Rietveld Phase Analysis of Deposits Formed at Different Locations within Electric Submersible Pumps

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ABSTRACT

Scale and corrosion deposits frequently form in electric submersible pumps (ESPs), which are placed in the borehole and used for numerous applications, and can unfortunately cause premature equipment failure and temporarily shut down operations. The ESPs are frequently used in oil production to provide a relatively efficient form of artificial lift, to enhance oil production. The main objective of this study is to extend the new sample preparation method [Sitepu and Al-Ghamdi (2019). *Adv. X-Ray Anal*, **62**; and referenced in], to particularly separate the crystalline inorganic materials (non-soluble or non-hydrocarbon) from the hydrocarbon of the sludge deposits and the other materials found in different locations within the ESP's parts. Once all the phases for each part of the XRD data of crystalline inorganic deposits, which show no amorphous inorganic phases present, then the quantitative phase analysis of the XRD data for each phase is determined using the Rietveld method with the generalized spherical harmonic description [Sitepu (2002). *J. Appl. Cryst.* **35**, 274–277; Sitepu et al. (2005). *J. Appl. Cryst.* **38**, 158–167; Sitepu (2009). *Powder Diff.*, **24**, 315-326]. Key information is not just the phase concentrations, but the lattice parameters — which can reflect composition — and information derived from the profile parameters, and the preferred orientation. The Rietveld phase analysis results revealed that the deposits mainly consist of corrosion products in the form of iron sulfides, iron oxides, and iron carbonates, formation materials in the form of sand, dolomite, scale deposits, i.e., $CaCO_3$, calcium sulfate ($CaSO_4$), salts (sodium chloride (NaCl)), cementing materials ($Ca_6Al_2(SO_4)_3(OH)_{12}$, brownmillirite ($Ca_2MgFeAlMgSi_2O_5$) and calcium silicate ($Ca(SiO_4)O$)). These compounds plugged the pump stages, causing motor overheating and pump failure. The findings help refinery and gas plant employees take proper action to prevent future occurrences of the deposits.