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Comparative Degradation of Aspirin

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ABSTRACT Safe drinking water is the need of human as well as plants and animals. The emerging technology, emerging processes and emerging products have also given birth to emerging pollutants. A number of emerging as well as priority pollutants have been listed across the globe. Every year new pollutants are added to the priority pollutants list. The focus of the nations and environmental agencies across the world is now shifting to safer environment. Only safer environments can guarantee longevity to the planet. Pharmaceuticals and pharmaceutical pollutants have also been listed as priority pollutants. Though the concentration may be less in some cases still their removal from water is a priority due to harmful effects these pollutants cause on the human health. Some contaminants cannot be removed by the conventional treatment methods hence special treatment has to be done. There are different Advance Oxidation Processes. Ultrasound is one such advance oxidation process which offers several benefits over the conventional oxidation processes. The degradation of drug Aspirin was studied using ultrasound. Aspirin is a listed priority pollutant. The occurrence of Aspirin has also been reported. Though Aspirin maybe beneficial to human health still excess quantity cannot be tolerated by human health and there are side effects of excess quantity. Comparative degradation under natural and induced conditions was studied employing a probe system under different conditions. Under all the induced conditions of study the drug showed good degradation response. The process can be one possible option for reducing priority pollutants from water.

KEYWORDS: Advance Oxidation Process, Emerging Pollutants, Environment, Priority pollutants.

I. INTRODUCTION

Advanced waste water treatment is defined as the additional treatment needed to remove suspended, colloidal and dissolved constituents remaining after conventional secondary treatment. Dissolved constituents may range from relatively simple inorganic ions, such as calcium, potassium, sulfate, nitrate and phosphate to an ever increasing number of highly complex synthetic organic compounds. In recent years the effects of many of these substances on environment has been understood more clearly. Research is still going on to determine (1) The environmental effects of potentially toxic and biologically active substances found in waste water and (2) how these substances can be removed by both conventional and advanced wastewater processes [10]. As a result, waste water treatment requirements are becoming more stringent in terms of both limiting concentration of many of these substances in the treatment plant effluent and establishing whole effluent toxicity limits. To meet these new requirements, many of the existing secondary treatment facilities will have to be retrofitted and new advanced waste water treatment integrated facilities will have to be constructed [7-9].

Different physical, chemical, and biological processes have been employed to treat domestic and industrial wastewaters such as Chemical industries [3-6], dye processing and textile, and landfill leachates effluents [14-17]. These processes have been used in waste water treatment since long [20].

AOPs for waste water treatment are a costly affair due to their high operating cost, thus; it is suggested that these technologies are effective when coupled with other technologies at end such as biological processes [11,18].

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II ACOUSTIC CAVITATION

Acoustic cavitation is effected using the high frequency sound waves usually ultrasound, with frequency range of 16 kHz-100 kHz. Alternate compression and rarefaction cycles of sound waves result in various phases of cavitation such as generation of bubble/cavity, growth phase and finally collapse phase releasing large amount of energy locally [9].

Ultrasound occurs at a frequency above 16 kHz, higher than the audible frequency of the human ear, and is typically associated with the frequency range of 20 kHz to 500 MHz [19]. The frequency level is inversely proportional to the power output. Low-intensity, high-frequency ultrasound (in the megahertz range) does not alter the state of the medium through which it travels and is commonly used for non destructive evaluation and medical diagnosis. However, high-intensity, low-frequency ultrasound does alter the state of the medium and is the type of ultrasound typically used for sonochemical applications. The applications of ultrasound are briefly explained in the Kirk Othmer Encyclopedia of Chemical Technology.

There are several references available which provide a general overview of the field of sonochemistry and the types of chemical reactions which have been studied [12,13]. Some authors have compared the various effects of ultrasound to other types of chemistry, such as mechano chemistry. However, as will be evident from this review, it will take the combined effort of scientists and engineers to thoroughly understand sonochemical reactions and develop rational design procedures for sonochemical reactors.

The chemical and mechanical effects of ultrasound are caused by cavitation bubbles which are generated during the rarefaction, or negative pressure, period of sound waves [1,2]. During the negative-pressure cycle, the liquid is pulled apart at sites containing some gaseous impurity (nucleation sites), forming a void. Nucleation sites are also known as "weak spots" in the fluid. Nucleation in the absence of ultrasound can be seen every day when drinking a carbonated beverage. The bubbles of carbon dioxide form at scratches in the glass where gaseous impurities, such as air, are harbored and act as nucleation sites. When using ultrasound, the cavitation activity is directly proportional to the number density of particles present in the medium. Chemical effects due to ultrasound are not observed when there are no dissolved gases in the system, when the sound intensity is not volatile enough to enter the cavitation bubble during its formation. The physical and chemical effects of ultrasound are a result of both stable and transient cavitation events. Competing theories exist to explain the chemical effects due to cavitation: the hot-spot theory and the electrical theory. The hot-spot theory postulates that when the bubbles cavitate, localized hot spots are formed which reach temperatures and pressures in excess of 5000 K and 500 atm. The electrical theory postulates that an electrical charge is created on the surface of a cavitation bubble, forming enormous electrical field gradients across the bubble which is capable of bond breakage upon collapse. The hot-spot theory is generally more accepted, although reports many phenomena which contradict this theory but are supported by the electrical theory. A Letter to the Editor published in 1996 completely discounted the electrical theory as a valid mechanism behind sonoluminescence and sonochemistry. The chemical effects of ultrasound have been attributed to the collapse of both stable and transient cavitation events. Stable cavities oscillate for several acoustic cycles before collapsing, or never collapse at all. Transient cavities, conversely, exist for only a few acoustic cycles.

III MATERIALS AND METHODS

Dispersible disprin tablets were used as the source of Aspirin. Each dispersible tablet contained 350 mg of Aspirin. A number of tablets 1-5 were used to prepare the solutions of different concentrations. Distilled water was used to prepare the sample solution. Deionised water used was of A.R. grade.

Natural degradation - In natural degradation the aspirin solution for different concentrations was allowed to degrade under natural conditions for same amount of time initially. Biodegradation is a very important process in the transformation of organic pollutants including such as pharmaceuticals. It can result in an energy gain for bacteria growth but it can also occur co metabolically during degradation of other organic compounds. Biodegradation can happen partially or completely. The latter, complete biodegradation to carbon dioxide (CO₂) and water (H₂O), is called mineralization. Partial biotransformation includes the conjugation of the pharmaceutical and the degradation of a compound to a metabolite (also occurring in human body). A conjugate is a complex formation of the pharmaceutical

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with glucuronic acid or sulphate. Conjugation of the pharmaceutical takes place usually before excretion in the human body. The result of this conjugation is that the compound is becoming more polar and can be excreted more easily. A conjugated compound can be easily transformed back to the free original compound in the sewage system or in a WWTP. Metabolites of pharmaceuticals can be produced through human metabolism and in WWTPs. Like the original pharmaceuticals, metabolites can be persistent and they might demonstrate effects in the environment. Identification of these metabolites in wastewater is therefore important.

Some studies have identified degradation products and possible degradation pathways of selected

1. pharmaceuticals.
2. Sonication method-The synthetic sample obtained was sonicated in a sonication system consisting of a probe of 18mm diameter and the US frequency of 20kHz. The samples were sonicated varying the parameters both on the liquid side as well as machine side parameters. The machine side parameters varied were Amplitude and the Sonication time. The liquid side parameters varied included the PH and the concentration of the sample. The studies were conducted on samples in batch mode. The temperatures varied during the intense process of sonication.

IV RESULTS & DISCUSSIONS

TABLE 1: EFFECT OF TIME ON % DEGRADATION(NATURAL)

S.No	Ambient Conditions	Concentration In Mg/Lit	Time Of Sonication	% Degradation
1.	--	175	0-5	00
2.	--	175	5-10	00
3.	--	175	10-15	00

TABLE 2: EFFECT OF SONICATION TIME ON % DEGRADATION

S.No	Amplitude Of Sonication	Concentration In Mg/Lit	Time Of Sonication	% Degradation
1.	100	175	0-5	86.96
2.	100	175	5-10	91.31
3.	100	175	10-15	91.31
4.	100	175	15-20	56.53

The Fig 1 shows the variation of % degradation with sonication time.

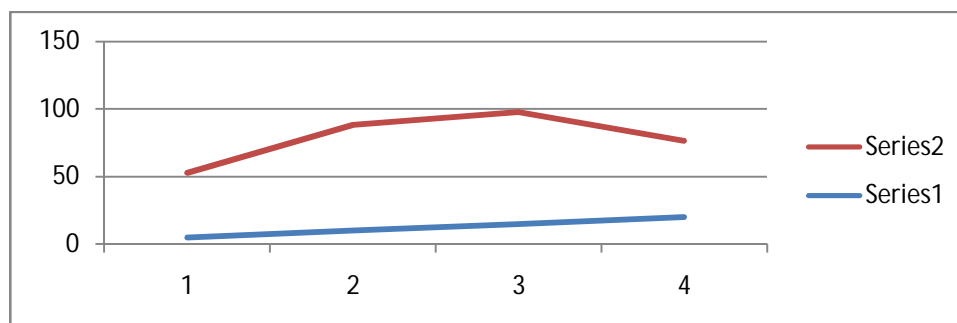


Fig 1: The process is optimized at the end of 15 Mints. of sonication. After optimization there is decrease in % degradation. It also shows the linear increase in time of sonication.

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TABLE 3: EFFECT OF CONCENTRATION ON % DEGRADATION BY SONICATION METHOD

s.no	Ampli Tude of son.	Time Of Son.	Concen Tration Of sample	% degradation
1.	100	15	175	91.31
2.	100	15	350	65.29
3.	100	15	525	37.69
4.	100	15	700	22.83
5.	100	15	875	17.04

The Fig 2 shows the effect of concentration on % degradation of Aspirin.

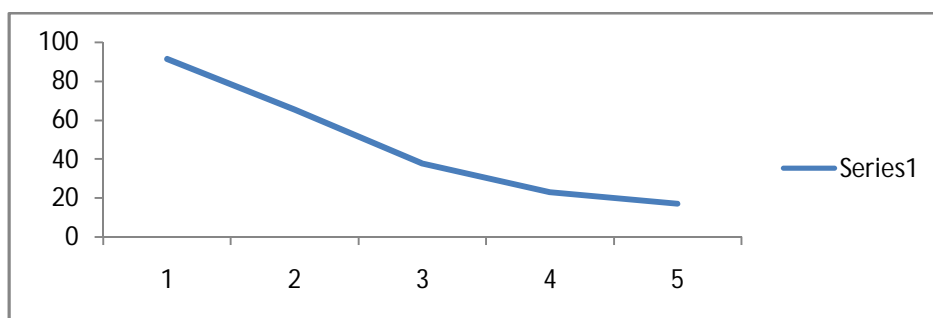


Fig 2 : As the concentration increases the % degradation goes on decreasing.

TABLE 4: EFFECT OF NATURAL DEGRADATION OVER LONG PERIODS

s.no	Ambient conditions (Temp) in °C	Time In hours	Concen tration Of sample	% degradation
1.	25-35	168	175	40.50
2.	25-35	168	350	22.60
3.	25-35	168	525	15.30
4.	25-35	168	700	12.40
5.	25-35	168	875	08.90

TABLE 5 RESULTS FOR DEGRADATION OF ASPIRIN WITH VARYING SONICATION TIME AND VARIABLE CONCENTRATION

S.No	Concentration In Mg	Time At The End Of Sonication Period	% Degradation
1.	175	15	91.31
2.	350	30	91.31
3.	525	45	91.31
4.	700	60	91.31
5.	875	75	91.31

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The fig 3 shows that in case of higher concentrations longer sonication periods are required.

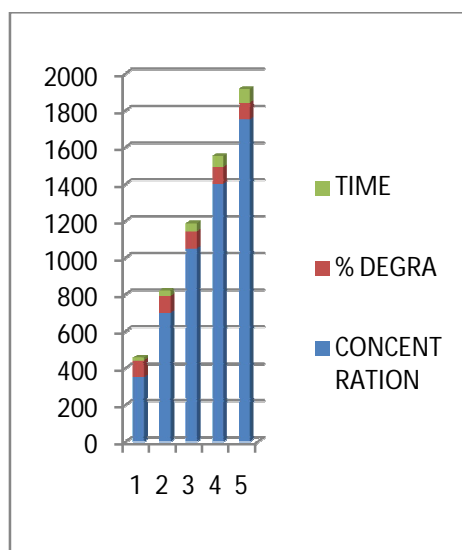


Fig 3: The sonication time depends on the concentration of the sample solution.

IV. CONCLUSION

The sono degradation of drug Aspirin was successfully studied in comparison with natural degradation. The sonication effects were studied by varying Amplitude, Sonication Time, Concentration. The efficiency obtained in the process is reasonably good. There are still chances to improve the efficiencies further with more optimization. The parameters studied i.e. Time of sonication, concentration of sample solution and their variation with % degradation. Maximum degradation percentage obtained was 91.31%. It is seen that post optimization there is decrease in the degradability.

REFERENCES

1. Adewuyi Yusuf G. 2001. Sonochemistry: Environmental Science and Engineering Applications. Ind. Eng. Chem. Res. 2001, 40, 4681-4682, 4706, 4707, 4708, 4709, 4710.
2. Arnim Henglein 1994. Chemical Effects of Continuous and Pulsed Ultrasound in Aqueous Solutions. Ultrasonics Sonochemistry 1995 Vol 2 No 2 p S115.
3. Aye T., W.A. Anderson, and M. Mehrvar. "Photocatalytic treatment of cibacron brilliant yellow 3G-P (reactive yellow 2 textile dye)". J. Environ. Sci. Heal. A, 38 (9): 1903-1914, 2003
4. Aye T., M. Mehrvar, and W.A. Anderson. "Effects of photocatalysis on the biodegradability of Cibacron Brilliant Yellow 3G-P (Reactive Yellow 2)". J. Environ. Sci. Heal. A, 39 (1): 113-126, 2004
5. Crini. G. "Non-conventional low-cost adsorbents for dye removal: A review". Bioresour. Technol., 97(9): 1061-1085, 2006
6. Esplugas . S., D.M. Bila, L.G.T. Krause, and M. Dezotti "Ozonation and advanced oxidation technologies to remove endocrine disrupting chemicals (EDCs) and pharmaceuticals and personal care products (PPCPs) in water effluents". J. Hazard. Mater., 149 (3): 631-642, 2007
7. Gogate Parag R, Pandit Anirudha B. 2003, A Review of Imperative Technologies for Wastewater Treatment I: Oxidation Technologies at Ambient Conditions. Advances in Environmental Research 8 (2004) 501, 502, 503.
8. Gogate Parag R, Pandit Anirudha B. 2003. A Review of Imperative Technologies for Wastewater Treatment II: Hybrid Methods. Advances in Environmental Research 8 (2004) 553-559.
9. Gogate Parag R 2002. Cavitation: An auxiliary technique in wastewater treatment schemes. Advances in Environmental Research 6 (2002) 335-340.
10. Ingole N.W. Khedkar S.V. 2012. Ultrasound Reactor Technology-A Technology For Future. International Journal of Advance Engineering Research And Studies. Vol II/issue I/oct-dec, 2012/72-75. p72,73.

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11. Johnson M.B. and M. Mehrvar. "Aqueous metronidazole degradation by UV/H₂O₂ process in single and multi-lamp tubular photoreactors: Kinetics and reactor design". *Ind. Eng. Chem. Res.*, 47 (17): 6525-6537, 2008
12. Jose Gonzalez-Garcia et al., 2010. Sonochemical Treatment of Water Polluted By Chlorinated Organic Compounds. *Water* p.29,30
13. Mason T.J. & Lorimer J.P. 2002 *Applied Sonochemistry: Uses of Power Ultrasound in Chemistry and Processing*, Published by Wiley-VCH Verlag GmbH & Co. KGaA ISBNs: 3-527-30205-0 (Hardback); 3-527-60054-X (Electronic) P 131,132,137.
14. Moo. H.K. -Young. "Pulp and paper effluent management". *Water Environ. Res.*, 79 (10): 1733-1741, 2007
15. Paraskeva P. and E. Diamadopoulos. "Technologies for olive mill wastewater (OMW) treatment: A review". *J. Chem. Technol. Biot.*, 81 (9): 1475-1485, 2006.
16. Renou S., J.G. Givaudan, S. Poulain, F. Dirassouyan, and P. Moulin. "Landfill leachate treatment: Review and opportunity". *J. Hazard. Mater.*, 150 (3): 468-493, 2008
17. Scott J.P. and D.F. Ollis. "Integration of chemical and biological oxidation processes for water treatment: review and recommendations". *Environ. Prog.*, 14 (2): 88-103, 1995
18. Stasinakis A.S. 2008. Use of Advance Oxidation Processes For Wastewater Treatment-A Mini Review *Global Nest* p. 377-382.
19. Uma Mukherji *Engineering Physics*, published by Narosa Publishing House ISBN 81-7319-240-5, pp 69,82,83.
20. Vandevivere P.C., R. Bianchi and W. Verstraete. "Treatment and reuse of wastewater from the textile wet-processing industry: Review of emerging technologies". *J. Chem. Technol. Biot.*, 72 (4): 289-302, 1998.
21. Katarzyna Kujawa-Roeleveld, Els Schuman WU, Biodegradability and fate of pharmaceutical impact compounds in different treatment processes, Project Report 2006, p-14.