In Acidic Porous Medium Under the Action of Humic Acid, Rice TiO$_2$. Migration and Retention Mechanisms

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Abstract: Mechanisms. mobility, retention. titanium dioxide nanoparticles (ntio$_2$). Well-defined Porous Media Composite of clean quartz sand in the presence of full acid (FA) and humic acid (HA) were studied under acidic conditions. ntio$_2$ Were immobile in the Poland media in the absence of FA and HA at pH 4.0. FA and ha could be absorbed into the surface of ntio$_2$. Change the electrochemical properties of ntio$_2$. The transport of ntio$_2$. The elution of ntio$_2$. Increased from 0.01 and 0.94 to 0.91 and 0.88 with the increase of FA and ha from 1 mg/L to 10 mg/L specially. Compared to FA, more ha was absorbed onto ntio$_2$. And us the affected Effect of ha on transport of ntio$_2$. Was stronger. ions inhibited the mobility of ntio$_2$. And the effect of CaCl$_2$ Was greater than that of NaCl in same concentration. The mobility of ntio$_2$. Was better in the presence of HA than FA. In addition, 7% ~ 56% ntio$_2$. Was preserved in the secondary energy minimum well in the presence of HA, higher than 4% ~ 17% in the presence of FA, which could be easily released when the environmental conditions have changed. High Energy barriers between ntio$_2$. And quartz promoted the mobility of ntio$_2$. While a combination of the secondary minimum energy, strain, diffusion and gratational position were involved in the retention of ntio$_2$. Keywords: Titanium Oxide Nanoparticles; Fulvic Acid; Humic Acid; Stability; Transport

1. Materials and Methods

1.1 Material

Since Fluka, Use deionized water as a measurement 1g/L Solution Ha Since Sigma-Aldrich, Use deionized water as a measurement 1g/L Solution, With 1mol/L NaOH pH To 10.0. Quartz Sand (40-40 ~ 70 Mu) Chemistry, chemistry, Reference Litton And Olson Fang Surface Removal Method$^{[10]}$. 1.2 Ntio$_2$ Qualitative

Accurate weighing 250 mg ntio$_2$. Scattered in 1L Deionized water, Ultrasound dispersion 4 min (JY92-IIDN Ultrasound cell Mill Ningbo xinzhi The same below), Made 250 mg/L ntio$_2$. Mother Liquor Placed 48 Small". To Ntio$_2$. Mother Liquor in join different FA, HA, NaCl Or CaCl$_2$. Solution With to water dilute 50 mg/L Of Ntio$_2$. Liquid 0.1 mol/L HCl pH, Ultrasound dispersion 4 min, Made different conditions under Ntio$_2$. Liquid (Table 1 ). The m particle size (Zetasizer nano ZS90 Malvern) Set Ntio$_2$. The particle size distribution, Zeta A and quartz sand Zeta A.

1.3 Ntio$_2$. FA And HA Of Adsorption

In and 1.2 The same conditions under set FA And HA In Ntio$_2$. Surface of adsorption capacity. Will different conditions under Ntio$_2$. Liquid placed 150 rpm Cyclotron-bed in room temperature shock 2 h. Use more times high-speed centrifugal Methods (9600g natural 20 min) Will Ntio$_2$. From liquid in Separation$^{[1]}$. Supernatant 0.22 antibody

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With the diameter 25 mm 100 mm of glass column chromatography Both ENDS points with aperture Natural 20 antibody mOft, Network. Every time said to take a certain amount of quartz sand slow into analysis column in Be careful Tamping Repeat more times until a column chromatography. Weight legal packed column of pore body (PV) Por 0.40 ~ 0.47.

Fill column after the specific process is as follows:(1) With stay conditions (Table 1) The background Solution (Does not contain Ntio₂) Balanced Packed Column; (2) Creep (BT100-2), Baoding Lattice Accurate 3 PV And background solution same conditions Ntio₂ Liquid; (3) 4 PV Background solution packed column; (4) The above steps beam after Then 3 PV Only contains FA Or HAOft background solution. (Does not contain ion and Ntio₂) Flushing packed column (Table 1 in serial number 10 ~ 23). All A process Solution and Ntio₂ To 0.81 ~ 0.89/min Speed bottom-up into the cylinder Effluent with self-part collector (BS-100A, Shanghai, Huax) Collection Effluent Ntio₂ Du yong UV spectrophotometry (Genesy 10 s uv-Vis Thermo Fisher) In wave 343 nm Colorimetric legal Quasi-of van in 0 ~ 80 mg/L, Related Coefficient 0.999. Every Repeat two times Two followed by poor < 3%, Take one of the fruit.

1.5 Data Analysis Methods
1.5.1 Exhibition DLVO (xdlvo) Mechanism Code
DLVOMechanism count of anti-Can including two surface each other close to there of Van der gravitational energy and double Static exclusion can sum[11] M-M of Department of Van der gravitational energy (V_{vaw,n}n) And double Static exclusion force (V_{del,nn}), M-Quartz Sand Department of Van der gravitational energy (V_{vaw,ns}) And double Static exclusion force (V_{del,ns}) Of a reference literature [11].

In surface adsorption humic acid of M Test In addition two kind of empty exclusion of Role: Penetration and spiral [12]. Penetration is due to each other close to of cause of coincidence regional in polygon degree of increase Dynamic parameter of increase Penetration exclusion can (V_{osm}) Count the literature [12] [13]; Surface Adsorption of humic acid (H=D) Will cause of loss Of of repellent force (V_{bas}) Of Students its a reference literature [14].

1.5.2 Colloidal Mechanism Colloidal Management Floating on the pore fluid of grain main 3 A mechanism and porous Mediated surface contact: Powder, interception and gravity settlement. In the world of contact efficiency Can expression [15].

Adsorption efficiency, Said the most of adsorption of grain and collector of the collision of Ratio Also is phase collector Removal Efficiency And phase collector contact efficiency % Ratio:

The parameters of specific count the literature [9].

2. Fruit and
2.1 Ntio₂ FA And HAOft Adsorption

By 1 Can Ntio₂ FA The adsorption capacity with the solution in the initial FA Degree of increased and increase PH 4.0 Adsorption capacity from 1 mg/L FAOft 95.93 mg/L increase 10 mg/L Oft 54.3 mg/L (1a). Ntio₂ of zero 6.2 And FA At PH 2 ~ 8 Under Zeta A were So Can inference static attractive in adsorption role to important role. In addition Ntio₂ Surface of base and FAOft of base and base of ligand pay is also important of Adsorption Mechanism [13,9]. And FA Compared HAINtio₂ Surface of adsorption capacity more

90f Ruichang such as: humic acid role under acid porous mediated in mTio₂ Of migration and Retention 10.3%, Less HAMolecular in content 28.1%, By 1Can PH 4.0 NaCl And CaCl₂ Of adsorption capacity were no influence

Same ion of under HAINtio₂ Surface of content adsorption capacity FA

2.2 FA And HAre of and aggregation Characteristics

Adsorption in Ntio₂ Surface of humic acid will influence m And M of each other role To influence m grain in Liquid in qualitative. M of qualitative is influence its migration and settlement line of the Factors. The conditions under Ntio₂ Zeta A such 2 Shown in By 2a We can know that PH 4.0, Does not exist FA Ntio₂ OZeta A+ 33.0 mV, There 1 mg/L fa zeta A drop+ 15.9 mV; faOft 2 mg/L zeta A a positive 13. 3 mV; When FAOft 10 mg/L Ntio₂ Of Zeta A drop -34.7 mV. HA Ntio₂ And Quartz Sand Zeta A of influence and FA Similar [2B]. Different of is PH 4.0 Because HAINtio₂ Surface adsorption capacity greater Make Ntio₂ Of Zeta Yuzheg’s Ha Du 0.8 mg/L, Less FA The degree 1.5 mg/L; Low, low( < 2 mg/L), ha Existence Ntio₂ Of Zeta Bit less Fa Bits of existence (Bigger). Influence of humic acid Ntio₂ Of Zeta The mechanism 3. Aspects (1) Adsorbed on Ntio₂ Base in surface humic acid molecule, neutralizing positive charge on Particle Surface Zeta Bit drop (2) Ntio₂ The coordination between the base group on the surface and humic acid decreased, Possible drop Ntio₂ Positive surface charge [16,17] (3) The organic anion of humic acid can increase the charge density on the grain surface, Section location, off-grain surface, Will also be reduced Ntio₂ OZeta Bit [8,18].

By 2c Can, 5 mg/L FA, PH 4.0 Ntio₂ OZeta
Position along the solution NaCl The degree of rise and rise (Jiang), By 5 mmol/L NaClO3-33.6mVSheng Gao Zhi 50 mmol/L NaClO2-22.5mV, The charge shielding effect and double effect are NaClCause Zeta The main cause Yin [1, 19] Same PH And NaClDion, With Fa Compare, Ha Under existing conditions Ntio2 Of Zeta Bit, bigger (2d). In addition to the charge shielding effect and double effect, Ca2+ Ntio2 SURFACE ADSORBED Fa The role of certain sets in the molecule also lowers the particle size Surface Charge (Zeta Bit elevation) [20, 21]. Therefore, Same degree CaCl2 Zeta The influence of BIT is greater NaCl (2E). 

Same as literature, Road [1-20], Static and repulsive forces of the presence of charged quartz sand and Humic Acid, Can the adsorption capacity of humic acid on quartz sand be ignored? Therefore, Humic Acid quartz sand in Solution Zeta No influence (3A). But NaCl With CaCl2 Presence lowers Quartz Sand Zeta Bit (Zeta Bit elevation), And CaCl2 The role of more (3d).

Table 1. Shown, Under all conditions Ntio2 Integrated homogenized particle size greater 400 nm of aggregates. Product Metal Oxide m of usually to powder in form in water with liquid after don’t is original in grain of-there But students gathered generation da ju collective [22]. Counted among the conditions under Ntio2 OF XDLVO Anti-

Can in 2.4 ~ 40.4kT Usually Greater 20kT Can prevent grain for collision and students Aggregation [23]. And Research Product Ntio2 Dispersion in ultra-water after forming flat Particle Size 1430 nm Of da ju collective Ultrasound 10 min After can will da ju collective damage generation average particle size 521 nm Of aggregates But the ultrasound or join Na3PO4 Twelve-based sulfonic acid or C and scattered can’t dispersion aggregates reduce aggregation Particle Size [22]. So In high (> 20kT) Also can’t dispersion generation of aggregates But low of aggregates step Aggregation. For example PH 4.0, 0.1 mg/L FAConditions under XDLVO Antican-

2.3 Fa And Ha Under the Action Ntio2 Migration

Different Humic Acid surface The opposite, Quiet, attractive Ntio2 All stranded in porous media, column. PH 4.0, FaDui 1 mg/L, ntoi2 Surface Zeta Bit still, positive (2), ntoi2 Almost all stay in porous media, column, Outflow rate 0.01, xdlvo It's an elephant, None under this condition. Existence (4). When Fa Degree, rise Ntio2 Surface Zeta Bit, Its reaction to quartz sand > 150kToF; Table, exclusion, Not good Ntio2 Settling into porous medium [14] Ntio2 Rising outflow rate, By 2 mg/L FA0.53 Add to 10 mg/L FA0.91 ~ 10 mg/L ha, ntoi2 Outflow rate 88% ~ 94%, Higher than the same, degrees Fa Under the Action Ntio2 Outflow rate.

Batch after release 7 ~ 10pv Flushing process of background solution without ion, Reduced degree of ion retention in porous media Ntio2 Line. A lot of research, When pore water ionicity, zero, Because double, The second minimum, the energy disappears, Settlement in the second minimum, energy area and quartz sand, not solid Rice, Grain Weight [24], 7 ~ 10pv The re-release process can be put 4% ~ 17% (Zhan Ntio2 Quantity) Of Ntio2. With Fa Compare, Ha With a greater molecular weight and a more complex space Construction, The empty will play a bigger role [16]. So In NaCl Same degree, Ha Under the Action Ntio2 The migration, Settling in the second minimum, the energy area, the grain size is more (7% ~ 56%). If the grain is deposited in the second minimum, the energy region, the grain is considered as a potential migration, So5 mg/L ha Existence, NaClToyo0 5 mmol/L Add 50 mmol/L, ntoi2; The potential migration is just a slight decline, Outflow rate (0 ~ 0 ~ 10pv) By 0.87 Drop 0.78, In this study, Although Ntio2 The reverse energy of quartz sand > 150kT, There's still a lot Ntio2 Stranded in porous media. For example, PH 4.0, 0.5 mg/L FA 25 mmol/L NaCl Under existing conditions 187kT, But Ntio2 Outflow rate 0.17 Ming except grain-Suke Xdlvo Anti-Energy, Has Its Caused by a resistance effect of reasons; (1) Mediated surface adsorption site yin neng And of the existence of exclusion can [23]. This study conditions under the decrease caused by the decrease of the sedimentation rate of rice and Grain [25, 2] The attraction of hysteresis particles and dielectric particles and the rejection of grains cannot be derived except from some particles in the medium, [26]. Steric Effect, And Pierce out, trailing, like, Therefore, Retention, grain surface, with the increase of pore body, Outflow rate increased (Re-release is the main reason causing the steric effect. Blocking is in 3.5). The first reason is mainly in grain-There is a small pore in the direction of the water absorption flow, and the particles can not be connected.

By table 1. You can see, Under most conditions Ntio2 Aggregate size 595 nm. Even if the average aggregation size is less, Due to aggregation Particle Size Distribution, The particle size of some aggregates has exceeded. Such The pH 4.0, 5 mg/L FA Under Conditions, 32.3% Of Ntio2 Aggregate size greater 595 nm (6). So, The blocking effect in this pH 4.0, 5 mg/L FA, 0.1 mmol/L NaCl Under Conditions Ntio2 Of Particle Size Distribution Colloid, mechanism, commonly used in solution, colloid in porous media, RETENTION MECHANISM OF PARTICLES [15, 20]. According to the conditions, Foshan Zhaohui And AlphaEqual Parameter table 1. Alpha<1 Shows a certain amount Ntio2 Migrate from Column. On the body, Alpha With PH And humic acid degrees rise With NaCl With CaCl2 Reduce, Yu Zhong Ntio2 Consistent outflow rate. Under all conditions, Zhan 0.42% ~ 83%, Zha With the liquid in Ntio2 The aggregation size, Such Ntio2 Aggregate.
size860nm,η3.4x10²,WhenNtio₂Particle size reduced434nm,ηGrow5.9x10².Research,Scattered is particle size less100nmThe most important sedimentation mechanism of particles in porous media[29 30].Because ofNtio₂Large particle size,Gravity subsidence plays a very important role,ηZhanη17% ~ 58%.Contrary,ηGIncreases with increasing particle size.For example,Liquid MediumCaCl₂Tooyo0.5 mmol/L (ntio₂Aggregate size450nm) Add5 mmol/L (ntio₂Poly SIZE718nm ),ηGAdded2.6Times.Under Various Conditions,ηDZhanηThe ratio is less0.2%,Can ignore?.In the porous medium, smallNtio₂,Dispersion is the main Settlement Mechanism. And in the aggregate size, large, grain,Gravity subsidence is the main sink Drop Mechanism.

References