ORIGINAL ARTICLES

Appraise the Influence of Sodium Silicates as Abrasive Materials in Petroleum Constructions

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ABSTRACT

The mean target of the present work producing a new abrasives matches with international cods, standers, industrial requirements and environmental safe products, by using of local raw materials. The Controlling of chemical and physical properties of the product passes into laboratory tests and practical production of the abrasive improvement of the hardness, grain sizes, and grain shapes. The obtained product is very promising for using as safe and effective abrasive for surface preparation before protective coatings applications.

Key words: Sodium silicates, Abrasive and Petroleum constructions.

Introduction

Several methods have been used to form nano grade cerium oxide, the powder in solution has always sedimented, because cerium oxide is too dense to remain suspended in solution. The sedimentation of cerium oxide induces an unstable polishing rate for changeable solid contain during polishing and the sedimentation aggregation creates surface scratches on the polished surface, both of which restrict its application in the IC industry. Colloidal silica nano particles have been known to form a stable suspension in water, even at a very dilute concentration and he has described processes for making colloidal silica that include a peptization method. Colloidal silica was successfully modified by titrating active silicic acid and cerium ions into a basic solution at 100°C (Yoshida, A., 1994).

The silicic acid is produced from sodium silicate through the cation exchange technique. The silica seeds prepared hydro-thermally have the diameter of 10–20 nm. by feeding the silicic acid precursor, the silica nuclei can be grown to the nano-particles with mono-disperse size of 60, 100, and 130 nm, respectively, depending on the amount of silicic acid added. The silica nano-particles are amorphous in structure and as compared to crystalline quartz; they possess a relative density of 93%. The as-grown large sized silica nano-particles are applied as abrasives in CMP slurry to polish silicon wafer, achieving MRR of 430 nm/min and RMS roughness of less than 0.97 nm, (Xiaokai, H., 2010).

Colloidal silica was successfully modified by titrating active silicic acid and cerium ions into a basic solution at 100°C. The zeta potential versus pH value curve was changed after modification of colloidal silica. The mean particle size of the modified colloidal silica increased as [Ce4+] or the seed concentration increased. An excess of cerium ions would compress the electrical double layer of the colloidal silica and induce particle aggregation. A higher seed concentration indicates a short distance between particles, which would aid aggregation in the modified colloidal silica during titration. The removal rate of the dielectric film was higher when the modified colloidal silica was used as a polishing slurry than when colloidal silica treated without cerium oxide or the original colloidal silica were used for polishing, (Ming-shyong Tasai, 2003).

2- Experimental

The present work aims to study the mechanical, mineralogical, chemical analysis, physical properties and engineering tests to appraise the influence of sodium silicates as abrasive material.

2.1-Mechanical analysis:

Mechanical analysis was performed for 10 samples of sodium silicates at Sedimentary Lab in Egyptian Petroleum Research Institute (EPRI).

2.2- Mineralogical analysis:

The studied four samples of sodium silicates were subjected to X-ray diffraction (XRD). The analysis was carried out at the Central Lab in (EPRI).

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2.3- Chemical analysis (X-ray fluorescence):

The detail chemical analysis (XRF) was carried out for four samples at Central Laboratories Sector in the Egyptian Mineral Resources Authority.

2.4- Physical analysis:

The physical analysis is including (grain and bulk densities and hardness properties).

2.4.1 Grain and bulk densities:

The grain and bulk densities were carried out for four samples at Core Lab in (EPRI).

2.4.2 Hardness test:

The hardness tests are carried out for four samples at Mechanical and Welding Lab, Metallurgical department; Engineering Collage - Cairo University using HLN-11A instrument serial no. A091602090.

2.5- Engineering tests:

The engineering tests were carried out for four samples at Yard in the workshops of Suez Canal Authority (Port Said).

2.5.1 Dust level:

The elcometer 142 dust tapes allow assessment of the quantity and size of dust particles on surfaces prepared for painting. (Elcometer 142 – ISO 8502 part 3 "dust tape" (ISO 8502 – 3, 2003).

2.5.2 Conductivity test:

Incorporating a flat sensor, the elcometer 138 conductivity Meter can measure the conductivity of a solution from a single drop of a sample. It is essential that the level of contamination on a surface is measured prior to application of the coating to ensure the quality of the coating and that its optimum lifetime is achieved. (Elcometer 138 conductivity Meter- USLCM – ISO 11127 part 6 & 7 and ASTM D 4940) (ISO 11127 – 6, 1993; ISO 11127 – 7, 1993).

2.5.3 Profile test:


2.5.4 Cleanliness Degree:

The cleanliness degree obtained according Swedish stander and ISO 8501 part 1 (ISO 8501 – 1, 1994).

2.5.5 Salt level test (on prepared surface):

The salt level tested by (Elcometer 130 SCM 400 salt contamination Meter) according to ISO 11127- part 6, ISO 8501 part 2, ISO 8502 part 6, (ISO 8501 – 2, 1994).

Result And Discussion

3.1 Abrasive grain size distribution specification:

The grain size distribution plays an important role in the use of sodium silicates as an abrasive according to ASTM C 33, (2002). Mechanical analysis was carried out by the conventional sieving method with screens placed at one-phi interval using a set of ASTM sieves of 20, 40, 60, 80, 200 and < 200 meshes. The table No. 1 is showing the main grains size is ranging from course to medium grains. These grains are sub-angular to sub-angular, (Pl. No. 1).
Table 1: The main grain sizes analysis of sodium silicates.

<table>
<thead>
<tr>
<th>Sieve U.S Standard</th>
<th>MM</th>
<th># 20 / 40</th>
<th># 20 / 60</th>
<th># 30 / 60</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>2.380</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>12</td>
<td>1.680</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>14</td>
<td>1.410</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>16</td>
<td>1.190</td>
<td>---</td>
<td>0 – 1</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>20</td>
<td>0.840</td>
<td>0 – 5</td>
<td>0 – 5</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>30</td>
<td>0.594</td>
<td>20 – 60</td>
<td>10 – 15</td>
<td>0 – 10</td>
</tr>
<tr>
<td>40</td>
<td>0.417</td>
<td>30 – 70</td>
<td>25 – 30</td>
<td>5 – 45</td>
</tr>
<tr>
<td>50</td>
<td>0.297</td>
<td>0 – 30</td>
<td>30 – 45</td>
<td>&gt; 40</td>
</tr>
<tr>
<td>60</td>
<td>0.249</td>
<td>0 – 5</td>
<td>0 – 15</td>
<td>0 – 40</td>
</tr>
<tr>
<td>80</td>
<td>0.178</td>
<td>&lt; 1</td>
<td>0 – 5</td>
<td>0 – 15</td>
</tr>
<tr>
<td>120</td>
<td>0.125</td>
<td>---</td>
<td>---</td>
<td>0 – 5</td>
</tr>
<tr>
<td>Pan</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

Plate 1

(A) (B)

(C) (D)

Fig. A: Photograph showing solidified sodium silicates.
Fig. B: Photograph showing specified required sizes.
Fig. C&D: Photo micrograph showing the sub-angular to sub-rounded sodium silicate grains.

3.2 Mineralogy:

The mineralogical analysis of the studied sodium silicates samples were conducting via the X-ray diffraction analysis (XRD).

The minerals identified from the bulk analysis of the sodium silicate sample are illustrated in (Fig. 1). From this figure it can be identify the sodium silicate by ASTM Cad No. 00-018-1240, showing in Fig. 1.

3.3 Chemical Analysis:

In order to determine the major oxides (SiO₂, TiO₂, Al₂O₃, Fe₂O₃, MnO, MgO, CaO, Na₂O, K₂O, P₂O₅, Cl, SO₃ and L.O.I) in the studied sodium silicate, (Table 2). In this Table the percentage of SiO₂ and Na₂O are represented more than 99% and the other elements are less than 1%, (Table No. 2).
3.4 Physical Analysis:

The physical analysis is including grain and bulk densities and hardness properties.

3.4.1 Grain and Bulk densities:

The density of a rock is defined as the mass of its unit volume. The grain density is defined as a mass of unit volume of solid phase and bulk density is defined as the mass of unit volume in its natural state, (Table 3).

Table 3: The average of sodium silicates grain and bulk densities.

<table>
<thead>
<tr>
<th></th>
<th>Grain density</th>
<th>Bulk density</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.42 gm/cm³</td>
<td>2.38 gm/cm³</td>
</tr>
</tbody>
</table>

3.4.2 Hardness Test:

Hardness is the property of a material that enables it to resist plastic deformation, usually by penetration. However, the term hardness may also refer to resistance to bending, scratching, abrasion or cutting, (Table 4).

Table 4: The average of sodium silicates hardness.

<table>
<thead>
<tr>
<th>HV 10</th>
<th>The Average HV 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>923</td>
<td>965</td>
</tr>
</tbody>
</table>

3.5 Engineering tests:

3.5.1 Dust level:

The dust level is obtained on prepared surface less than rate 2, (Pl. No. 2).
3.5.2 Conductivity test:

The conductivity test result is 500 µs/cm.

3.5.3 Profile test:

The profile tests obtained results are 75 – 110 µm.

3.5.4 Cleanliness Degree:

The surface cleanliness degree is Sa 2.5 (near white metal) to Sa 3 (white metal, Pl. No. 2).

3.5.5 Salt level test (on prepared surface):

The salt level test results on prepared metallic surface are less 3 µgr/ cm².

<table>
<thead>
<tr>
<th>Plate 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A)</td>
</tr>
<tr>
<td>(B)</td>
</tr>
</tbody>
</table>

Fig. A: Photograph of rusted surface before surface preparation by using of sodium silicates.
Fig. B: Photograph of surface preparation after using of sodium silicates.

4- Conclusion:

In the present study prepared (manufactured) sodium silicates act as abrasives for metals surface preparation before anti corrosion coatings applications, the results obtained are as follows:

4.1- due to the product hardness, grain shapes, grain sizes, purity, non presence of pollution causing substances and another chemical and physical properties, the obtained product give us ideal abrasive material matches with international cods standers and applications requirements.

4.2- The practical demonstration and using of the abrasive at the yards of the professional applicators gives us good results, and acceptance foe using the abrasives in there authorities and companies as industrial materials.

References


