

Abstract

Hydrogen sulphide (H_2S) is considered the most significant cause of odour and corrosion in sewage systems and in wastewater treatment plants. It causes an odour nuisance for local residents. In higher concentrations, it could be also dangerous for health and life. Field investigations show that H_2S concentrations in the air could be as high as 1000 ppm in discharge wells. Concentrations of sulphide in sewage can reach up to 70 mg/dm^3 . The following are mentioned as the main factors influencing the formation of hydrogen sulphide in sewers: high values of BOD and COD, high temperatures, flow turbulence (in gravity systems), long hydraulic retention time, low concentrations of dissolved oxygen (lower than $0,1 \text{ mg/dm}^3$), low flow rate, low sewage pH.

The total retention time of the sewage in the entire sewerage system, from the origin to the treatment plant should be less than 8 h according to polish standard PN-EN 1671. However, in the research, sewage retention time in single force mains are often observed, amounting to several dozen or even several hundred hours. Since 1959, many models describing the rate of hydrogen sulphide formation, which depends both on the properties of wastewater and the characteristics of the sewage systems themselves have been developed. Many studies consider the prediction of increase in the concentration of sulphides in a real pressure sewage system using existing empirical formulas. However, no examples of studies, in which was effectively predicted were found in the literature.

Prediction of the concentration of hydrogen sulphide in the air is a demanding task for many reasons. In practice, operators of sewage networks more often use H_2S detectors to assess the problem related to gas emissions. Theoretically, based on the concentration in the air, it is possible to conclude about the concentration of hydrogen sulphide concentration in the wastewater. This relation is described by Henry's law. However, this applies to an equilibrium of the liquid phase and gas phase which does not occur in sewage systems.

The main aim of the research was to determine the influence of hydraulic retention time in the pressure sanitary sewer on hydrogen sulphide concentration in the discharge well. The additional purposes were: comparison of the obtained concentration of H_2S in the gas phase with the calculated equilibrium concentrations (from Henry's law), verification of the existing models used to calculate the sulphide concentrations in the sewage, empirical verification of the relation between H_2S concentrations in the gas phase and concentration of sulphide in the wastewater and pH value. An experiment conducted on a lab-scale model was designed. The aim was to model a real pressure system. Municipal wastewater for the experiment, which was

obtained from the wastewater treatment plant „Pomorzany” in Szczecin was used. Used wastewater was collected from the canal after first clarifier. 4, 8, 12, 16, 24, 36, 48, and 96 hours of hydraulic retention times were tested on the laboratory model. The following sewage parameters were controlled: COD, sulphide concentration, sulphate concentration, pH, and suspension concentration. Temperature and dissolved oxygen concentration at the end of the pressure pipe were also measured.

Significant increases of sulphide and H₂S in gas phase concentration were observed for the retention time to 16-24 hours. Then the concentrations of the increases were slower and the function that describes this relation became logarithmic. A similar effect was observed for other parameters. A clear relationship between hydrogen sulphide concentrations in the air with the concentrations of sulphide in the wastewater ($R = 0,87$) was found. Considering the pH value in the analysis resulted in increasing in the correlation coefficient to 0,94. Most of the models used to predict sulphide in wastewater overestimate the results many times compared to the data obtained during the experiment and presented in the literature. In that case, the model of Hvitved-Jacobsen et al. [1] provides the closest outcomes compared to the observed values. In the investigation observed H₂S concentrations in the air were compared to calculated equilibrium values resulting from Henry's law. In the research, 13 to 43 % of the equilibrium concentration of H₂S was found. Conducted research suggests that the assumption of a linear increase in the content of sulphides in wastewater depending on the retention time should be re-verified.

Future research plans include an attempt to verify the presented conclusions in the field studies. Also, another laboratory experiment is planned to be conducted to verify the obtained relations in modified conditions. Finally, works on the development of knowledge on methods of control of H₂S emissions in sanitary sewage systems will be carried out.

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