Operational implementation of PHREEQc in the process control of a surface water treatment

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Introduction

At the water treatment plant (WTP) De Punt, from Water Company Groningen in the Netherlands, drinking water is produced from groundwater as well as from surface water. The surface WTP treats water from the river Drentsche Aa, that is stored in a retention basin, by means of coagulation, sedimentation, rapid sand filtration, activated carbon filtration, UV disinfection and slow sand filtration followed by cascade aeration combined with dosing of sodium hydroxide to control the oxygen level and pH.

The control of the pH of the drinking water is important to ensure a stable water in the distribution network (de Moel et al., 2007). The saturation index (SI) is an indicator for the chemical stability of the water. Therefore in the Netherlands, the SI should be above -0.2 and preferably below 0.2 to prevent corrosion in the distribution system and minimize chemical usage. In the current situation, the control of the SI of the treated water is based on weekly laboratory analyses. It is preferred to have a more adequate and direct control of the SI.

In this research the treatment processes of the WTP were simulated using the computer program PHREEQc. The focus of the research was to calculate the saturation pH (pHs) using PHREEQc and use this as an input for the process control of the SI.

Materials and Methods

The research was carried out at WTP De Punt. A water quality model was computed for the entire treatment process. Based on a thorough analysis of the historical water quality data, the processes that showed the largest variation were identified. These parameters were selected and together with the current water quality of the retention basin and the dosing of chemicals (hydrochloric acid, poly aluminium chloride and sodium hydroxide) were used as input for the model.

From July till December 2014 the pHs and the required sodium hydroxide concentration (in mg/L) in the effluent to achieve this pHs were calculated on a weekly basis. These outcomes were used as input for the dosing of the sodium hydroxide. The model has been calibrated and validated based on water quality analyses in the process. Next step will be the generation of an automatic coupling between the water quality model and the process data from the Power Generation Information Manager (PGIM) and the water quality data from the Laboratory Information Management System (LIMS).

Results

Evaluation of the historical data showed that the water quality of the retention basin fluctuates with seasonal influences, but week-to-week variations are limited. Especially fluctuations in the temperature of the water have a large effect on the pHs. During half a year the model was used to predict the pHs and required sodium hydroxide dosing. The model provided good estimates on the pHs. However, the sodium hydroxide concentration needed to obtain this pHs was not predicted accurately. Reasons for this were the sub optimal operational conditions of the cascade aeration and dosing of sodium hydroxide. It was concluded that there are possibilities to optimize the cascade and dosing of sodium hydroxide resulting in lower operational costs.

Besides the calculation of the target parameters, pHs and the sodium hydroxide concentration, it was found that the model was very useful to evaluate the entire treatment process. When trying to match theory with practise deviations can be present. A closer look at the performance of the processes together with the model helped in understanding the treatment processes even better.

Conclusions

From this study it can be concluded that the water quality model, based on PHREEQc, is able to calculate the pHs based on raw water quality and dosing of chemical in the processes. Additionally, the model has been a very useful tool in helping to understand the entire treatment process, and therefore it is proposed to use the model to optimize the process. Next step will be implementing the model in the operational process control, by coupling it to PGIM and LIMS. In future, the plant operator will be able to use the model and to calculate the input parameters for the process control of the SI.

Reference

De Moel, P. J., Verberk, J. Q. J. C. and Van Dijk, J. C., 2007. Drinking Water: Principles And Practice.

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