo y error. Evidentemente, para futuros estudios se tendrá en consideración este tipo de software para el caso de aguas superficiales, para lo cual será necesario tener información de parámetros como magnesio, potasio, fosfatos y sulfatos, parámetros que no se miden de manera rutinaria en la operación de la planta de tratamiento.

Although information was reviewed regarding the software mentioned, in this work we apply the qualitative indexes that could be calculated with common physical-chemical analysis performed in the drinking water treatment plant and only a quantitative index could be determined who was the PPCC, which also calculated with software but in the absence thereof, an excel spreadsheet was designed for equilibrium conditions presenting as limiting an iterative process of trial and error. Clearly, future studies will take into account this kind of software for the case of surface waters, which will be necessary to have information on additional parameters such as magnesium, potassium, phosphates and sulfates, parameters not measured routinely in the operation or the drinking water treatment plant.

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