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PREPARED ANATASE TIO2 NANO PARTICLE BY SOL-GEL METHOD & PHOTOCATALYTIC DEGRADATION OF TEXTILE INDUSTRIAL WASTE WATER

Environmental Science

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ABSTRACT

its outstanding performance characteristics, according to this research, titanium dioxide is the best nano particle. One of titanium dioxide's most exclusive properties is its photocatalytic activity. By employing titanium tatra isopoxide for precursor, HCL for catalyst, and ethanol and distill water for solvents, titanium dioxide (TiO2) nanoparticles have been formed. The pH level is measured to be 3. The gel was dried for one hour at 100 degrees in order to remove any residual water and organic matter. To produce the necessary TiO2 nanoparticle, the dried gel calcined at 300 degrees by baffle furnace with a heating rate of 10 degrees per minute and a 2-hour soak period. X-ray diffraction (XRD) used for phase analysis of titanium dioxide nanoparticles, and the band gap energy is 3.65eV. The titanium dioxide anatase phase, which is produced through synthesis, has a significant impact. The COD value is reduced by photodegradation process with the help of photo reactor at different time variation and constant value of TiO2 Nanoparticle (Anatase). Due to this, we determined the COD variation in value.

KEYWORDS

Anatase, Nanoparticle, sol-gel, titanium dioxide. photoreactor, COD, XRD, Variation, Hour.

1.INTRODUCTION:

its strong performance characteristics, according to this research, titanium dioxide is the best nano particle. Titanium (IV) oxide is another name for titanium dioxide. Therefore, TiO2 nanoparticles are observed as a more functional material (1,2). Titanium dioxide is also used as an environmental decontamination agent in cleaning surface, in chemical sensor, in the evolution of H_2 gas, in solar cells etc. (3). One of titanium dioxide's most characteristic qualities is its photocatalytic activity, which is primarily partial by crystalline phase, crystalline size, and definite surface area (4). Anatase, rutile, and brookite are examples of the crystalline polymorphous forms of titanium dioxide, which appear to include most of the content. The rutile and anatase states of titanium dioxide are more reactive (5,6). Active photocatalytic activity occurs in the anatase phase which is stable as compared to the rutile phase (7). In the current past, sol-gel techniques have been used often to create anatase TiO2 nanostructures (8). In this study, titanium tetraisopropoixde, an organometallic precursor, was used to create nano-TiO2 (TTIP). Making titanium dioxide nanoparticles with titanium alkoxide is a simple process that has no environmental risks (9). The prepared sample will be characterized in this study applying methods including X-ray diffraction (XRD).

Processing Condition, Such As Following—

1. Chemical concentration
2. pH
3. Stirring time
4. Calcinations time and temperature

All method steps are due to final powder size and step and phase transparency.

2.MATERIAL & PROCESS

Titanium tetraisoproxide (96% SRL Organic), Hydrochloric acid (NS chemical), Ethanol (90 % CPG chemical), distill water.

2.1 Preparation of TiO_2 Nano particle by "Sol-Gel" process

After mixing titanium iso-propoxide in ethanol for ½ an hour with a magnetic stirrer, we slowly add water and HCL acid solution to modify the pH levels in the three ranges. Using a magnetic stirrer at room temperature for 120 minutes results in a homogenous solution that is kept there for 24 hours to create a gel. Drying the gel at 110 degree removes residual water and other material. To produce the necessary TiO2 nanoparticle, the dried gel calcined at 300 degrees by baffle furnace with a heating rate of 10 degrees per minute and 3-hour soak period.

2.2 CHARACTERIZATION METHOD

The phase analysis was done using X-ray diffraction . The Characterization of nano particle like, Lattice constants, D- spacing, Crystallinity, Thickness (films), Particle size (grains). X-rays is an electromagnetic radiation that is more penetrative than visible light with a smaller wavelength and higher energy.

2.3 Photocatalytic Degradation

The photocatalytic degradation process is a major contribution in the area of wastewater treatment. The method is a form of absorption oxidation reaction that serves as an efficient technique for the degradation of organic compound. Photocatalytic degradation is more effective than other techniques, because Semiconductors are low cost and Complete mineralization of organic compounds occur at low temperature and pressure and there is no waste disposal problems.

3. RESULT AND DISCUSSION

Performed phase analysis of titanium dioxide and reached its conclusion. X-ray diffraction, the phase analysis of titanium dioxide nano particles obtained using X-ray diffraction. Using a step size of 0.002 degrees and a scan rate of 5 degrees/min, the XRD patterns were recorded in the 2 thetas = 10–90-degree range. Figure 1 shows the x-ray diffraction patterns of titanium dioxide particles as they formed on pH3 during the production of sol.

TiO_2 calcined at 300 degrees and give a XRD pattern as shown in Figure 1. After calcination, three anatase peaks of TiO2 powder were clearly formed at the pH level 3. The amorphous phase of TiO2 particles that were dried for pH3 crystallised into the anatase phase after calcination at temperature of 300 degrees. X-ray patterns of TiO2 particles that were made at pH3 show a sharp peak which appears as an anatase peak at 2θ = 25.30°, 37.80°, 48.03°, 55.06°, 62.69°, 70.29°, and 75.05 The presence of the titanium at 2θ = 25.30° parallels to pH3's (101) value.

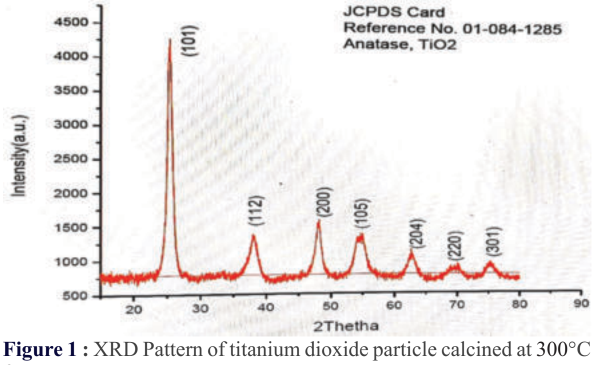

Figure 1 : XRD Pattern of titanium dioxide particle calcined at 300°C for pH 3 **.**

3.1 Band Gap Energy Measurements

Recorded the Spectra of prepared TiO2 to determine the optical band gap energy. The spectra are shown in Figure-2 respectively and the result obtained via equation (1)

Band gap (eV) = 1240/λ(nm)------------(1)

Where λ is the wavelength that represents the maximum intensity of spectrum.

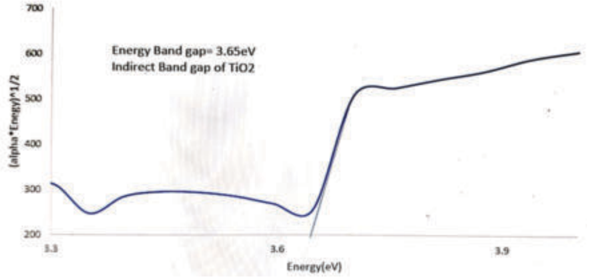

Figure – 2 : Band gap graph of prepared TiO2 anatase nanoparticle

3.2 Band Gap Energy Measurement Result

Parameter	Commercial TiO2	Commercial nano TiO2	Prepared TiO2
Eg/eV	3.56	3.53	3.65

4.0 Effect of Anatase Titanium Dioxide Nanoparticles in textile wastewater:

4.1 Sample collection and analysis of sample:

- For analysis ware collected water form the study area (industrial area, sehor district).
- Following standard procedure analysis was done in research laboratory of the department of chemistry Narmada collage Narmada Puram (M.P.). Analysis was carried out according to the method of standard method (APHA,1989).
- We can analysis by different parameter which has shown as below:

Table-1: Parameter And Their Different Value

S.No.	Parameter	Standard value	Sample value
1	pH	6.5-8	9.2
2	Alkalinity	50-100 mg/L	243 mg/L
3	Hardness	100 mg/L	200 mg/L
4	DO	4.5-8 mg/L	2.5 mg/L
5	BOD	150 mg/L	300.12 Mg/L
6	COD	250 mg /L	1150 mg/L

4.2 Experiment

In photocatalytic degradation process, we can treat textile industrial wastewater sample with the help of TiO2 nanoparticle. In this we use photocatalytic reactors which have shown as below :

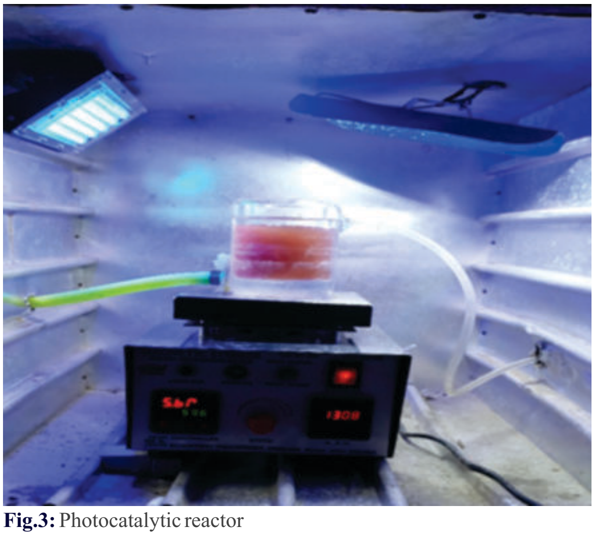

Fig.3: Photocatalytic reactor

From the above image of a multiple skill reactor that is close to an actual application. A magnetic stirrer and a 500 cm3 Pyrex glass beaker makes up the reactor. A powerful UV lamp is the source of the radiation. The titration method is used to determine the sample's COD (Chemical Oxygen Demand) value. Without photodegradation, the COD of the water sample was 1150 mg/L. With the help of photo reactor and photodegradation at various times with a constant amount of TiO2 nanoparticle (Anatase), we calculated the variation in COD value.

Table-2: value of textile industrial wastewater after photodegradation

S. No.	Variation of Time (min.)	Constant value of catalyst dose	COD value of without photodegradation	COD value of with TiO2 Nano catalyst after photodegradation
1	120	0.50 mg/L	1150mg/L	975mg/L
2	240	0.50 mg/L	1150mg/L	541mg/L
3	720	0.50 mg/L	1150mg/L	220mg/L
4	960	0.50 mg/L	1150mg/L	110mg/L

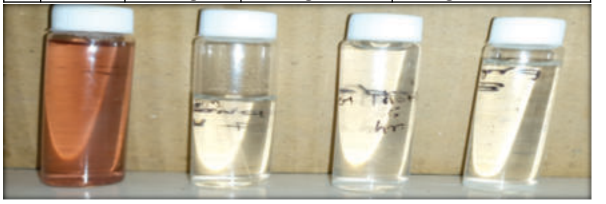

Fig.4 : changes of real textile industrial waste water colour with time using anatase TiO2 and UV radiation

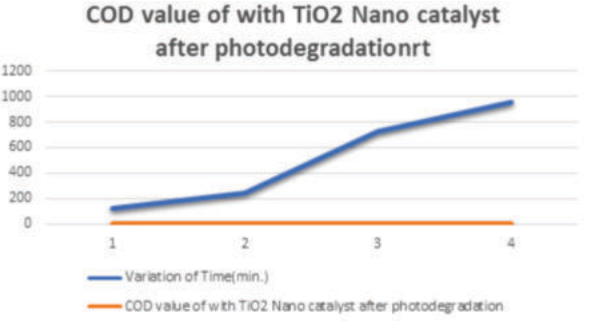

Fig.-4 Photo Degradation of textile industry waste water by using TiO2 Nano catalyst

4. Application of Anatase Titanium Dioxide Nanoparticles

The industries of plastics, ink, coatings, paper, rubber, chemical fibre, ceramics, pharmaceutical, food, and some others use anatase titanium dioxide widely.

Following are some of the key applications for Anatase titanium dioxide:

1. Since it has a good photocatalytic activity, anatase titanium dioxide is commonly employed in air cleansers and photocatalysts.
2. Due to its enormous specific surface, anatase titanium dioxide is widely utilised in lithium batteries, gas sensors, photocatalysis, catalyst media, solar cells, and environmental cleaning.
3. Anatase titanium dioxide is utilised in the production of paper; it can brighten, fluoresce, and enhance the paper's whiteness. A thickness of less than 100 mm is required. therefore, very thin pigment titanium dioxide is used in the printing industry. For the paper business, fillers like chalk, talc, or kaolin are utilised.
4. It is also working in the making of ink. In modern inks, it is a vital white pigment.
5. The textile and chemical fibre industries use Anatase titanium dioxide. They remove the oily appearance on fibres taken on by the resin's transparent characteristics.
6. Anatase Titanium dioxide is active as a colour in the rubber sector and it also has strengthening, anti-aging and filling benefits.
7. Additionally, white cement, the ceramic industry, and the colouring of rubber or linoleum all utilize titanium dioxide from Anatase.
8. In some cosmetic creams, titanium dioxide helps as a catalyst, a pigment, and a skin-protective agent against UV rays. It is utilised in sunscreens, culinary dyes, self-cleaning surfaces, and colours in nanoparticle form.

4.1 Application in Textile Wastewater

Textile wastewater is considered an important source of industrial pollution due to its heavy discharge [80]. Different processes are used in textile industry which are as follows, fibre sizing, scouring, desizing, bleaching, rinsing, mercerizing, dyeing, and finishing [14]. A wide range of textile items are now available. However, heavy pollution due to heavy duty sewage disposal is harmful to the environment. According to previous studies, textile waste water holds fibres, grease, oil, heavy metals, inorganic salts, dyes, and detergents [24]. Of these, the dye residue is known as a contaminant that builds up and is also created after the finishing process [20]. The presence of several dyes results in a pronounced colour in the fabric. More than 30% of the dye remains in the reactor after the process, due to which the azo dye content remains in the waste water [15]. The US National Organization for Industrial Protection and Well-being has classified azo dyes as mutagenic and carcinogenic [16, 17]. It is significant to note that these dyes are challenging to decolorize [18,19]. Although most textile waste water is treated before release, the increased release parameters cannot be met by conventional methods of aerobic biological process and physical-chemical treatment [24]. We know that a significant concentration of COD occurs in waste water that destroys micro-organisms in biological waste water treatment system.

Material based on TiO2 offer advantage for environmental application but at present they are difficult to separate from textile suspensions which limits the re-use of the photocatalyst TiO2 can be placed on a varity of substrates including glass light and contains both fibres, according to Alinsafi et al. [23]. The photocatalyst demonstrated excellent decolorization for the treatment of textile industry waste water. The performance of the photocatalyst was highy depended on the dyes and other chemical composition. Additionally, Rao et al. [21].

5. CONCLUSION

Anatase form of TiO2 nano particle synthesized by sol gel process, with distil water and ethanol as the solvents, titanium tatra-isoproxide as the precursor, HCL as the catalyst. By using X-ray diffraction to characterise synthetic titanium dioxide, it was discovered that temperature and pH have a significant impact on the phase transformation of titanium dioxide and its band gap energy of 3.65 eV. The titanium dioxide anatase phase, which is produced through synthesis, has a significant impact. The immobilised photocatalysts demonstrated outstanding decolourization capability for the treatment of textile industry waste water. The COD value is reduced by photodegradation process with the help of photo reactor at different time variation and constant value of TiO2 Nanoparticle (Anatase). Due to this, we determined the COD variation in value.

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