



Smart Removal Pb²⁺ using Green Nanocapsules (GNC) prepared via Nano-Emulsion Liquid Membrane (NELM) based paraffin oil/Na-silicate from aqueous solution

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1. Abstract

The removal of heavy metal ions from various waste streams, such as industrial and nuclear facilities, has emerged as a crucial objective in sustainable development to address the water issue. In this context, we synthesized and implanted Green Nano-Emulsion Liquid Membrane (GNELM), which uses paraffin oil as a green diluent, 0.05 M Ionquest801 as a carrier phase, and Span 80 as an emulsifying agent, to remove 1000 mg/L Pb(II) from an aqueous solution. We used 0.5 M H₂SO₄ as an internal phase in the batch technique and studied the stability and various parameters of GNELM. The optimum conditions for the capsulation and stabilization process of the membrane were carried out using 3% MgCl₂ and 1% Na-silicate under stirring speed = 700 rpm, T = 25°C, and stirring time = 60 min. DLS, EDX, FT-IR, We used DLS, EDX, FT-IR, SEM, and AFM to characterize the GNELM particles, and dynamic light scattering (DLS) revealed an average particle size of 29.9 nm. The permeation efficiency of 1000 mg/L Pb²⁺ through GNC was 75% at V/m = 0.1 L/g, shaking time = 45 min, and T = 25 C. We studied various parameters, including time, V/m, and initial Pb concentrations. The results suggest that the stabilized GNC particles hold promise as environmentally friendly methods for removing Pb from aqueous solutions.

Keywords: Lead (II); paraffin oil; nanocapsules; Emulsion; silicate

2. Introduction

In this context, a unique and efficient nano-globules stabilized emulsion with nanometal oxide additives (Pickering emulsion) will be prepared and immobilized for the removal of investigated heavy metals. To overcome on the insufficient instability of emulsion liquid membrane there's two option the first one by inserting magnetic nanoparticles in the ELM phase offers higher emulsion stability and easier demulsification than traditional ELM surfactant transformed to nanoglobules which give more coherency and stability [1], the second way is to stabilize by different alkaline earth metal chlorides salts such as MgCl₂, NiCl₂, CoCl₂, BaCl₂ and Na-silicate [2-4]. Ionquest 801 extractant was used in the recovery of valuable elements and different heavy metals from different aqueous media [5-6] through using different extraction techniques. ELM based surfactants previously were used for the recovery of rare earth metal ions [7] precious metals from different media [8-9], toxic heavy metals such as Pb ions from aqueous solution by stabilization of magnetic with Fe₂O₃ particles and nonionic surfactants [10] as well as Pickering emulsion for the removal of ciprofloxacin [11]. Nanofluid membranes play important roles in the removal and adsorption of different pharmaceutical materials such as ethylparaben [12-15], methylparaben [16], antibiotic tetracycline [17-18] from aqueous solution as well as for wastewater treatment [19]. Lead is very toxic metal and present in direct tap water in different countries as well as it is conflicted with fission product included in the spent nuclear fuels at different nuclear facilities so it's important to developed selective, rapid and sustainable techniques to remove such this metal ion from different aqueous media. The benefits of the current technique are to combines adsorption and desorption process in one step with high removal efficiency.

3. Aim of Work

In this direction, GNC capsules were synthesized by Liquid surfactant membrane system of IQ801/Paraffin oil/H₂SO₄ and stabilized using sodium silicate/Mg-chloride. GNC was implanted for the removal of Pb²⁺ from aqueous solution. Different parameters were investigated such as shaking time, V/m ratio and initial Pb concentration.

4. Experimental

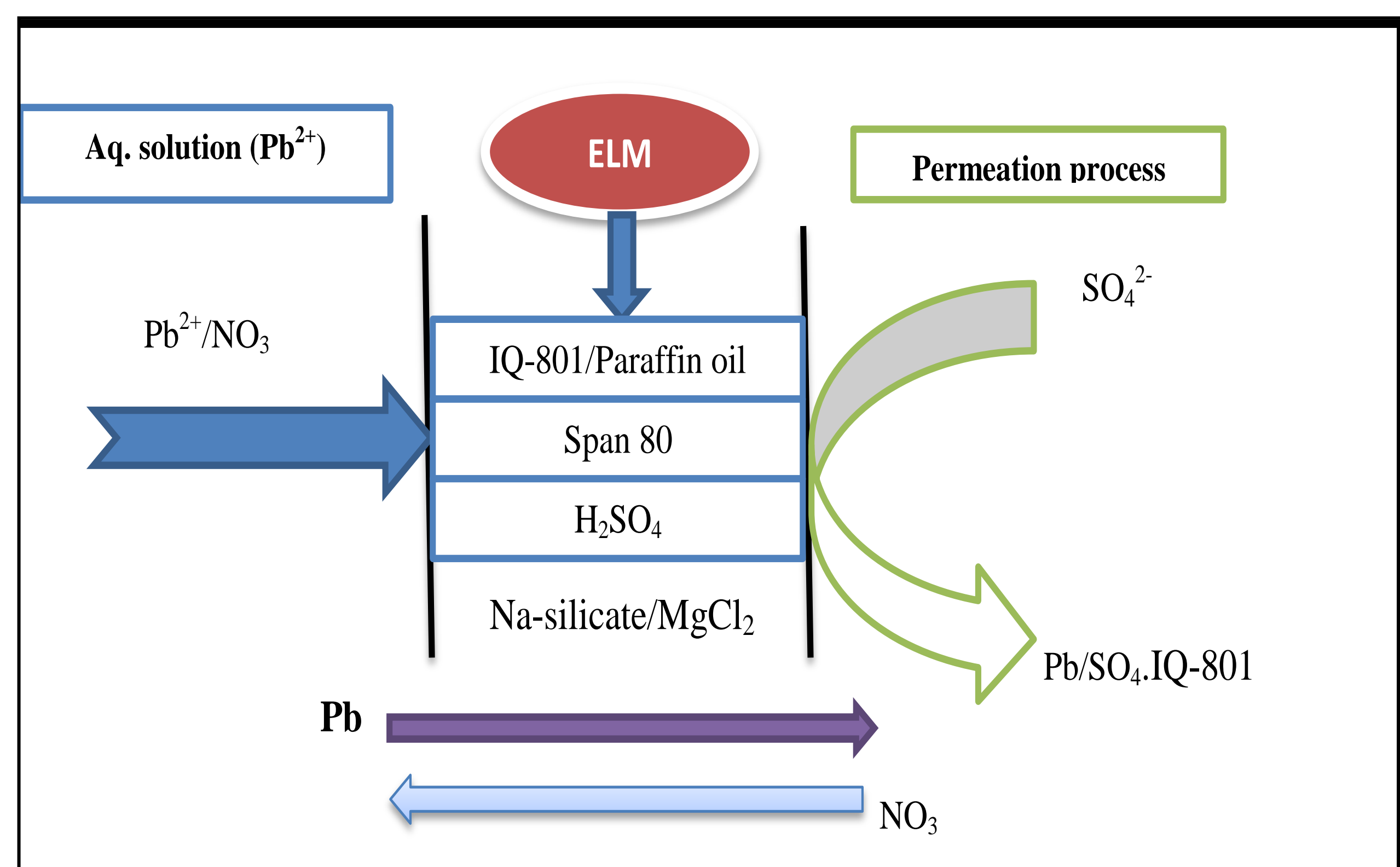


Fig. (1): Mechanisme of (GNELM)

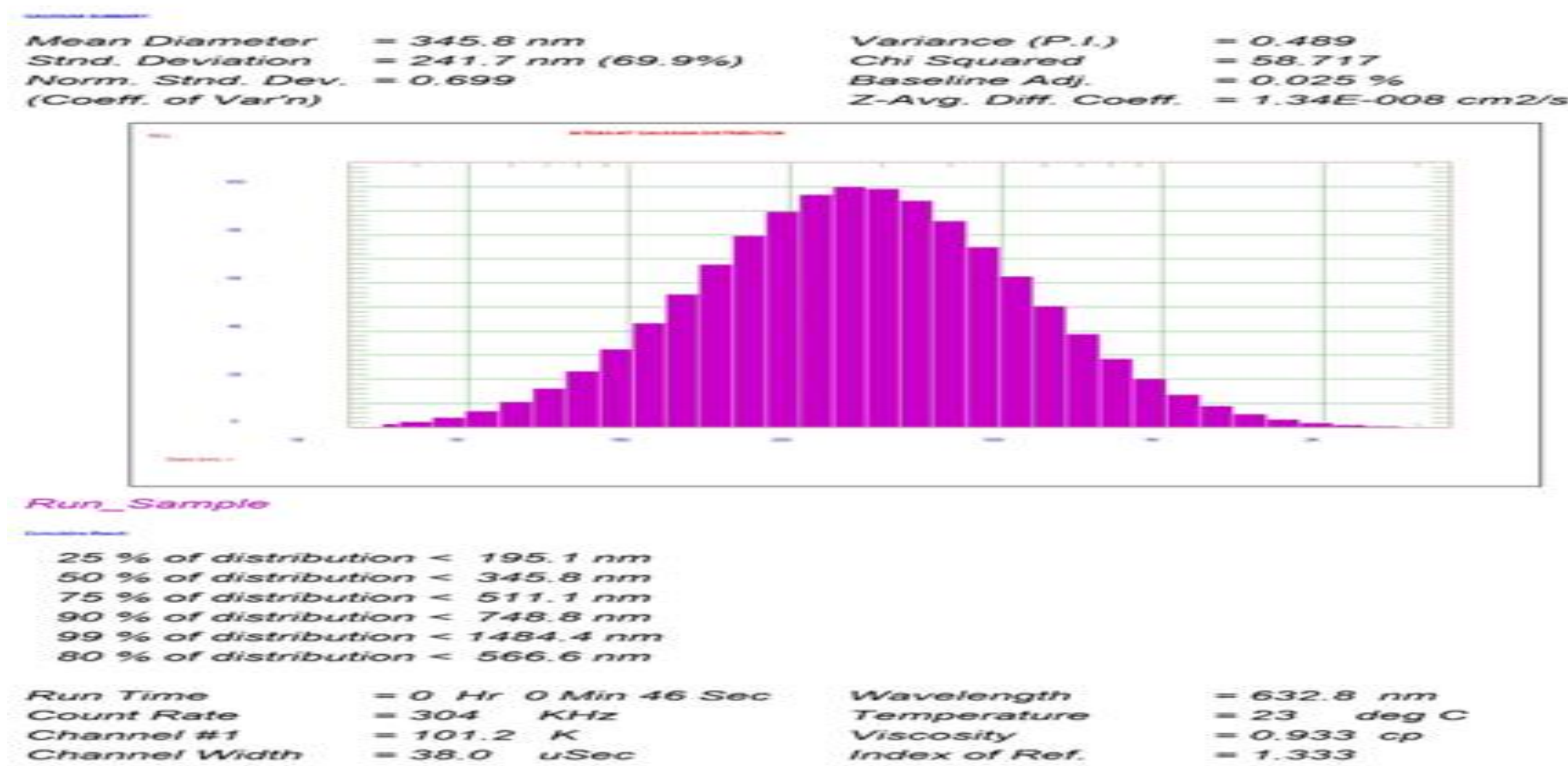
5. Results

Stripping results of Pb²⁺ loaded on IQ/paraffin oil solution

Stripping Agent	Conc., M	%S
HNO ₃	0.5	2
HCl	1	3
Thiourea	0.5	28.6
H ₂ SO ₄	0.5	69
Oxalic acid	1	25

values of the best stability conditions for ELM containing IQ-801/ H₂SO₄/span 80 at 25 °C

parameters	Best conditions
Emulsification rotating speed, rpm	15000
Emulsification time (min.)	3
[IQ], M	0.05
[Internal phase]=[H ₂ SO ₄], M	0.5
Span 80	2%
ELM/external phase volumes	1mL/5 mL
String speed, rpm	400



Fig(2): DLS diagrams of NELM at of GNELM

7. References

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Thank you!