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Effects of Environmental Factors and Recovered Sulfur in Shahid Hashemi Nezhad Gas Refinery on the Soils Quality for Irrigation

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Introduction: Elemental sulfur is byproduct of natural gas refining which during this process, H_2S is removed from sour gas and after changes to solid sulfur, it is stored in large block forms. Continuous precipitation of sulfur and its oxidation causes soil acidification and as a result, nutrient cations such as Ca^{2+}, Mg^{2+}, Na^+ and K^+ will leach from the soil profile. Also, sulfate accumulation led to soil acidification and accelerates the silicates weathering in upper layer of the soil profile. Accumulation of water soluble sulfate in the soil and increase the nutrient cations leaching from the soil depend on sulfate resistance rate. Also, addition of sulfur to the soil for a long time can cause calcium sulfate formation that will cause problems such as increase in soil salinity. Shahid Hashemi Nezhad gas refinery is located about 35 km south of Sarakhs city and about165 km east north of Mashhad. In addition to exploiting, refining and producing 50×10^6 $m^3.day^{-1}$ natural gas, recovered sulfur with %99/9 purity and 2000 tons per day production capacity is one of the byproducts of this gas complex.

Materials and Methods: 22 soil samples were collected from surface soil in Shahid Hashemi Nezhad gas refinery (3 samples) and nearby areas (19 samples) (Fig.1). Soil extracts pH was measured in equilibrium with pure water and with KCl 1M solution in 1:2.5 soil solution ratio. EC of the soil samples was measured in different soil water ratios to obtain the EC 1:1 (Fig.2). Total sulfate content was measured by gravimetry method at geochemistry laboratory of Faculty of Sciences at Ferdowsi University of Mashhad. To get the digestion extract, a mixture of 2 ml concentrated HF, 5 ml HCl and 8 ml $HNO_3$was added to 0.5 gr soil in a teflon vessel, then heated for 60 min at 170° C. After cooling, the solution was evaporated at 130 °C to dry it. Then, the dried salt was dissolved in a mixture of 2 ml HNO_3 and 2 ml HCl and diluted with deionized water up to 25 ml. Ca^{2+} and Mg^{2+}contentswere measured through titration of the soil extract with EDTA 0.01 N and in EBT reagent at the first stage, and titration of the soil extract by EDTA 0.01 N and in Moroxide reagent at the second stage. Na^+ and K^+ contents were determined using AAS method at geochemistry laboratory at Ferdowsi university of Mashhad after extraction with $CaCl_2$ 0.01 M.

Results and Discussion: Based on EC values, 77% of the soil samples were non-saline (EC < 2 dS m^{-1}), 18% were slightly saline (EC= 2-4 dS m^{-}1) and 5% were highly saline (EC=8-16 dS m^{-1}) (Fig.3). In addition, low ΔpH values in the soil samples showed high salinity and similar results to EC. SAR index had the highest value in TS5 sample, and the cations content in this index can be attributed to evaporative sediments with carbonate and sulfate salts in the area (Shurijeh and Chehel-Kaman formations). Moreover, the halite bearing formations in the study area can be regarded as a source for Na^+. Based on SAR and EC, majority of the samples (except TS5 in saline and non-sodic) were non-saline and non-sodic that were suitable for agriculture. ESP index of less than 15% in all samples indicated that Na^+ concentration has no danger to crops. Relation between the total sulfate content to pH and EC was inverse and direct, respectively. This indicates that recovered sulfur affect in the soil acidification within the refinery site and increase the soluble salts content. These effects are very considerable in the soils inside the refinery site.

Conclusions: Salinity is the major factor affecting decrease of the samples quality for agriculture. Exposed formations in the area with highly soluble rocks causes to increase the soluble salts in the soil. The second factor is high temperature and low precipitation that led to increase the evaporation from the soil surface and accumulation of salts on the soil. Recovered sulfur from natural gas processing can reduce the soil pH and increases the soluble salts to some extent, especially in the inside refinery samples, and then decreases the soil quality for agricultural purposes. Except for one, all studied samples were classified as non-saline and non-sodic soils. Furthermore, the samples were classified in two classes of flocculated soils and potentially dispersive soils based on SAR and EC. ESP index indicates that there is no serious problem regarding sodium concentration in

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the soils. The pH values indicate that the samples were almost alkaline soils except for the samples inside the site, which are slightly acidic. Acidity of those few samples are attributed to the sulfur released from gas refinery process and its effect on the soil pH.

Keywords: Gas refinery, SAR, Soil quality, Total sulfate, EC, ΔpH