The Effect of Different Water Types on The Water Powder Ratio of Dental Gypsum Products

Amer A Taqa  
BSc, MSc, PhD (Asst. Prof.)

Dept of Department of Dental Basic science  
College of Dentistry, University of Mosul

Nada Z Mohammed  
BDS, MSc (Lec.)

Department of Prosthodontics  
College of Dentistry, University of Mosul

Alia’a W Alomari  
BDS, MSc (Lec.)

Department of Prosthodontics  
College of Dentistry, University of Mosul

ABSTRACT

Aims: To evaluate the effect of different water types on the water powder ratio of dental gypsum products. Materials and Methods: In this study five types of water (distilled, tab, slurry, de-ionized and well water) were used to be mixed with two types of dental gypsum products (plaster and stone). Results: Results showed a statistically significant difference at \( p \leq 0.05 \) in water powder ratio of gypsum products when mixed with different types of water that used in this study. Conclusions: Water requirement of gypsum product varies in respect to the type of water used to be mixed with. The most pronounce decrease in water requirement of dental gypsum products was achieved with slurry water. Key words: types of water, water powder ratio and gypsum product.


INTRODUCTION

Gypsum materials are popular as a die material because of ease of use, low cost, compatibility with most impression materials and appropriate setting expansion and familiarity.\(^{(1,3)}\)

Water powder ratio is an important factor in the quality of gypsum materials,\(^{(4,5)}\) many experimental attempts to improve mechanical properties of dental stone are oriented mainly towards the decrease of gauging water requirement.\(^{(6-11)}\) Accurate compassion of gypsum properties should be undertaken while all materials are mixed to the same consistency.\(^{(12)}\) The principal difference among gypsum products is in the physical shape and nature of the calcium sulfate crystals makes it possible to obtain the same consistency with less excess water with dental stone and high stone than with model plaster.\(^{(13-15)}\)

Although particle size and the total surface area are the chief factors in determining the amount of gauging water, the particle size distribution, grinding of the particles and adhesion between particles of hemihydrate are also a factor in determining the amount of water requirement.\(^{(16-19)}\)
MATERIALS AND METHODS
1: Materials:
Materials used in this study can be classified into: First: Dental gypsum products; two types of dental gypsum products used in this study (plaster and stone). Two types of plaster (Al-Ahliya Co. for gypsum industries Ltd, and Al-Alaf Co. for gypsum industries Ltd) and two types of stone (Elite, Zhermack SPA-45021Badia Poesine, Italy and Dental stone China Meheco co.P.R. China).

Second: Mixing water; five types of mixing water have been used in this study (distilled water, tap water, slurry water, deionized water and well water (AL-Rashedia well water)). The distilled water was used to prepare the control specimen to study the effect of other types of water on the water requirement of dental gypsum products used in this study.

2: Methods: Water analysis was done in the Nenava environmental center analysis department (Table 1).

<table>
<thead>
<tr>
<th>Type</th>
<th>Distilled water</th>
<th>Tap water</th>
<th>Deionized water</th>
<th>Well water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>0</td>
<td>49.6</td>
<td>0</td>
<td>820</td>
</tr>
<tr>
<td>Magnesium</td>
<td>0</td>
<td>15.6</td>
<td>0</td>
<td>195</td>
</tr>
<tr>
<td>Sulfate</td>
<td>0</td>
<td>60</td>
<td>0</td>
<td>2050</td>
</tr>
<tr>
<td>carbonate</td>
<td>0</td>
<td>124</td>
<td>0</td>
<td>248</td>
</tr>
</tbody>
</table>

Table (2): Testing Consistency

<table>
<thead>
<tr>
<th>Type</th>
<th>Cone Penetration</th>
</tr>
</thead>
<tbody>
<tr>
<td>II plaster, mold</td>
<td>30 ± 2*</td>
</tr>
<tr>
<td>III dental stone</td>
<td>30 ± 2**</td>
</tr>
<tr>
<td>IV dental stone, high strength</td>
<td>30 ± 2**</td>
</tr>
</tbody>
</table>

*Cones penetration depth (35gm) total weight. **Cones penetration depth (100gm) total weight. ADA specification No. 25 (1975).
RESULTS

The mean and standard deviation of water powder ratio of gypsum products mixed with different types of water were listed in Table (3). This table reveals that the water requirement of each type of gypsum specimens used in this study varies according to the type of mixing water. The most pronounced decrease in water powder ratio of both stone and plaster was achieved with slurry water (Table 3).

Table (3): The Effect of Different Water Types on Water Powder ratio of Gypsum Products

<table>
<thead>
<tr>
<th>Gypsum products</th>
<th>Distilled water mean</th>
<th>Distilled water SD</th>
<th>Slurry water mean</th>
<th>Slurry water SD</th>
<th>Tab water mean</th>
<th>Tab water SD</th>
<th>De-ionized water mean</th>
<th>De-ionized water SD</th>
<th>Well water mean</th>
<th>Well water SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elite stone</td>
<td>33</td>
<td>0.0</td>
<td>29</td>
<td>0.37</td>
<td>32</td>
<td>0.57</td>
<td>34</td>
<td>0.00</td>
<td>34</td>
<td>0.0</td>
</tr>
<tr>
<td>Dental stone</td>
<td>34</td>
<td>0.0</td>
<td>30</td>
<td>0.012</td>
<td>33</td>
<td>0.0</td>
<td>34</td>
<td>0.0</td>
<td>35</td>
<td>0.577</td>
</tr>
<tr>
<td>Al-Ahli plaster</td>
<td>54</td>
<td>0.00</td>
<td>49</td>
<td>0.561</td>
<td>55.5</td>
<td>0.57</td>
<td>56</td>
<td>0.577</td>
<td>58</td>
<td>0.577</td>
</tr>
<tr>
<td>Al-Alaf plaster</td>
<td>46</td>
<td>0.577</td>
<td>44</td>
<td>0.045</td>
<td>48</td>
<td>0.00</td>
<td>49</td>
<td>0.0</td>
<td>50</td>
<td>0.577</td>
</tr>
</tbody>
</table>

For both dental stone and plaster specimens increase in their water powder ratio was noted in Table (3) when they mixed with de-ionized water. The most pronounced increase in the water powder ratio of both plaster and stone specimens was achieved with well water.

One way analysis of variance (ANOVA) revealed that there was a statistically significant difference at p≤0.05 on the effect of water type on the water requirement of all gypsum products that is used in this study at f=78.56, f=37.83, f=24, f=24 for Al-Ahli, Al-Alaf, Elite stone and Dental stone respectively (Table 4).

Table (4): One Way ANOVA of the Effect Different Water Types on Water Powder ratio of Gypsum Products

<table>
<thead>
<tr>
<th>S.O.V</th>
<th>Al-Ahli plaster</th>
<th>Al-Alaf plaster</th>
<th>Dental stone</th>
<th>Elite</th>
</tr>
</thead>
<tbody>
<tr>
<td>DF</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>MS</td>
<td>19.658</td>
<td>6.306</td>
<td>37.83</td>
<td>0.083</td>
</tr>
<tr>
<td>F*</td>
<td>78.6</td>
<td>2</td>
<td>24</td>
<td>0.083</td>
</tr>
<tr>
<td>Error</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
</tbody>
</table>

*Statistically Significant at p ≤0.05

Duncan multiple comparison rang test for the effect of different types of water on the water requirement of elite stone and dental stone (Figure 1) revealed that their were statistically significant differences at p ≤ 0.05 on the water requirement of elite stone and dental stone when mixed different types of water that used in this study. Duncan’s multiple range test Figure(2) revealed that their were a statistically significant differences p ≤ 0.05 among the effect of water types used in this study on the water requirement of Al-Ahli plaster and Al-Alaf plaster. Except that there was no statistically significant difference in water requirement of Al-Alaf plaster when mixed with tab or de-ionized water Figure (2).
DISCUSSION

Calcium sulphate hemihydrates (gypsum) is an ionic solid and is therefore essentially hydrophilic. The surface interactions play an appreciable part in determining the water requirement; this can act through changing the condition of the grains and forces between the grains.\(^{(16,23)}\)

Analysis of the mean and standard deviation Table (3) reveals that slurry water produces the most pronounced decrease in the water powder ratio of both stone and plaster specimens. This can be explained according to the crystallization theory.\(^{(15,24-26)}\) Increasing the nucleolus of crystallization (calcium sulfate dihydrate) that present in slurry water enhances the wetting of gypsum crystals by water and thereby decreasing their water powder ratio.\(^{(21,22)}\)

According to this study, a decrease in water powder ratio of stone specimens was noted when mixed with tab water as compared with that when it mixed with distilled water Table (3). Tab water contains large amount of calcium carbonate ions (CaCO\(_3\)) Table (1) and this salt highly soluble in water and make tab water as soft water; this means that salt makes tab water easy dispense between the particles of stone powder( it provides sites for nucleation of the newly formed dehydrate)\(^{(21)}\) and thereby decrease their water powder ratio. While For plaster tab water increases
its water requirement; this difference may be due to the difference in physical properties of dental stone and plaster or to the addition of chemical materials during manufacturing, that makes distilled water more easily disperse between gypsum particles and thereby decrease their water requirement.\(^{10, 27}\)

In this study an increase in the water powder ratio was noted Table (3) when mixed with de-ionized water. This can be explained by the fact that there are no ions in this type of water Table (1) so that it's more difficult for de-ionized water to disperse between gypsum particles and thereby increasing their water powder ratio. Well water produces the most pronounced increase in the water powder ratio of both plaster and stone specimens was achieved with, this is due to that type of water contain large amount of calcium and magnesium sulphate ions (CaSO\(_4\) and MgSO\(_4\)) Table (1). These ions make the well water as hard water\(^{(28, 29)}\) i.e hard dispersion of the ions of well water between gypsum particles and thereby increasing their water powder ratio.

**CONCLUSIONS**

The results suggest that the water powder ratio of dental gypsum product varies with respect to the water types used to be mixed with. The most pronounce decrease in water powder ratio of dental gypsum products was achieved with slurry water.

**REFERENCES**