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THE POTENTIAL OF VINYL SULFONATED CO-POLYMER (VS-Co) TO INHIBIT SILICATE SCALE FORMATION

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ABSTRACT

Silicate scale has been a significant problem especially in industry such as geothermal, oilfield production and water treatment by which ASP flooding is known as one of enhanced oil recovery method that contribute to this problem. ASP was injected into the reservoir at high pH value and will dissolve the silica in the reservoir. When the high pH of ASP flooding meet with neutral pH connate water, the pH will reduce as well as the solubility of silica hence producing silicate scale as it cannot dissolve anymore. Hence, there are many studies have been conducted to find the most effective ways to inhibit or at least to slow down the formation of silicate scaling. The common method to remove the silicate scale is by traditional mechanical removal. However, this method is not preferred as the scale is already formed and the cost of shutting down the plant for the maintenance is too high. Chemical or scale inhibitors (SI) are one of the favored methods to prevent silicate scale formation in which among several chemical inhibitors that have being used to slow down the scale formation are polyphosphino polycarboxylic acid (PPCA), polyvinyl sulfonate (PVS) and polyacrylic acid (PAA). From the previous study, it has been reported that magnesium has little effect on these SI that resulted in approximately the same inhibition efficiency (IE). In this study, the effect of vinyl sulfonated copolymer (VS-Co) as inhibitor was studied by analyzing the precipitate produced from VS-Co inhibited Mg/Si brine using X-Ray Diffraction (XRD) and Fourier-transform infrared spectroscopy (FTIR). Vinyl sulfonated copolymer (VS-Co) has sulfonate ions (SO^{3-}) which have anions that needed to bind the positively charges ions in water. Bulk inhibited scaling brine test was conducted at 60^{o}C and pH8.5 by mixing silicon brine (with VS-Co) that represent the inhibited ASP leachate with magnesium brine to represent the connate water to replicate the reservoir condition during ASP flooding. The samples tested in this study are noninhibited 60Mg:940Si (i.e. Mg/Si mixed brine of final concentration of 60ppm magnesium ion with 940ppm silicon ion) as a blank and inhibited 60Mg:940Si with various VS-Co concentrations being added at 20ppm, 50ppm and 100ppm respectively. IR spectra for all sample of 60Mg:940Si show a similar peak at 1050 cm-1 to 1080 cm-1which attributed to Si-O covalent bond and at band of 790 cm-1 to 800 cm-1 showing the presence of Si-O-Si stretching. XRD patterns produced a broad scattering peak for all samples at 2θ of 24° showing that the samples resemble amorphous silica. However, at high concentration

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CHAPTER ONE

INTRODUCTION

1.1 Research Background

Silica and silicate scale formation have been encountered in various operation plants/systems such as steam generator, desalination, water treatment, geothermal and oilfield production. It is known that formation of silicate scale occurs through silica condensation and polymerization (Wang and Wei, 2016). Formation of silicate scale usually controlled by a few factors which are amorphous silica solubility, temperature, composition, pH of solution, rate of growth, dimension, hydrodynamic conditions of brine flow, and concentration of colloidal particles (Kashpura and Potapov, 2000).

In oil and gas industry, alkaline surfactant polymer (ASP) is an emerging and promising method that been given much attention for enhanced oil recovery. However, several case studies found that it is almost unavoidable not to encounter silicate scaling in the production well when ASP flooding is applied in sandstones reservoir (Arensdorf *et al.*, 2010). This phenomenon can lead to various technical problems such as obstruction to pipes and equipment that eventually cause damages and economic losses. The expenses to eradicate this problem was estimated about 0.8 billion USD in Great Britain, 3 billion USD in Japan and 9 billion USD in USA (Ge *et al.*, 2016). Due to these reasons, many studies have been conducted to prevent the scaling or at least to slow down the silicate scale formation to prolong the lifespan of existing asset and infrastructure. Also, it is crucial for engineers to understand the scale formation mechanism, its type in effort to manage this scale.

Silicate scale is very difficult to remove in which the only method being used traditionally is by mechanical removal. A diverse range of polymer and chemicals have been developed and tested as scale inhibitor of amorphous silica and magnesium silicate scales (Arensdorf *et al.*, 2011) .Gallup *et al.* has tested various of scale inhibitors formulation from different manufacturers and tested them using synthetic brine solution; as well as brine acidification. According to (Wang and Wei, 2016) the brine acidification was far more effective than the tested scale inhibitors for field operation in Mak-Ban field, Philippines.