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Environmental Geotechnical Treatment of Polluted Soil from Waste Ash in Factory

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Abstract: The waste alkali liquor is mainly derived from the petrochemical production. It is a waste liquid with a large amount of pollutants formed by the absorption of NAOH solution, alkali washing oil and cracking gas. The alkalinity of the spent caustic is extremely high. If the reasonable pretreatment is not carried out, the high concentration of the spent caustic soda will enter the sewage biochemical treatment system, which will hinder the growth and reproduction of the microorganisms, and will cause serious consequences of the extinction of the microorganisms, and eventually interfere with the sewage. The normal operation of the treatment plant and the standard discharge of the total discharge of wastewater, so the treatment of contaminated soil from the factory waste alkali is a very important issue. This paper mainly studies the environmental geotechnical engineering control methods of polluted soil of factory waste lye. Based on the relationship between the equivalent elastic stress and the yield strength of contaminated soil, the ductile mechanical parameters of the contaminated soil of waste alkali liquor are calculated. On this basis, the clay particle analysis control model of the contaminated soil of waste alkali liquor is established to predict the soil contaminated by waste alkali liquor. The distribution of particles and pores is completed, and the detection of contaminated soil of waste alkali liquor in geotechnical engineering is completed. The solidification agent (cement) and sodium persulfate are added to the contaminated soil of waste alkali liquor to realize the purification treatment of contaminated soil of waste alkali liquor. The experimental results show that the benzene content in each soil layer after purification treatment is larger, and the benzene content after purification is below 4.3mg/kg, and the soil layer pollution is treated by CPS method and tandem mass spectrometry. Although the benzene content in the soil decreased, the benzene content was still higher than the larger specific gravity after purification. The simulation results in this paper show that the curing agent (cement) can promote the treatment of benzene and 1,4-dichlorobenzene in the contaminated soil of waste alkali liquor by sodium persulfate purification, and the proposed method can purify and treat the waste soil in different depths of the surface. The ability of benzene and 1,4-dichlorobenzene is better than the comparison method, and it is a method for purifying contaminated soil of waste alkali liquor in rock engineering with high purification degree.

1. Introduction

The waste alkali liquor is mainly derived from the petrochemical production, and is a waste liquid with a large amount of pollutants formed by the absorption of the NAOH solution, the alkali washing oil and the cracking gas [1]. Because of the presence of inorganic and organic sulfides such as sulfides and mercaptans, the smell of spent caustic is relatively unpleasant [2]. The alkalinity of the spent caustic is extremely high. If the reasonable pretreatment is not carried out, the high concentration of the spent caustic soda will enter the sewage biochemical treatment system, which will hinder the growth and reproduction of the microorganisms, and will cause serious consequences of the extinction of the microorganisms, and eventually interfere with the sewage. Standard operation of normal operation of the treatment plant and total discharge of wastewater [3-4]. Waste liquid pollutants include odor, high toxicity sulfides, phenols, naphthenic acid sodium salts, oils, heterocyclic aromatic hydrocarbons, and residual sodium hydroxide [5]. The treatment of contaminated soil from waste lye is a key issue in the management of water pollution in China's refineries and ethylene plants [6]. The recycling of waste lye in the factory effectively saves resources [7]. Not only the full utilization of alkali resources, but also the process and cost of subsequent treatment of lye [8]. The use of the recovered lye for pretreatment of cotton fabric not only can obtain better pre-treatment effect, but also can significantly improve the economic efficiency of the factory and improve environmental problems, and meet the requirements of green and clean production. After the foundation soil infiltrates into the industrial waste liquid, the soil particles and cement are eroded by the waste liquid. Over time, the structure and composition of the soil are destroyed to varying degrees, resulting in the decrease of the strength of the foundation soil and the destruction of the upper structure [9]. In the paper making, plastics, chemical, and leather industries, there are a large number of acidic or alkaline waste liquids discharged and run, run, drip, and leak. If it penetrates into the foundation soil, the damage is not shallow. In fact, many factories have experienced the above situation, which affects the normal production. Should attract the attention of relevant enterprises. Effective measures must be taken to prevent the infiltration of waste liquid [10].

Jie said that combining a variety of soil purification technologies can improve the phytoremediation efficiency of blue mites and alleviate the corresponding environmental risks. He used a chelating agent, electric repair, phytohormone foliar application and phytoremediation to repair polymetallic contaminated soil from a notorious e-waste recycling station. The low voltage (2v) and medium voltage (4v) electric fields promote the growth of the plant, while the high voltage (10v) electric field is reversed. As the voltage increases, the plant metal concentration increases. Due to electroosmosis and electrolysis, the volume of leachate was reduced from 1224 ml to 134 ml, and the voltage was increased from 0 volts to 10 volts. Compared to phytoremediation alone, foliar cytokinin treatment produced 56*%* more biomass and the intercepted leachate was 2.5 times more transpiration. Compared to other methods, under stress conditions, synergistic combinations between individuals result in the highest biomass yield and metal accumulation of the species. The time required to purify *Cd*, *Pb*, and *Cu* from the soil is 2.1-10.4 times that of the chelating agent alone, electric field application, or plant hormone utilization. Of particular importance is that his multi-technical system collected almost no leachate (total 60 *ml*). His method is a suitable method to control the pollution of metal sites considering its purification efficiency and related environmental risks are negligible [11-12]. *Beata* believed that plant extraction from mercury-contaminated soils is a new strategy for the non-toxic treatment of soils by higher plants. He said that the main problem in this process is the low solubility and bio-availability of mercury in the soil, but soil amendments can be used to improve the efficiency of Hg plant extraction. The purpose of his research was to use the commodity compost in urban green waste to increase the efficiency of extracting mercury-contaminated soil from plants and to determine the leaching of mercury after composting. His results show that the application of compost can increase the accumulation of mercury in the whole plant and the migration of mercury to the upper part of the soil. Composting has no effect on plant biomass and its biological parameters, and compost is applied in the soil, whether in acidic or neutral solution. It can reduce the leaching of mercury without considering the composition and analysis time of the growth medium [13-14]. *Arezoo* believed that simultaneous restoration of multiple pollutants is a major challenge in phytoremediation of co-polluted soils, rather than the removal of contaminants. In his experiments, although plants did not accumulate hydrocarbons from contaminated soil, significant bioaccumulation of lead in the roots and stems of *D*. reflexa was observed. At the end of 180 days of his experiment, 16.7 mg/kg and 9.8 mg/k of lead in *D*. reflexa stems and roots were recorded for tea treatment. His research shows that the revision of organic waste has potential for improving the environment [15-16]. *W* used enzyme and other leaching methods to analyze the removal effect of heavy metals in contaminated soil. Based on the single factor experiment, he used the response surface method to optimize the reaction conditions of heavy metals in contaminated soil. His experimental results show that the optimal conditions are as follows: α-amylase mass concentration is 0.2*%*, *pH* value is 3.5, reaction time is 12 hours, removal rate is up to 82.36*%*, and heavy metal removal rate is *Cd*, *Cr*, *Zn*. , *Cu*, *Ni*. His experiments show that enzymes are part of the soil, and the use of enzymes to repair heavy metal contaminated soils can reduce environmental risks and has broad application prospects [17-18]. *Ma* proposed a new method for treating poly-cyclic aromatic hydrocarbons contaminated soil with cement activated per-sulfate. The removal rate of poly-cyclic aromatic hydrocarbons in the soil increases with the increase of initial per-sulfate concentration, initial Portland cement (*PC*) concentration and oxidation reaction time. The initial per-sulfate concentration was 19.20 *mol/kg*, the *PC* concentration was 10*%* of the soil mass, the reaction time was 24 *h*, and the removal rate of poly-cyclic aromatic hydrocarbons reached 57.3*%*. Residual poly-cyclic aromatic hydrocarbons are mainly adsorbed in the soil particles and become difficult to obtain. The mechanism by which *PC* promotes the oxidation reaction is that the addition of PC can increase the *pH* and temperature of the system. When 10*% PC* stabilized/solidified soil, the leaching concentration of poly-cyclic aromatic hydrocarbons and *TOC* was significantly higher than that of untreated soil. Per-sulfate oxidation reduces the leaching concentration of poly-cyclic aromatic hydrocarbons, but increases the leaching concentration of *TOC* in the solidified/stabilized product. The addition of activated carbon reduces the leaching concentration of poly-cyclic aromatic hydrocarbons and *TOC*. His freeze-thaw durability test showed that the leaching rate of poly-cyclic aromatic hydrocarbons was not affected by the freeze-thaw cycle [19-20].

The innovations of this paper are as follows: (1) This paper adopts the combination of alkali washing and photo-oxidation/photochemical oxidation to degrade cyanide in soil. Firstly, the cyanide in cyanide-contaminated soil is washed by alkali. Into the liquid phase, the cyanide in the liquid phase is degraded. This is different from the traditional direct degradation treatment of cyanide in soil; (2) This paper studies the alkaline washing and eluting effect of waste alkali contaminated soil (including artificially prepared cyanide contaminated soil and actual contaminated soil) and discusses The main factors affecting the effect of alkaline washing and washing.

2. Proposed Method

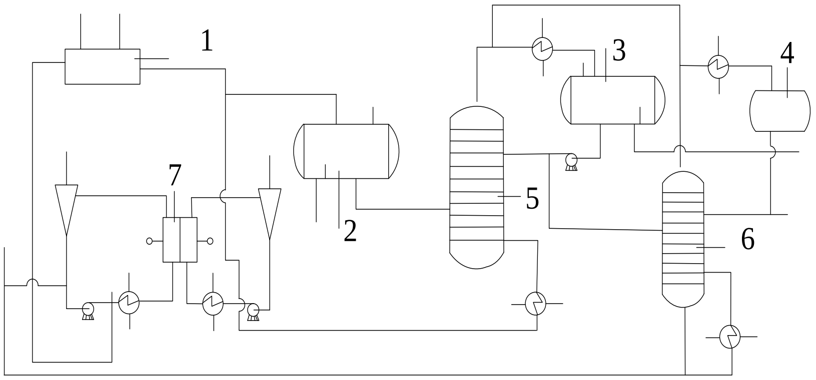
2.1. Alkali Recovery and Resource Treatment Technology

2.1.1. Decompression Evaporation Concentration-Stripping Method

The Chinese patent *CN1065642A* uses the reduced pressure evaporation concentration method to return the concentrated alkaline wastewater to the condensation system, and participates in the reaction twice. The evaporated effluent is treated by a stripping process, and the *COD* is reduced to less than 1000 mg/L. After the vapor phase portion is condensed, it is subjected to chromatographic separation to remove organic matter. However, the industrialization practice proves that the technology does not remove the sodium butyrate salt contained in the spent caustic so that the sodium butyrate salt in the system gradually accumulates, and finally crystallizes the plugged pipeline, so that the condensation reaction system device cannot operate normally. Patented technology presents difficulties in industrial applications [21].

2.1.2. Acidification-rectification-electrolysis

As shown in Figure 1, it is a schematic diagram of the acidification-rectification-electrolysis process. Acidification is first carried out, and the *pH* is adjusted to 6 or less by using a mineral acid, and the organic matter precipitated therein is recovered, and the clarified aqueous phase is subjected to rectification treatment to obtain a butyric acid azeotrope having a water content of 81.6%. The distillation liquid in the distillation column contains almost no organic matter, and is subjected to electrolytic treatment to separate the complex inorganic acid and sodium hydroxide solution at the anode and the cathode, and then return the inorganic acid as an acidifying agent to the first acidizing treatment system. The separated sodium hydroxide solution is returned to the condensation system as a catalyst, recycled, and the butyric acid azeotrope obtained by distillation is incinerated. This method allows the octanol spent caustic to be thoroughly treated, but the recovery of butyric acid is not achieved.



1. Condensation reactor 2.Acidifier 3. The chromatography 4.Organic tank 5. Primary distillation column 6. Secondary distillation column 7. Electrolytic cell

Figure 1. Schematic diagram of the acidification-rectification-electrolysis process

In summary, although there are many treatment methods for octanol waste alkali liquor, there is currently no treatment method with good environmental and economic benefits. Mainly manifested in:

(a) From the current state of technological development, among the three aspects involved in the treatment of the waste lye solution, the remaining alkali can be neutralized by acid treatment, and the recovery of the oily substance can be precipitated by acidification, and then separated. Recovery is carried out, and the recovery of sodium butyrate (or butyric acid) has not been well solved, and there is no cost-effective method. This is mainly determined by the nature of sodium butyrate (or butyric acid), sodium butyrate (or butyric acid) is readily soluble in water, and butyric acid is miscible with water to form an azeotrope containing butyric acid of 18.4% by weight. However, its concentration in the spent caustic is low, and it is difficult to obtain effective recovery. Therefore, the efficient recovery of sodium butyrate (or butyric acid) in octanol waste lye is a key technical problem for governance and should be the focus of current research [22].

(b) From the perspective of its technological development trend, the treatment of the waste lye of the stock has progressed from harmless to resource-oriented, but there is currently no economic and effective treatment technology for simultaneous recovery of alkali and butyric acid (or sodium butyrate). Therefore, it is not yet possible to achieve comprehensive resource management of octanol waste alkali liquor.

(c) The use of any single technology to treat octanol spent caustic is difficult to cost-effectively and fully resourced. It is recommended to comprehensively analyze the advantages and disadvantages of existing technologies, optimize the combination of existing governance technologies, seek more economical and simplified treatment methods, and find new breakthroughs in dealing with key problems such as butyric acid recovery [23]. In turn, a comprehensive resource treatment of the octanol waste lye is realized.

2.2. Waste Alkali Soil Contaminated Soil Detection Method

2.2.1. Method for Detecting Contaminated Soil of Waste Alkali Liquor by Stiffness Softening Transfer Mechanics Analysis

A method for detecting contaminated soil of waste alkali liquor based on stiffness softening transfer mechanics analysis is proposed. The pore variation control equation under the pollution of waste alkali liquor is established by the method of stiffness softening detection of contaminated soil:

$$a\frac{\partial b}{\partial c} = H_y\left(\frac{\partial b}{\partial y}\right)^2 - \frac{\partial b}{\partial x}\left(H_x + q\right) + q \tag{1}$$

In the formula, the elastic modulus coefficient is set to a; the soil stress component parameters of different waste acid liquid strength pollution are set to H_x, H_y; the m+1, m time step creep strain fixed component is set to q; b represents ductility mechanics Estimation factor; c represents the pore change interval. Analyze the distribution relationship of soil mechanics during geotechnical engineering construction, and obtain the model of infiltration of contaminated soil from waste alkali liquor:

$$H_m \rho \frac{\partial b}{\partial m}\Big|_{\beta_1} = p(x, y, s, c) \tag{2}$$

Where $p(x, y, s, c)$ describes the load-bearing mechanical distribution function for soil construction of x, y, s, and c parameters; the uniform normal distribution function is set to β_1. Calculating the ductile mechanical parameters of contaminated soil from waste lye according to the relationship between equivalent elastic stress and yield strength of contaminated soil:

$$e_s^2 = D\left[s_j^c(m) s_s^*(m)\right] \tag{3}$$

$$K_{yy}(H) = D\left[Y(m) Y(m-H)\right] \tag{4}$$

Where, the Toeplitz matrix of $y(m)$ is $Y(m)$; e_s^2 represents the tensile strength bearing component; $K_{yy}(H)$ represents the stress creep attenuation separation of polluted soil carrying waste alkali liquor contamination. Under the influence of strain force, the correlation test method is used to obtain the ductile mechanical estimation results of the waste alkali contaminated soil during geotechnical construction:

$$b_j^* = \frac{1}{e_s^2} K_{yy}(H-1) g_j(m) \tag{5}$$

The strain increment of the contaminated soil of waste alkali liquor during geotechnical construction:

$$\tilde{y}(m) = y(m) - \tilde{b}_j(m) * \tilde{z}(m) \tag{6}$$

In the formula, $\tilde{b}_j(m) * \tilde{z}(m)$ represents the autocorrelation function, and the mechanical distribution of contaminated soil detection is carried out by using the segregation quality evaluation method. If the orthogonal quantities of $\tilde{y}(m)$ and $s_j(m)$ are 0, and the equation is a normal distribution of θ, then:

$$D\left[\tilde{y}(m) s_j^*(m-h)\right] = 0 \tag{7}$$

Where $h=H$-1, h represents the number of iterations. Therefore, the ductile mechanical parameter distribution model that can obtain the contaminated soil of waste alkali liquor is:

$$H_m \frac{\partial b}{\partial m} - \frac{b-b_z}{e}\Big|_{\beta_2} = 0 \tag{8}$$

2.2.2. Mechanical Testing of Contaminated Soil from Spent Lye

Based on the distribution results of ductile mechanical parameters of contaminated soil of waste alkali liquor, the clay particle analysis control model of polluted soil of waste alkali liquor was established, and the mechanical distribution function $v_{1/j}(h-1/h-1)$ of the contaminated soil for geotechnical engineering construction was obtained:

$$v_{1/j}(h-1/h-1) = q\left(n_i(h-1)/n_j(h), y^{h-1}\right) = \frac{1}{\bar{r}_j} q_{ij} v_i(h-1) \tag{9}$$

Where q is the permeation data; formula (9) performs the soil acid-base regression analysis from a statistical perspective to predict the distribution of particles and pores after the soil is contaminated by spent caustic soda, and n describes the intermittent consumption time of the spent caustic soak, in h steps Under iteration, the likelihood function of $\mathrm{n_j}(\mathrm{j}=1,2,\ldots,\mathrm{n})\forall_{\mathrm{n_j}} \in \mathrm{N}$ is calculated, and the calculation results of the mechanical parameters for the detection of contaminated soil of waste alkali liquor are:

$$\begin{aligned} T &= q\left(y(h)/n_j(h), y^{h-1}\right) = q\left(y(h)/n_j(h), \hat{y}(h-1/h-1), q(h-1/h-1)\right) \\ &= N\left(\left(y^j(h) - y^j(h/h-1)\right) \middle| 0, y(h)\right) \end{aligned} \tag{10}$$

Based on the above calculations, the detection of contaminated soil of waste alkali liquor in geotechnical engineering can be completed.

2.3. Waste Alkali Liquor

In the coal-to-methanol-methanol-to-olefin coal chemical industry, there are also the same problems as other coal chemical wastewater treatment. The wastewater treatment has the phenomenon that the water quality is not up to standard and the system stability is poor, but also because it is more than the traditional coal chemical industry. Subsequent sections, such as methanol to olefins, olefin separation, carbon four carbon five refining and other sections, the wastewater is larger than traditional coal chemical production, the composition is more complex, and the treatment is more difficult. The waste alkali liquor produced by the olefin separation system has a serious impact on the subsequent wastewater treatment process due to the high pollutant content, which brings pressure to the process safety and environmental protection operation.

Olefin separation process $DMTO$ olefin separation unit mainly includes three sections: compression, separation and refrigeration. The compression section is a four-stage compression of the reaction mixture from the reaction unit, and the compressor is driven by a steam turbine. Methanol water washing and acid gas alkali washing are arranged after two-stage compression, after three-stage compression, gas/liquid phase drying and high-pressure low-de-propane system, and four-stage compression is arranged after high-pressure depropanizer. The separation section mainly includes pre-cutting-oil absorption system (absorbent is circulating propane), de-ethane, benzene, butane and ethylene, and propylene rectification. The propylene refrigeration compressor is a four-stage compression that provides four grades of propylene cooling: 18^oC, 4^oC, -25^oC, -41^oC, driven primarily by a steam turbine. The alkali/water washing tower is designed to be separated into two sections of alkali washing and one stage of water washing in the compression section of the $DMTO$ product gas into the compression section of the olefin separation unit to remove the acid gas in the product gas. The product gas enters from the bottom of the alkali/washing column, first in contact with the weak base, then with the medium base and the strong base, and finally reaches the water-washed portion at the top of the caustic wash tower, and all the alkali carried in the product gas is removed in the water-washed portion. Each alkali cycle section is provided with a base circulation loop, and the lye is pumped from the bottom of the circulation section to the top of the circulation section. During the alkaline washing process, the unsaturated hydrocarbons in the MTO reaction gas are polymerized. These polymers are liquids, and are in contact with air to form a yellow viscous or solid substance, which is a "butter" in the spent lye. In order to suppress the generation of butter in the waste lye, the butter inhibitor is injected into the inlet of the lye circulating pump, and the amount of butter is reduced to some extent by adding a butter suppressant, but a large amount of butter is still generated, resulting in a large amount of oil. Waste lye [24]. Since the amount of alkali has been reduced after the gas reaches the washing stage, the discharged water is less polluted and can be reused. In the process, it is mainly used to dilute the concentration of each lye, and other wastewater is sent to the sewage treatment system, waste alkali. And the butter is discharged from the tower.

The principle of CO_2 neutralization method is similar to that of sulfuric acid neutralization. A company uses the internal waste gas generated by CO_2 to treat ethylene waste alkali liquor, CO_2 reacts with Na_2S and $NaOH$ in waste alkali liquor to generate Na_2CO_2 and $NaHCO_3$, and produces H_2S gas. It is sent to an incinerator for incineration to remove sulfides and neutralize the spent caustic. After the ethylene ash solution treated by the method, the butter can be substantially removed, and the sulfide concentration can be reduced to 40 *mg/L* or less. In addition, the content of Na_2CO_2 and $NaHCO_3$ in the waste lye solution after treatment by the method can reach about 20%, and can be utilized as industrial soda ash.

As shown in Figure 2, in order to overcome the deficiencies of the wet oxidation process, a catalytic wet oxidation technique, abbreviated as (*CWAO*), that is, a wet oxidation reaction in the presence of a catalyst, has been proposed. It uses a catalyst to reduce the activation energy of the reaction, thereby effectively improving the oxidative decomposition ability, lowering the reaction temperature and pressure, accelerating the reaction rate, shortening the reaction time, reducing the cost, and generally exhibiting good catalytic oxidation performance for industrial wastewater. Compared with (WAO), due to the addition of the catalyst, the reaction conditions become relatively mild, which deeply oxidizes toxic and harmful substances, reduces the formation of toxic intermediate substances, and expands the application range.

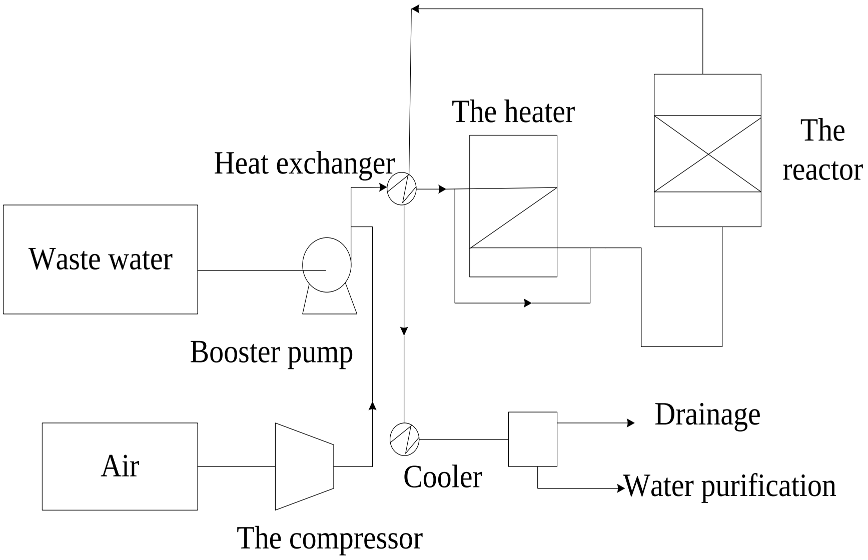


Figure 2. CWAO technology process flow chart

3. Experiments

3.1. Experimental Design

Based on the analysis of the contaminated soil of waste alkali liquor in geotechnical engineering, an appropriate amount of curing agent and sodium persulfate are placed in the repairing agent to purify the contaminated soil of the waste alkali liquor and improve the bearing capacity of the geotechnical engineering foundation.

A certain proportion of curing agent (cement) is introduced into the repairing agent, and the soil carrying capacity of the purified soil is improved while purifying the contaminated soil of the spent caustic. Weigh 300g of waste lye contaminated soil samples in turn, put in different proportions of sodium persulfate and cement, and then stir evenly, then carry out the sample for 7 days to test the organic pollutants in the contaminated soil of waste alkali liquor.

The first option is to add two subgroups according to the 2% ratio of sodium persulfate added to the soil;

The second option is to add five sub-groups according to the 4% ratio of sodium persulfate.

Option 3 is to add two subgroups according to the 6% ratio of sodium persulfate added to the soil;

Option 4 is to add two groups according to the 8% ratio of sodium persulfate added to the soil;

Scheme 5 is to set up two subgroups based on 10% of the soil in which sodium persulfate is added. The detailed sample grouping is shown in Table 1.

Table 1. Detailed sample grouping

Program code	Soil sample(g)	Water(g)	Sodium persulfate(%)	Cement(%)
1	300	26	20	
	300	26		7
	300	26		0
	300	26		4
	300	26	4	7
2	300	26		10
3	300	26		14
	300	26	6	0
	300	26		7
4	300	26	8	0
	300	26		7
5	300	26		0
	300	26	10	7

In this study, the total organic matter analyzer was used to determine the *TOC* content in the alkaline washing extract; in this study, the concentration of cations in the alkaline washing extract was determined by flame atomic absorption spectrometry.

3.2. Data Collection

3.2.1. Sample Collection

In order to ensure the accuracy of the experimental data and the reliability of the research results, and to eliminate the interference of the original cyanide in the soil, this paper chooses to prepare the iron-containing cyanide-containing soil when studying the alkaline washing and denitrification of ferricyanide in the soil. Soil sample *A* (ie, soil not contaminated with cyanide) was collected from a university's vegetation land; soil sample *B* was actually cyanide-contaminated soil, taken from a former chemical plant site.

3.2.2. Sample Pretreatment

The collected soil samples *A* and *B* are laid on the polyethylene film to remove obvious large impurities such as stones, branches, glass, etc., protected from light, naturally dried, and then pulverized to all 2 mm standard sieve, mixed, and used in ziplock bags. Sealed and stored, ready to use.

3.2.3. Analytical Method

In order to understand the basic properties of the tested soil, the basic physical and chemical properties of the soil were determined in this study. The determination methods used in the determination of the basic physical and chemical properties of the soil are all national standard methods, and the specific reference standards are shown in Table 2.

Table 2. Method for determining basic physical and chemical properties of soil

Physical and chemical properties	Measuring method and reference standard
pH value	NY/T 1121.2-2006
Dry matter and moisture	"HJ613-2011"
Total nitrogen	Semi-micro-Kelvin method,"GB9837-88"
Total phosphorus	*NaOH* melting-molybdenum anti-colorimetric method,"HJ 632-2011"
Organic matter	Potassium dichromate volumetric method"NY/T 1121.6-2006"
Main chemical component	Determined by X-ray fluorescence spectrometer(*XRF*)

4. Discussion

4.1. Analysis of Contaminated Soil Treatment of Factory Waste Lye

4.1.1. Analysis of Relationship between Curing Agent (Cement) and Oxidation Performance of Sodium Persulfate

Analyze the effect of the addition of curing agent (cement) on the purification effect of the repair agent. The detailed changes of the purification rate of the contaminated soil of the waste alkali liquor by the addition amount of different oxidizing agents sodium persulfate are shown in Figure1.

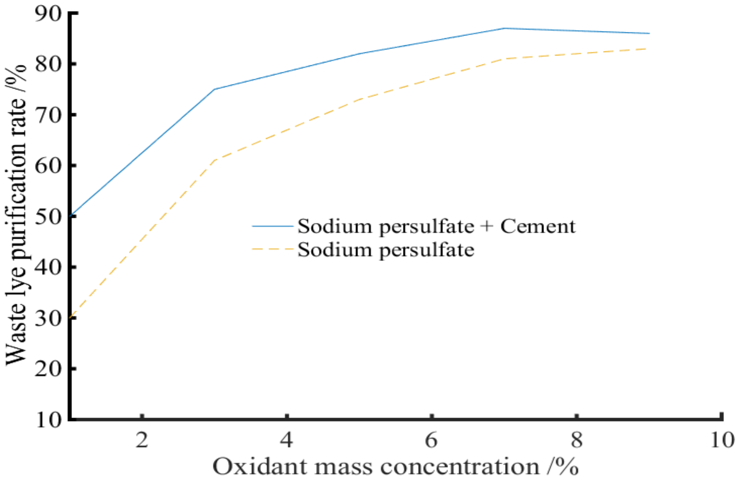


Figure 3. Effect of different oxidant sodium persulfate additions on the purification rate of contaminated soil from spent caustic

As can be seen from the data in Figure3, the mass concentration of sodium sulphate sulphate gradually increases, and the purification rate of the contaminated soil of the spent lye is also gradually increased, and it can be seen from Figure3 that when the concentration of oxidant sodium persulfate is increased to 7% At the time, the purification rate of the contaminated soil of the waste alkali liquor is extremely high. After the addition of sodium persulfate, the purification rate is almost no change, indicating that the optimum concentration of the oxidant sodium persulfate is the best when the waste alkali soil is contaminated in the geotechnical engineering. 7%. The same analysis of Figure 1 shows that with the addition of oxidant sodium persulfate and curing agent (cement) concentration, the purification rate of contaminated soil of waste alkali is increasing, and comparing the two curves, adding curing agent (cement) and The purification rate of contaminated soil of sodium sulphate after sodium sulphate is slightly higher than that of sodium persulfate alone. The reason for this result may be due to the alkalinity of cement acidity, and the best degradation environment of sodium sulphate is also alkali. Sexual environment, the alkaline character of cement can effectively promote the oxidation of oxidizing agent sodium persulfate. In addition, when sodium persulfate is mixed with cement, a small amount of heat is released, and the high temperature also promotes the purification of waste alkali liquor by sodium persulfate. Therefore, it is indicated that the curing agent (cement) can accelerate the purification of the contaminated soil of the spent caustic soda by the oxidizing agent sodium persulfate to some extent.

4.1.2. Mixing and Purifying Effect of Different Proportions of Cement and Mass Fraction 3% Sodium Persulfate

The purification results of benzene and 1,4-dichlorobenzene in contaminated soil of waste alkali liquor were obtained by mixing different proportions of cement with 3% by mass of sodium persulfate to obtain different proportions of cement and 3% by mass of sodium persulfate.

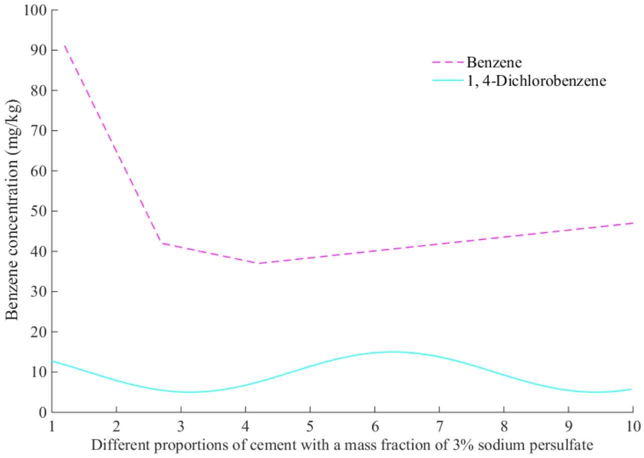


Figure 4. Mixing and purifying effect of cement with different proportions and mass fraction of 3% sodium persulfate

As can be seen from the graph of Figure 4, with the increasing amount of cement added to the curing agent, the content of benzene and 1,4-dichlorobenzene in the contaminated soil of waste alkali liquor is also decreasing. Analysis of the variation curve of benzene content shows that the cement content of different proportions is The concentration of 1,4-dichlorobenzene was not obvious. With the increase of cement content of curing agent, the change of benzene content in contaminated soil was divided into three stages. The proportion of cement in the first stage was between 1% and 2.8%, and the concentration of benzene decreased rapidly. The second stage cement ratio is between 2.9% and 4.6%, and the benzene concentration is lower. When the third stage cement ratio is higher than 4.6%, the benzene content is no longer reduced but starts to increase. Therefore, when the cement ratio is 4.6%. When it is mixed with 3% sodium persulfate, the benzene purification effect is the best.

4.1.3. Evaluation of Benzene Purification Effect of Oxidant Sodium Persulfate on Polluted Soil

The effect of different concentrations of oxidant sodium persulfate on the purification rate of benzene in the contaminated soil of waste alkali liquor is shown in Figure 5. It can be seen from the graph of Figure 5 that as the mass concentration of the oxidizing agent sodium persulfate increases, the purification rate of benzene in the contaminated soil of the spent caustic is also increased. At the same time, the benzene purification curve of adding curing agent cement (6.5%) and sodium persulfate is always higher than that of sodium persulfate alone. It also shows that the curing agent cement has a promoting effect on the purification of waste alkali liquor by sodium persulfate, and the single After adding sodium persulfate purification and sodium persulfate and cement to purify the waste alkali pollutants, both meet the purification requirements of benzene.

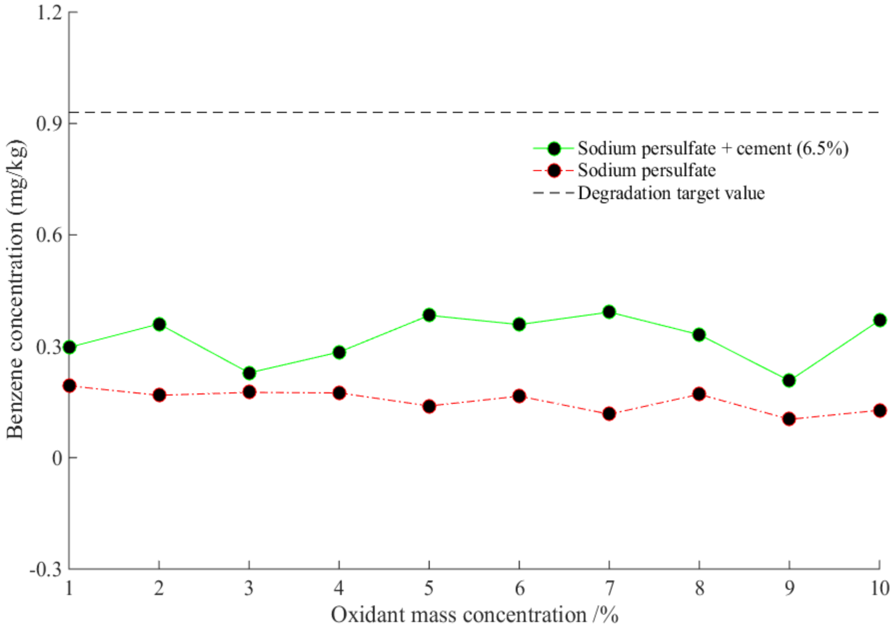


Figure 5. Effect of oxidant sodium persulfate on benzene degradation rate in contaminated soil from spent caustic

4.1.4. Comparison of Different Purification Treatment Methods

The purification process of waste alkali contaminated soil in geotechnical engineering includes various methods. The experiment is to verify the high quality of waste alkali contaminated soil in geotechnical engineering. The *CSP* treatment method and tandem mass spectrometry method and method purification results are compared. Taking a geotechnical mining project as the research object, as shown in Table 3, 15 samples of waste soil contaminated soil were randomly selected for experimental analysis during the construction of the project, and the contaminated soil samples were selected at different depths in the geotechnical soil layer. At the selected point, 5 experimental samples were selected at depths of less than 5*cm*, 5*cm*~10*cm* and greater than 10*cm*, respectively. The benzene and 1,4-dichlorobenzene in the contaminated soil of waste alkali liquor were used as purification treatment objects. The content of benzene and 1,4-dichlorobenzene in each sample after purification treatment was as shown in Figure 6 and Figure 7.

Table 3. Changes in benzene content after contaminating soil with waste alkali liquor by three methods

	The surface depth is greater than 10*cm*					The surface depth is 5*cm*-10*cm*					The surface depth is less than 5 *cm*				
Contaminated soil number(n)	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Weight of contaminated soil(g)	100	200	300	400	500	100	200	300	400	500	100	200	300	400	500

As shown in Figure 6, there is a difference in the content of benzene contained in the polluted soil at different depths in the geotechnical engineering, and the benzene content decreases with the increase of the geotechnical depth. After using three methods to purify the contaminated soil of waste alkali liquor, the benzene content in the contaminated soil decreased. The figure shows that the benzene content in each soil layer decreased after the purification method, and the benzene content after purification was 4.3 *mg*. While using *CPS* method and tandem mass spectrometry, the benzene content in the soil contaminated soil decreased, but the benzene content was higher than the larger specific gravity after purification. The results showed that the method was used to purify the geotechnical engineering. When the waste alkali liquor pollutes the soil benzene content, the purification effect is strong.

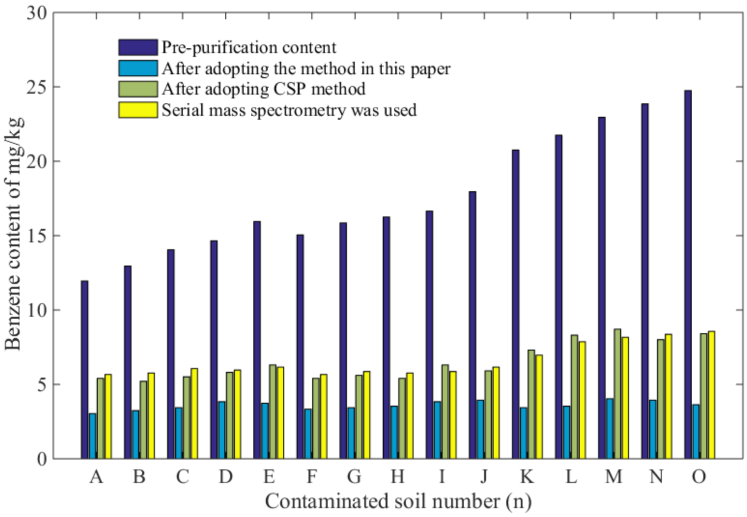


Figure 6. Results of benzene content change after purification by three methods

As shown in Figure 7, the content of 1,4-dichlorobenzene in the contaminated soil of different depths of the geotechnical surface is also present. The surface is less than 5*cm*> the surface is 5*cm*~10*cm*> the surface is larger than 10*cm*. The detailed analysis results show that the results are clear. The content of 1,4-dichlorobenzene is higher in contaminated soil, and it is reduced after purification by three methods. Three methods can purify the content of 1,4-dichlorobenzene in the waste lye soil. The detailed analysis shows that the method can purify the 1,4-dichlorobenzene in the contaminated soil of waste alkali liquor, and the surface depth is less than 5 *cm*>surface depth The results are less than 5*cm*~10*cm*>the depth of the surface is more than 10*cm*, and the purification results of the methods in each deep polluted soil are better than the other two methods. The same method is used to purify the 1,4-dichlorobenzene in the contaminated soil of waste alkali liquor. Strong, improve the cleanliness of the waste alkali soil.

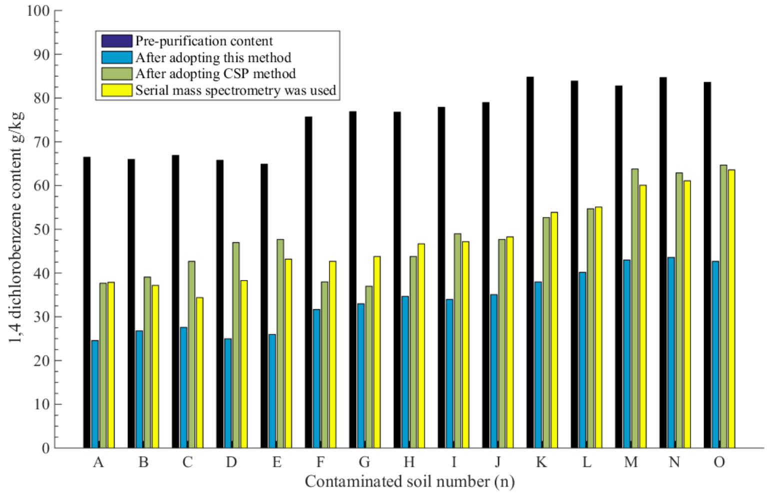


Figure 7. Results of 1,4-dichlorobenzene content after purification by three methods

5. Conclusion

The waste alkali liquor is mainly derived from the petrochemical production. It is a waste liquid with a large amount of pollutants formed by the absorption of the *NAOH* solution, the alkali washing oil and the cracking gas. Because of the presence of inorganic and organic sulfides such as sulfides and mercaptans, the smell of spent caustic is relatively unpleasant. The alkalinity of the spent caustic is extremely high. If the reasonable pretreatment is not carried out, the high concentration of the spent caustic soda will enter the sewage biochemical treatment system, which will hinder the growth and reproduction of the microorganisms, and will cause serious consequences of the extinction of the microorganisms, and eventually interfere with the sewage. Standard operation of the normal operation of the treatment plant and the total discharge of wastewater. When geotechnical engineering is carried out on contaminated soil of waste alkali liquor, the soil carrying capacity is greatly degraded due to severe soil destruction, which cannot meet the normal development of geotechnical engineering. Therefore, it is necessary to carry out the waste alkali contaminated soil before the start of geotechnical engineering. It is necessary to purify and improve the carrying capacity of the soil.

In this paper, the curing agent (cement) and sodium persulfate are used to purify the contaminated soil of waste alkali liquor, which can significantly reduce the content of benzene and 1,4-dichlorobenzene in the contaminated soil, improve the cleanliness of the soil, and analyze the method and *CSP* method. The results of mass spectrometry of waste alkali contaminated soil purification show that the three methods can reduce the concentration of benzene and 1,4-dichlorobenzene, but the overall purification results are the best.

According to the research results and shortcomings of this paper, the following suggestions are put forward: under ultraviolet light conditions, the efficiency of conversion of ferricyanide into easily released cyanide in the alkali-washing and washing solution of plant waste alkali liquor is not high, which may be It is related to the UV lamp power, the UV light path, the initial pH of the alkaline washing and eluating solution, etc. It is recommended to design the relevant experiments to further explore the influencing factors and mechanism of the ultraviolet photolysis of the alkali-washing eluent in the contaminated soil; the $\mathrm{UV-H_2O_2}$ method to the factory The degradation and removal of cyanide in the eluent contaminated soil is not ideal, which may be related to the *UV* lamp power, *UV* path, initial *pH* of the alkaline washing eluate, molar ratio of

H_2O_2 to CN^-, etc. It is suggested to further design and carry out relevant experiments to further explore the degradation and removal effect of the $UV-H_2O_2$ method on the alkali-washing and eluent of contaminated soil in factory waste alkali liquor.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

References

[1] Reginald B.Kogbara.Interrelationships among geotechnical and leaching properties of a cement-stabilized contaminated soil.Environmental Letters,2017,52(2):149-157. https://doi.org/10.1080/10934529.2016.1240483

[2] Z.Wang,Y.-K.Ding,S.-F.Xu.Semi-dynamic leaching tests on leaching properties of MPC-solidified zinc-contaminated soil under acid rain environment.Chinese Journal of Geotechnical Engineering,2017,39(4):697-704.

[3] B.Sun,Z.Dang,C.Guo.Simultaneous desorption of heavy metals and PCBs by composite eluents from contaminated soils.Chinese Journal of Environmental Engineering,2015,9(3):1463-1470. http://industry.wanfangdata.com.cn/yj/Detail/Periodical?id=Periodical_hjwrzljsysb201503078

[4] Rita Sousa,Karim S.Karam,Ana Laura Costa.Exploration and decision-making in geotechnical engineering–a case study.Georisk Assessment&Management of Risk for Engineered Systems&Geohazards,2017,11(1):129-145. https://doi.org/10.1080/17499518.2016.1250916

[5] Jianye Zheng.Consistency Guarantees for Professional Appraisal of Geotechnical Engineering Design under Market Leading and Deciding.Frontiers of Engineering Management,2015,2(1):82. https://doi.org/10.15302/J-FEM-2015012

[6] Muhammad Imran Khan,Muhammad Irfan,Mubashir Aziz.Geotechnical characteristics of effluent contaminated cohesive soils.Journal of Environmental Engineering&Landscape Management,2017,25(1):75-82. https://doi.org/10.3846/16486897.2016.1210155

[7] Tomoaki Miura,Mahmudul Kabir,Shyunsuke Nakajima.Cesium Removal from Contaminated Soil by Electrokinetic Process Considering for Slope Areas of Mountains.Ieej Transactions on Fundamentals&Materials,2015,135(11):725-726. https://doi.org/10.1541/ieejfms.135.725

[8] Amine Hmid,Ziad Al Chami,Wouter Sillen.Olive mill waste biochar:a promising soil amendment for metal immobilization in contaminated soils.Environmental Science and Pollution Research,2015,22(2):1444-1456. https://doi.org/10.1007/s11356-014-3467-6

[9] Maja Radziemska,Magdalena Daria Vaverková,Zbigniew Mazur.Pilot Scale Use of Compost Combined with Sorbents to Phytostabilize Ni-Contaminated Soil Using Lolium perenne L.Waste&Biomass Valorization,2017(10):1-11. https://doi.org/10.1007/s12649-017-0166-9

[10] F.I.Achuba,M.O.Ja-anni.Effect of abattoir waste water on metabolic and antioxidant profiles of cowpea seedlings grown in crude oil contaminated soil.International Journal of Recycling of

Organic Waste in Agriculture,2018,7(1):59-66. https://doi.org/10.1007/s40093-017-0190-6

[11] Jie Luo,Limei Cai,Shihua Qi.A multi-technique phytoremediation approach to purify metals contaminated soil from e-waste recycling site.Journal of Environmental Management,2017,204(Pt 1):17-22. https://doi.org/10.1016/j.jenvman.2017.08.029

[12] M D Yuniati.Bioremediation of petroleum-contaminated soil:A Review.IOP Conference Series Earth and Environmental Science,2018,118(1):012063. https://doi.org/10.1088/1755-1315/118/1/012063

[13] Beata Smolinska.Green waste compost as an amendment during induced phytoextraction of mercury-contaminated soil.Environmental Science&Pollution Research International,2015,22(5):3528-3537. https://doi.org/10.1007/s11356-014-3601-5

[14] Feng Li,Zhian Li,Peng Mao.Heavy metal availability,bioaccessibility,and leachability in contaminated soil:effects of pig manure and earthworms.Environmental Science&Pollution Research International,2018,26(9):1-10. https://doi.org/10.1007/s11356-018-2080-5

[15] Arezoo Dadrasnia,Agamuthu Pariatamby.Phyto-enhanced remediation of soil co-contaminated with Pb and diesel fuel using biowaste and Dracaena reflexa:A laboratory study.Waste Management&Research,2015,34(3):246. https://doi.org/10.1177/0734242X15621375

[16] Dhiraj Kumar Chaudhary,Jaisoo Kim.Novosphingobium naphthae sp.nov.from oil-contaminated soil.Int J Syst Evol Microbiol,2016,66(8):3170-3176. https://doi.org/10.1099/ijsem.0.001164

[17] W.Lin,H.Wu,J.Hu.Bioremediation of heavy metal contaminated soil by enzymes.Chinese Journal of Environmental Engineering,2015,9(12):6147-6153. http://en.cnki.com.cn/Article_en/CJFDTOTAL-STTB201605003.htm

[18] Nikolina Tzvetkova,Kamelya Miladinova,Katya Ivanova.Possibility for using of two Paulownia lines as a tool for remediation of heavy metal contaminated soil.Journal of Environmental Biology,2015,36(1):145-151. https://www.docin.com/p-1381948572.html

[19] Ma F,Zhang Q,Wu B,et al.Treatment of PAH-contaminated soil using cement-activated persulfate.Environmental Science and Pollution Research,2017,25(1):1-9. https://doi.org/10.1007/s11356-017-0268-8

[20] H.Sui,H.Li,J.Song.Selection of milling reagents for mechanochemical degradation of high concentrations of DDTs in contaminated soil.Research of Environmental Sciences,2015,28(8):1227-1233.http://en.cnki.com.cn/Article_en/CJFDTOTAL-HJKX201508007.htm

[21] Sabina Jeschke, Christian Brecher, Houbing Song, and Danda Rawat, Industrial Internet of Things: Cybermanufacturing Systems. ISBN: 978-3-319-42558-0, Cham, Switzerland: Springer, 2017, pp. 1-715. https://doi.org/10.1007/978-3-319-42559-7_30

[22] J. Yang, C. Wang, B. Jiang, H. Song and Q. Meng, "Visual Perception Enabled Industry Intelligence: State of the Art, Challenges and Prospects," in IEEE Transactions on Industrial Informatics, doi: 10.1109/TII.2020.2998818. https://doi.org/10.1109/TII.2020.2998818

[23] Lv Z , Chen D , Lou R , et al. Industrial Security Solution for Virtual Reality. IEEE Internet of Things Journal, 2020, PP(99):1-1.

[24] Zhang, Y., Ni, W., & Li, Y. (2018) “Effect of Siliconizing Temperature on Microstructure and Phase Constitution of Mo–Mosi2 Functionally Graded Materials”, Ceramics International, 44(10), pp. 11166-11171. https://doi.org/10.1016/j.ceramint.2018.03.136