



# KARBALA HERITAGE

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**Quarterly Authorized Journal  
Specialized in Karbala Heritage**

Issued by: Karbala Heritage Centre  
Department Of Cultural and Intellectual Affairs  
Al-Abbas Holy Shrine

First Year Volume No.1 Issue No.1  
2014 A.D / 1436-1435 A.H

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In the Name of Allah  
Most Gracious Most Merciful

But We wanted to be gracious to those abased in the land, and to  
make them leaders and inheritors

(Al-Qasas-5)



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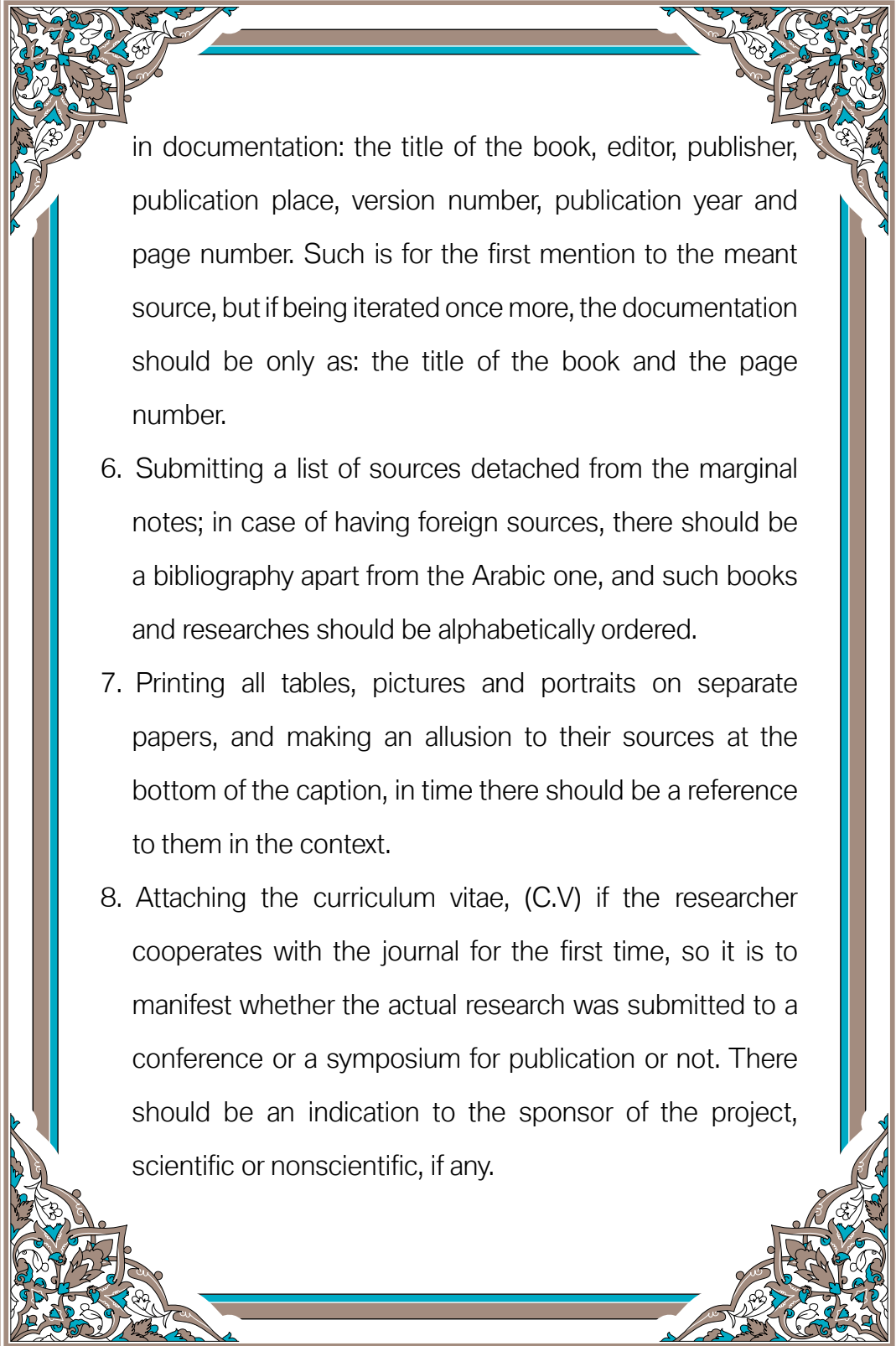
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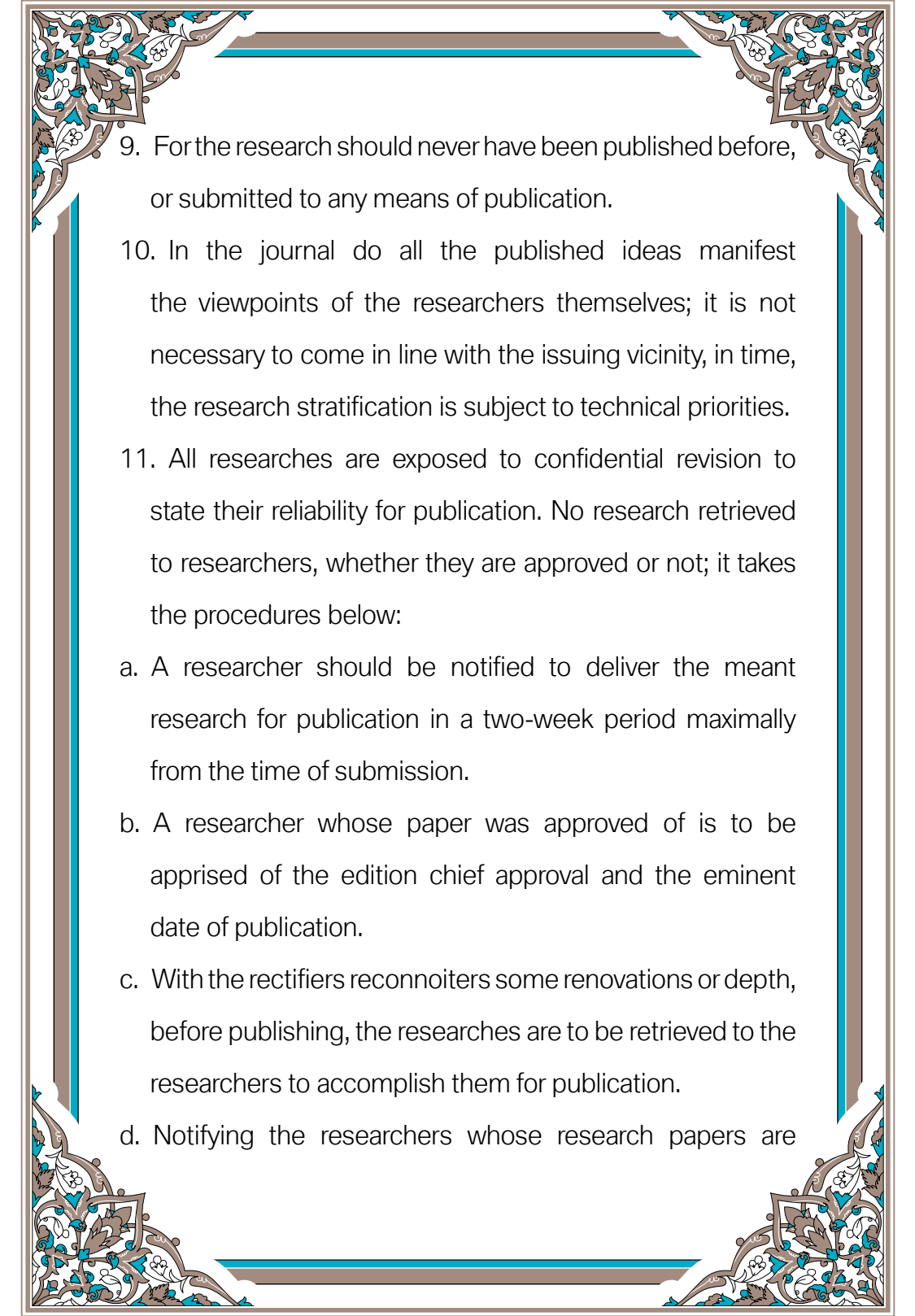
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7. Printing all tables, pictures and portraits on separate papers, and making an allusion to their sources at the bottom of the caption, in time there should be a reference to them in the context.
8. Attaching the curriculum vitae, (C.V) if the researcher cooperates with the journal for the first time, so it is to manifest whether the actual research was submitted to a conference or a symposium for publication or not. There should be an indication to the sponsor of the project, scientific or nonscientific, if any.





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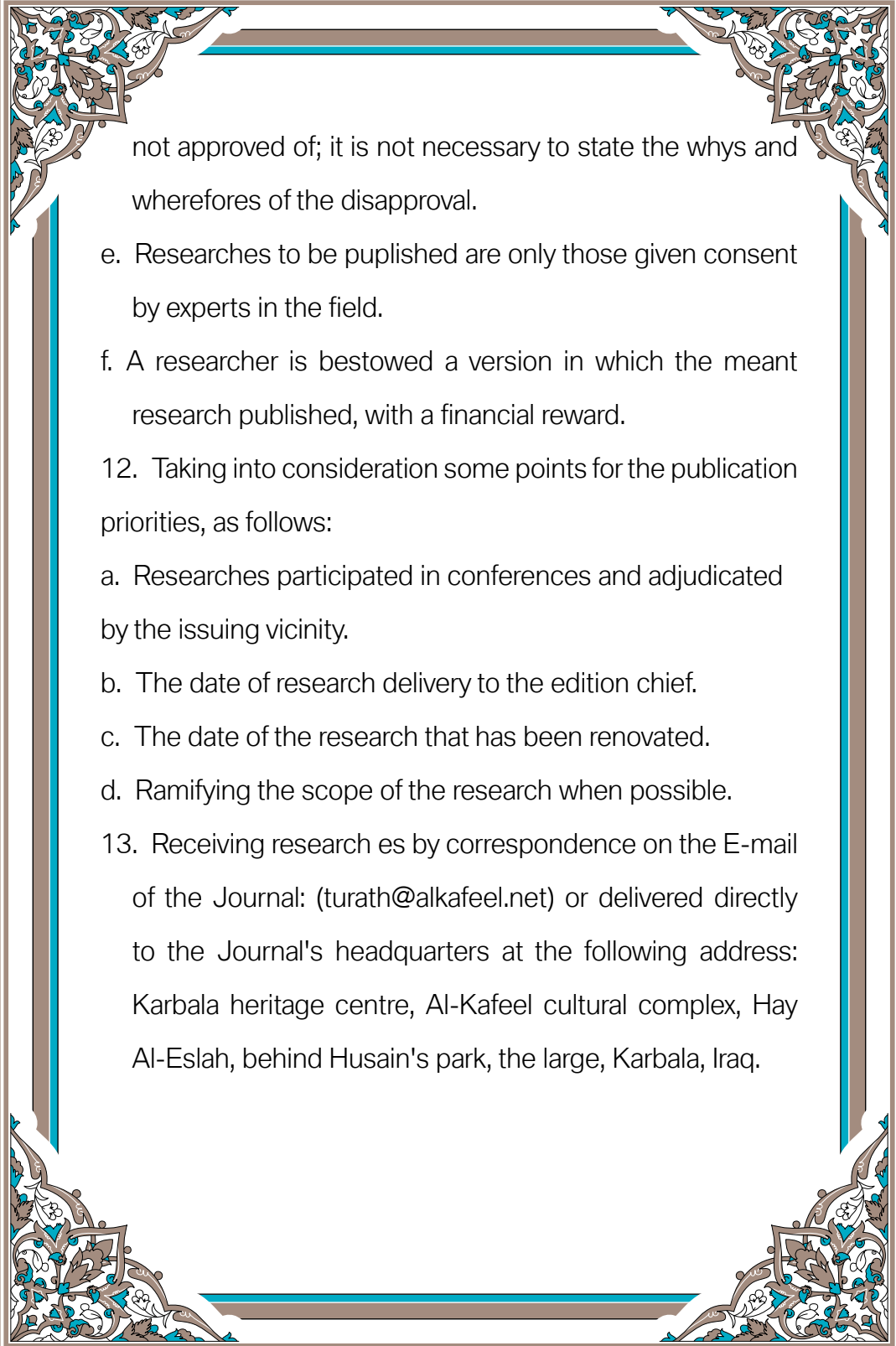
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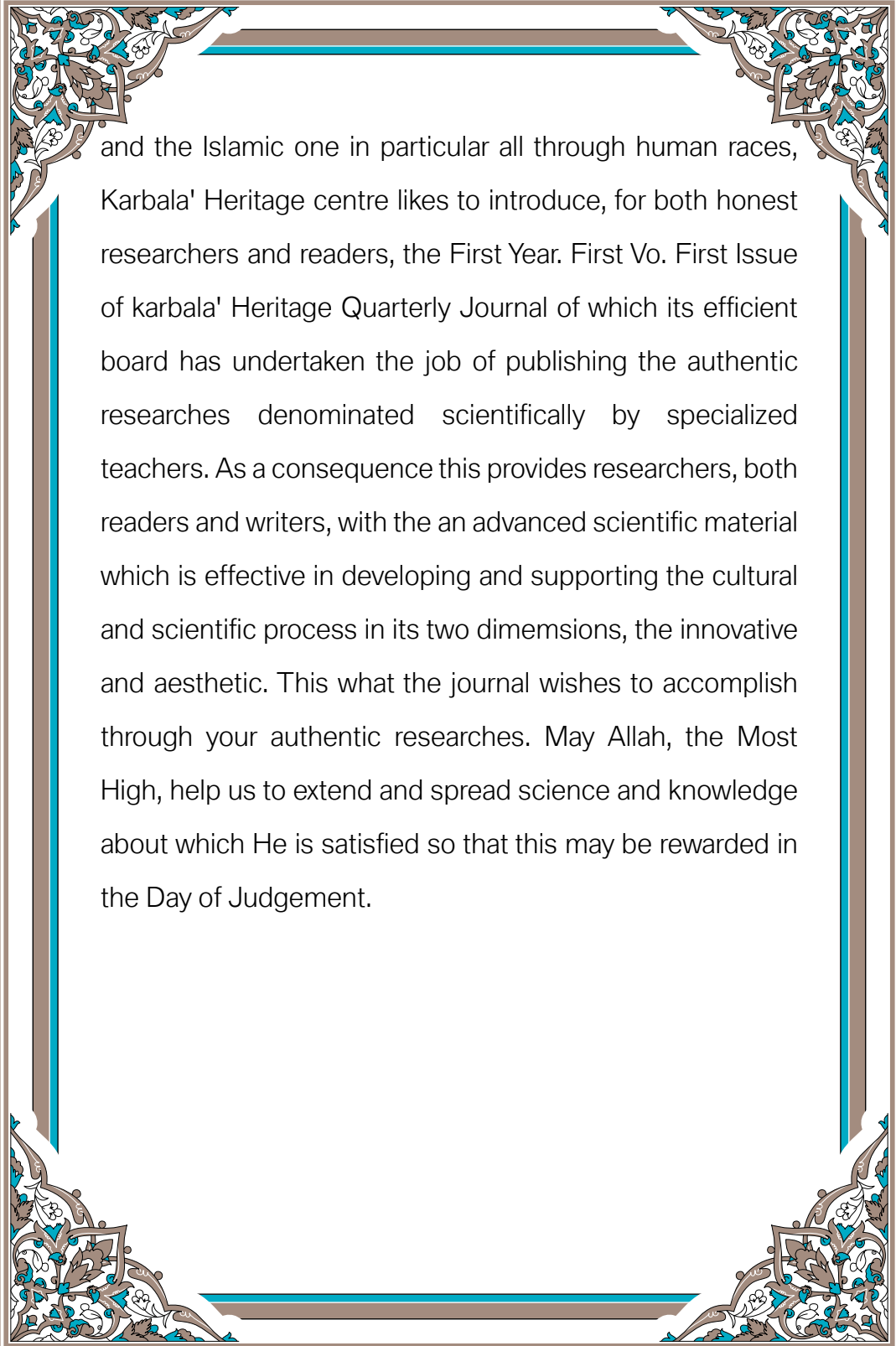
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## **Editor-in-chief Speech**

In the Name of Allah' All compassionate, All Merciful  
Praise be to Allah, Lord of the world and blessings and  
peace be upon His prophet and this progeny, the ingenuous  
and virtuous.

All developed countries attach great importance to  
scientific and experimental research and seriously and  
intensely try to develop it by providing researchers with  
all the prerequisites and services to carry out their studies  
and researches. This has contributed to the development  
of science in such societies and has been considered a  
vital source of such development. In order to contribute  
to spreading out and publishing the heritage and cultural  
knowledge and also recreating the heritage of Imam Husain's  
(peace be upon him) city, which is considered a mirror of  
Ummah and its cultural and educational history and which  
has had an impact on all types of human civilization in general



and the Islamic one in particular all through human races, Karbala' Heritage centre likes to introduce, for both honest researchers and readers, the First Year. First Vo. First Issue of karbala' Heritage Quarterly Journal of which its efficient board has undertaken the job of publishing the authentic researches denominated scientifically by specialized teachers. As a consequence this provides researchers, both readers and writers, with the an advanced scientific material which is effective in developing and supporting the cultural and scientific process in its two dimemnsions, the innovative and aesthetic. This what the journal wishes to accomplish through your authentic researches. May Allah, the Most High, help us to extend and spread science and knowledge about which He is satisfied so that this may be rewarded in the Day of Judgement.

## Issue Prelude

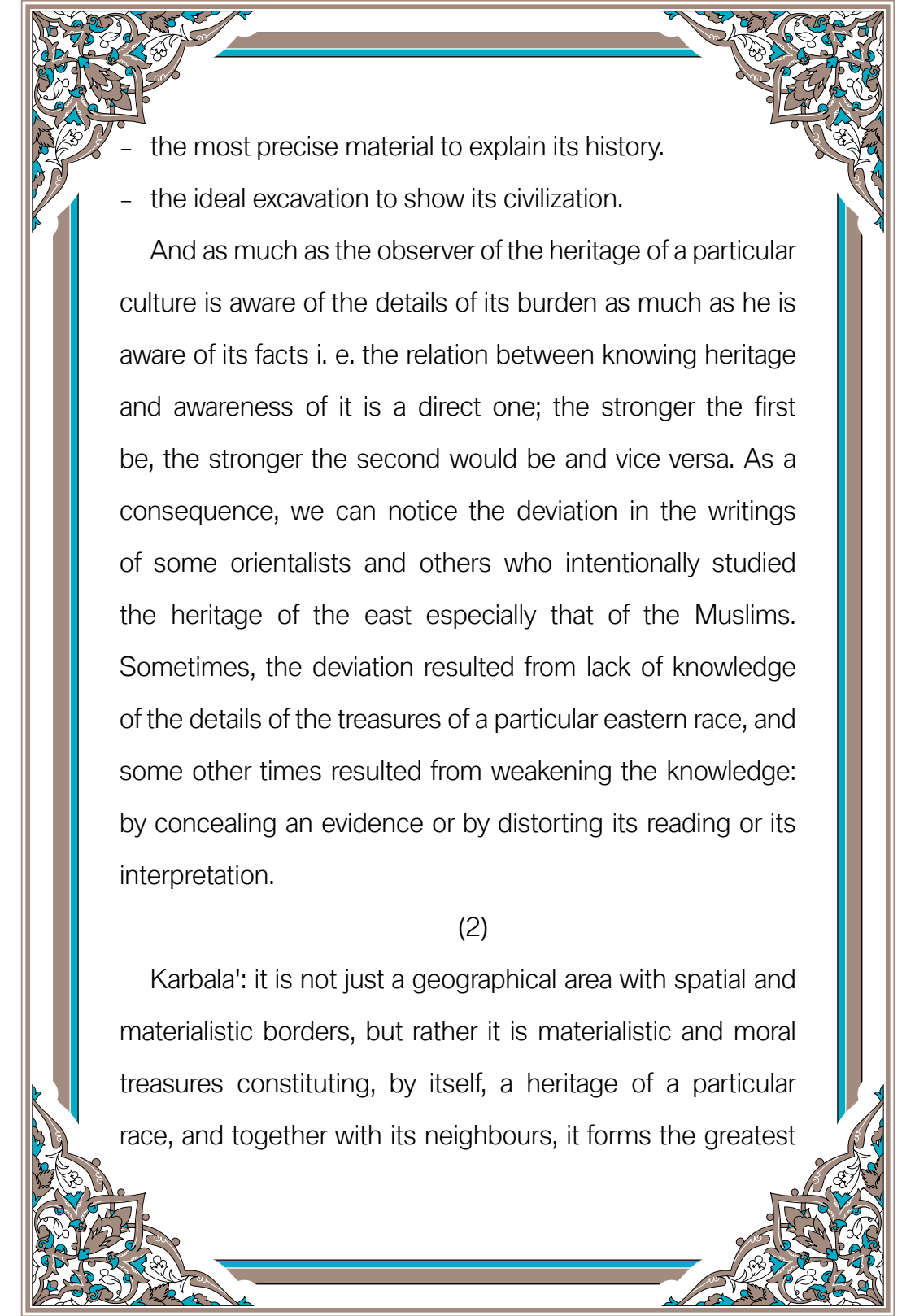
### **Why Heritage? Why Karbala'?**

(1)

Human race is enriched with an accumulation both materialistic and moral, which diagnoses, in its behaviour, as associative culture and by which an individual's activity is motivated by word and deed and also thinking, it comprises, as a whole, the discipline that leads its life. And as greater as the activity of such weights and as greater their effect be as unified their location be and as extensive their time strings extend; as a consequence, they come binary: affluence and poverty, length and shortness, when coming to a climax.

According to what has been just said, heritage may be looked at as a materialistic and moral inheritance of a particular human race, at a certain time, at a particular place. By the following description, the heritage of any race is described:

- the most important way to know its culture.

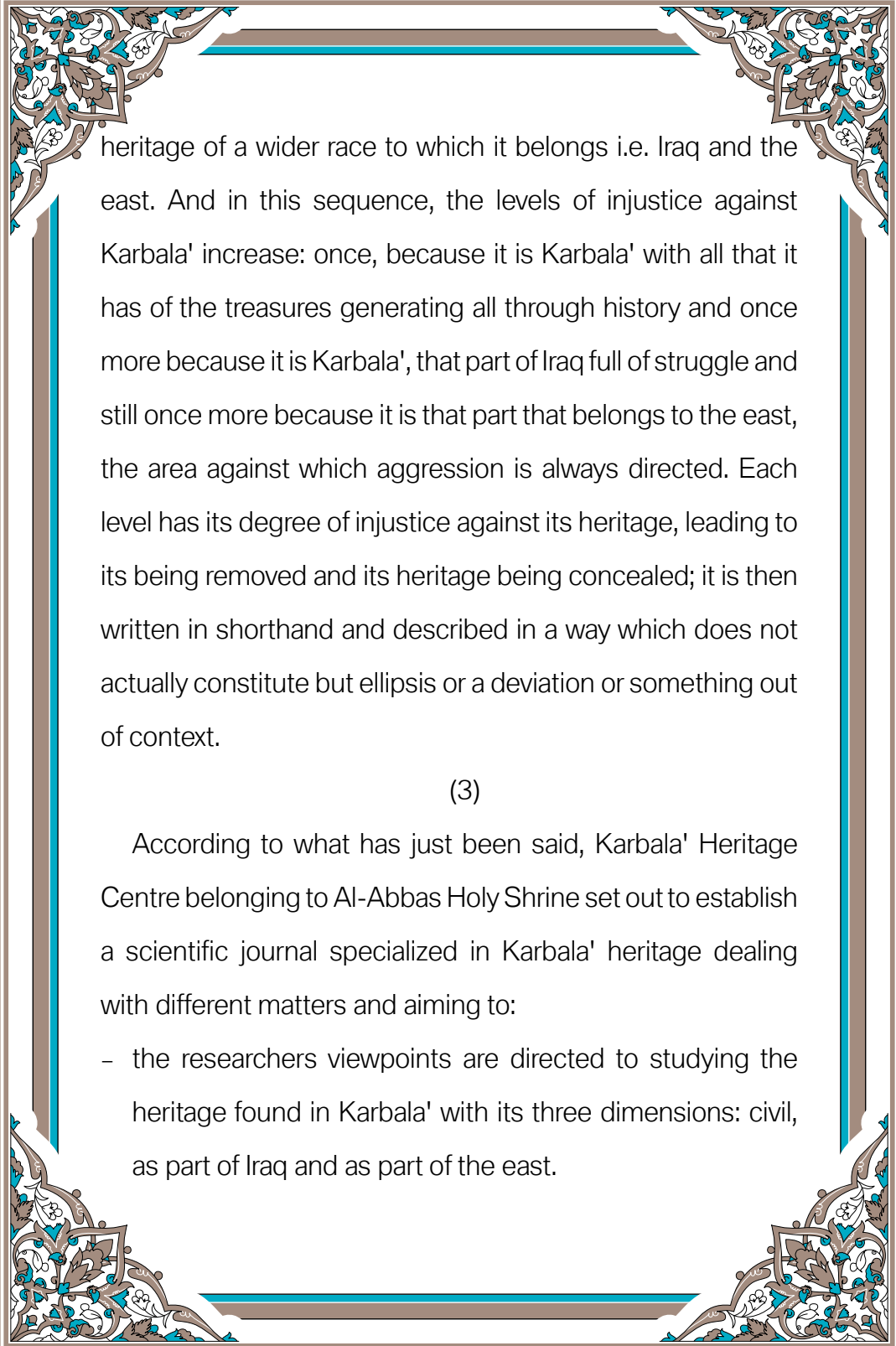
- 
- the most precise material to explain its history.
  - the ideal excavation to show its civilization.

And as much as the observer of the heritage of a particular culture is aware of the details of its burden as much as he is aware of its facts i. e. the relation between knowing heritage and awareness of it is a direct one; the stronger the first be, the stronger the second would be and vice versa. As a consequence, we can notice the deviation in the writings of some orientalists and others who intentionally studied the heritage of the east especially that of the Muslims. Sometimes, the deviation resulted from lack of knowledge of the details of the treasures of a particular eastern race, and some other times resulted from weakening the knowledge: by concealing an evidence or by distorting its reading or its interpretation.

(2)

Karbala': it is not just a geographical area with spatial and materialistic borders, but rather it is materialistic and moral treasures constituting, by itself, a heritage of a particular race, and together with its neighbours, it forms the greatest



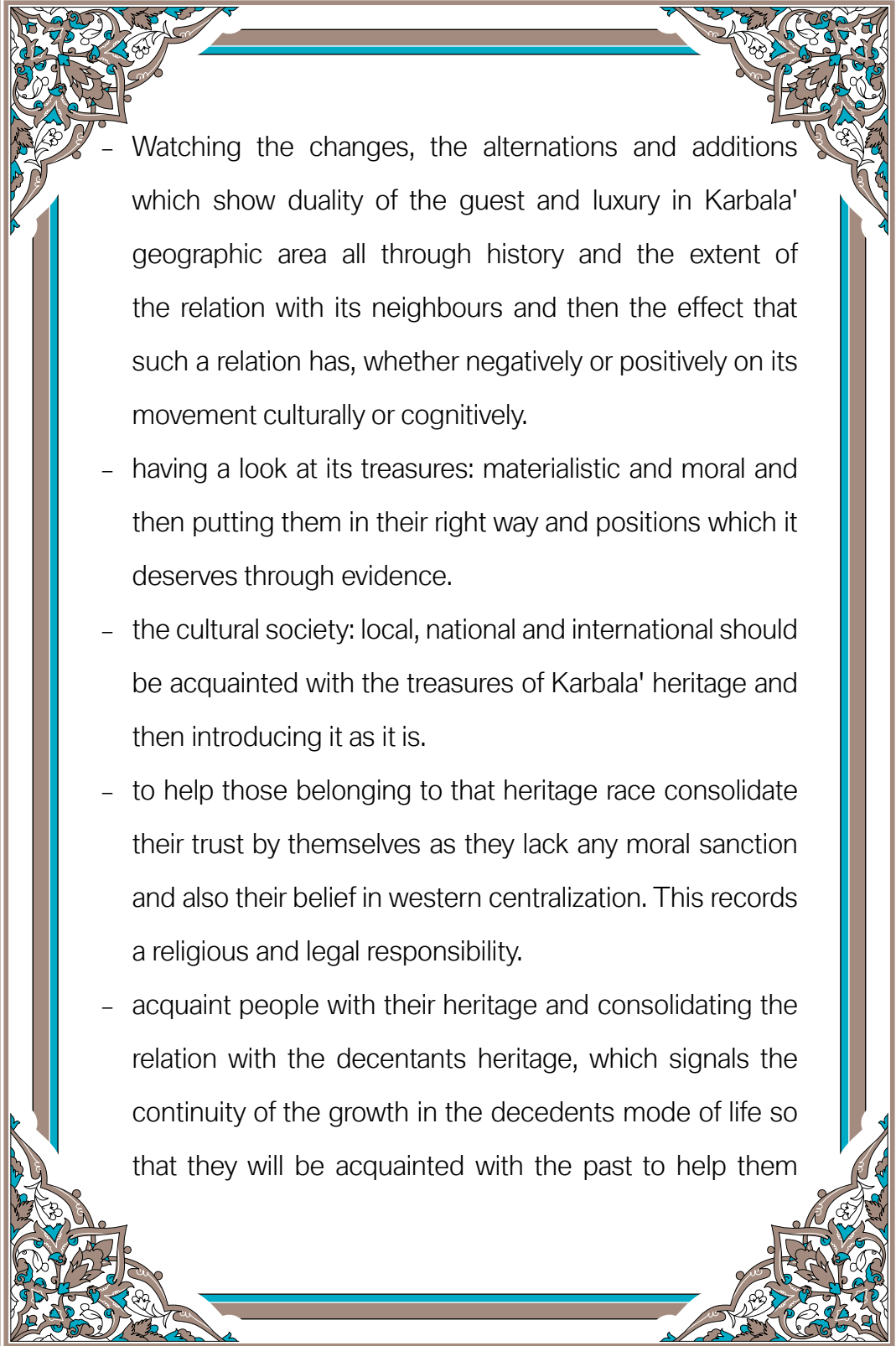


heritage of a wider race to which it belongs i.e. Iraq and the east. And in this sequence, the levels of injustice against Karbala' increase: once, because it is Karbala' with all that it has of the treasures generating all through history and once more because it is Karbala', that part of Iraq full of struggle and still once more because it is that part that belongs to the east, the area against which aggression is always directed. Each level has its degree of injustice against its heritage, leading to its being removed and its heritage being concealed; it is then written in shorthand and described in a way which does not actually constitute but ellipsis or a deviation or something out of context.

(3)

According to what has just been said, Karbala' Heritage Centre belonging to Al-Abbas Holy Shrine set out to establish a scientific journal specialized in Karbala' heritage dealing with different matters and aiming to:

- the researchers viewpoints are directed to studying the heritage found in Karbala' with its three dimensions: civil, as part of Iraq and as part of the east.

- 
- Watching the changes, the alternations and additions which show duality of the guest and luxury in Karbala' geographic area all through history and the extent of the relation with its neighbours and then the effect that such a relation has, whether negatively or positively on its movement culturally or cognitively.
  - having a look at its treasures: materialistic and moral and then putting them in their right way and positions which it deserves through evidence.
  - the cultural society: local, national and international should be acquainted with the treasures of Karbala' heritage and then introducing it as it is.
  - to help those belonging to that heritage race consolidate their trust by themselves as they lack any moral sanction and also their belief in western centralization. This records a religious and legal responsibility.
  - acquaint people with their heritage and consolidating the relation with the decentants heritage, which signals the continuity of the growth in the decedents mode of life so that they will be acquainted with the past to help them



know the future.

- the development with all its dimensions: intellectual, economic, etc. Knowing the heritage enhances tourism and strengthens the green revenues.

And due to all the above, Karbala' Heritage journal emerged which calls upon all specialist researchers to provide it with their writings and contributions without which it can never proceed further.

Editorial & Advisory Boards

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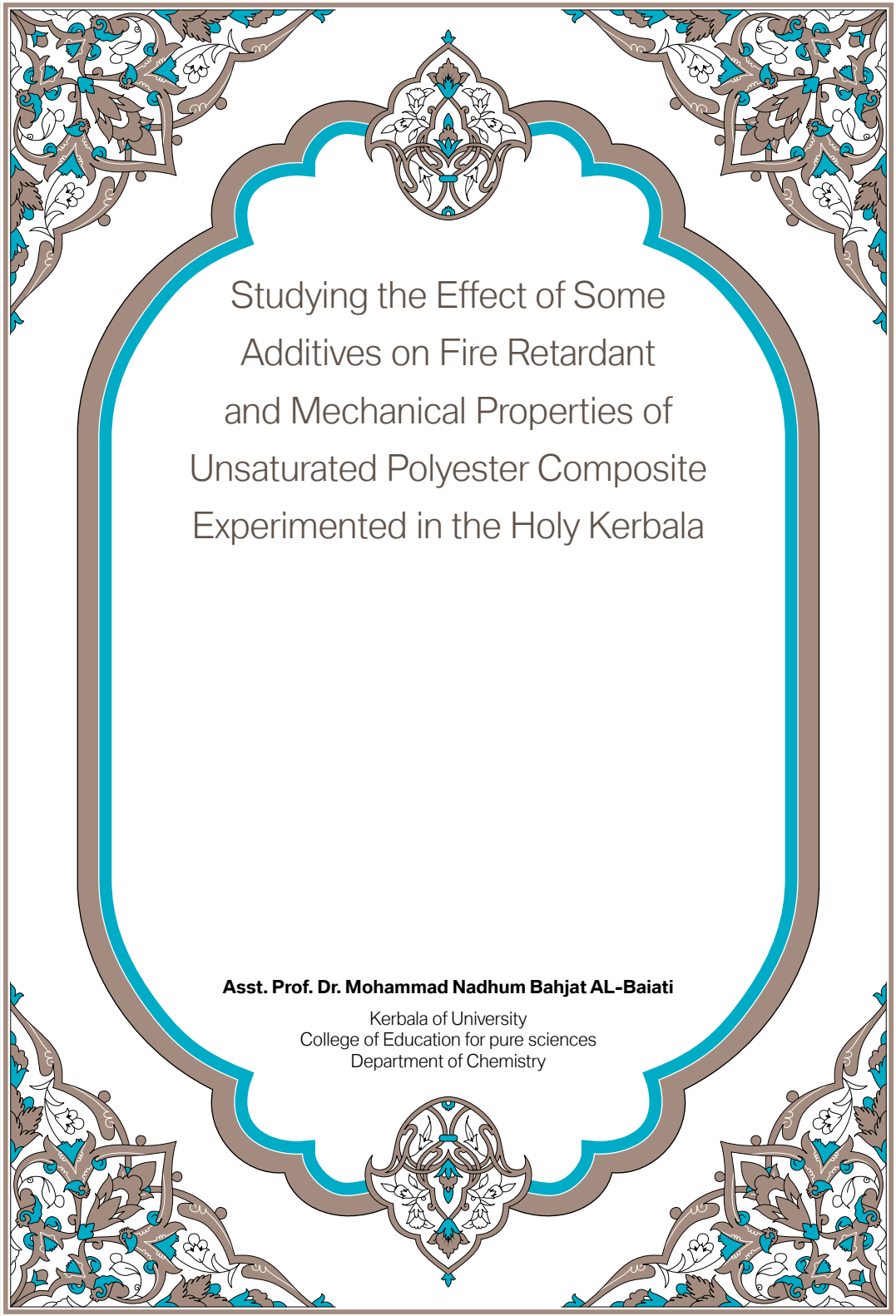
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Studying the Effect of Some  
Additives on Fire - Retardant  
and Mechanical Properties of  
Unsaturated Polyester Composite  
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Studying the Effect of Some  
Additives on Fire Retardant  
and Mechanical Properties of  
Unsaturated Polyester Composite  
Experimented in the Holy Kerbala

**Asst. Prof. Dr. Mohammad Nadhum Bahjat AL-Baiati**

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## Abstract

In this investigation, the effect of four types of inorganic phosphors salts on flammability and mechanical properties, of unsaturated polyester reinforced with glass fibers have been studied; also, the influence of two types form of glass fibers (E-Glass), on flammability and mechanical properties of the composite, have been studied. Sheets of composites with different weight percentage of additives and reinforced with three layers of each type of glass fibers, were prepared. Four standard test methods have been used to measure the flame retardation and mechanical properties. This material conducted practical experiments to use these resins resistance to ignition in the workshop repair of plastic parts for the cars in the province of holy Karbala in the district of industrial neighborhood and hold controlled fire artificially, had been given this experience amazing results.

Results obtained from these tests indicated that, additive



IV has high efficiency as a flame retardant and showed high effect to reduce the value of the mechanical behaviors, but additive I has low effect on retard composition and showed low effect on the values of mechanical properties.



**دراسة تأثير بعض المضافات على تثبيت الهويية  
والخواص الميكانيكية لمتراكب البولي استر غير المشبع  
والتي جربت في كربلاء المقدسة**

أ.م.د. كتور محمد ناظم بهجت البياتي  
قسم الكيمياء/ كلية التربية للعلوم الصرفة/ جامعة كربلاء  
كربلاء المقدسة/ العراق



## المخلص

في هذا البحث، تم دراسة تأثير أربعة أنواع من أملاح الفسفور اللاعضوية على تشييط اللهبوية والخواص الميكانيكية، لراتنج البولي استر غير المشبع المتراكب مع الألياف الزجاجية، كذلك تم دراسة تأثير نوعين من الألياف الزجاجية (من نوع E-Glass) على تشييط اللهبوية والخواص الميكانيكية للمتراكب. تم تحضير ألواح راتنج البولي استر غير المشبع المتراكب بإضافة نسب مئوية من المضافات مع ثلاثة طبقات من كل نوع من الألياف الزجاجية. أربعة طرق اختبار قياسية استخدمت لحساب تشييط اللهبوية والخواص الميكانيكية.

تم اجراء تجارب عملية وتطبيقية على استخدام هذه الراتنجات المقاومة للأشغال في ورشة تصليح الأجزاء البلاستيكية للسيارات في محافظة كربلاء المقدسة في منطقة الحي الصناعي واجراء حريق مفتعل مسيطر عليه، اعطت هذه التجربة نتائج مذهلة.

ان النتائج المستحصلة من هذه الاختبارات تشير إلى إن المضاف IV يمتلك تأثير عالي على تشييط اللهبوية، وكذلك فإنه يظهر تأثير عالي في خفض قيم الخواص الميكانيكية، لكن المضاف ا يمتلك تأثير قليل على تشييط اللهبوية ويظهر تأثير واطى على قيم الخواص الميكانيكية.



## Key word

Polymers; Unsaturated polyester resin; Fire retardant;  
Flammability; Additives; Mechanical properties; Fiber glass;  
Composite materials.



## Introduction

Polymers, also called macromolecules are giant molecules in which atoms are linked together by covalent bonds along molecules<sup>(1)</sup>. the polymers were prepared by process called polymerization where monomers (structural units) react together chemically to form linear or branched chains or three dimensional polymer network<sup>(2)</sup>. In the cross linked polymers, the chains are joined chemically at fastening points. the degree of cross-linking has effect on the physical and chemical properties of polymer<sup>(3)</sup>.

Composite is generally defined as any physical combination of two or more dissimilar materials used to produce a result that cannot be obtained by each component individually<sup>(4)</sup>. Properties of composites are strongly influenced by the properties of their constituent materials, their distribution and the interaction between them. Besides, specifying the constituent materials and their properties, a composite





material as a system is described by the geometry of reinforcement<sup>(5)</sup>. the geometry of reinforcement may be described by some important factors<sup>(6)</sup>: shape, size and size distribution of reinforcing materials; concentration distribution and orientation of reinforcing material.

Most composite materials developed thus far have been fabricated to improve mechanical properties<sup>(7)</sup>. the interaction between the matrix and fibers are effective in improving the fracture resistance of the matrix. the fibers have small cross sectional dimensions so that they are embedded in matrix materials to form fibrous composites<sup>(8)</sup>. Most of reinforced plastics are glass fiber reinforced polyesters. They are used in many important applications<sup>(9,10)</sup>, so that, in this work the influence of increasing the ratio of additives as flame-resistance on mechanical properties of reinforced polyester composite were studied.



## Experimental Part

### 1. Materials

- a. Unsaturated polyester resin, hardener type (MEKP), imported from Industrial Chemical & Resin Co. LTD., Kingdom of Sudia Arabia.
- b. Glass fiber type (E-Glass), were used as reinforcing materials in the two forms; chopped strand mat, randomly oriented, has surface density equal to (0.277 Kg/M<sup>2</sup>), and woven roving, has surface density equal to (0.5 Kg/M<sup>2</sup>), imported from company(Moulding, LTD., UK).
- c. Flame-retardant; Monoammoniumphosphate, with purity 99% (additive I); Diammoniumphosphate, with purity 99.5% (additive II); Triammoniumphosphate, with purity 98% (additive III) & Polyammoniumphosphate with purity 97% (additive IV), in powder form; imported from MERCK Co.

### 2. Standard Tests

- a. ASTM: D-2863: the measurement of limiting oxygen



index (LOI), it is widely used for measuring flammability of polymers<sup>(11)</sup>.

- b. ASTM: D-635: the measurement of rate of burning (R.B), average extent of burning (A.E.B), average time of burning (A.T.B), self - extinguishing (S.E) and non-burning (N.B.)<sup>(12)</sup>.
- c. ASTM: D-790: the measurement of flexural strength, by three point method<sup>(13)</sup>, with constant rate of displacement (crosshead speed) equal to 1 mm/Min., by using Instron -1122 instrument.
- d. ASTM: D-638: the measurement of tensile strength<sup>(14)</sup>, with constant rate of displacement (crosshead speed) equal to 1 mm/Min., by using Instron-1122 instrument.

### **3. Preparing of specimens**

The specimens of polymeric material containing additives and reinforced with two layers from two types of glass fibers were prepared in dimensions (150 x 150 x 5) mm, two sheets were prepared for each percentage weight (0.5, 1.0, 1.5, 2.0 & 2.5 %) of flame retardant materials with each type of glass fibers. These sheets cut as samples according to ASTM standard were used in this work.



## Results and Discussions

### A. Flammability Tests:

The results of the flammability tests for unsaturated polyester resin reinforced with glass fibers in the form of chopped strand mat and in the form of woven roving, were shown in Tables 1-4, for limiting oxygen index and rate of burning respectively. the limiting oxygen index (LOI), increased with increasing the weight percentage of additives, as shown in Tables 1 & 2 respectively, and illustrated in Figures 1 & 2 for tow types form of glass fibers respectively. the rate of burning (R.B) of the resin reinforced with glass fibers in two types form with the additives has a continuous reduction with increasing the percentage weight of additives (inversely proportional), as in tables 3 & 4 respectively. Figures 3 & 4 showed the flame speed curves of flame retardation for resin in two types form. This result indicated that, the additive IV has high efficiency on self-extinguishing (S.E) of resin, especially in percentage



2.0% for the resin reinforced with glass fiber type chopped strand mat and in percentage 1.5% for resin reinforced with glass fiber type woven roving. Non-burning (N.B) occur in percentage 2.5% for the resin reinforced with glass fiber type woven roving.

In general, additive IV has the best efficiency on retard combustion. This high efficiency depends basically on the structure of this material (Polyammoniumphosphate), it's contained in their structure on phosphour element and nitrogen which have high effect on retard combustion. the free radicals were formed from decomposition of these materials (P and N) will react rapidly with the free radicals of flame chain, such as (H. O. O.OH, ..., etc.) to form inert compounds like (HPO, NH<sub>4</sub>OH, ..., etc.) and work on inhabitation of thermal decomposition will occur in flame front, because decreases of amount of generation heat and to form a group from the non-flammable gases, such as (CO, CO<sub>2</sub>, H<sub>2</sub>O, ..., etc) thus will decrease from volatile materials flammable. the char will form as results from the thermal decomposition of the specimen; it covered the polymer specimen's roof.



The difference in the results of the flammability tests between the polyester reinforced with chopped strand mat and that reinforced with woven roving, results from the difference in the form and size distribution of glass fibers. The layers of glass fibers in the resin reinforced with the woven roving of glass fiber would move away from one another during the burning of the composite due to the presence of the resin-rich layers between the plies, this movement led to facility in the flame spread, while that did not occur in the case of the resin reinforced with the chopped strand mat of glass fiber.

## **B. Mechanical Properties Tests**

the mechanical properties of polymers depend on many factors like: molecular structure, types of branching, space distribution between main chains which contains molecular groups and the percentage of cross linking density between these back-bones chains (15-17).

In this work, the mechanical properties of composites depend on two factors; the types form of glass fibers and the structure of additives. the woven roving form of glass fibers





caused increase in the mechanical behavior compared with the chopped strand mat form, because regular distribution of fibers in woven roving form, caused high density cross linking of this composite. the results of the mechanical tests for the resin reinforced with two types form of glass fibers and containing different percentage of additives, showed that the mentioned additives would lead to lower values, as illustrated in Figures 5 & 6. This reduction in the mechanical behaviors is attributed to influence of these additives on matrix, because the hard particles placed in brittle material lead to stress concentration in adjacent matrix and the presence of these additives between polymer chains obstructs local mobility of chains and thus, the polymer will show little strain, and their effect on the interface where they reduce the adhesion (interfacial bonding) between the fibers and matrix. Also, results of tests showed that the additives caused decrease in mechanical strength and modulus for composites with increasing of the percentage of additives, as shown in Tables 5 & 6 for both tests (flexural and tensile) respectively.



## Conclusions

The main conclusions of this work can be summarized as follows:

1. The efficiency of the flame retardation for additives was in the following order: IV > III > II > I
2. Limiting oxygen index (LOI) was increased with increasing of weight percentage of additives, but the rate of burning (R.B) was decreased with increasing of weight percentage of additives.
3. Additive IV has high effect on retard combustion for two types of composite, but it reduces the mechanical properties.
4. Additive I showed low effect on retard combustion for two types of composite, and it showed little effect on the values of mechanical properties comparing with additive IV.
5. The glass fiber type woven roving showed high effect in both tests (flammability and mechanical properties)



compared with chopped strand mat form.

6. The ideal percentage of additive is 1.5% from additive IV with woven roving form of glass fiber, to using for the general purpose, as shown in the following tables and figures.



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**Table (1): Limiting Oxygen Index (LOI) of unsaturated polyester resin reinforced with glass fiber type chopped strand mat, with additives.**

<b>% Additives</b>	<b>(LOI)</b>					
	<b>Non</b>	<b>0.5</b>	<b>1.0</b>	<b>1.5</b>	<b>2.0</b>	<b>2.5</b>
<b>I</b>	19.6	20.31	20.84	21.32	21.85	22.33
<b>II</b>	19.6	20.52	21.17	21.68	22.21	22.69
<b>III</b>	19.6	20.78	21.48	22.19	22.88	23.56
<b>IV</b>	19.6	21.01	21.89	22.70	23.69	24.35

**Table (2): Limiting Oxygen Index (LOI) of unsaturated polyester resin reinforced with glass fiber type woven roving, with additives.**

<b>% Additives</b>	<b>(LOI)</b>					
	<b>Non</b>	<b>0.5</b>	<b>1.0</b>	<b>1.5</b>	<b>2.0</b>	<b>2.5</b>
<b>I</b>	19.8	20.74	21.28	21.73	22.25	22.80
<b>II</b>	19.8	20.93	21.65	22.34	23.06	23.73
<b>III</b>	19.8	21.25	21.85	22.63	23.45	24.61
<b>IV</b>	19.8	21.83	22.24	23.20	24.36	25.34



**Table (3): Rate of burning (R. B) of unsaturated polyester resin reinforced with glass fiber type (chopped strand mat) with additives.**

<b>Additives%</b>	<b>Non</b>	<b>0.5</b>	<b>1.0</b>	<b>1.5</b>	<b>2.0</b>	<b>2.5</b>	<b>Additives</b>
<b>Test</b>							
<b>AEB (cm)</b>	10	10	10	9.7	9.0	8.3	<b>I</b>
	10	10	10	9.1	8.2	7.0	<b>II</b>
	10	10	9.6	8.3	7.2	6.4	<b>III</b>
	10	10	9.1	7.6	6.3	4.6	<b>IV</b>
<b>ATB (Min.)</b>	5.03	5.80	6.07	6.32	6.19	6.32	<b>I</b>
	5.03	5.93	6.39	6.13	6.01	5.90	<b>II</b>
	5.03	6.12	6.51	6.38	6.20	6.15	<b>III</b>
	5.03	7.07	7.73	7.01	7.63	7.77	<b>IV</b>
<b>R.B (Cm/Min.)</b>	1.988	1.70	1.62	1.51	1.43	1.29	<b>I</b>
	1.988	1.66	1.54	1.46	1.34	1.18	<b>II</b>
	1.988	1.61	1.48	1.31	1.17	1.05	<b>III</b>
	1.988	1.39	1.18	1.09	0.83	0.61	<b>IV</b>
<b>S.E</b>	-	-	-	-	-	-	<b>I</b>
	-	-	-	-	-	-	<b>II</b>
	-	-	-	-	-	yes	<b>III</b>
	-	-	-	-	yes	yes	<b>IV</b>
<b>N.B</b>	-	-	-	-	-	-	<b>I</b>
	-	-	-	-	-	-	<b>II</b>
	-	-	-	-	-	-	<b>III</b>
	-	-	-	-	-	-	<b>IV</b>



**Table (4): Rate of burning (R. B) of unsaturated polyester resin reinforced with glass fiber type (woven roving) with additives.**

<b>Additives%</b>	<b>Non</b>	<b>0.5</b>	<b>1.0</b>	<b>1.5</b>	<b>2.0</b>	<b>2.5</b>	<b>Additives</b>
<b>Test</b>							
<b>AEB (cm)</b>	10	10	10	9.2	8.4	7.0	<b>I</b>
	10	10	9.4	8.3	7.7	6.5	<b>II</b>
	10	10	8.9	7.8	6.9	5.5	<b>III</b>
	10	10	8.5	7.0	5.8	-	<b>IV</b>
<b>ATB (Min.)</b>	5.08	6.00	6.34	6.41	6.20	6.03	<b>I</b>
	5.08	6.23	6.30	6.01	6.10	6.05	<b>II</b>
	5.08	6.47	6.14	6.18	6.15	5.62	<b>III</b>
	5.08	7.50	7.63	6.90	7.67	-	<b>IV</b>
<b>R.B (Cm/Min.)</b>	1.968	1.64	1.55	1.41	1.33	1.17	<b>I</b>
	1.968	1.58	1.50	1.37	1.26	1.10	<b>II</b>
	1.968	1.52	1.44	1.26	1.13	0.99	<b>III</b>
	1.968	1.31	1.13	1.02	0.76	-	<b>IV</b>
<b>S.E</b>	-	-	-	-	-	-	<b>I</b>
	-	-	-	-	-	-	<b>II</b>
	-	-	-	-	-	yes	<b>III</b>
	-	-	-	yes	yes	yes	<b>IV</b>
<b>N.B</b>	-	-	-	-	-	-	<b>I</b>
	-	-	-	-	-	-	<b>II</b>
	-	-	-	-	-	-	<b>III</b>
	-	-	-	-	-	yes	<b>IV</b>





**Table (5): Flexural Strength (SF) and Flexural Modulus (EF) of unsaturated polyester resin reinforced with glass fiber (in two forms) with additives.**

Form of glass fiber	Test of mechanical properties	Additives%						Additives
		Non	0.5	1.0	1.5	2.0	2.5	
Chopped strand mat	Flexural strength (S <sub>F</sub> ) MPa	3.64	3.61	3.58	3.55	3.52	3.49	I
		3.64	3.60	3.57	3.54	3.51	3.48	II
		3.64	3.59	3.56	3.53	3.50	3.47	III
		3.64	3.58	3.55	3.52	3.49	3.46	IV
	Flexural Modulus (E <sub>F</sub> ) MPa	151.2	149.3	147.1	144.8	141.9	137.9	I
		151.2	148.1	146.4	143.5	139.0	136.4	II
		151.2	147.0	145.3	142.0	138.1	134.8	III
		151.2	146.9	144.2	141.2	137.3	133.1	IV
Woven roving	Flexural strength (S <sub>F</sub> ) MPa	4.80	4.77	4.45	4.11	3.84	3.51	I
		4.80	4.65	4.37	4.00	3.72	3.43	II
		4.80	4.53	4.25	3.96	3.65	3.36	III
		4.80	4.41	4.13	3.83	3.50	3.24	IV
	Flexural Modulus (E <sub>F</sub> ) MPa	245	243	241	239	237	235	I
		245	242	240	238	236	234	II
		245	241	239	237	235	233	III
		245	240	238	236	234	232	IV



**Table (6): Tensile Strength ( $\bar{OT}$ ) and Young Modulus (E) of unsaturated polyester resin reinforced with glass fiber (in two forms) with additives.**

Form of glass fiber	Test of mechanical properties	Additives%						Additives
		Non	0.5	1.0	1.5	2.0	2.5	
Chopped strand mat	Tensile strength ( $\bar{OT}$ ) MPa	15.05	15.03	15.01	14.97	14.95	14.92	I
		15.05	15.02	14.99	14.96	14.94	14.91	II
		15.05	15.01	14.98	14.95	14.93	14.90	III
		15.05	15.00	14.97	14.94	14.2	14.89	IV
		211	208	206	204	202	200	I
		211	207	205	203	201	199	II
	Young Modulus (E) MPa	211	206	204	202	200	198	III
		211	205	203	201	199	197	IV
		16.32	16.30	16.28	16.26	16.24	16.22	I
		16.32	16.29	16.27	16.25	16.23	16.21	II
		16.32	16.28	16.26	16.24	16.22	16.20	III
		16.32	16.27	16.25	16.23	16.21	16.18	IV
Woven roving	Young Modulus (E) MPa	410.1	407	404	401	398	395	I
		410.1	406	403	400	397	394	II
		410.1	405	402	399	396	393	III
		410.1	404	401	398	395	392	IV

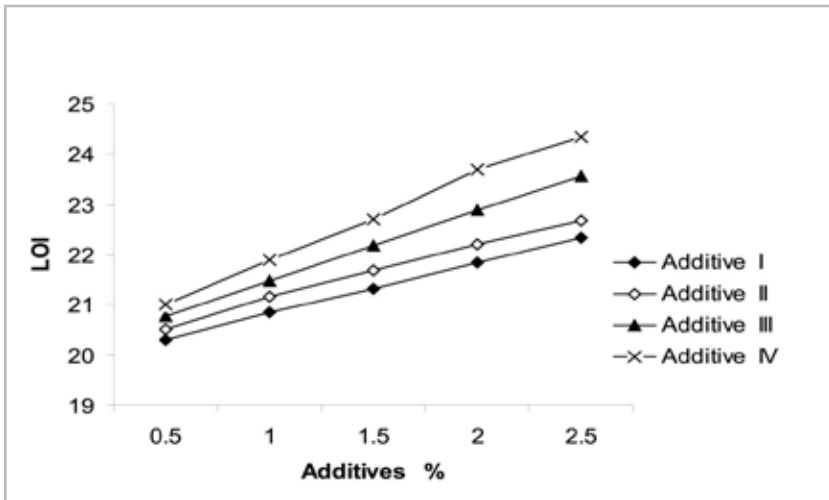


Figure (1): Limiting oxygen index (LOI) for resin reinforced with glass fiber from type chopped strand mat with different percentage of additives.

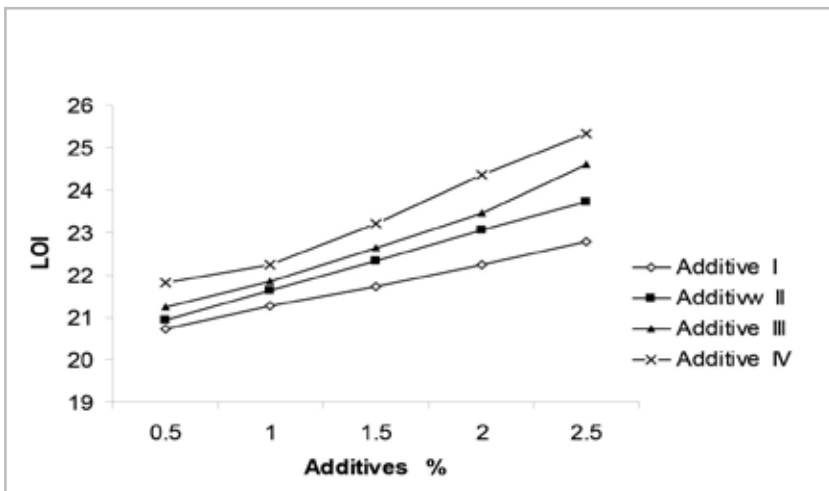


Figure (2): Limiting oxygen index (LOI) for resin reinforced with glass fiber from type woven roving with different percentage of additives.

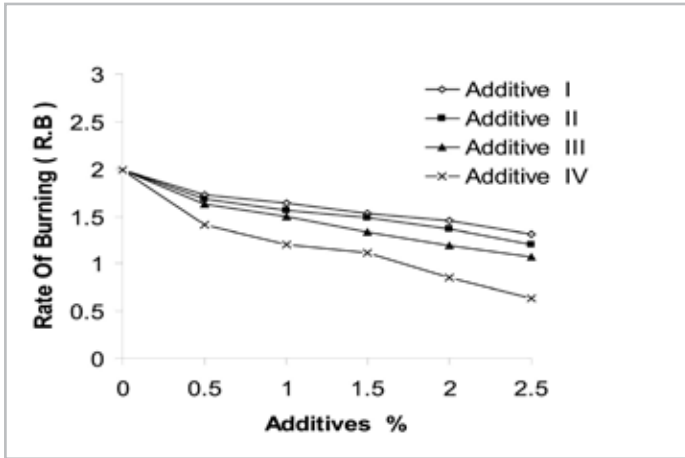


Figure (3): Rate of burning (R. B.) for resin reinforced with glass fiber from type copped strand mat with different percentage of additives.

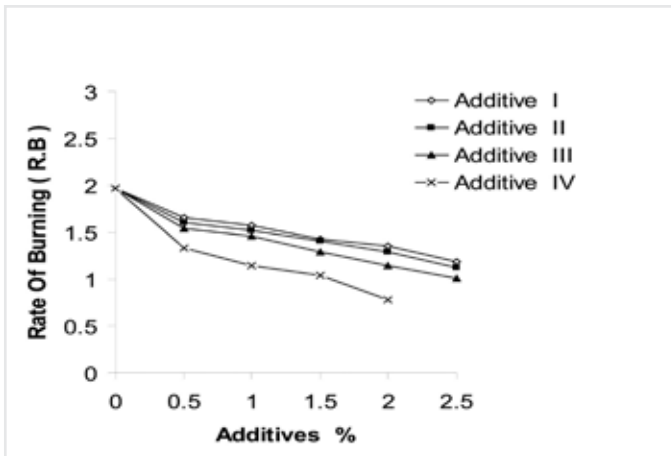
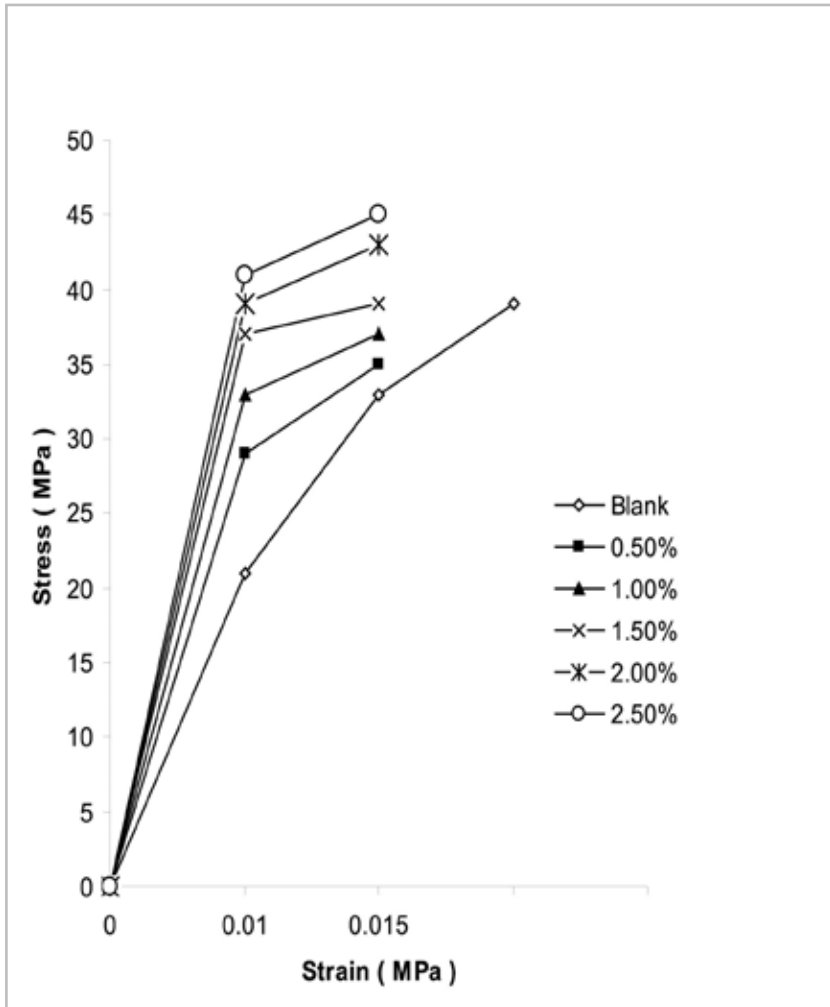
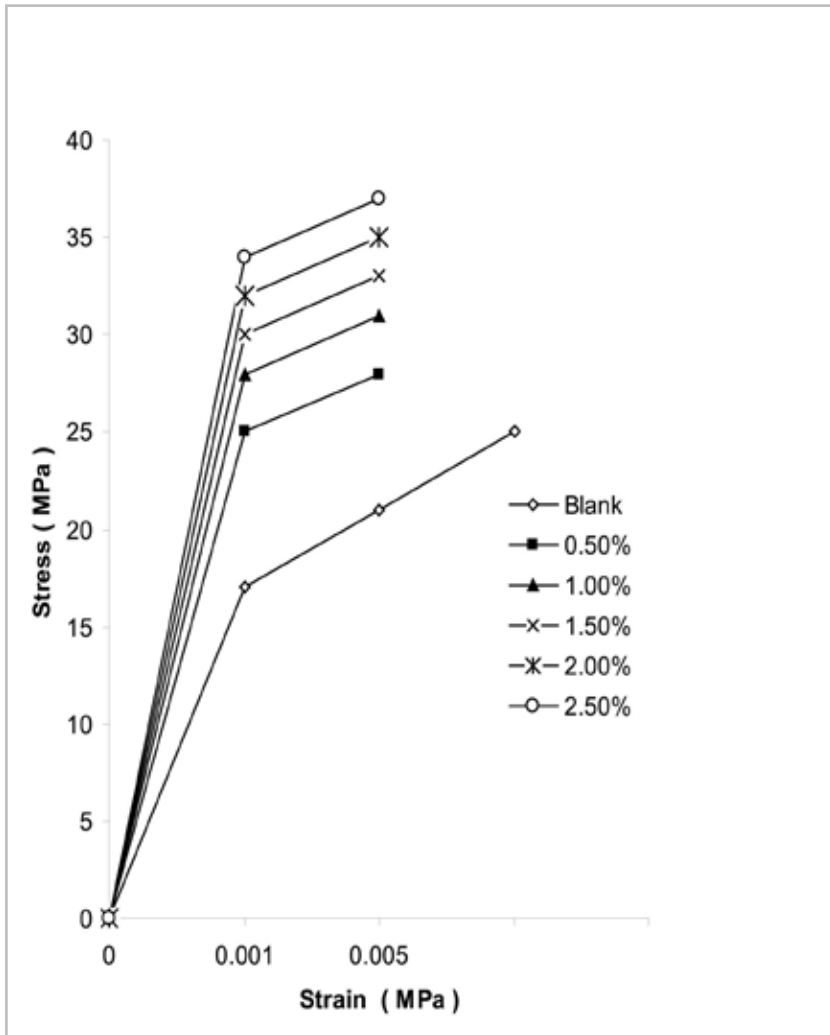


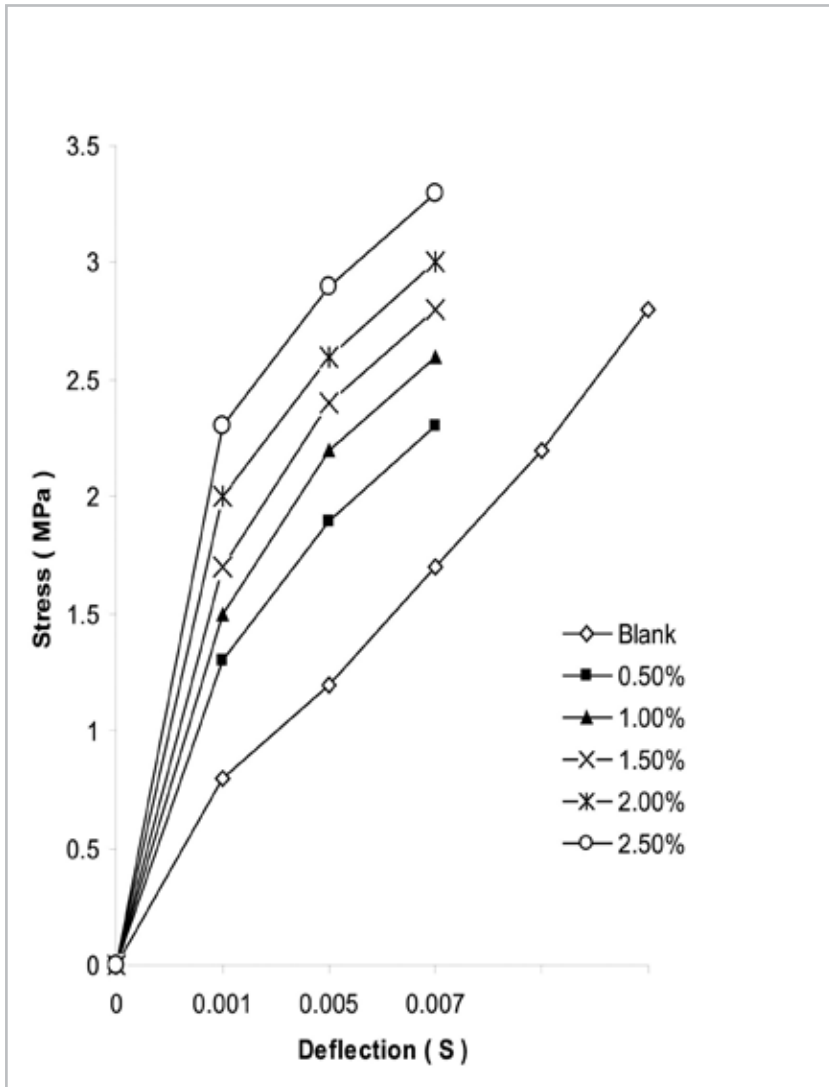
Figure (4): Rate of burning (R. B.) for resin reinforced with glass fiber from type woven roving with different percentage of additives



**Figure (5): Stress - strain curve for resin reinforced with glass fiber type chopped strand mat with different percentage of polyammoniumphosphate.**



**Figure (6): Stress - strain curve for resin reinforced with glass fiber type woven roving with different percentage of polyammoniumphosphate.**



**Figure (7): Stress - deflection curve for resin reinforced with glass fiber type chopped strand mat with different percentage of polyammoniumphosphate.**

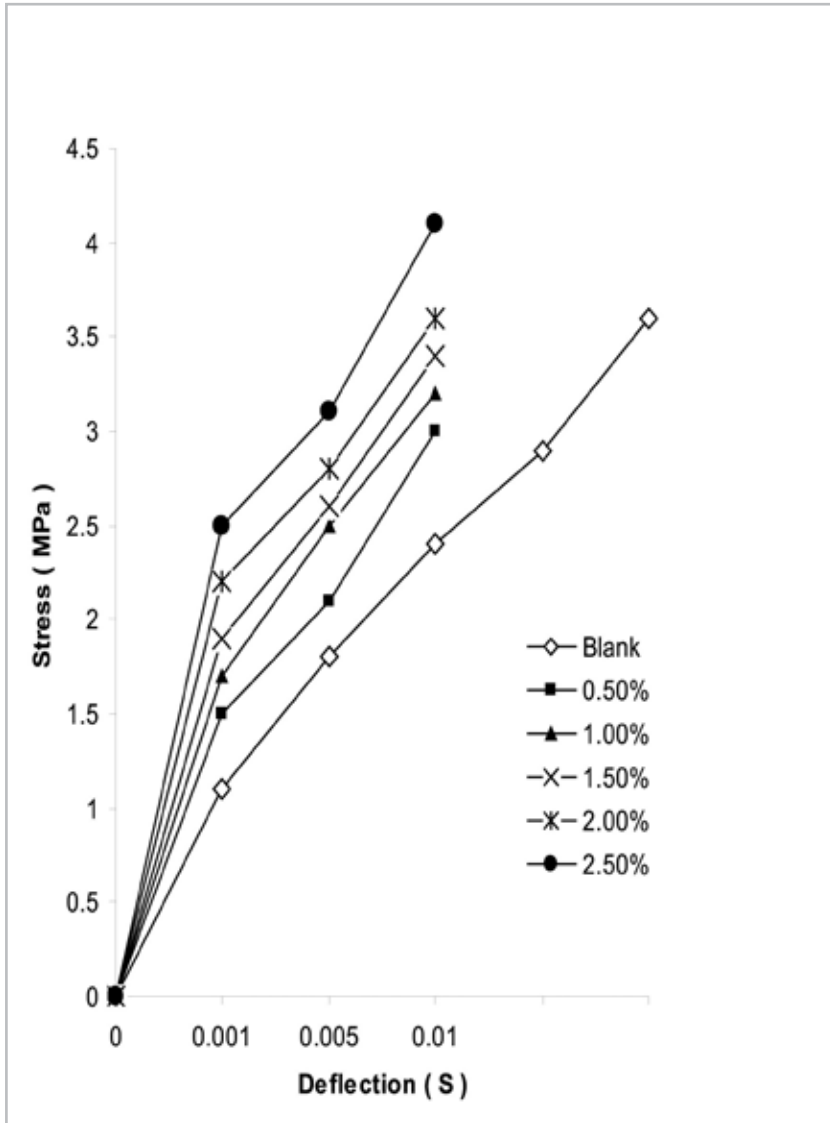


Figure (8): Stress - deflection curve for resin reinforced with glass fiber type woven roving with different percentage of polyammoniumphosphate.