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Research on Preparation Technology of Recycled Building Decoration Materials

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In the present study, mechanical and physical properties were studied about the composite which was hot pressed by different kinds of modified phenol resin, then, one modified way was decided. Orthogonal experiment and single factor experiment, as well as the effect of mixture ratio on the composite properties, were designed to study systematically hot-pressing parameters. This paper also discusses the mechanism of interfacial bonding between aluminum and PF by analyzing the surface free energy, FTIR, SEM and XPS. The findings provide theoretical and technical support for the aluminum/wood decorative board hot-pressing with modified PF.

1. Introduction

Every year, there are lots of architectures were demolished in China because of the speeding up of urban construction, and at the same time, many cities have been damaged by the earthquake and other disasters, and all of these have produced a large number of waste concrete. Therefore, it has become one of one of the hotspots that how to reuse the waste concrete and the sustainable development of building materials (Zhang and Han, 2016). From a long-term point of view, it has important theoretical significance and engineering application value about the development and application of the technology of recycled aggregate concrete.
Vanadium tailings of direct leaching from stone coal are the waste residue which was obtained by stone coal after acid vanadium extracted and rich in carbon (Zhou et al., 2015). At present, vanadium-extraction tailings mostly are stockpiled or land filled to handle, not only occupied land resources, increased enterprise costs, but also lead to environmental pollution problems. With the nonferrous metals industry and southern Shaanxi circular economy policy development requirements, the level of comprehensive utilization of vanadium tailings improved is necessary Combined with local conditions, the use of vanadium tailings preparation related construction materials is one of important research direction

2. Preparation technology of recycled gypsum

Gypsum is a kind of green building material; It is widely used in architecture. China's gypsum is rich in resources, but the distribution of resources is not balanced, and the proportion of high quality gypsum resources is small (Huang et al., 2016). As gypsum is widely used, resulting in a large number of waste gypsum. These gypsums not only occupy a lot of farmland, pollute the environment, but also is a waste of resources. In theory, gypsum can be recycled. But at present, the research on gypsum is mainly aimed at the primary gypsum and industrial by-product gypsum. Well less research on the waste gypsum. With the resource crisis is more and more serious, the re-use of materials is even more important (Figure 1). So it is necessary to research the recycled gypsum, which provides theoretical guidance for the utilization of waste gypsum. 0ur group has made some basic research on recycled gypsum. The difference between natural and recycled gypsum has been revealed from the aspects of phase composition, thermal properties, micro structure and so on (Takeshi Kamei et al., 2013). On this basis, this paper explores the best preparation technology of recycled gypsum, and explores the ways of resource utilization of recycled gypsum.
The thermal performance of recycled gypsum is different from that of primary gypsum. So, the production process of the original gypsum can not be copied to be used in the recycled gypsum (Suarez et al., 2016). In

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this paper, we changing the grinding time, calcinations temperature, calcinations time three conditions to explore the best preparation technology of recycled gypsum. Water-reducer and cement is often added to the gypsum to improve its performance. And the building gypsum is sometimes difficult to separate from the cement mortar. So, In this paper, the effect of water reducing agent and Portland cement on the properties of primary and recycled gypsum was studied. The setting time of recycled gypsum is longer, and the strength is lower, well plastering gypsum requires a long setting time and low strength. So it is suitable for use recycled gypsum to prepare plastering gypsum. In this paper, we modified the setting time, water retention property, bond strength and strength of recycled gypsum (Mardani-Aghabaglou et al., 2016). Based on the influence of several additives on the performance of recycled gypsum, determine the best volume of admixture, and formulate recycled plastering gypsum with good performance.

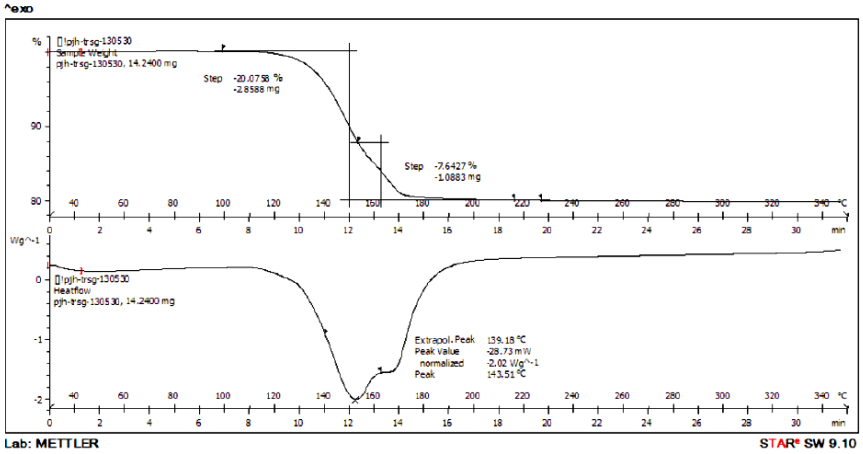

Figure 1: Thermal analysis of virgin gypsum.

3. Preparation technology of aluminium, stone coal and concrete

Aluminium/wood composite has developed into a high-end decorative material though it was applied relatively late in China. It is used widely as functional materials of buildings, furniture and vehicles due to its striking advantages, such as decorativeness (Figure 2), toughness damp, flame, heat insulation and so on. This composite, however, is to be made with a special and costly adhesive because of the different property of aluminium and wood, and the complexity of their surface pre-treatment and hot-pressing (Mukherjee et al., 2016). In order to help promote the new composite, this paper focuses on its hot-pressing process and compounding mechanism based on the selection of the low-price and high-quality adhesive.

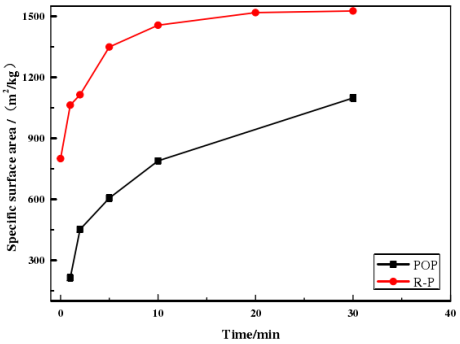

Figure 2: Specific surface area of plaster of Paris (POP) and recycled plaster(R-P) in different grinding time.

Physical and chemical properties of vanadium tailings have been studied, which has a certain radioactivity and belongs to the class C decoration materials The main chemical composition of tailings were Si02, A1203, Ca0 and 503, loss on ignition amounted to 13.64%. The main mineral compositions were quartz and gypsum, the minor minerals were pyrite. The tailings had coarser granularity, lower powder content, and less plastic characteristics, so preparation of wall materials needed to add plastic binder phase. The experiment determined the conditions to make unfired bricks, a mass ratio of raw tailings to powder tailings and cement

was 65:27:8, a water addition for mixing amounting was 8% of the total dry solids, and a forming pressure was 15MPa, natural maintenance was 28 days (Karaipekli et al., 2016). The microstructure of products were analyzed, the main phase of products were quartz, calcite and microcline, which constituted the main skeleton of unburned brick, giving samples high strength with gelling materials as binders. When at such conditions above MU25 unfired bricks can be made with porosity of 10%, a bulk density of2.15g/c , and compressive strength of 30.4MPa, which meet the national standards in JC/T 422-2007. And tailings utilization of unit's unburned brick can reach to 92%. The sintering mechanism and process method were studied, which used vanadium tailings as raw material matched with local clay as supplementary material to made sintered bricks (Licari et al., 2011). A mass ratio of raw tailings to clay and powder tailings was 65:15:20, a water addition for mixing amounting was 8% of the total dry solids, and a forming pressure was 15MPa. After drying and sintering at 1000, then insulating for 3hours, the sintered bricks could be prepared this process can take full advantage of carbon in the tailings and save energy. The main phase of sintered products was quartz, microcline, and hematite. To avoid over-burning phenomenon, the sintering temperature should not exceed 1100 0C.When at such conditions above MU10 sintered bricks made bulk density of2.15g/c , porosity of 30%, and compressive strength of 14MPa, which meet the national standards (Ucar et al., 2011). And tailings utilization of units sintered brick can reach to 85%. Analysis showed that the sulphur content of vanadium tailings was 10.35% and content was 1.58%. Sulphur in the sintering process mainly converted to 502, in order to prevent air pollution, wet-ammonia desulfurization process for S02 was effectively absorbed (Figure 3). Through experimental research the preparation of sintered brick made of vanadium tailings expanded production is technically feasible. Vanadium tailings can be efficiently processed with certain environmental and economic benefits. The research results provided an effective way for the comprehensive utilization of vanadium tailings. There are some theoretical significance and important application value for the development of southern Shaanxi vanadium industry.

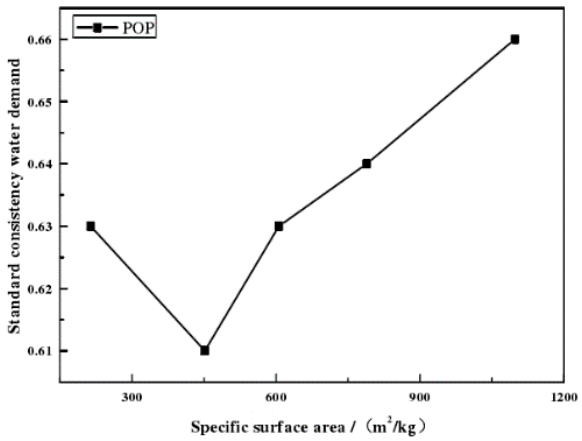

Figure 3: Standard consistency water demand of plaster of Paris (POP) in different specific surface area.

Compared with natural aggregate concrete, recycled aggregate concrete is complex, whose properties are influenced by many factors. The source of recycled aggregates, namely the original concrete and the mixing method of mixture are both the important aspects, which are rarely studied. Therefore, this topic aims to study on the effect of original concrete and mixing method on properties of recycled aggregate concrete. Three kinds of original concrete with different design strength grade and a group of air-entrained original concrete were produced, which were all crushed at the age of 60 days to obtain seven different kinds of recycled coarse aggregates. And the relationship between recycled aggregates and the original concrete were explored by testing the basic properties of recycled aggregates. Then groups of recycled concrete were produced using these different recycled coarse aggregates that replaced natural coarse aggregate by 100%, and in the meantime three kinds of mixing methods were used (normal mixing method and two double mixing methods). The mechanical properties tests were carried out after 28 days. The test for resistance of these recycled concrete to rapid freezing and thawing was also started at the same time, and four kinds of evaluation index, i.e. weight loss, relative dynamic modulus of elasticity, ultrasonic relative dynamic modulus of elasticity and strength loss rate were used to evaluate the frost resistance of recycled concrete. A microscopic investigation was carried out on some specimens of recycled concrete, which were sampled by cutting slices when different freeze-thaw cycles. Through the micro statistics to each slice, the cracking degree of every component in recycled concrete were quantitatively evaluated by two micro structural damage parameters: mortar cracking

ratio and interface cracking ratio. The results reflected the freeze-thaw failure mechanism of recycled concrete and the influence mechanism on frost resistance of recycled concrete when original concrete was air-entrained.

4. Result and discussion

Research results show that, the best preparation technology of recycled gypsum is different from that of primary gypsum. Prepare recycled building gypsum need longer grinding time, lower calcinations temperature. Analysis shows that, this is due to the increase in the specific surface area of recycled gypsum plaster to a certain extent, its grain is fine, surface is smooth and easy to flow, cause the reduce of standard water requirement. And the thermal stability of recycled gypsum decreased, dehydration temperature decreased. Recycled gypsum prepared according to the best process, the initial setting time is 8min, final setting time is 12min, 2h flexural strength is 2.33MPa, compression strength is 4.45MPa, properties meet the gypsum standard GBT9776-2008, 2 rate of building gypsum.

As shown in Figure 1, the more water reducing capacity was possessed by recycled gypsum at the same dosages with primary gypsum. The performance of recycled gypsum was continuously enhanced under the content of 0.2007o. Portland cement can improve the strength of recycled gypsum. Analysis shows that, this is due to the large surface area of recycled gypsum, so the water reducer can easily play a role of disperse. The mixed growth of cement hydration product and gypsum crystal can improve the performance of gypsum. The water reducing agent of primary gypsum still has the function of reducing water in recycled gypsum. And the cement in the primary gypsum has a negative effect on the recycled gypsum. Analysis shows that, this is due to the calcinations temperature is not enough to make poly carboxylic acid water reducing agent to produce thermal decomposition and desorption. And cement in the recycle process is no reversible. After regeneration, it become inert power, have disadvantage to gypsum strength.

It is presence critical volume (0.4070) when adjusting the setting time of recycled gypsum with sodium phosphate retarder. Above this amount, the setting time was significantly increased, and the strength deteriorated seriously. To improve the water retention of recycled gypsum with hydro methyl cellulose ether, it improves the water retention property of gypsum and it is disadvantageous to the strength of gypsum, selection 0.1507ocontent (Figure 4). To improve the performance of recycled gypsum bonded with rubber powder, below the critical volume (1.507o), it is favourable to bond performance, above the critical volume have disadvantage. The strength of recycled gypsum increases with the increase of the content of water reducing agent and desulfurization gypsum. Selection of 0.05070 water reducing agent or 20070 desulfurization gypsum. Several kinds of admixture prepared recycled plastering gypsum to meet the requirements of GB/T 28627-2012standard.For the bottom plastering gypsum, 20-40 purpose sand should be selected, and selects and binder ratio of 1:0.5. The bottom plastering gypsum prepared can meet the standard requirements.

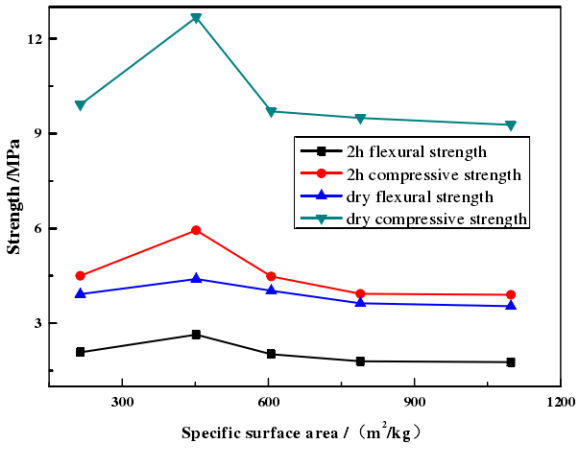

Figure 4: Compressive strength (CS) and flexural strength (FS) of plaster of Paris (POP) in different specific surface area.

We produced the different composites by modifying PF with other thermoplastic resins as polyvinyl butyric (PVB) and polyvinyl acetate emulsion. The results showed the modified PF with PVAc had better performance whose average value of the surface bonding strength is 1.36MPa. This kind of adhesive was chosen for further study.

An orthogonal experiment was designed to examine the mechanical and physical effects on the composite from the following process parameters: hot-pressing temperature, hot-pressing time, unit pressure and glue content. An analysis of the range and variance of the results shows that hot-pressing temperature has the largest effect on every quality index of the product. The order of relevant factors is hot-pressing temperature> hot-pressing time> unit pressure>glue content. The optimal variables were hot-pressing temperature of 1400C, pressure of 0.6MPa, hot-pressing time of 9min and glue content of 200g/m2 respectively.

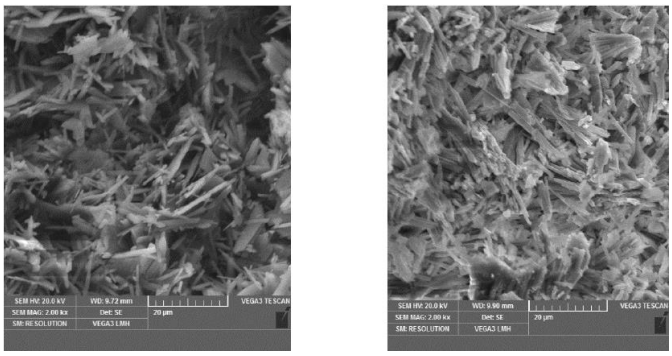

Figure 5: Crystal morphology of recycled plaster (R-P) (specific surface areais1253 m2/kg) (x2000).

Surface bonding strength of mixture ratio of PF with PVAc was over 1. OMPa. It had the largest effect on the basis of poplar veneer, but no significant influence on medium density fibber board. The optimum mixture ratio of modified PF with PVAc was 2:1. The filling of coupling agent could improve the surface bonding strength and had the largest effect were in Figure 5.

The composites could not be ignited. Comparing to MDF, HRR, Avg-HRR, EHC and THR went down by 97.3%, 98.3%, 90.6% and 96.6%. But TSR and mass rose by 716% and 331.9%. The smoke inhibiting property became worse. Release of CO and C02 was more steady and lower than MDF (Figure 6).

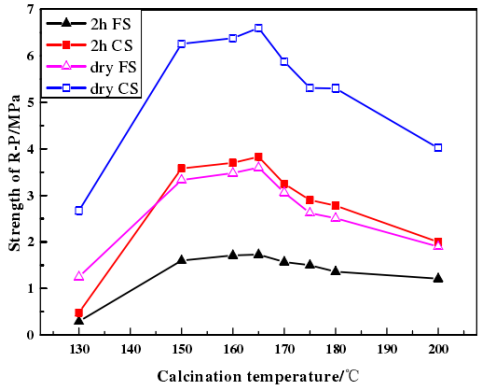

Figure 6: Compressive strength (CS) and flexural strength (FS) of recycled plaster(R-P) indifferent calcination temperature.

After the aluminium foils were treated with sanding and sanding/watering, its surface free energy had been improved by 3 and 5 times respectively, as well as a higher wetting. The SEM results showed that modified PF could wet the aluminium foil surface adequately. Though the contact rate between aluminium foil and poplar veneer was only about 30%, its surface bonding strength was improved greatly, which showed that the chemical bond had been formed between aluminium and adhesive (Figure 7). The infrared spectrum analysis showed that the absorption peak was absent on the surface of aluminium foils while cured adhesives had the absorption peak of -OH. These above results showed that the chemical bond had been formed between the aluminium and the hydroxyl (-OH) of the adhesives. The absorption peak of carbonyl groups(C=O) had migrated to higher peak area in PVAc and modified PF with PVAc. As a result, Al-O-C bond was formed. The XPS results showed that A1 and A1 Oxide existed in the interface and the binding energy of C and O migrated to higher area. Meanwhile, many peaks indicated that the coordination bond between A1 and adhesives had been formed.

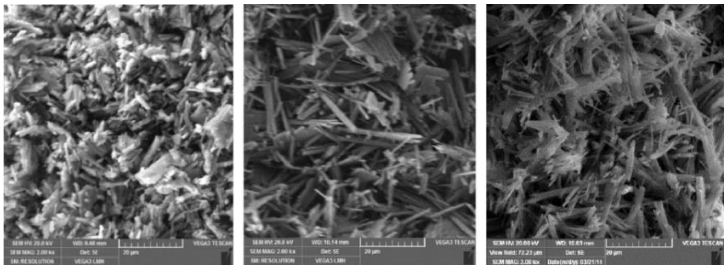

Figure 7: Crystal morphology of recycled plaster(R-P) indifferent calcinations temperatures(x2000) a-1500C, b-1650C, c-1800C

5. Conclusion

The results showed the quality of recycled aggregate was effected by the properties of original concrete , resulting in a significant influence on the strength and frost resistance of recycled aggregate concrete. The quality of recycled aggregate that came from original concrete with higher strength was better, leading to the higher strength and better frost resistance of recycled aggregate concrete. When the original concrete was air-entrained, on one hand, the strength of recycled aggregate became lower, which led to the lower strength of recycled aggregate concrete, and on the other hand, the pore structure of the adhered mortar of recycled aggregate was more reasonable, and the cracking of the adhered mortar in the process of freezing and thawing is less, which significantly improve the frost resistance of recycled aggregate concrete. The two double mixing methods could improve the strength of the recycled aggregate concrete, but there was little influence on its frost resistance.

Acknowledgments

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