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The use of various inorganic acids as shelf deposition solutions and their effect on nickel plates

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The present study shows the efficiency of various inorganic acids as shelf deposition solutions and their effects on nickel plates of 99% purity, 25 mm diameter and 0.50 mm of thickness [1]. 0.5M, 2M and 0.1M hydrochloric acid solutions in addition to 0.1M and 0.5M solutions of nitric, sulfuric, hydrofluoric and phosphoric acid were studied and compared.
Tap water was used as matrix, polonium analysis performed in 0.5L, while 209Po was used as an internal tracer. The pre-concentration of polonium performed via rotary evaporation at 40mbars/ 45oC. The deposition solutions were kept in a calibrated water bath, ascorbic acid was used as reducing agent and the temperature of each process was monitoring by a calibrated thermometer. The sources were measured by a-spectrometry.
Hydrochloric acid solutions are mostly preferable in polonium deposition. 0.5M hydrochloric acid solution was primarily examined at various temperatures and maximum deposition times of 6h (fig.1), since it is considered one of the most common used deposition solution in polonium analysis [2].

Figure 1. Polonium chemical recoveries on nickel plates in 0.5M HCL, at various deposition times and temperatures.

No damages were observed on nickel surface after the use of 0.5M hydrochloric acid solution at 55oC, 65oC and 75oC. Nevertheless, after 4h of stirring at 85oC potential corrosion was observed at the surface of the nickel plates which was indicated by a dark brown coloration of the deposition solution. Additionally, a reduction in chemical recovery observed after 4h of stirring at 85oC either due to damage on nickel surface or due to volatility of polonium although losses have been found to take place at 100oC [3]. 2M hydrochloric acid solution was afterwards examined. High chemical recoveries were achieved at 55oC for 4h and 6h of stirring however potential corrosion on the metal surface was similarly observed as the deposition solution acquired a dark brown coloration. 0.1M hydrochloric acid solution was also studied at the same conditions with no observed damages on nickel surface.
Nitric acid was rejected due to its corrosive effect on nickel surface even at room temperature. In contrast, the rest solutions caused no effect on the surface of the plates at the specific temperature (fig. 2).

Figure 2. Effect of various shelf deposition solutions on nickel plates at room temperature.

The deposition conditions for the rest solutions of the study were steadily selected at 55oC and 4hours stirring. The chemical recoveries and the solutions'effects on nickel plates are presented in table 1. The best chemical recoveries achieved via the use of 0.5M and 2M hydrochloric acid solutions, though 2M solution caused damage on nickel surface. Except nitric acid solutions which found to corrode nickel the rest inorganic acids of the study could successfully been used as alternative polonium shelf deposition solutions on nickel plates.

Deposition Temperature Time of Chemical Effects on nickel surface
solution (oC) deposition (h) recovery (100%)

2M HCL 55 4 89 Potential corrosion
2M HCL 55 6 97 Potential corrosion

0.1 M HCL 55 4 68 None
0.1 M HCL 55 6 71 None

0.1M HNO3 Room temp. Corrosion
0.5MHNO3 Room temp. Corrosion

0.5M H2SO4 55 4 80 None
0.1M H2SO4 55 4 66 None

0.5M H3PO4 55 4 75 None
0.1M H3PO4 55 4 56 None

0.5M HF 55 4 74 None
0.1M HF 55 4 50 None

Table 1. Polonium recoveries after the use of various deposition solutions and the solutions'effect on nickel plates.

References

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