

Determination of Triprolidine Hydrochloride Using High Sensitivity Selective Nano-Electrode and Conventional Coated Wire Electrodes

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Abstract

The tremendous developments in nanoscience and nanoparticles witnessed great success for nanoparticles due to their unique properties, diverse fields, and uses in a significant way and because they are electrically active, prompting scientific researchers in the various and multifunctional activities of the nanoparticle to give critical attention to these nanoparticles as materials of great usefulness and effective in electrochemical uses as well as for sensing. This study was able to calculate the potential difference after two electrodes were made to estimate the antihistamine drug triprolidine hydrochloride (TPN) One is the conventional coated wire electrode (I) (TPN-STPB-DEP) and the other is the wire electrode enriched with copper oxide nanoparticles (II)(TPN- STPB -DEP-CuONPs) (modified electrode) The results showed that the linear range of the conventional selective electrode (I) is the range of $(10^{-2} - 10^{-6})$ mol/L, while the linear range of the nanoscale electrode (II) is the range of $(10^{-2} - 10^{-8})$ mol/L, We note that the slope of the electrode of the conventional coated wire and the electrode of the copper oxide (I, II) nano-coated wire are (56.4, 58.321) mV/decade, respectively. It is shown that the estimation coefficients for the manufactured electrodes are (II, I) (0.9990, 0.9986) in a successive manner. Through these results, it was found that the electrode enriched with (modified) copper oxide nanoparticles (II) is more sensitive and selective and has an advantage over the traditional selective electrode (I), And that its advantage in electrical improvement enabled it to quickly perform the search for the drug under study (TPN) with wide ranges of concentrations and low limits, in addition to the rapid response of the electrode to the drug (TPN).

Keywords: Triprolidine Hydrochloride, Electrodes, Copper Oxide Nanoparticles.

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INTRODUCTION

Triprolidine hydrochloride (figure 1) is an antihistamine with many effects, including antimuscarinic and a mild sedative.

It is a white powder that dissolve quickly in water and has a melting point of 60°C. It is in the form of tablets of 500 mg⁽¹⁻³⁾. The scientific name of the drug is [(E)-2-[3-(1-Pyrrolidinyl)-1-p-tolylpropenyl] pyridine hydrochloride, trans-2-[3-(1-Pyrrolidin-yl)-1-p-tolylpropenyl] pyridine hydrochloride].

The molecular formula for triprolidine hydrochloride is C₁₉H₂₂N₂. HCl has a molecular weight of 314.9 gm/mol, and its structural formula is⁴:

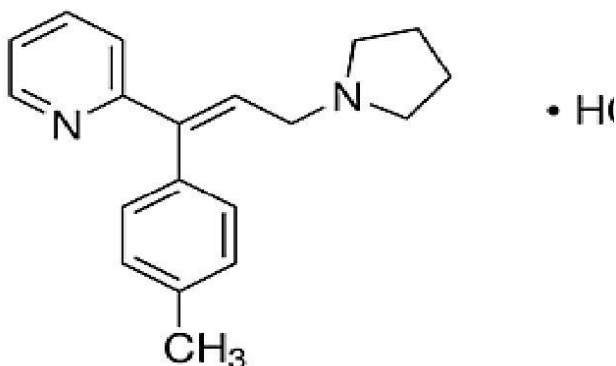


Figure 1: The synthetic formula of Triprolidine hydrochloride

Triprolidine hydrochloride relieves and treats allergies, colds and coughs^(6,5), including seasonal and perennial rhinitis and skin infections⁽⁷⁾. It is also used with pseudoephedrine hydrochloride for the treatment of diseases. It has side effects including sedation, dizziness, and incoordination⁽⁸⁾, blurred vision, dry mouth⁽⁹⁾, tightness in the chest, blood and gastrointestinal disturbances, nausea, vomiting, and diarrhea⁽¹⁰⁾. There are many techniques used to determine the pure state and pharmaceutical preparations of Triprolidine hydrochloride, including high-performance liquid chromatography (HPLC), thin-layer chromatography (TLC)⁽¹²⁾, gas chromatography (GC), spectroscopic method⁽¹⁴⁾, and electrophoresis.⁽¹⁵⁾ and many other ways.

Ion selective electrodes are electrolytic sensors that produce an electric potential in their ionic solutions⁽¹⁶⁾. These ion-selective electrodes were discovered by (Wilhmst-Ostwald) in 1890 and depend on the transfer of ions in the electrolytic solution. It is connected to one of the reference electrodes of constant voltage⁽¹⁷⁻¹⁹⁾. After that, the selective electrodes were developed, as the glass electrode was discovered to measure the acidity function pH in 1900 through the potentiometric measurement of hydrogen ions across the sensitive membrane, and these selective electrodes were developed to become sensitive to some ions such as (K⁺, Li⁺,

Na⁺)⁽²⁰⁻²¹⁾. The ion-selective membrane is a liquid, solid, or vitreous solution⁽²²⁾. Ion-selective electrodes (ISEs) are among the essential modern electrolytic techniques⁽²³⁾.

Recently, nanoparticles have been a potential key for manufactured electrodes, materials components, the medical field, drug delivery systems, etc. Researchers have continued to develop research in this field due to the good properties and advantages of nanoparticles in manufacturing electrodes with high sensitivity and selectivity⁽²⁴⁾. Copper oxide is essential in the chemical and physical fields as well as other sciences⁽²⁵⁾. The development of the electrode became possible for the strong bonding between copper oxide nanoparticles⁽²⁶⁻²⁷⁾

EXPERIMENTS

Chemicals

Sodium hydroxide NaOH, acid hydrochloride HCL, copper nitrate Cu(NO₃)₂, sod tetra phnylborat (flocculating agent) (STPB), solvent tetrahydrofuran (THF), triprolidine hydrochloride (TPN), polyvinyl chloride (PVC), diethyl phthalate (DEP), sucrose, glucose, starch, lactose, magnesium stearate.

Tools and devices

It is used pH meter (3545 pH Meter) company (Jenway), a device (Jenway) to measure potential difference (mV), saturated calomel electrode (Fisher Scientific Co. Germany) as a reference electrode, a sensitive electrical balance with four-tenths orders Sartorius BL210 S AG GOTTINGEN, Jenway Hot Plate With magnetic stirrer_Germany, electric drying oven (Germany).

Nanoparticles (CuONPs)

After preparing 100 ml of 0.1 mol/L copper nitrate solution. 50 ml of this solution was poured into a glass beaker, and 100 ml of 0.1 mol/L sodium hydroxide solution was added to it by burette with constant stirring until the pH became 14. Then leave it for a day in a dark place to get a black precipitate and filtrate. The precipitate is washed with absolute ethanol, then distilled water several times, and left to dry at laboratory temperature for a day. After this, it is dried in the oven at 80 °C for 16 hours.

Preparing a standard solution of Triprolidine HCl (0.01M) (TPN)

Prepared by dissolving 0.7873 g of TPN powder in an amount of distilled water in a volumetric flask of 25 mL and complete to the mark with distilled water. Then preparing a series of standard solutions range of (10⁻⁸–10⁻³) molar of it by the dilution.

Preparation of the ion pair (TPN-STPB)

The ion-pair (TPN-STPB) is prepared by adding 50 ml each

of 0.01 M TPN and 0.01 M STPB in a 250 mL beaker with stirring on the magnetic stirrer for half an hour. Leave for a day in a dark place, so that a light brown precipitate is formed, then filtered and the precipitate is washed with distilled water and left for another day at laboratory temperature until it dries dried in the oven at a temperature of 60°C.

Membrane composition and electrode fabrication

To prepare the conventional TPN_STPB_DEP coated wire membrane electrode (I), 0.19 g of PVC was mixed with 0.01 g of the ion pair (TPN_STPB) in a 10 ml beaker and dissolved in 5 ml of THF, then mixed well by a glass stirrer and 0.35 ml of DEP plasticizer was added. Then a copper wire 5 cm long was taken, it was washed well, then rinsed with distilled water acetone. Left to dry and placed in a polyethylene tube, leaving one end of the wire connected to the potential difference device and the other 1 cm of the wire immersed several times to form a thick layer of the membrane in the cocktail solution and left to dry for 5 minutes.

To prepare a wire membrane electrode coated with copper oxide nanoparticles (modified electrode) TPN_STPB_DEP_CuONPs(II) 0.19 g of PVC was mixed with 0.01 g of the ion pair (TPN_STPB) with 0.005 g of nanoparticles (CuONPs) in a 5 ml glass beaker and dissolved In 5 ml of THF, then mix well by a glass stirrer and add 0.35 ml of plasticizer DEP. A copper wire 5 cm long was taken and washed well, then rinsed with distilled water and then acetone and left to dry and placed in a polyethylene tube, leaving one end of the wire to be connected to the potential difference device and the end. The other 1 cm of wire is immersed in the membrane solution and left to dry for 5 minutes. The process is repeated several times until a thick layer of membrane is formed.

Calibration curve

(20 ml) of series of concentrations range of (10⁻⁸ -10⁻²) mol/L of TPN standard solution were measured at the rate of six readings for each using the manufactured electrodes (I, II) (conventional selective electrode, The wire electrode enriched with copper oxide nanoparticles) is coupled with the reference calomel electrode respectively, the electrodes are cleaned with distilled water and dried with a tissue after each successive measurement, and the calibration curve is drawn in Excel (2010) using Microsoft office.

The effect of pH

To find out the effect of the pH function on the TPN standard drug solution of concentration (10⁻⁴,10⁻²) mol/L after adding drops of the prepared (0.1)M HCL hydrochloride solution and then increasing the pH after adding drops from the basic solution of NaOH (0.1)M and measure the potentiometric after coupling the fabricated electrodes (conventional selective electrode, copper oxide-enriched nanowire electrode) (I,II) respectively with the reference

calomel electrode, the electrodes are cleaned with distilled water and dried with a tissue after each time Measure it, then draw the curve by Microsoft office system (Excel 2010).

Preparation of TPN® solution for drug (TPN)

To prepare a solution of the syrup triprolidine (Rafidain Company Actifedin), each 5 ml contains 1.25 mg of TPN at a concentration of (10^{-4}) mol/L. 6.7 ml is withdrawn by a 10

ml pipette from the preparation vial and added to a 50 ml volumetric vial. Then it is diluted with distilled water to the mark, and a series of (10-5-10-8) mol/L are prepared according to the dilution law.

RESULTS AND DISCUSSION

Behavior of manufactured electrode devices (I,II)

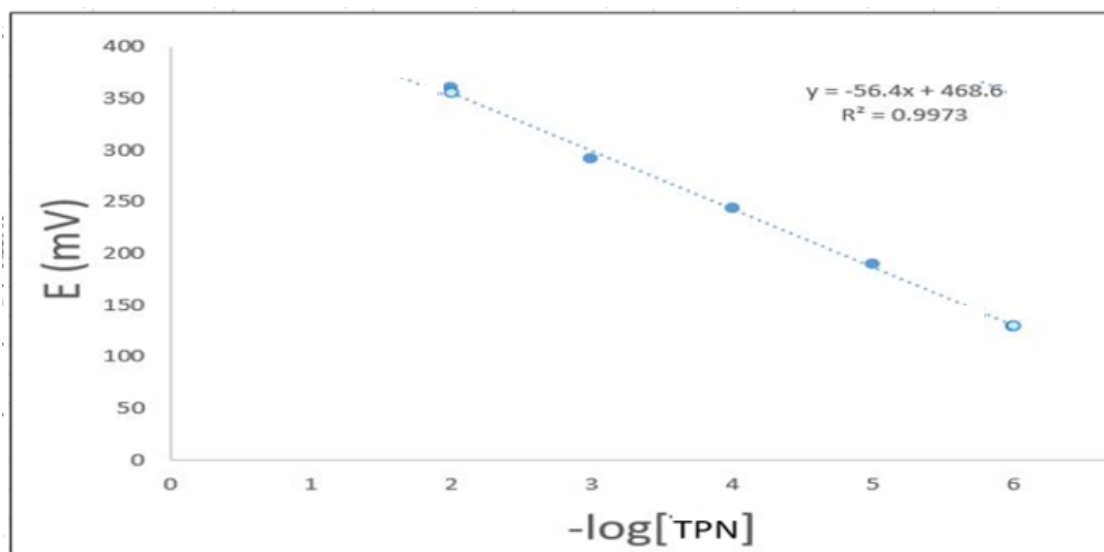


Figure (2) Calibration graph of Conventional Coated Wire Electrode (TPN- STPB-DEP) (I)

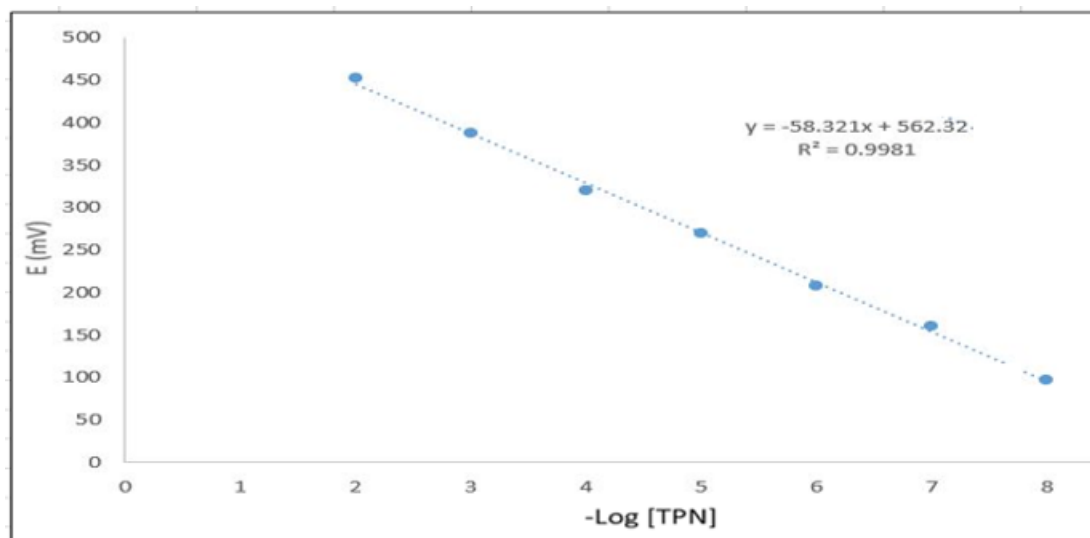


Figure (3) Calibration graph of Copper Oxide(II) Coated Wire Electrode (TPN - STPB -DEP-CuONPs)

Table (1) Electrochemical response properties of conventional electrode wire (I) (TPN-STPB-DEP) and copper oxide nanoparticle (II) electrode wire (TPN-STPB-DEP-CuONPs)

| Parameter | TPN- STPB – DEP(I) | TPN- STPB -DEP- CuONPs(II) |
|----------------------------|--|--|
| Slope (mV/decade) | 56.4 | 58.321 |
| Regression equation | -56.4x+468.6 | -58.321x+562.32 |
| Intercept | 79.257 | 22.429 |
| Linear range (M) | (10 ⁻² – 10 ⁻⁶) | (10 ⁻² – 10 ⁻⁸) |
| Correlation coefficient(r) | 0.9986 | 0.9990 |
| Response time/s | (10-48) | (4-30) |
| Working PH range | (2.6-4.5) | (2.6-4.8) |
| Lifetime/day | 18 | 32 |
| Temperature C | 20-30 | 20-30 |
| LOD | 5.49×10 ⁻⁷ | 5.62×10 ⁻⁹ |

The complex ionic (ion pair) (TPN_STPB) is produced from the reactance of the drug (TPN) and the precipitate (STPB), where the ion pair (TPN_STPB) is stable and can dissolve in organic solvents such as (THF) in the presence of PVC and the plasticizer diethylphthalate (DEP), which is A fluidized substance that makes the ionic complex its homogeneous dissolution and then spreads in the electrode membrane in a uniform manner, where we note through the results shown in Table (1) that the linear range of the conventional selective electrode (I) is the range of (10⁻² – 10⁻⁶) mol/L, while the linear range of the nanoselective electrode (II) is the range of (10⁻² – 10⁻⁸)mol/L.

It was shown that the slope of the conventional electrode and the nano-electrode enriched with nanoparticles (I, II) are (56.4, 58.321) mV\decade, respectively.

We note that the estimation coefficients for the manufactured electrodes are (II,I) (0.9990, 0.9986), where the response time for the conventional selective electrode (I) is 48 seconds for a concentration of 10⁻²mol/L and 10 seconds for a concentration of 10⁻⁶ mol/L, while the response time of the nanoselective electrode (II) is 30 seconds for 10⁻²mol/L concentration and 4 seconds for 10⁻⁸mol/L and the lifetime of the conventional selective electrode (I) 18 days and 32 days for the selective electrode coated with copper oxide (II) and both electrodes (conventional and nano) work at the best temperature of 25 °C .

And the detection limit average of six readings for the conventional and nano-electrodes (I, II) is (5.49 × 10⁻⁷ and 5.62× 10⁻⁹) mol/L, respectively. The effect of the pH function on the response of the conventional and nano-electrodes (I,II) was studied in the estimation of (TPN) It was found that the best range of the acidity function of the conventional selectivity electrode and the nanoselective electrode(10⁻⁴,10⁻²)mol/L is (4.5-2.6) and is (4.8-2.6) respectively.

That the increase and decrease of the acid function may affect the response and functioning of the conventional and nano-electrodes (I, II) after they were operating in a linear range at pH (4.5-2.6, 4.8-2.6), respectively, in the detection of the drug for the two concentrations of the drug (10⁻⁴,10⁻²) mol/L. The manufactured electrodes (II,I) at the high acidity function by adding a basic solution of NaOH decrease the voltage value due to the formation of a white precipitate of the pharmaceutical substance TPN or the salt of the drug substance in addition to the turbidity of the solution to be measured and the flocculation of the electrode membrane as a result of the increase in the concentration of the hydroxyl ion ⁽²⁸⁾. That is, there is intense competition between the hydroxyl ion and the drug ion towards the site of the double ion, and a decrease in the linear regression occurs due to the decrease in the interaction of hydroxyl ions and drug ions ⁽²⁹⁾. As for the low pH ratios by adding drops of HCl solution, we also notice a (decrease) in the values of the potential difference, and this may explain the reason for the interference of the hydronium ion, i.e. the increase of the hydrogen ion, and the formation of hydrogen ion pairs that are less sensitive towards drug ions while highly sensitive towards the hydronium ion inside the solution to be measured.

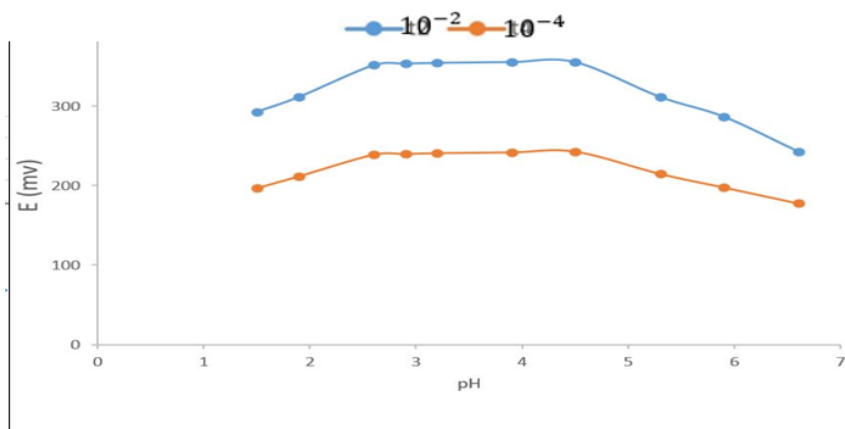


Figure (4) Effect of the acid function on the response of the conventional coated wire electrode (I) (TPN-STPB-DEP).

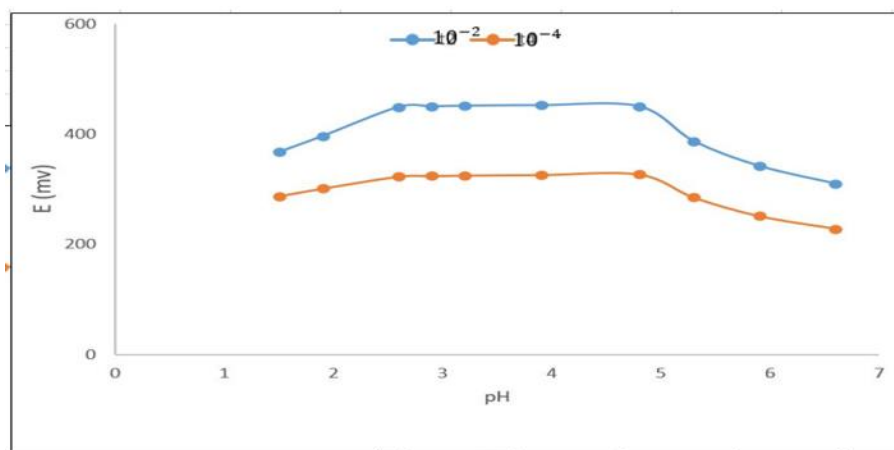


Figure (5) Effect of the pH function on the response of the nano-coated wire electrode (II) TPN- STPB -DEP-CuONPs

Table (2) Statistical treatment of the results of the calibration curve for electrode (I) TPN- STPB-DEP

| (taken)-Log[TPN] | (found)-Log[TPN] | RSD% | Recovery% |
|------------------|------------------|-------|-----------|
| 2 | 1.92 | 0.22 | 96 |
| 3 | 3.13 | 0.203 | 104.3 |
| 4 | 3.93 | 0.25 | 98.2 |
| 5 | 4.93 | 0.172 | 98.6 |
| 6 | 5.93 | 0.324 | 98.8 |

Table (3) Statistical treatment of the results of the calibration curve for electrode (II) TPN - STPB - DEP-CuONPs

| (taken)-Log[TPN] | (found)-Log[TPN] | RSD% | Recovery% |
|------------------|------------------|-------|-----------|
| 2 | 1.95 | 0.056 | 97.5 |
| 3 | 2.98 | 0.032 | 99.3 |
| 4 | 4.03 | 0.051 | 100.7 |
| 5 | 5.01 | 0.077 | 100.1 |
| 6 | 6.04 | 0.124 | 100.6 |
| 7 | 6.9 | 0.088 | 98.4 |
| 8 | 7.98 | 0.312 | 99.7 |

Table (4) values of the selectivity coefficient (K) for each of the manufactured electrodes (I) (TPN- STPB-DEP),(II) (TPN-STPB-DEP-CuONPs)

| Interfering ion | $K_{i,j}^{pot}$ | |
|------------------|----------------------------|---------------------------|
| | Coated wire electrodes TPN | |
| | TPN- STPB -DEP(I) | TPN- STPB -DEP-CuONPs(II) |
| sucrose | 0.517 | 0.240 |
| glucose | 0.9 | 0.022 |
| starch | 0.4007 | 0.044 |
| Magnesium Street | 0.37 | 0.068 |
| lactose | 0.226 | 0.085 |

As we note through the results shown in Table (4) that the selective nano-electrode (II) of TPN has a higher selectivity than the traditional selective electrode(I), and it appears that the additives (glucose, sucrose, starch, magnesium stearate, lactose) do not occur Any interference with the ion to be measured because the values of the selectivity coefficient are less than one correct for both the conventional and nano-fabricated electrodes (I,II)

CONCLUSIONS

Electrochemistry was studied, measuring the potential difference after fabricating two sensing copper wires, one of which is the electrode of the wire covered with copper nanoparticles (the nano-modifier electrode) and the other electrode of the traditional coated wire (the traditional electrode) to test the drug in its pure form and in the form of a pharmaceutical preparation, Whereas, through this study, it is clear that there is a difference in the selectivity and sensitivity in the results of the copper oxide (II) nano-coated wire electrode and the results of the conventional coated wire (I) electrode for antihistamine (TPN), It was found that the copper oxide (II) nanowire coated electrode has higher sensing and fast response time with stable results compared to the conventional selective coated wire(I) electrode, This is due to the characteristics of copper oxide nanoparticles in the electrical improvement, in addition to a larger surface area and small particle size, which made them more selective and more sensitive, and enabled them to quickly perform the search for the drug under study with wide concentration ranges and low limits, As a result of its good physical and chemical properties, it made the transfer of drug ions ⁽³⁰⁾ fast and thus the speed of sensitivity of the electrode towards the drug (TPN), Its selectivity is related to the free energy of movement of the drug ion between the membrane of the selective electrode and the solution of the drug, which is measured in reverse, This led to a successful adoption of a selective electrode enriched with copper oxide (II) nanoparticles in the rapid detection of triprolidine in pharmaceutical compounds and research centers.

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