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# The Effects of High Temperature Storage on Microhardness and Depth of Cure of Dental Resin-Based Composites

MAJ(P) Stephen J. Sebastian

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## **ABSTRACT**

**Purpose:** The Army utilizes metal storage containers (Tricons) for shipping and storage of dental resin-based composite materials during deployments. Often these containers are deployed to desert locations where temperatures reach well beyond manufacturer's recommended storage temperatures. The purpose of this study is to determine if these high temperature storage conditions decrease the microhardness and depth of cure of dental resin-based composites stored in these containers.

**Methods:** Three commonly used dental resin-based composites were selected and stored in a metal Tricon container and sent downrange with an Army dentist to Kuwait. Materials were stored in the Tricon without climate control during the hottest months of the year from May to September. Upon return of stored materials, ten cured samples of each composite brand were created and measured for microhardness using the Knoop Hardness Test (KHN). Measurements were compared to the same number of cured samples from a corresponding batch stored at room temperature during the same period of time, according to the manufacturers' recommendation.

**Results:** Microhardness decreased for all brands of resin-based composite stored in a desert Tricon. Tetric decreased the most, followed by TPH Spectra ST, then Filtek Supreme Ultra. The mean KHN was significantly higher for Filtek in both the desert-stored batch and room-temperature stored batch. Overall, the brand of resin-based composite influenced microhardness more than the storage temperature.

**Conclusion:** Storing resin-based composite in the desert in a metal Tricon container decreased the microhardness of all composite brands in this study, but Filtek Supreme Ultra decreased the least. Average microhardness also measured highest for Filtek Supreme Ultra compared to other brands in this study, making it the material of choice when storing in desert temperatures.

## **INTRODUCTION**

The Army operates in austere environments. From cold weather conditions to the searing heat of the desert, the Army goes wherever their mission takes them. In the last several decades, the Army has conducted campaigns in desert climates in Iraq, Kuwait, and parts

of Afghanistan, where temperatures can reach extreme levels. Kuwait earned the distinction as one of the hottest places on earth when, on July 21, 2016, it reached the “highest temperature ever recorded in continental Asia” with a temperature of 53.9°C (129°F).<sup>1</sup> Army dentists deployed to these hot climates utilize dental materials that are typically transported and stored in metal storage containers (called Tricons) which trap heat and raise temperatures even higher. Does the use of these metal storage containers in the desert create detrimental effects on our dental materials as a result of the high temperatures inside? How do we know that storing our materials at high temperatures do not compromise the integrity of the dental restorations placed in soldiers’ mouths?

This study seeks to answer these questions as they pertain to the depth of cure and microhardness of dental resin-based composites. Most dental manufacturers recommend storing their resin-based composites at room temperature (about 22°C/71°F), warning of ill-effects of doing otherwise.<sup>2</sup> It is well-documented that poorly polymerized resin-based composites corresponds to a reduction in physical properties.<sup>3,4,5</sup> Resin-based composites that fail to reach an adequate depth of cure result in weakened restorations, recurrent decay, and the release of free monomers that are toxic to the pulp.<sup>6,7,8</sup> Free monomers also irritate soft tissue and promote bacterial growth.<sup>9,10</sup> They ultimately reduce the lifespan of our dental restorations.<sup>11,12</sup> When restorations fracture or fail, soldiers spend valuable time at the dental clinic rather than doing their jobs. During Operation Iraqi Freedom, dental emergencies cost the U.S. Army \$21.4M and \$21.9M for the years 2009 and 2010 respectively.<sup>13</sup> Of greater cost and consequence is the fact that getting dental work done while deployed downrange takes soldiers out of the fight and away from the mission.<sup>14</sup> This study looks at whether the use of Tricon storage containers during desert deployments is contributing to the problem.

Many studies have been conducted on pre-heating resin-based composites for short periods of time immediately before clinical use. This practice improves viscosity of the material and actually increases polymerization of the restoration.<sup>15,16</sup> However, the studies showing these benefits utilized warming devices made by dental manufacturers specifically for this purpose.<sup>17</sup> There is a noticeable absence of studies on exposing resin-

based composites to high temperatures over longer periods of time, which would simulate the Dental Corps' use of Tricons during desert deployments.

Designed in 1948 by the Army Transportation Corps, the first metal storage containers were initially called the "Transporter" and later developed into the Container Express Box (Conex for short), with some units capable of being divided into three smaller ones (thus, Tricon).<sup>18</sup> A typical Tricon consists of rigid corrugated steel, measures approximately 8 x 6 x 6 ft, and is capable of carrying approximately 9000 lbs.

Like walking into a sauna, opening the doors to a Tricon on a hot summer day can be a sweltering experience. And yet, it is a common practice for dental materials to be transported downrange and stored in these high temperature containers for months at a time, or even longer.

Are we jeopardizing the integrity of our restorations with our current transport and storage practices? What is the influence of high temperature storage on the microhardness and depth of cure of our resin-based composites? These are the question this study seeks to address. Doing so will help to ensure that our dental restorations perform the way we intend, and our deployed soldiers stay focused on the mission at hand.

## **MATERIALS AND METHODS**

This is a single case design experimental study. Three resin-based composites were selected that are commonly used as universal restorative materials: Filtek Supreme Ultra (3M), TPH Spectra ST (Dentsply Sirona), and Tetric (Ivoclar Vivadent).

One sample set from each material was set aside to serve as the control group. During the trial period, control groups were stored at room temperature of approximately 22°C (71°F), well within the manufacturer's recommend range for storage temperature. Another sample of each brand was placed in plastic containers which were then placed inside a larger polymer storage box. This box was placed inside a Pelicon storage case

and stored inside a Tricon metal container, belonging to the the 257<sup>th</sup> Dental Company Area Support (DCAS) stationed at Fort Bragg, NC. The Tricon deployed with the 257<sup>th</sup> DCAS to Kuwait, where materials remained inside the Tricon from 22 May to 23 September. The Tricon spent approximately half its time at Camp Arifjan, Kuwait, and later moved to Camp Buehring, Kuwait, where it stayed for the remainder of the trial period. In both locations, the Tricon was stored outdoors where it received nearly full sun exposure.

An Amprobe TS300 Temperature/RH Data Logger inside the polymer box recorded the temperatures inside the Tricon on an hourly basis. At the end of the trial period, materials were returned to Fort Bragg where samples were made and tested for microhardness. At that time, samples from the room-temperature stored set of materials were also created and measured for microhardness.

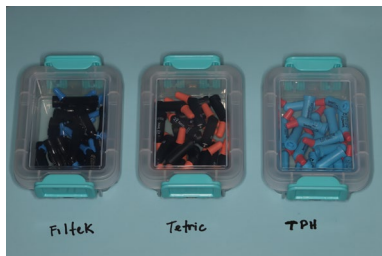


Fig. 1. Resin composites tested: Filtek Ultra, Tetric, TPH Spectra ST



Fig. 2. Case used for storing resin composites inside Tricon



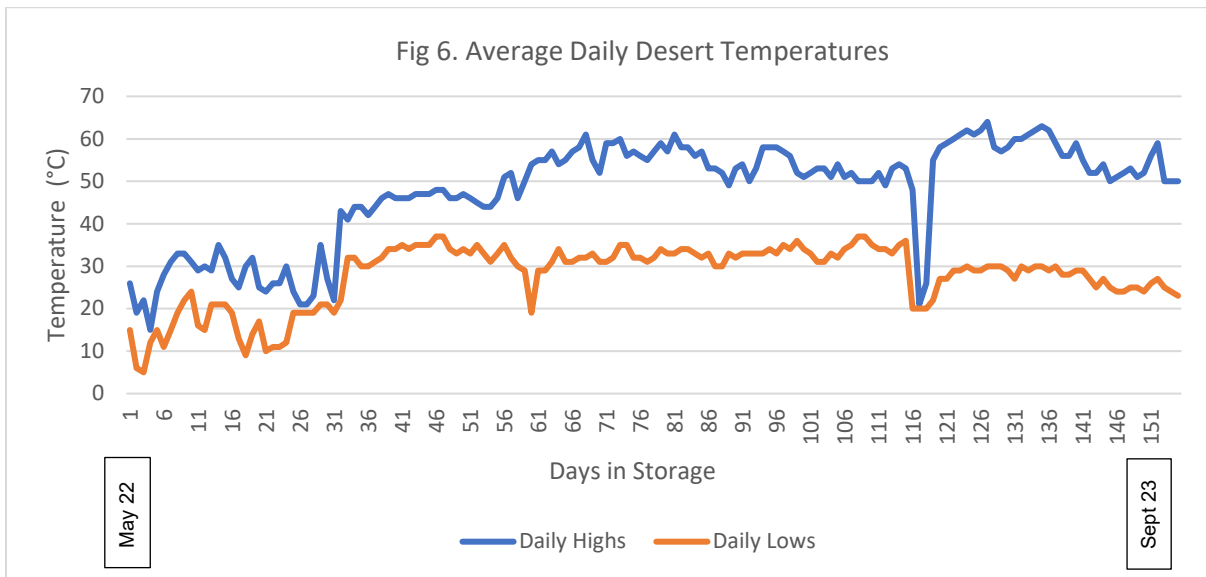
Fig. 3. Data logger used to record hourly temperatures



Fig. 4. Tricon storage unit ready for shipment to Kuwait



Fig. 5. Pelicon storage boxes inside Tricon unit



All samples were prepared utilizing a 6 mm diameter by 2 mm deep stainless steel mold (Everbilt, Atlanta, GA). A clear mylar matrix (DuPont Mylar 0.002 gauge/60mm thick) was then placed over the top of the mold (marked “T” for top), and polymerization was performed through the matrix using the Kerr Demi Plus LED light curing system (Danbury, CT). The LED was charged per manufacturer’s recommendation (2 hours on charging base) and tested with an LED radiometer (Demetron, SDS/Kerr, Orange, CA), prior to every sample cure to verify full and consistent light intensity (1100 mW/cm<sup>2</sup>). Microhardness of cured samples were then evaluated using the Knoop hardness tester (Leco, LM 300 AT, St Joseph, MI). This device placed the sample under a load of 50 grams for a dwell time of 15 seconds.<sup>19</sup> The Knoop hardness number (abbreviated either HK or KHN) was then calculated using the following equation:

$$HK = \frac{\text{load(kgf)}}{\text{impression area(mm}^2\text{)}} = \frac{P}{C_p L^2}$$

L = length of indentation along its long axis in mm (Variable)

C<sub>p</sub> = correction factor related to the shape of the indenter (ideally 0.070279)

P = load in Newton (N); 100g = .98 N = .1kgf

Each sample was subjected to four top and four bottom surface points to gather microhardness measurements. Mean KHN values were calculated for each sample, along with a bottom to top Knoop hardness surface ratio to evaluate adequate depth of cure. An 80% depth of cure ratio was used as minimally acceptable.<sup>20</sup> A factorial analysis of variance (ANOVA) was then used to assess differences between hardness, storage conditions, and composite brand.



Fig 7: Leco 300AT Knoop Hardness Tester.

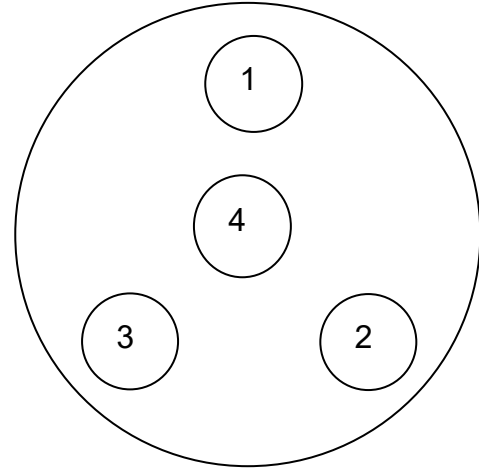


Figure 8: Sequence of Sample Collection

## RESULTS

Of the three composite brands selected, only the TPH Spectra ST samples achieved the industry standard depth of cure (80%). Bottom/top KHN ratios are presented in Table 1 by brand and storage condition. With a ratio of 0.83, TPH Spectra ST had the best depth of cure followed by Filtek Supreme Ultra (KHN = 0.76) and Tetric (KHN = 0.60) respectively.

A two-way ANOVA revealed significant main effects on sample hardness for both storage condition and composite brand (both  $P < 0.05$ ). The effect sizes for storage and brand were  $\eta^2 = 0.02$  and  $\eta^2 = 0.33$  respectively. Additionally, a significant interaction effect between storage condition and brand was noted ( $P = 0.04$ ;  $\eta^2 = 0.02$ ). Although the hardness of all composites decreased following storage at high temperatures, the Tetric samples suffered a significantly larger reduction in KHN compared to the declines seen

in the Filtek Supreme Ultra and TPH Spectra ST samples. Figure 9 shows mean KHN values by storage condition and composite type.

Mean Knoop hardness values are presented in Table 2. With an overall mean KHN of 40.88 (SD = 9.16), the Filtek Supreme Ultra samples were significantly harder compared to both the TPH Spectra ST and Tetric samples (both  $P < 0.001$ ). The mean KHN values for the TPH Spectra ST and Tetric samples were 28.93 (SD = 4.29) and 28.32 (SD = 10.97) respectively. No difference in mean KHN was found between the TPH Spectra ST and Tetric samples,  $P = 0.80$ . The overall mean KHN value for samples stored at high temperatures was 31.76 (SD = 10.74). This was significantly lower than the mean hardness of 33.67 (SD = 9.90) for samples stored at 22°C ( $P = 0.04$ ).

## **DISCUSSION**

The Army utilizes Tricon units in desert climates to transport and store dental materials and supplies. Temperatures inside these units far exceed dental manufacturers' storage recommendations for dental resin-based composite. Do these temperatures affect the microhardness of our resin-based composite restorations? The answer is yes for all samples in this study, but more so for Tetric. Desert-stored Tetric produced samples significantly lower in hardness than its room temperature counterparts. The fact that desert-stored Tetric had to be tested at a lower load force in order to produce a measurable KHN further indicates high temperatures inhibit polymerization with this product.

More influential in this study than storage temperature was the effect seen in composite brands. In this regard, Filtek Supreme Ultra stood above the others. Filtek produced samples far greater in mean hardness values than those made from either TPH Spectra ST or Tetric, with little difference in KHN between room temperature and desert temperature samples. To summarize the effect sizes, the results from this study showed a large difference in hardness due to brand, a small difference due to storage condition, and a small difference in the way the different brands responded to high temperature storage, with the exception of Tetric.

While TPH Spectra ST was the only brand to meet the industry standard of depth of cure (80%), Filtek fell short by only .04%. Overall, the significantly lower mean KHN for TPH Spectra ST compared to the mean KHN for Filtek make it a less desirable restorative material. In fact, in both storage conditions, even the mean bottom KHN for Filtek (35.29 in desert storage, 35.61 in room-temperature storage) exceeded the mean top KHN of TPH Spectra ST (31.51 in desert storage, 32.26 in room-temperature storage).

Should Army dentists store their resin-based composite in Tricons in the desert? It depends on which brand we are considering. This study shows the brand we store down range has more effect on hardness than the temperature at which we store it. Although depth of cure for Filtek samples did not reach industry standards, the mean KHNs for Filtek far outperformed its competitors in this study, making it the clear choice for Tricon storage in desert conditions.

Table 1. Bottom to Top KHN ratio (Depth of Cure)

Composite			
Brand	Desert	22°C	Total
Filtek	0.77	0.75	0.76
TPH	0.82	0.83	0.83
Tetric	0.65	0.56	0.60
Total	0.75	0.71	0.73

Table 2. Mean KHN by Storage Location and Composite Type

Storage Location	Composite Brand	N	Mean	Std. Deviation
High Temperature	Filtek	80	40.55	9.71
	TPH	80	28.75	3.78
	Tetric	80	25.97	10.91
	Total	240	31.76	10.74
22°C	Filtek	80	41.20	8.63
	TPH	80	29.12	4.77
	Tetric	80	30.67	10.58
	Total	240	33.67	9.90
Total	Filtek	160	40.88	9.16
	TPH	160	28.94	4.29
	Tetric	160	28.32	10.97

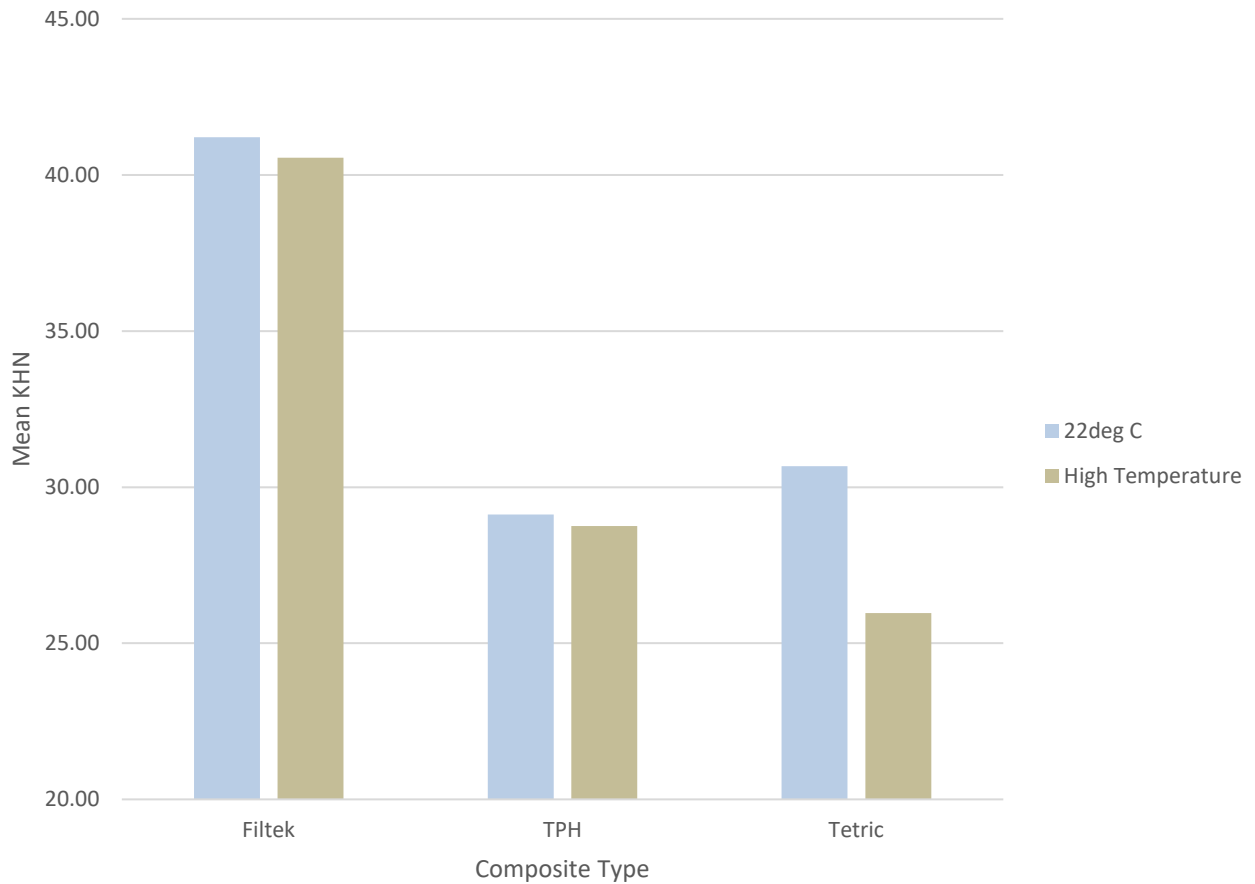


Fig. 9. Mean KHN values by Storage Condition and Composite Type

## CONCLUSION

The results of this study show that the brand of dental resin-based composite influenced microhardness more than storage temperature, with Filtek Supreme Ultra producing the highest average hardness values among the brands evaluated. Furthermore, Tetric was the brand that suffered the greatest decrease in KHNs as a result of high temperature conditions.

Dental problems, like fractured restorations, can distract a soldier from his work. Restorations that break or fail prevent a soldier from focusing on the mission. In cases involving tooth pain in remote or far forward positions, a soldier may have to be evacuated by air or convoy to a higher level of care, taking up valuable time and Army resources. Are we contributing to the problem by storing our dental resin-based composites in Tricons in the desert? This study would suggest that we are not. But it also suggests that we should think twice about what brand we take on deployments to hot desert climates. Filtek Supreme Ultra was the brand that outperformed the others in this study. These results warrant further studies of this brand to determine its performance under longer storage conditions, other weather conditions (i.e., cold temperatures), as well as temperature effects on other material properties. Doing so will help ensure the best possible dentistry done for soldiers downrange.

## **AUTHOR CONTRIBUTIONS**

Stephen Sebastian contributed to conception, design, data acquisition, analysis, and interpretation, drafted and critically revised the manuscript. Gamal Baker contributed to data acquisition during deployment to Kuwait. Thomas Beltran contributed to design, analysis, and data interpretation. Research Advisor Parth Mewar contributed to research design and manuscript editing.

## **DECLARATION OF CONFLICTING INTERESTS**

The authors and contributors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

**TABLE 1: KHN RESULTS for ROOM TEMPERATURE STORED SAMPLES**

\*All samples are 2mm thick, material stored at room temp of 22°C

Sample Number	Brand-Top or Bottom	DC or mm	KHN	Mean	T/B KHN Ratio	
<b>1</b>	Filtek-T	2	45.2			
	Filtek-T	2	43.5			
	Filtek-T	2	53.4			
	Filtek-T	2	52	<b>Filtek T = 48.53</b>	<b>71.625 %</b>	
	Filtek-B	2	34.8			
	Filtek-B	2	34.4			
	Filtek-B	2	35.4			
	Filtek-B	2	34.5	<b>Filtek B = 34.76</b>		
	<b>2</b>	Filtek-T	2	42.6		
		Filtek-T	2	42.6		
Filtek-T		2	42.2			
Filtek-T		2	45.5	<b>Filtek T = 43.23</b>	<b>87.624 %</b>	
Filtek-B		2	36.2			
Filtek-B		2	36.7			
Filtek-B		2	40.1			
Filtek-B		2	38.5	<b>Filtek B = 37.88</b>		
<b>3</b>		Filtek-T	2	38.4		
		Filtek-T	2	48.4		
	Filtek-T	2	44.3			
	Filtek-T	2	47.6	<b>Filtek T = 44.68</b>	<b>104.700 %</b>	
	Filtek-B	2	48.5			
	Filtek-B	2	49.4			
	Filtek-B	2	42.6			
	Filtek-B	2	46.6	<b>Filtek B = 46.78</b>		

<b>4</b>	<b>Filtek-T</b>	2	43.8		
	<b>Filtek-T</b>	2	50.1		
	<b>Filtek-T</b>	2	48.8		
	<b>Filtek-T</b>	2	46.8	<b>Filtek T = 47.38</b>	<b>81.891 %</b>
	<b>Filtek-B</b>	2	41		
	<b>Filtek-B</b>	2	37.7		
	<b>Filtek-B</b>	2	38.3		
	<b>Filtek-B</b>	2	38.2	<b>Filtek B = 38.8</b>	
<b>5</b>	<b>Filtek-T</b>	2	42.5		
	<b>Filtek-T</b>	2	44		
	<b>Filtek-T</b>	2	45.1		
	<b>Filtek-T</b>	2	44	<b>Filtek T = 43.9</b>	<b>70.501 %</b>
	<b>Filtek-B</b>	2	34		
	<b>Filtek-B</b>	2	31.8		
	<b>Filtek-B</b>	2	30.4		
	<b>Filtek-B</b>	2	27.6	<b>Filtek B = 30.95</b>	
<b>6</b>	<b>Filtek-T</b>	2	40		
	<b>Filtek-T</b>	2	43.3		
	<b>Filtek-T</b>	2	45.4		
	<b>Filtek-T</b>	2	47.1	<b>Filtek T = 43.95</b>	<b>69.624 %</b>
	<b>Filtek-B</b>	2	30.6		
	<b>Filtek-B</b>	2	33.2		
	<b>Filtek-B</b>	2	29.3		
	<b>Filtek-B</b>	2	29.4	<b>Filtek B = 30.6</b>	
<b>7</b>	<b>Filtek-T</b>	2	45.5		
	<b>Filtek-T</b>	2	45.2		
	<b>Filtek-T</b>	2	44.4		
	<b>Filtek-T</b>	2	43.8	<b>Filtek T = 44.73</b>	<b>55.220 %</b>

	<b>Filtek-B</b>	2	24.9		
	<b>Filtek-B</b>	2	26.6		
	<b>Filtek-B</b>	2	24		
	<b>Filtek-B</b>	2	23.3	<b>Filtek B = 24.7</b>	
<b>8</b>	<b>Filtek-T</b>	2	45.2		
	<b>Filtek-T</b>	2	45.5		
	<b>Filtek-T</b>	2	44.7		
	<b>Filtek-T</b>	2	43.9	<b>Filtek T = 44.83</b>	<b>78.139 %</b>
	<b>Filtek-B</b>	2	36.7		
	<b>Filtek-B</b>	2	33		
	<b>Filtek-B</b>	2	34.1		
	<b>Filtek-B</b>	2	36.3	<b>Filtek B = 35.03</b>	
<b>9</b>	<b>Filtek-T</b>	2	40.6		
	<b>Filtek-T</b>	2	47		
	<b>Filtek-T</b>	2	48.2		
	<b>Filtek-T</b>	2	51.2	<b>Filtek T = 46.75</b>	<b>76.577 %</b>
	<b>Filtek-B</b>	2	34.8		
	<b>Filtek-B</b>	2	35.1		
	<b>Filtek-B</b>	2	38		
	<b>Filtek-B</b>	2	25.3	<b>Filtek B = 35.8</b>	
<b>10</b>	<b>Filtek-T</b>	2	56.6		
	<b>Filtek-T</b>	2	65.6		
	<b>Filtek-T</b>	2	67.4		
	<b>Filtek-T</b>	2	60.5	<b>Filtek T = 56.53</b>	<b>72.138 %</b>
	<b>Filtek-B</b>	2	45.6		
	<b>Filtek-B</b>	2	44.6		
	<b>Filtek-B</b>	2	41		
	<b>Filtek-B</b>	2	31.9	<b>Filtek B = 40.78</b>	

<b>1</b>	<b>TPH-T</b>	<b>2</b>	<b>32.4</b>		
	<b>TPH-T</b>	<b>2</b>	<b>32.6</b>		
	<b>TPH-T</b>	<b>2</b>	<b>32.4</b>		
	<b>TPH-T</b>	<b>2</b>	<b>25.2</b>	<b>TPH T = 30.65</b>	<b>89.820 %</b>
	<b>TPH-B</b>	<b>2</b>	<b>25.2</b>		
	<b>TPH-B</b>	<b>2</b>	<b>27.5</b>		
	<b>TPH-B</b>	<b>2</b>	<b>28.3</b>		
	<b>TPH-B</b>	<b>2</b>	<b>28.8</b>	<b>TPH B = 27.53</b>	
<b>2</b>	<b>TPH-T</b>	<b>2</b>	<b>31.6</b>		
	<b>TPH-T</b>	<b>2</b>	<b>27.8</b>		
	<b>TPH-T</b>	<b>2</b>	<b>29.3</b>		
	<b>TPH-T</b>	<b>2</b>	<b>31.6</b>	<b>TPH T = 30.08</b>	<b>82.878 %</b>
	<b>TPH-B</b>	<b>2</b>	<b>23.4</b>		
	<b>TPH-B</b>	<b>2</b>	<b>25.2</b>		
	<b>TPH-B</b>	<b>2</b>	<b>25</b>		
	<b>TPH-B</b>	<b>2</b>	<b>26.1</b>	<b>TPH B = 24.93</b>	
<b>3</b>	<b>TPH-T</b>	<b>2</b>	<b>28.5</b>		
	<b>TPH-T</b>	<b>2</b>	<b>30</b>		
	<b>TPH-T</b>	<b>2</b>	<b>26.5</b>		
	<b>TPH-T</b>	<b>2</b>	<b>24.2</b>	<b>TPH T = 27.3</b>	<b>104.871 %</b>
	<b>TPH-B</b>	<b>2</b>	<b>30.3</b>		
	<b>TPH-B</b>	<b>2</b>	<b>27.7</b>		
	<b>TPH-B</b>	<b>2</b>	<b>28.3</b>		
	<b>TPH-B</b>	<b>2</b>	<b>28.2</b>	<b>TPH B = 28.63</b>	
<b>4</b>	<b>TPH-T</b>	<b>2</b>	<b>38.6</b>		
	<b>TPH-T</b>	<b>2</b>	<b>38.2</b>		
	<b>TPH-T</b>	<b>2</b>	<b>39.7</b>		
	<b>TPH-T</b>	<b>2</b>	<b>31</b>	<b>TPH T = 39.18</b>	<b>79.887 %</b>

	TPH-B	2	25.9		
	TPH-B	2	32.9		
	TPH-B	2	30.9		
	TPH-B	2	35.5	<b>TPH B = 31.3</b>	
5	TPH-T	2	32.3		
	TPH-T	2	29.6		
	TPH-T	2	32.7		
	TPH-T	2	31	<b>TPH T = 31.38</b>	<b>74.729 %</b>
	TPH-B	2	23.3		
	TPH-B	2	23.3		
	TPH-B	2	24.2		
	TPH-B	2	23.3	<b>TPH B = 23.45</b>	
6	TPH-T	2	29.9		
	TPH-T	2	36.9		
	TPH-T	2	32.1		
	TPH-T	2	39.2	<b>TPH T = 34.53</b>	<b>79.582 %</b>
	TPH-B	2	27.2		
	TPH-B	2	27.6		
	TPH-B	2	27.2		
	TPH-B	2	27.9	<b>TPH B = 27.48</b>	
7	TPH-T	2	35		
	TPH-T	2	31.1		
	TPH-T	2	44.9		
	TPH-T	2	35.3	<b>TPH T = 36.58</b>	<b>81.465 %</b>
	TPH-B	2	29.1		
	TPH-B	2	29.2		
	TPH-B	2	29.2		
	TPH-B	2	31.7	<b>TPH B = 29.8</b>	

8	TPH-T	2	32.4		
	TPH-T	2	34.6		
	TPH-T	2	36.4		
	TPH-T	2	28.5	<b>TPH T = 32.98</b>	<b>72.316 %</b>
	TPH-B	2	23.3		
	TPH-B	2	23.3		
	TPH-B	2	24.8		
	TPH-B	2	24	<b>TPH B = 23.85</b>	
9	TPH-T	2	23.3		
	TPH-T	2	34.6		
	TPH-T	2	25.1		
	TPH-T	2	36	<b>TPH T = 32.35</b>	<b>73.353 %</b>
	TPH-B	2	23.3		
	TPH-B	2	23.3		
	TPH-B	2	24.2		
	TPH-B	2	24.1	<b>TPH B = 23.73</b>	
10	TPH-T	2	30.8		
	TPH-T	2	26.3		
	TPH-T	2	26		
	TPH-T	2	27.3	<b>TPH T = 27.6</b>	<b>87.137 %</b>
	TPH-B	2	23.3		
	TPH-B	2	23.3		
	TPH-B	2	24.1		
	TPH-B	2	25.5	<b>TPH B = 24.05</b>	
1	Tetric-T	2	34.9		
	Tetric-T	2	34.7		
	Tetric-T	2	40		
	Tetric-T	2	38.4	<b>Tetric T = 37</b>	<b>70.756 %</b>

	<b>Tetric-B</b>	2	29.2		
	<b>Tetric-B</b>	2	25.1		
	<b>Tetric-B</b>	2	24.6		
	<b>Tetric-B</b>	2	25.8	<b>Tetric B = 26.18</b>	
<b>2</b>	<b>Tetric-T</b>	2	34.7		
	<b>Tetric-T</b>	2	30		
	<b>Tetric-T</b>	2	31.4		
	<b>Tetric-T</b>	2	37	<b>Tetric T = 33.28</b>	<b>72.055 %</b>
	<b>Tetric-B</b>	2	23.3		
	<b>Tetric-B</b>	2	23.3		
	<b>Tetric-B</b>	2	24.4		
	<b>Tetric-B</b>	2	24.9	<b>Tetric B = 23.98</b>	
<b>3</b>	<b>Tetric-T</b>	2	33.7		
	<b>Tetric-T</b>	2	45		
	<b>Tetric-T</b>	2	47.3		
	<b>Tetric-T</b>	2	53.7	<b>Tetric T = 34.4</b>	<b>48.488 %</b>
	<b>Tetric-B</b>	2	15.6		
	<b>Tetric-B</b>	2	16.2		
	<b>Tetric-B</b>	2	18.6		
	<b>Tetric-B</b>	2	16.3	<b>Tetric B = 16.68</b>	
<b>4</b>	<b>Tetric-T</b>	2	34.8		
	<b>Tetric-T</b>	2	38.2		
	<b>Tetric-T</b>	2	26.7		
	<b>Tetric-T</b>	2	37.5	<b>Tetric T = 34.4</b>	<b>80.901 %</b>
	<b>Tetric-B</b>	2	35.7		
	<b>Tetric-B</b>	2	26.4		
	<b>Tetric-B</b>	2	26.7		
	<b>Tetric-B</b>	2	22.5	<b>Tetric B = 27.83</b>	

<b>5</b>	<b>Tetric-T</b>	2	48.2		
	<b>Tetric-T</b>	2	40.5		
	<b>Tetric-T</b>	2	42.1		
	<b>Tetric-T</b>	2	42.5	<b>Tetric T = 43.44</b>	<b>50.943 %</b>
	<b>Tetric-B</b>	2	18		
	<b>Tetric-B</b>	2	20.3		
	<b>Tetric-B</b>	2	23.8		
	<b>Tetric-B</b>	2	26.4	<b>Tetric B = 22.13</b>	
<b>6</b>	<b>Tetric-T</b>	2	37		
	<b>Tetric-T</b>	2	49.5		
	<b>Tetric-T</b>	2	52.2		
	<b>Tetric-T</b>	2	43.7	<b>Tetric T = 45.6</b>	<b>46.929 %</b>
	<b>Tetric-B</b>	2	20.7		
	<b>Tetric-B</b>	2	21.5		
	<b>Tetric-B</b>	2	22.1		
	<b>Tetric-B</b>	2	21.3	<b>Tetric B = 21.4</b>	
<b>7</b>	<b>Tetric-T</b>	2	32.6		
	<b>Tetric-T</b>	2	46.5		
	<b>Tetric-T</b>	2	42		
	<b>Tetric-T</b>	2	44.2	<b>Tetric T = 41.33</b>	<b>56.254 %</b>
	<b>Tetric-B</b>	2	25.2		
	<b>Tetric-B</b>	2	22.3		
	<b>Tetric-B</b>	2	24.1		
	<b>Tetric-B</b>	2	21.4	<b>Tetric B = 23.25</b>	
<b>8</b>	<b>Tetric-T</b>	2	42.9		
	<b>Tetric-T</b>	2	43.9		
	<b>Tetric-T</b>	2	43.1		
	<b>Tetric-T</b>	2	46.8	<b>Tetric T = 44.18</b>	<b>49.864 %</b>

	<b>Tetric-B</b>	2	13		
	<b>Tetric-B</b>	2	20.4		
	<b>Tetric-B</b>	2	25.9		
	<b>Tetric-B</b>	2	28.8	<b>Tetric B = 22.03</b>	
<b>9</b>	<b>Tetric-T</b>	2	32.3		
	<b>Tetric-T</b>	2	41.7		
	<b>Tetric-T</b>	2	37.4		
	<b>Tetric-T</b>	2	39	<b>Tetric T = 37.6</b>	<b>57.978 %</b>
	<b>Tetric-B</b>	2	22.6		
	<b>Tetric-B</b>	2	20.3		
	<b>Tetric-B</b>	2	21.4		
	<b>Tetric-B</b>	2	22.9	<b>Tetric B = 21.8</b>	
<b>10</b>	<b>Tetric-T</b>	2	46.8		
	<b>Tetric-T</b>	2	30.8		
	<b>Tetric-T</b>	2	27.8		
	<b>Tetric-T</b>	2	20.8	<b>Tetric T = 31.55</b>	<b>47.702 %</b>
	<b>Tetric-B</b>	2	13.3		
	<b>Tetric-B</b>	2	15.9		
	<b>Tetric-B</b>	2	14.5		
	<b>Tetric-B</b>	2	16.5	<b>Tetric B = 15.05</b>	

**TABLE 2: KHN RESULTS for DESERT TEMPERATURE STORED SAMPLES**

\*All samples are 2mm thick, material stored in Kuwait Desert Conex

Sample Number	Brand - Top or Bottom	DC mm	KHN	Mean	T/B KHN Ratio	
<b>1</b>	Filtek-T	2	42.8			
	Filtek-T	2	38.3			
	Filtek-T	2	48.6			
	Filtek-T	2	53.8	<b>Filtek T = 45.88</b>	<b>103.487 %</b>	
	Filtek-B	2	49.5			
	Filtek-B	2	45.4			
	Filtek-B	2	45.7			
	Filtek-B	2	49.3	<b>Filtek B = 47.48</b>		
	<b>2</b>	Filtek-T	2	43.6		
		Filtek-T	2	49		
Filtek-T		2	49.5			
Filtek-T		2	52.3	<b>Filtek T = 48.6</b>	<b>76.646 %</b>	
Filtek-B		2	38.2			
Filtek-B		2	38.4			
Filtek-B		2	39.4			
Filtek-B		2	33	<b>Filtek B = 37.25</b>		
<b>3</b>		Filtek-T	2	40		
		Filtek-T	2	51.1		
	Filtek-T	2	49.3			
	Filtek-T	2	47.2	<b>Filtek T = 46.9</b>	<b>86.311 %</b>	
	Filtek-B	2	37.1			
	Filtek-B	2	40.8			
	Filtek-B	2	40.7			
	Filtek-B	2	43.3	<b>Filtek B = 40.48</b>		

<b>4</b>	<b>Filtek-T</b>	2	28.1		
	<b>Filtek-T</b>	2	36.9		
	<b>Filtek-T</b>	2	41.4		
	<b>Filtek-T</b>	2	51.8	<b>Filtek T = 39.55</b>	<b>75.221 %</b>
	<b>Filtek-B</b>	2	31.9		
	<b>Filtek-B</b>	2	30.7		
	<b>Filtek-B</b>	2	26.7		
	<b>Filtek-B</b>	2	29.7	<b>Filtek B = 29.75</b>	
<b>5</b>	<b>Filtek-T</b>	2	43.8		
	<b>Filtek-T</b>	2	55.9		
	<b>Filtek-T</b>	2	57.7		
	<b>Filtek-T</b>	2	57.7	<b>Filtek T = 53.78</b>	<b>64.894 %</b>
	<b>Filtek-B</b>	2	32.2		
	<b>Filtek-B</b>	2	33.3		
	<b>Filtek-B</b>	2	36.4		
	<b>Filtek-B</b>	2	37.7	<b>Filtek B = 34.9</b>	
<b>6</b>	<b>Filtek-T</b>	2	51.4		
	<b>Filtek-T</b>	2	59.2		
	<b>Filtek-T</b>	2	45		
	<b>Filtek-T</b>	2	60.1	<b>Filtek T = 53.93</b>	<b>64.249 %</b>
	<b>Filtek-B</b>	2	30.4		
	<b>Filtek-B</b>	2	33.9		
	<b>Filtek-B</b>	2	37.4		
	<b>Filtek-B</b>	2	36.9	<b>Filtek B = 34.65</b>	
<b>7</b>	<b>Filtek-T</b>	2	46.8		
	<b>Filtek-T</b>	2	51.5		
	<b>Filtek-T</b>	2	50.4		
	<b>Filtek-T</b>	2	56.7	<b>Filtek T = 51.35</b>	<b>63.777 %</b>

	<b>Filtek-B</b>	2	28.5		
	<b>Filtek-B</b>	2	32		
	<b>Filtek-B</b>	2	34.4		
	<b>Filtek-B</b>	2	36.1	<b>Filtek B = 32.75</b>	
<b>8</b>	<b>Filtek-T</b>	2	43.5		
	<b>Filtek-T</b>	2	37.2		
	<b>Filtek-T</b>	2	33.9		
	<b>Filtek-T</b>	2	34.4	<b>Filtek T = 37.25</b>	<b>70.013 %</b>
	<b>Filtek-B</b>	2	23.9		
	<b>Filtek-B</b>	2	24.6		
	<b>Filtek-B</b>	2	27.9		
	<b>Filtek-B</b>	2	27.9	<b>Filtek B = 26.08</b>	
<b>9</b>	<b>Filtek-T</b>	2	50.4		
	<b>Filtek-T</b>	2	32.3		
	<b>Filtek-T</b>	2	65.5		
	<b>Filtek-T</b>	2	51.8	<b>Filtek T = 50</b>	<b>73.860 %</b>
	<b>Filtek-B</b>	2	26.9		
	<b>Filtek-B</b>	2	41.9		
	<b>Filtek-B</b>	2	41.1		
	<b>Filtek-B</b>	2	37.8	<b>Filtek B = 36.93</b>	
<b>10</b>	<b>Filtek-T</b>	2	36.3		
	<b>Filtek-T</b>	2	31		
	<b>Filtek-T</b>	2	28.5		
	<b>Filtek-T</b>	2	27.9	<b>Filtek T = 30.93</b>	<b>105.496 %</b>
	<b>Filtek-B</b>	2	27.6		
	<b>Filtek-B</b>	2	37.8		
	<b>Filtek-B</b>	2	31.5		
	<b>Filtek-B</b>	2	33.6	<b>Filtek B = 32.63</b>	

<b>1</b>	<b>TPH-T</b>	<b>2</b>	<b>26.5</b>		
	<b>TPH-T</b>	<b>2</b>	<b>30.3</b>		
	<b>TPH-T</b>	<b>2</b>	<b>32.4</b>		
	<b>TPH-T</b>	<b>2</b>	<b>33.8</b>	<b>TPH T = 30.75</b>	<b>97.658 %</b>
	<b>TPH-B</b>	<b>2</b>	<b>29.3</b>		
	<b>TPH-B</b>	<b>2</b>	<b>27.1</b>		
	<b>TPH-B</b>	<b>2</b>	<b>30.4</b>		
	<b>TPH-B</b>	<b>2</b>	<b>33.3</b>	<b>TPH B = 30.03</b>	
<b>2</b>	<b>TPH-T</b>	<b>2</b>	<b>33.3</b>		
	<b>TPH-T</b>	<b>2</b>	<b>34.4</b>		
	<b>TPH-T</b>	<b>2</b>	<b>33.5</b>		
	<b>TPH-T</b>	<b>2</b>	<b>30.6</b>	<b>TPH T = 32.95</b>	<b>79.362 %</b>
	<b>TPH-B</b>	<b>2</b>	<b>25.7</b>		
	<b>TPH-B</b>	<b>2</b>	<b>26.4</b>		
	<b>TPH-B</b>	<b>2</b>	<b>25</b>		
	<b>TPH-B</b>	<b>2</b>	<b>27.1</b>	<b>TPH B = 26.15</b>	
<b>3</b>	<b>TPH-T</b>	<b>2</b>	<b>34.1</b>		
	<b>TPH-T</b>	<b>2</b>	<b>37.7</b>		
	<b>TPH-T</b>	<b>2</b>	<b>30.8</b>		
	<b>TPH-T</b>	<b>2</b>	<b>32.6</b>	<b>TPH T = 33.8</b>	<b>73.017 %</b>
	<b>TPH-B</b>	<b>2</b>	<b>23.3</b>		
	<b>TPH-B</b>	<b>2</b>	<b>23.3</b>		
	<b>TPH-B</b>	<b>2</b>	<b>25</b>		
	<b>TPH-B</b>	<b>2</b>	<b>27.1</b>	<b>TPH B = 24.68</b>	
<b>4</b>	<b>TPH-T</b>	<b>2</b>	<b>24.8</b>		
	<b>TPH-T</b>	<b>2</b>	<b>31.8</b>		
	<b>TPH-T</b>	<b>2</b>	<b>28.8</b>		
	<b>TPH-T</b>	<b>2</b>	<b>33</b>	<b>TPH T = 29.6</b>	<b>87.770 %</b>

	TPH-B	2	24.5		
	TPH-B	2	24.7		
	TPH-B	2	25.9		
	TPH-B	2	28.8	<b>TPH B = 25.98</b>	
5	TPH-T	2	32.8		
	TPH-T	2	31.3		
	TPH-T	2	26.3		
	TPH-T	2	32.4	<b>TPH T = 30.7</b>	<b>83.648 %</b>
	TPH-B	2	24		
	TPH-B	2	28		
	TPH-B	2	25.6		
	TPH-B	2	25.1	<b>TPH B = 25.68</b>	
6	TPH-T	2	29		
	TPH-T	2	36.5		
	TPH-T	2	32.8		
	TPH-T	2	33.8	<b>TPH T = 33.03</b>	<b>76.233 %</b>
	TPH-B	2	25.6		
	TPH-B	2	25.3		
	TPH-B	2	24.6		
	TPH-B	2	25.2	<b>TPH B = 25.18</b>	
7	TPH-T	2	29.8		
	TPH-T	2	30.4		
	TPH-T	2	30.8		
	TPH-T	2	33.7	<b>TPH T = 31.18</b>	<b>80.756 %</b>
	TPH-B	2	24.1		
	TPH-B	2	25.8		
	TPH-B	2	24.8		
	TPH-B	2	26	<b>TPH B = 25.18</b>	

8	TPH-T	2	31.9		
	TPH-T	2	32.5		
	TPH-T	2	33.9		
	TPH-T	2	34	<b>TPH T = 33.08</b>	<b>74.969 %</b>
	TPH-B	2	24.3		
	TPH-B	2	24.2		
	TPH-B	2	24.2		
	TPH-B	2	26.5	<b>TPH B = 24.8</b>	
9	TPH-T	2	31.2		
	TPH-T	2	24.4		
	TPH-T	2	29.6		
	TPH-T	2	29.4	<b>TPH T = 28.65</b>	<b>86.212 %</b>
	TPH-B	2	23.4		
	TPH-B	2	23.3		
	TPH-B	2	24.7		
	TPH-B	2	27.4	<b>TPH B = 24.7</b>	
10	TPH-T	2	31.8		
	TPH-T	2	36.6		
	TPH-T	2	27.9		
	TPH-T	2	29.2	<b>TPH T = 31.38</b>	<b>88.113 %</b>
	TPH-B	2	27		
	TPH-B	2	28		
	TPH-B	2	27		
	TPH-B	2	28.6	<b>TPH B = 27.65</b>	
1	Tetric-T	2	20.7		
	Tetric-T	2	23.8		
	Tetric-T	2	22.2		
	Tetric-T	2	24.3	<b>Tetric T = 22.75</b>	<b>87.252 %</b>

	<b>Tetric-B</b>	2	19.7		
	<b>Tetric-B</b>	2	18.9		
	<b>Tetric-B</b>	2	20.4		
	<b>Tetric-B</b>	2	20.4	<b>Tetric B = 19.85</b>	
<b>2</b>	<b>Tetric-T</b>	2	47.6		
	<b>Tetric-T</b>	2	71		
	<b>Tetric-T</b>	2	55.5		
	<b>Tetric-T</b>	2	62.1	<b>Tetric T = 59.05</b>	<b>33.497 %</b>
	<b>Tetric-B</b>	2	19.4		
	<b>Tetric-B</b>	2	17.2		
	<b>Tetric-B</b>	2	20.9		
	<b>Tetric-B</b>	2	21.6	<b>Tetric B = 19.78</b>	
<b>3</b>	<b>Tetric-T</b>	2	22.6		
	<b>Tetric-T</b>	2	22.1		
	<b>Tetric-T</b>	2	21.9		
	<b>Tetric-T</b>	2	22.1	<b>Tetric T = 22.18</b>	<b>83.183 %</b>
	<b>Tetric-B</b>	2	18		
	<b>Tetric-B</b>	2	17.5		
	<b>Tetric-B</b>	2	19.1		
	<b>Tetric-B</b>	2	19.2	<b>Tetric B = 18.45</b>	
<b>4</b>	<b>Tetric-T</b>	2	33.8		
	<b>Tetric-T</b>	2	55.4		
	<b>Tetric-T</b>	2	37.8		
	<b>Tetric-T</b>	2	36.5	<b>Tetric T = 40.98</b>	<b>60.151 %</b>
	<b>Tetric-B</b>	2	21.8		
	<b>Tetric-B</b>	2	25.1		
	<b>Tetric-B</b>	2	25.7		
	<b>Tetric-B</b>	2	26	<b>Tetric B = 24.65</b>	

<b>5</b>	<b>Tetric-T</b>	2	16.9		
	<b>Tetric-T</b>	2	28.1		
	<b>Tetric-T</b>	2	26.3		
	<b>Tetric-T</b>	2	20.7	<b>Tetric T = 23</b>	<b>78.695 %</b>
	<b>Tetric-B</b>	2	16.5		
	<b>Tetric-B</b>	2	19.2		
	<b>Tetric-B</b>	2	18.2		
	<b>Tetric-B</b>	2	18.5	<b>Tetric B = 18.1</b>	
<b>6</b>	<b>Tetric-T</b>	2	29.7		
	<b>Tetric-T</b>	2	32.3		
	<b>Tetric-T</b>	2	33.1		
	<b>Tetric-T</b>	2	32.1	<b>Tetric T = 31.8</b>	<b>48.522 %</b>
	<b>Tetric-B</b>	2	13.9		
	<b>Tetric-B</b>	2	14.7		
	<b>Tetric-B</b>	2	17.3		
	<b>Tetric-B</b>	2	15.8	<b>Tetric B = 15.43</b>	
<b>7</b>	<b>Tetric-T</b>	2	20.6		
	<b>Tetric-T</b>	2	20.6		
	<b>Tetric-T</b>	2	35.6		
	<b>Tetric-T</b>	2	37.6	<b>Tetric T = 28.6</b>	<b>65.559 %</b>
	<b>Tetric-B</b>	2	19.2		
	<b>Tetric-B</b>	2	18.7		
	<b>Tetric-B</b>	2	18.3		
	<b>Tetric-B</b>	2	18.8	<b>Tetric B = 18.75</b>	
<b>8</b>	<b>Tetric-T</b>	2	17.5		
	<b>Tetric-T</b>	2	14		
	<b>Tetric-T</b>	2	13.7		
	<b>Tetric-T</b>	2	20.1	<b>Tetric T = 16.33</b>	<b>140.538 %</b>

	<b>Tetric-B</b>	2	22.9		
	<b>Tetric-B</b>	2	23.6		
	<b>Tetric-B</b>	2	20.5		
	<b>Tetric-B</b>	2	24.8	<b>Tetric B = 22.95</b>	
<b>9</b>	<b>Tetric-T</b>	2	27.9		
	<b>Tetric-T</b>	2	30.1		
	<b>Tetric-T</b>	2	38.4		
	<b>Tetric-T</b>	2	33	<b>Tetric T = 32.35</b>	<b>81.607 %</b>
	<b>Tetric-B</b>	2	25.6		
	<b>Tetric-B</b>	2	24.8		
	<b>Tetric-B</b>	2	26.1		
	<b>Tetric-B</b>	2	29.1	<b>Tetric B = 26.4</b>	
<b>10</b>	<b>Tetric-T</b>	2	40.9		
	<b>Tetric-T</b>	2	38.8		
	<b>Tetric-T</b>	2	36.7		
	<b>Tetric-T</b>	2	35.6	<b>Tetric T = 38</b>	<b>52.973 %</b>
	<b>Tetric-B</b>	2	18.1		
	<b>Tetric-B</b>	2	19.9		
	<b>Tetric-B</b>	2	20.5		
	<b>Tetric-B</b>	2	22	<b>Tetric B = 20.13</b>	

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<sup>1</sup> Temperature reading taken in Mitribah, Kuwait, and declared by the World Meteorological Organization as the highest ever recorded on continental Asia. See their official statement at <https://public.wmo.int/en/media/press-release/wmo-verifies-3rd-and-4th-hottest-temperature-recorded-earth>.

<sup>2</sup> Filtek Supreme Ultra Universal (3M) instructions for use state: "Ambient temperatures routinely higher than 27°C/80°F may reduce shelf life. Do not expose restorative materials to elevated temperatures." TPH Spectra ST (Dentsply) instructions for use state: "Inadequate storage conditions may shorten the shelf life and may lead to malfunction of the product.... Store in well ventilated place at temperatures between 2 - 24°C/35 - 75°F." Tetric (Ivoclar Vivadent) instructions for use state: "Storage temperature 2 - 28°C (36 - 82°F)."

<sup>3</sup> Alrahlaha, A, Silikasa N, Watts DC. Post-Cure Depth of Cure of Bulk Filled Dental Resin-Composites. *Dental Materials*. 2016; 30:149-154.

<sup>4</sup> Schneider LFJ, Pfeifer CS, Consani S, Prael SA, Ferracane JL. Influence of Photoinitiator Type on the Rate of Polymerization, Degree of Conversion, Hardness and Yellowing of Dental Resin Composites. *Dental Materials*. 2008; 24:1169-77.

<sup>5</sup> Ferracane JL, Mitchem JC, Condon JR & Todd R. Wear and Marginal Breakdown of Composites with Various Degrees of Cure. *Journal of Dental Research*. 1997; 76(8):1508-1516.

<sup>6</sup> Kovarik RE, Ergle JW. Fracture Toughness of Posterior Composite Resins Fabricated by Incremental Layering. *Journal of Prosthetic Dentistry*. 1993; 69:557-560.

<sup>7</sup> Franz A, Konig F, Anglmayer M, Rausch-Fan X, Gille G, Rausch WD, Lucas T, Sperr W, Schedle A. Cytotoxic Effects of Packable and Nonpackable Dental Composites. *Dental Materials*. 2003; 19:382-392.

<sup>8</sup> Caughman WF, Caughman GB, Shiflett RA, Rueggeberg F, Schuster GS. Correlation of Cytotoxicity, Filler Loading and Curing Time of Dental Composites. *Biomaterials*. 1991; 12:737-740.

<sup>9</sup> Sideridow ID, Achilias DS. Elution Study of Unreacted Bis-GMA, TEGDMA, UDMA, and Bis-EMA from Light-Cured Dental Resins and Resin Composites Using HPLC. *Journal of Biomedical Materials Research. Part B, Applied Biomaterials*. 2005; 74(1):617-626.

<sup>10</sup> Lee SY, Huang HM, Lin CY, Shih YH. Leached Components from Dental Composites in Oral Simulating Fluids and the Resultant Composite Strengths. *Journal of Oral Rehabilitation*. 1998; 25(8):575-588.

<sup>11</sup> Schneider LFJ, Pfeifer CS, Consani S, Prael SA, Ferracane JL. Influence of Photoinitiator Type on the Rate of Polymerization, Degree of Conversion, Hardness and Yellowing of Dental Resin Composites. *Dental Materials*. 2008; 24:1169-1177.

<sup>12</sup> Baharav H, Brosh T, Pilo R, Cardash H. Effect of Irradiation Time on Tensile Properties of Stiffness and Strength of Composites. *Journal of Prosthetic Dentistry*. 1997; 77:471-474.

<sup>13</sup> Colthirst P, Berg R, DeNicolo P, Simecek J. Operational Cost Analysis of Dental Emergencies for Deployed U.S. Army Personnel During Operation Iraqi Freedom. *Military Medicine*. 2013; 178(4):427-431.

<sup>14</sup> One study found the mean incident rate of dental emergencies was 118.2 per 1000 personnel per year in theater of operations. See Deutsch WM, Simecek JW. Dental Emergencies Among Marines Ashore in Operations Desert Shield/Storm. *Military Medicine*. 1996; 161(10):620-623.

<sup>15</sup> Lucey S, Lynch CD, Ray NJ, Burke FM, Hannigan A. Effect of Pre-Heating on the Viscosity and Microhardness of a Resin Composite. *Journal of Oral Rehabilitation*. 2010; 37(4):278-282.

<sup>16</sup> Ayub KV, Santos Jr GC, Rizkalla AS, Bohay R, Fernando Pegoraro L, Rubo JH, Jacinta M, Santos MC. Effect of Preheating on Microhardness and Viscosity of 4 Resin Composites. *Journal of the Canadian Dental Association*. 2014; 80:e12.

<sup>17</sup> Coincidentally, these warmers heat composite to temperatures similar to what was found inside the deployed Tricon during this experiment (50-70°C).

<sup>18</sup> "History & Development of the Container – The 'Transporter' Predecessor to the CONEX." [www.transportation.army.mil](http://www.transportation.army.mil). U.S. Army Transportation Museum. 15 May 2013. Archived from the original on 20 July 2015.

<sup>19</sup> The load of 50g was the highest load that could be applied while still producing a measurable Knoop. For the desert-stored Tetric, it was necessary to reduce the load to 25g in order to produce a measurable Knoop.

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<sup>20</sup> Bouschlicher MR, Rueggeberg FA, Wilson BM. Correlation of Bottom to Top Surface Microhardness and Conversion Ratios for a Variety of Resin Composite Compositions. *Operative Dentistry*. 2004; 29(6):698-704.