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The experimental study of contaminant removal in water quenched slag biological aerated filter (BAF)

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Abstract. In order to effectively resolve pollution issue of water quenched slag and its comprehensive use or second use of materials, the water quenched slag filter material is developed using water quenched slag with the addition of adhesion-increasing agent and porogen by commingle, pelletizing and curing. Experimental results indicate that water quenched slag filter material is used as filter medium in biological aerated filter for wastewater treatment,and the removal rate of COD, NH_3-N comes up to 84.62%,90.20% respectively. The filter material is much more predominant and possesses a much wider application prospect in the treatment of wastewate.

Introduction

Water quenched slag is the most number of a waste residue in metallurgical industry,it is vitreous structure material that has high potential activity[1], In recent years,its recycling is more and more importance, So how to make the waste be useful and cycling resource is an important issue, it has aroused extensive concern of scholars at home and abroad.

At present, the filter material is mainly ceramicite in water treatment and has a high production cost. The traditional ceramicite in biological aerated filters has many defects,including big flow resistance, small porosity, prone to blockages, poor strength, easily crushed, ineffective water processing. According to the deficiency of the existing technology,we study a non burning and porous filter materials

Production process of water quenched slag filter material

Row material. Water quenched slag is from steel works Shandong, Through analytical method of chemical compositions and XRD(See fig. 1) for raw materials, through analytical method of chemical compositions and XRD for raw materials,its phase composition is amorphous phase, 2 θ in 20° ~ 40° range has a obvious diffraction peak, the practice showed that the blast furnace slags mainly consisted of melilite,pseudowollastonite,anorthite, olivine. The main chemical compositions is in table 1. Water quenched slag can be prepared by simple breaking ,grinding and select the particle size < 0.5 mm.

The binder are P·S32.5R portland cement, the main chemical compositions is in table 2.

The pore agents belong to all kinds of inorganic salt or other compounds that soluble in water,it may be one kind of Na_2SO_4, $CaSO_4$, NaCl, $CaCl_2$.

Table 1 The chemical composition of water quenched slag

chemical composition	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Loss	Σ
wt%	34.84	14.76	2.25	36.45	9.35	0.33	97.85

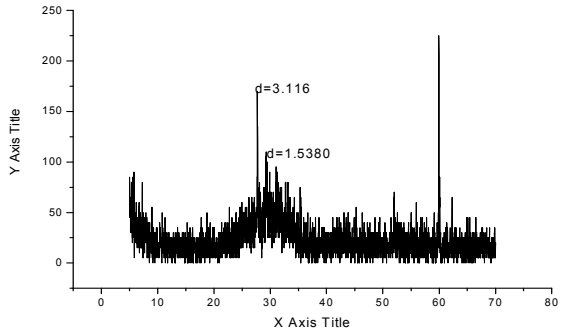


Fig. 1 Fig of water quenched slag XRD

Table 2 The chemical composition of portland cement

chemical composition	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	K_2O	Na_2O	Loss	Σ
wt%	21.96	4.76	3.30	64.88	2.86	0.59	0.80	0.20	0.24	99.59

Experiment formulas and processes. The effect of consumption of water quenched slag, cenent, pore agents and curing time on the quality of product was researched using orthogonal test method, orthogonal experiment results show that the best formulas are water quenched slag,:cenent:pore agents=40%~75%:10%~40%:5%~20%, uring time is 3 to 12 days.

The production process as following :

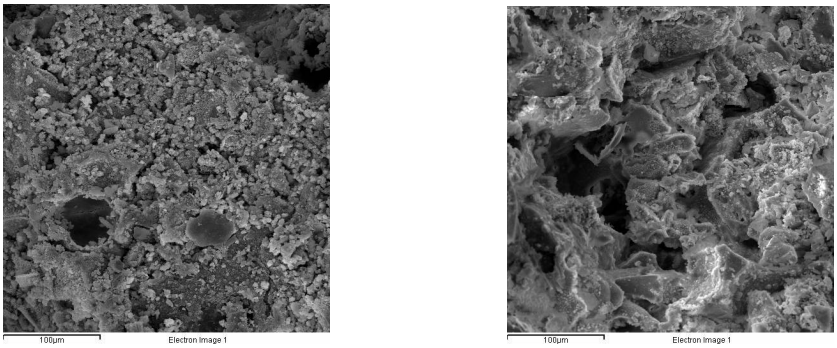
Material processing→ingredient→mixed evenly→forming→maintenance→wash→dry→ performance test

Characteristics test of products. The performance of products that made on best design conditions were tested and ,the surface morphological structures were observed with SEM and compared with ceramsite, result shows in table 3

Table. 3 The comparison on elemental property between water quenched slag filter and ceramsite

	Size /(mm)	Density /(kg·m^{-3})	Wear rate /(%)	Damaged rate /(%)	Porosity /(%)	Specific area /(%)	Biomass /(g·g)	Hydrochloric acid capacity rate (%)
water quenched slag	3~5	1982.6	1.50	1.15	48.17	13.79	0.045	32.15
ceramsite	3~5	2262.4	1.80	1.62	29.59	0.73	0.029	2.83

The data from table 3 shows that this new type of filter compared with the ceramic grain has following trait, water quenched slag filter material had small density, wear rate and damaged rate, excellent mechanical strength,this can be capable of resisting hydrodynamic shear stress preventing filter medium movement and collision to cut down crushing amount, large specific surface and porosity that is favorable for the attached growth of microorganisms and weaking the impact of hydrodynamics shear.



a. Micro-structured surfaces b. Micro-structured section

Fig. 2 SEM photographs of water quenched slag filter material(magnification 300)

SEM photos of surfaces and section(Fig. 2) show that the suface of this new ceramsite has higher roughness can improve the adhesion strength of microorganisms. Filter internal contain many hole and pore which are arranged orderly, connected with each other and cuted off outside, Suitable for attaching large microbes.

Water treatment

Experiment device. Experiment device is shown in figure 3. The diameter of reactor is 150 mm,feed height is 1500mm, the reacter is filled with 200mm cobble which particle size is 15mm as graded gravel layer at its bottom,the aerator is under the cobble100mm[2].

The operation of the biological aerated filters: filter material of prepared were filled in reactor,then we conducted biofilm startup, until the biofilm stable,during the stability time period for biological aerated filters , the capability of organic contamination , ammonia nitrogen ,SS and chroma removal were studied in water quenched slag biological aerated filter. Tthe removal rate of COD and ammonia nitrogen were measured.

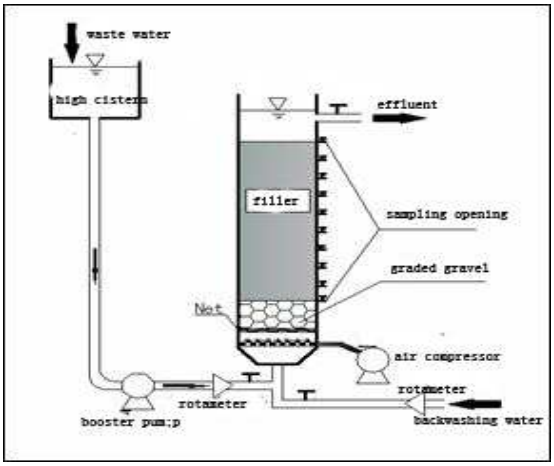


Fig. 3 Experiment device

Removal effect of CODcr. CODcr was used to characterize organic content in the treatment of sewage[3]. The removal efficiency of water quenched slag that was used as filtration material in the biologica is in Fig. 4.

According to the experimental result of the figure 4, when the influent flow was 400ml•min^{-1}, the ratio of gas supply and designing water quantity is 15, the temperature of the water was 20.00~26.00°C, pH value was 7.0~8.0, the concentration of influent CODcr was 67.00 mg•L^{-1}~290.00 mg•L^{-1}, the average concentrations of influent CODcr was 167.58 mg•L^{-1}.The effluent CODcr concention of water quenched slag biological aerated filter was 16.00 mg•L^{-1}~74.00mg•L^{-1}, the average concentrations of enfluent CODcr was 37.73 mg•L^{-1},it meets the requirements of discharging standard of our country(GB8978-1996),the removal rate of CODcr was 68.06%~84.62%,the average removal rate of CODcr was 77.70%.

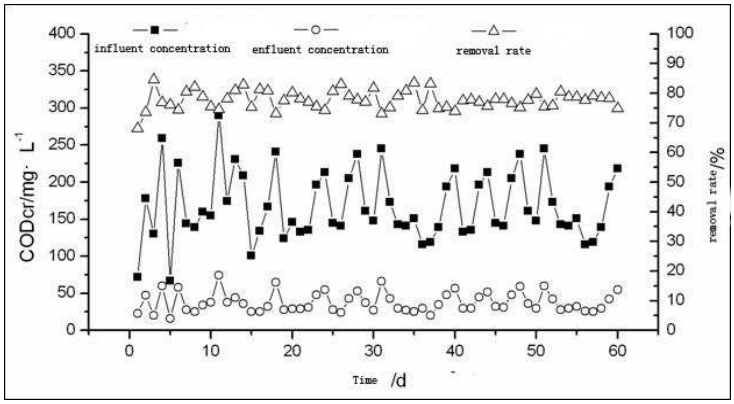


Fig. 4 CODcr removal in water quenched slag BAF

Ammonia nitrogen removal characteristics. The experimental results as shown in figure. 5, under the same conditions with fig 4,when the influent flow concentration of ammonia nitrogen was 22.54 mg•L^{-1}~55.96mg•L^{-1}[4], the average concentration of ammonia nitrogen was 36.45mg•L^{-1}, The effluent ammonia nitrogen concention of water quenched slag biological aerated filter was 2.21 mg•L^{-1}~10.01mg•L^{-1}, the average concentrations of enfluent ammonia nitrogen was 5.39mg•L^{-1}, it meets the requirements of discharging standard of our country(GB8978-1996), the removal rate of ammonia nitrogen was 70.52%~90.20%, the average removal rate of ammonia nitrogen was 85.18%. the ionic release of $CaCO_3$ out of water quenched slag changed pH volue, especially, when water pH value is lower,it can provide alkalinity for nitration.

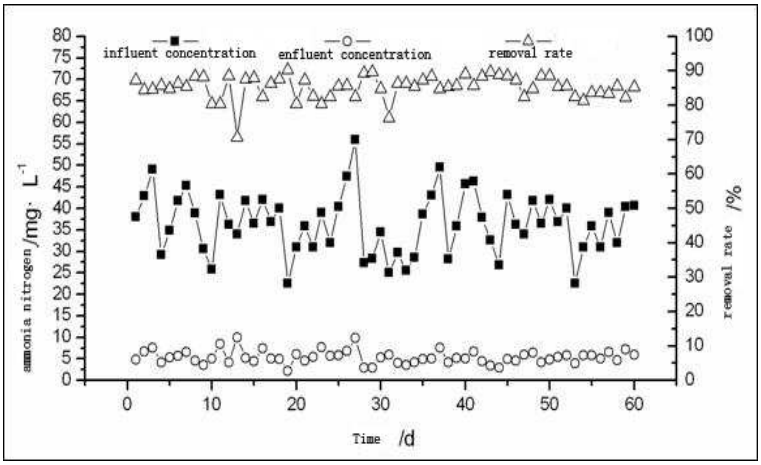


Fig. 5 Ammonia removal in water quenched slag BAF

Conclusion

The experimental results shows that the surface of non-sintering porous water quenched slag filter material was roughness and porous,it is favorable for the attached growth of microorganisms in biological filter and have excellent absorbability,the non-sintering porous water quenched slag filter material used for treatment of domestic sewage has many advantages,such as high removal efficiency of pollutant,the processed domestic sewage meet the requirements of discharging standard of our country(GB8978-1996).The production materials of new type filter material based on waste residues, without the geographical limitations of raw materials,this not only solve the problem of waste residuesdeposited,but also control environmental pollution, because filter material was made in non burning situation,so this reduce energy consumption and the cost of the product, it meets the environmental policies of the current national energy saving,therefore, the researching and spreadingof water quenched slag filter material will have important significance.

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