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RESEARCH ARTICLE

Improvement of Unsaturated Polyester Properties by different Types of slag

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Abstract

It is very important reducing the cost in the modern industries also decreasing the pollution which represents a big harmfulness to the environment, this research was came to use waste materials to create new composite materials have good properties. In this research, the effect of three slags powder (cast iron slag, cement dust) on some mechanical and physical properties of unsaturated polyester were studied. The results showed that the hardness and modulus of elasticity, increased with increasing of the powder. The hardness was (24.43 MPa) for pure unsaturated polyester, while was (44.83 MPa) at percentage of powder (25 wt %).

Introduction

The slag is a non-metallic by-product of the steelmaking process. It primarily consists of silicates, aluminosilicates, calcium-aluminium silicates, iron oxides and other crystalline compounds [1]. Nowadays, a large amount of the slag is produced due to the high demand of steel and its related alloys. The slag obtained at steel factories has been mainly used for building materials such as raw material for cement, roadbed material and fertiliser. There are, however, some difficulties in recycling the slag, because it usually consists of various crystalline compounds with a broader variation of compositions depending on the processes of the steelmaking [1].

The term "slag cement" is a very general one that can include many types of materials and combinations. We need only to look through a list of the papers submitted at the 7th International Congress on the Chemistry of Cement (Paris, 1980) to find that blast-furnace slags, basic-oxygen furnace steel slags and magnesium slags are used, or are under investigation for potential applications, in cements, and that both copper and nickel slags can be utilized with cements as pozzolanic materials. "Slag cement" is also used at times to refer to a very specific material, as it is in ASTM Standards C219 1 and C595 2. In C219, slag cement is defined as a "blend of granulated blast-furnace slag and hydrated lime in which the slag constituent is more than a specified minimum percentage." C595 gives the minimum percentage applicable in that particular specification. In recent years, "slag cement" has been commonly used to refer to either combinations of Portland cement and ground slag or to the ground slag alone [2].

As a waste material, slag is a by-product manufactured in industry during thermal and combustion processes. Basic types of slag are divided into blast furnace slag and basic oxygen furnace slag (Fig. 1 and 2), these types are generally called crystalline slag; they are generated by slow solidification of melt age during manufacturing of pig iron or steel. Chemical composition and temperature during manufacturing determinates structure of the slag, what further influences other properties. Slag aggregate - the main objective of this article, is then manufactured by crushing and separation of crystalline slag and other by- products of metallurgical industry. Granulated slag aggregate is currently utilized mainly in earthworks of linear transport communications [3],

Fig. 1 Fractions of blast furnace slag 0/8 mm a 0/32 mm [4]

There is a little researches deals with use of slag as reinforced materials where, Abbass Salim Abbass AL-Ameeri and Suhaila Gh. Mattar investigated the use of iron industry by-products in concrete, as partial replacement of gravel. The study included slag effects on concrete properties namely slump, compressive strength, tensile strength, and shrinkage. One set of experiments was carried out. This set deals with the effects of replacement of coarse aggregate by slag with the following percentages (0 ،30, 60)% at ordinary temperature. Generally, the result of this set of experiments showed, reduction in workability, Improvement compressive strength, tensile strength, reduction in shrinkage [5].

The aim of this research is to benefit from a waste material and use it to create a new composite material has a good properties and cheap, and to reducing of the environmental pollution. In the present study, it was used a thermoset polymer (polyester) as the matrix and a Cast Iron slag, dust of Kufa cement and dust of Najaf cement powder as the reinforcing filler to prepare a particle-reinforced composite to examine the possibility of using these waste material as reinforcing fillers and to determine some mechanical properties of the composite according to the reinforcing filler content in respect to unsaturated polyester.

2. Experimental Procedure

2.1. Materials

2.1.1. Matrix Polymer

Unsaturated Polyester (UPE) was used in this research. The mixing ratio used was 100g of UPE resin with 0.5g accelerator (Cobalt napthenate) and 2g hardener (Methyl Ethyl Ketone peroxide).

2.1.2. Reinforcing Filler

Three types of filler were used in this research. These types were Cast Iron slag, dust of Kufa cement and dust of Najaf cement p**o**wder. The Chemical compositions of Slags showed in table 1. The chemical analysis result of dusts of Kufa and Najaf Cement and cast iron slag carried out in chemical lab of Najaf cement factory (Iraq) and was as following:

Table (1): Chemical compositions of dusts of Kufa and Najaf Cement and cast iron slag

component	Weight content % (Kufa) dust cement	Weight content % (Najaf) dust cement	Weight content % cast Iron
SiO2	13.38	6.14	77.44
Al2O3	5.87	1.74	0.06
Fe2O3	1.61	0.86	12.78
Cao	40.35	18.94	2.71
Mgo	3.08	1.17	0.76
So3	8.83	25.25	0.61
L.O.I	21.8	18.07	2.30

2.2. Samples Preparation

The samples were prepared by mixing unsaturated polyester with Slag powder using different filler content. The three powders were added to polyester and hardener and then they were homogeneously mixed. The mixed of composites was poured into the mold according to test.

2.3. Mechanical Tests

2.3.1 Compression Test

Compressive strength test was carried out according to ASTM D695 at room temperature. In this test, the load is applied gradually to the longitudinally fixed sample, and then the reduction in the length is determined by the dial gage, the increasing in the load continues till sample fails. Compressive strength was determined from this test by divided maximum load on cross sectional area of sample.

2.3.2 Hardness Test

Hardness test was conducted with TH-717 (Digital Micro Vickers Hardness Tester). The load time was used in this test was 15 seconds and maximum load was 2.942 N.

2.3.3 Wear Resistance

A Pin -on- Disc wear testing machine of variable speed has been used. The weighing method was used to determine the mass loss of the test specimens. The surfaces of the samples were cleaned and grinded to become ready to the test.

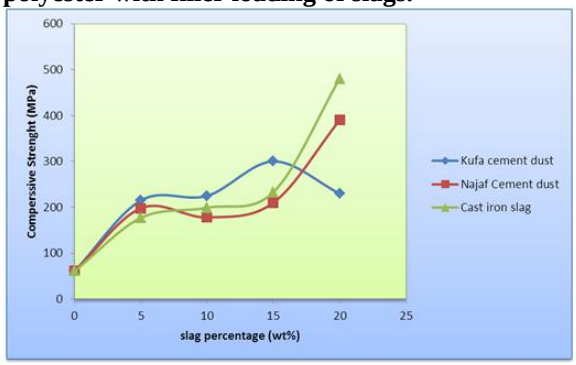
3. Results and discussion

3.1. Compressive Strength

Figure (1) illustrates the variation of compressive strength with filler loading. It can be seen that the compressive strength increases with filler addition. The results showed that the compressive strength of

the pure UP illustrated higher than of UP reinforced with slag powder, this is attributed to a large interface distances among particles that lead to increase of free paths and then lead to failure of sample at applied compressive load. While at addition high percent of particles to matrix that lead to formation a brittle material that it stables to micro cracks, hence the fracture of material was relayed [6].

Fig.(1): Variation of the compressive strength of polyester with filler loading of slags.

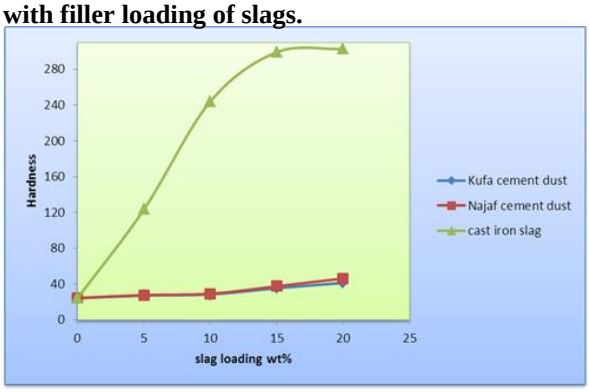


3.2. Hardness

The variation of hardness with filler addition is shown in Fig. (2). The Hardness of composites jumps with increasing in concentration of slag. This is may be attribute to increase of the bond and cross linking that decrease of movement of polymer molecular which lead to increase of strength of material to scratch and increase of the material strength to plastic deformation.

From the same figure we have seen a large increment in hardness of samples of unsaturated polyester reinforced with cast iron slag that they attribute to the brittle nature of components of cast iron that serves to increase of hardness especially the high percentage of SiO_2.

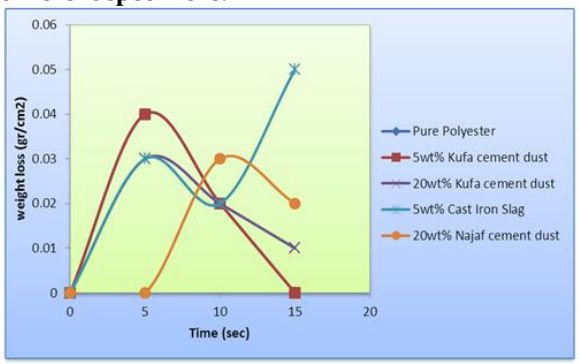
Fig.(2): Variation of the Hardness of polyester with filler loading of slags.



3.3 Wear Resistance

Figure (3) demonstrates the relationship between the loss of weight and time in wear test. The results showed that the wear resistance increases with increasing of the weight fraction of the reinforcing particles while weight loss decreases with increasing period test. This is due to increase of elimination from sample due to friction and the generator heat from the friction.

Fig. (3): the weight loss – Time curves for different specimens.



4- Conclusions:

In this paper, effects of three types of slags on some mechanical properties of unsaturated of polyester were investigated. Based on the analysis in the present experimental work, the following conclusions can be deduced:-

- The results encourage to use any waste material is not useful lonely but may be very useful as reinforced material to create a new composite material has good properties and cheap, and to reducing the environmental pollutions.
- The compressive strength and hardness went up with increasing of filler addition. The impact strength declines with increasing of filler loading.

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