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DEVELOPMENT OF A SMART TOOL FOR ACETONE ON PAPER PLATFORM: A GREEN CHEMICAL APPROACH

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ABSTRACT

Pollution reaches levels of serious concern and it has now attracted the attention of world. It is a mixture of solid particles and gases in the air. Organic and inorganic compounds are now a day a major part of air pollution. Aldehydes and ketone including formaldehyde, acetaldehyde, and acrolein and acetone are toxic organic components of air pollution that cause lung cancer and cardiovascular disease with chronic exposure. A sensitive method is proposed for the determination of Acetone in air. Acetone reacts with vanillin in alkaline medium forming a yellow –orange dye with an absorption maximum at 430 nm.

Key words: Acetone, Colorimetric, green chemistry

I. INTRODUCTION

Acetone is a clear colourless liquid with a sweetish odour and taste.It is also known as dimethyl ketone, 2-propanone, and beta-Ket propane formula $(CH_3)_2CO$[1]. It evaporates easily, and highly flammable and dissolves in water, it haslow density as compare to water, Acetone is used to make plastic,fibers, drugs, an antiseptic and other chemical. It is used in the preparation of paper coatings, adhesives, and heat-seal coatings and is also employed as a starting material in the synthesis of many compounds.[2]It occurs naturally in plants, trees, volcanic gases, forest fires, and as a product of the breakdown of body fat.It has a role as a polar aprotic solvent, a human fat breakdown metabolite and an EC (amidase) inhibitor. It is present in vehicle exhaust, tobacco smoke, and landfill sites. Used as a solvent in paint and nail polish removers. Industrial processes contribute more acetone to the environment than natural processes.Skin defatting&Dermatologists use acetone with alcohol for acne treatments to chemically peel dry skin.Make-up artists use acetone to remove skin adhesive from the netting of wigs and Mustaches by immersing the item in an acetone bath, then removing the softened glue residue with a stiff brush.[3-10] Acetone is a good solvent for many plastics and some synthetic fibers. It is used for thinning polyester resin, cleaning tools used with it, and dissolving two-part epoxies and superglue before they harden. It is used as one of the volatile components of some paints and varnishes. As a heavy-duty degreaser, it is useful in the preparation of metal prior to painting or soldering, and to remove rosin flux after soldering (to prevent adhesion of dirt and electrical leakage and perhaps corrosion or for cosmetic reasons), although it may attack some electronic components, such as polystyrene capacitors. Although itself flammable, acetone is used extensively as a solvent for the safe transportation and storage of acetylene, which cannot be safely pressurized as a pure compound. Acetone is used to precipitate proteins. Low-grade acetone is commonly used in academic laboratory settings as a glassware rinsing agent for removing residue and solids before a final wash. A mixture of acetone and dry ice is a popular cooling bath that maintains a temperature of −78 °C as long as there is some dry ice left. It is a ketone body, normally present in very small quantities in urine and blood; larger amounts may be found in the urine and blood of diabetics and ketonuria. Acetone is not currently regarded as a carcinogen, a mutagen, or a concern for chronic neurotoxicity effects. Acetone is one of the ketone bodies produced during ketoacidosis. In 1995, the United States Environmental Protection Agency (EPA) removed acetone from the list of volatile organic compounds. The companies requesting the removal argued that it would "contribute to the achievement of several important environmental goals and would support EPA's pollution prevention efforts", and that acetone could be used as a substitute for several compounds that are listed as hazardous air pollutants (HAP) under section 112 of the Clean Air Act. In making its decision EPA conducted an extensive review of the available toxicity data on acetone, which was continued through the 2000s. It found that the evaluable "data are inadequate for an assessment of the human carcinogenic potential of acetone".[11-21]]**NIOSH**TLV value of formaldehyde for long exposure (TLV-TWA)**250 PPM**, and short term exposure(TLV-STEL) **750ppm**. **OSHA** the legal airborne permissible exposure is **1000 PPM** not to be exceeded. **ACGIH** TLV is **500PPM**[22]. Some other spectrophotometric methods for the determination and detection of acetone was reported as well ,Colorimetric determination of water in acetone utilising dithizone for the determination of water in acetone is described. The method is based on the change of colour with water content[24]A ZnO based sensors show great potential for acetone gas due to their high chemical stability and simple synthesis process[25]An attempt has been made to devise a method which combines the sensitivity of the iodine titration (Hubbard's Method) with the specificity of the Denigk's-Van Slyke method. In this method the ketone bodies are precipitated as in Van Slyke's method.[26]A sensitive and selective spectrophotometric method for the determination of acetone in acetic acid has been worked out. It is based on the reaction of acetone with diazotized *p*-aminobenzoic acid in a strongly alkaline medium to form a purple colour with maximum absorption at 540 nm. Spot test analysis for qualitative determination of materials on an absorbent material has been extensively studied for many years. Feigl and Anger have provided the basis for many such studies.[27] Qualitative spot test analysis, however, is not very usual. Studies show that spectroscopy cannot yield precision better than 10% when used to obtain quantitative data directly from spot test analysis as mentioned by Kealey[28]. Previously, Amlathe and Gupta had developed indicator plates and tubes.[29] Later on, using the same principle Abbaspour et al. introduced paptode ,paptodes were similar to optodes in many features. In optodes, an ionophore is immobilized on a hydrophilic or hydrophobic polymer while in paptodes simply a paper or another ordinary porous material such as clay or cotton or even TLC can be used as a substrate support for the reagent. They have also developed method and disposable sensors for water pollutants like phenol, hydrazine, arsenic ,lead, methyl parathion, cadmium, formaldehyde.[30-38] A coloured reaction product can be produced on the surface of a reagent impregnated inert support, by a single drop of solution of analyte, producing distinct flecks or rings. The degree of colour of the spot was found to be proportional to the concentration of the analyte. As in this method, the various properties of strips are observed.

II. EXPERIMENTAL

Apparatus
EI Double beam Spectrophotometer,
EI digital pH meter model 111
All Glass wares were used made up of 'A' grade Borosilicate glass.

Reagents

All chemicals used were of analytical-reagent grade, and all solutions were prepared with double distilled water.

Acetone. A stock solution of 1 mg ml-1 (v/v) acetone was prepared in 0.5% sodium hydrogen sulphite solution. A working standard of 20 μg ml-1 was prepared by appropriate dilution of the stock solution.

Vanillin. A 2% solution was prepared in 25% aqueous ethanol (i.e.,25 ml of ethanol diluted to100ml with water).

Sodium hydroxide. A 1 molar solution was used.

III. PROCEDURE

The known concentration of acetone is taken in a graduated beaker then vanillin solution is added and shaken well. After 5 min sodium hydroxide solution is added and shaken well and heated at 40° c temperature for 10 min and cool down. A yellow cooler dye appears indicating presence of acetone.The absorbance is then measured at 430nm. A reagent blank was also prepared in the same manner. To construct the sensor strips for Whatman filter paper were immersed in 2% solution of vanillin followed by immersing in 1M NaOH solutions well and then air dried. Aliquots of acetone solutions of various concentration were injected on these strips to develop the spot.

(A) (B)

Photograph: colour developed at different concentration of formaldehyde
(A)colour variation on paper strips (B)Colour variation in tubes

IV. RESULTS AND DISCUSSION

Acetone reacts with vanillin in alkaline medium to produce a yellow-coloured dye. Thus, even the tube contains both the reagent but no colour production takes place until the acetone sample is added.

Effect of Varying Reaction Conditions:

It was found that a minimum of 1 ml of 2% vanillin solution was required for complete colour development. Larger amounts of vanillin increase the absorbance of the sample and of the reagent blank. It was found that **1** ml of 1 molarsodium hydroxide solution was sufficient to obtain maximum absorbance.

Effect of temperature:

The effect of time and temperature was studied. The colour of the dye started to appear after 5 min. at ***15***-20°C; maximum intensity was obtained after 10 min.

Response time, stability and detection limit of the system:the response time of the system was evaluated under optimum conditions for 80ppm of acetone. It was calculated by measuring the time required to achieve a steady colour intensity. The response time of 5-10 minutes was achieved. To study the stability of the colour. The colour intensity remains nearly constant for the period of 48 hours. After that the colour of dye start change from yellow to orange.

Effect of foreign species:
The effect of various interferents commonly found in polluted water during the determination of formaldehyde. As the reaction is carried out in a strongly alkaline medium, metal ions such as Sn^{2+}, Cu^{2+},Ni^{2+}, Ca^{2+} and Ag^{+},Mg^{2+}which form hydroxides will interfere by precipitation. Para-substituted phenols such as p-cresol, p-nitrophenol and p-chlorophenol did not interfere.

V. APPLICATIONS

The proposed method has been applied successfully for the determination of acetone in industrial waste water and biological samples. The samples were spiked by adding known amounts of acetone. A recovery test of Acetone was performed to compare the developed method with the official analysis method (method of Aldridge). The developed method was used to determine the acetone levels in several water samples. The results obtained are given in the Table. The data show that the recovery of formaldehyde is quantitative and hence the method can be satisfactorily applied to hygiene work.

Table 1. **Determination of Formaldehyde in spiked waste water samplesFormaldehyde found*, p.p.m.**

Concentration of acetone added(p.p.m.)	Proposed method(p.p.m.)	Standard method(p.p.m.)	Recovery, %
3	2.78	2.90	92.3
5	4.53	4.35	90.7
8	7.26	8.00	90.8
12	11.2	11.00	93.4
15	14.25	14.80	93.5
18	16.95	17.10	94.2

* Mean of three repeated determinations.

VI. CONCLUSIONS

The described method in the present paper has many advantages as it does not need many instruments, it is very simple, selective and rapid. Its range is much wider as compared to other methods for determination of acetone Immobilization of reagents is very simple.

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