UNIVERSITI TEKNOLOGI MARA

EFFECT OF HYDROLYZED POLYACRYLAMIDE (HPAM) POLYMER TOWARDS MICROBIOLOGICAL INDUCED CORROSION (MIC) BACTERIA GROWTH AND CORROSOSION RATES

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MSc

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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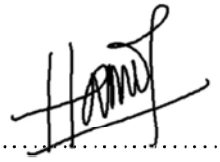
Signature of Student	:	
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ABSTRACT

Oil and gas production continues to dwindle nowadays, which requires oil and gas operators to deploy various interventions to maintain or increase their production. Hydrocarbon production primarily depends on its natural reservoir pressure. Once reservoir pressure drops, secondary recovery methods are deployed, such as waterflooding or gas flooding. After a certain amount of time, production and pressure will drop further, which will once again require additional measures to boost the reservoir's pressure and recover more hydrocarbons. Hence, tertiary recovery procedures, such as the enhanced oil recovery (EOR) methods have been implemented. In Malaysia, EOR was implemented using the chemical flooding method, which is also known as chemical EOR (CEOR). The two most common chemicals used within this strategy are surfactant and polymer. This study will be focusing on polymer, since according to an internal study by PETRONAS, 90% of the polymer will backflow into the pipelines. Pipelines, which play an important role in transporting hydrocarbons from offshore platforms to onshore facilities are always exposed to integrity threats, with corrosion acting as the primary threat. According to National Association of Corrosion Engineers (NACE), up to 40% of cases of internal pipeline corrosion are caused by microbiological induced corrosion. Previous studies found that Hydrolyzed Polyacrylamide (HPAM) polymer, the polymer used in CEOR is susceptible to bacterial degradation. Thus, concerns were aroused around the possibility of microbiological induced corrosion (MIC) bacteria utilizing HPAM, and worsening the integrity issues of the pipeline. Through this study, investigations will be conducted to assess the effect of the HPAM polymer towards bacterial growth and its contribution towards MIC rates, both as a single component in the culture media, and as a mixture with volatile fatty acids (VFA) and lactate, respectively. VFA and lactate served as carbon sources, to support microorganisms' growth and energizing their metabolic activities. Based on the results obtained, bacterial growth in all media with HPAM showed longer survivability than bacteria cultured without organic carbon or with only a single component of VFA and lactate. The numbers of these bacteria were also observed to be higher. This shows that the addition of HPAM did enhance their survival and provides the growing bacteria with an additional source of nutrients. In regards to the corrosion aspect, weight loss corrosion assessments were conducted on each metal coupon which was immersed in each bottle of culture media. The results showed that the weight loss and corrosion rate from the coupon immersed in the culture media which contained HPAM recorded a lower corrosion rate in comparison to the coupons from the culture media without organic carbon and only a single component of VFA or lactate. This phenomenon was believed to be caused by the formation of a Iron Sulfide (FeS) layer due to the corrosion reaction occurring on the surface of the metal coupon. Since uniform corrosion rates can't be used to form a conclusion on MIC rates, coupons were then examined under Scanning Electron Microscope (SEM) for observations on the pits formed on the surface, as that is one of the characteristics for MIC. The study showed that more pits were observed from the coupons which were immersed in the media with HPAM. In order to determine the mechanism of MIC in the presence of EOR, whether the corrosion can be considered as localized or as simply uniform, pit depth must be measured as it will be used for pit ratio calculation. Based on the results obtained, all pit ratios from all coupons were recorded higher than 5, which confirmed that the mechanism of corrosion in the presence of HPAM is a localized pitting corrosion.

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