**WEST VIRGINIA DEPARTMENT OF TRANSPORTATION**
**DIVISION OF HIGHWAYS**
**MATERIALS CONTROL, SOILS AND TESTING DIVISION**

**MATERIALS PROCEDURE**

# CHEMICAL ANALYSIS OF ALUMINUM ALLOYS

## 1.0 PURPOSE

1.1 To provide a method to determine the chemical analysis of Aluminum Alloys by Atomic Absorption and Gravimetric analysis.

## 2.0 SCOPE

2.1 This procedure is applicable to Aluminum Alloys furnished under Sections 661.2.1.1.1, 661.2.1.1.2, 661.2.1.2, 661.2.1.3 and 661.2.1.4 of the West Virginia Division of Highways Standard Specifications for Roads and Bridges.

## 3.0 REFERENCES

ASTM E1024
ASTM E34
ASTM C114
Ravenswood Aluminum Technical Method Number 100; Sheet Number 1100.00 thru Number 1100.12.

## 4.0 ATOMIC ABSORPTION SPECTROPHOTOMETER METHOD

With the exception of Silicon, which will be determined by Gravimetric Analysis (Section 4.2), all required chemical analysis under this procedure will be conducted by using the Atomic Absorption Spectrophotometer calibrated in accordance with ASTM E1024. This method covers the analysis and percentage determination of the following metals in accordance with ASTM E34; Fe (Iron), Cu (Copper), Mn (Manganese), Cr (Chromium), Zn (zinc), Ti (Titanium), Mg (Magnesium), and Ni (Nickel).

**4.1 Reagents Needed**

**4.1.1 Hydrochloric Acid (HCl), specific gravity 1.19**

**4.1.2 Hydrogen Peroxide ($H_20_2$), 30 percent solution.**

**4.2 Preparation of Standards**

**4.2.1 NBS and Alcoa Aluminum Standards are prepared that will bracket alloys received in the laboratory for analysis.**

**4.2.2 Weigh out 1.0000 plus or minus 0.0005 grams of alloy, place in a 1,000 mL volumetric flask, add 40 mLs 1 plus 1 HCL. After violent reaction ceases, add 2 mLs $H_20_2$ to the flask, place on pad on hot plate and finish dissolution (5 minutes). Cool, dilute to mark, mix thoroughly, and analyze on Atomic Absorption using working standards.**

**5.0 GRAVIMETRIC ANALYSIS METHOD**

**This method covers the analysis and percentage determination of Silicone. The method used for the analysis is in accordance with the Ravenswood Aluminum Technical Method Number 100; Sheet Number 1100.11 thru Number 1100.12.**

**5.1 Reagents and Equipment Needed**

**5.1.1 Mixed Acid Solution – Mix in order given: 700 mL $H_20$, plus 500 ml 1:1 sulfuric acid ($H_2SO_4$), 400 ml nitric acid ($HNO_3$), 400 ml hydro-chloric acid (HC1). Let cool after each acid addition. Store in plastic bottles.**

**5.1.2 Sulfuric Acid ($H_2SO_4$) - 10%**

**5.1.3 Hydrogen Peroxide ($H_2O_2$) – 3%**

**5.1.4 Number 40 Whatman (or equivalent) filter paper**

**5.1.5** **Porcelain Crucible – 15 to 30 mL capacity**

**5.1.6** **Muffle furnace conforming to ASTM C114, Section 4.2.7**

**5.2** **PROCEDURE**

**5.2.1** **Weigh one gram sample into a 250 mL Erlenmeyer wide mouth flask.**

**5.2.2** **Add 35 ml mixed acid solution slowly (for ½ g sample use 17.5 ml and for 2 g sample use 70 ml of mixed acid solution).**

**NOTE: Carry through a reagent blank.**

**5.2.3** **Evaporate to fumes after sample is completely in solution. Continue to fume until all heavy fumes have been driven from the bottom of the flask.**

**NOTE: Blank will go to complete dryness, only if started early.**

**5.2.4** **Remove from hot plate and cool to touch.**

**5.2.5** **Add 50 ml 10% $H_2SO_4$ (80 ml 10% $H_2SO_4$ for 2 g sample).**

**5.2.6** **Add several drops 3% $H_2O_2$.**

**5.2.7** **Place on hot plate and heat until all soluble salts are in solution. (Everything is in solution now but silicon.)**

**5.2.8** **Filter through Number 40 Whatman (or equivalent) filter paper.**

**5.2.9** **Wash flasks three times with hot water (police if necessary) and pour through filter also.**

**5.2.10** **Wash filter papers about ten times with hot water. Wash the papers approximately another five times or until the papers are acid free to the taste.**

**5.2.11** **Place filter papers in clean porcelain crucibles.**

**NOTE: Crucibles should have no pits or traces of previous ignitions.**

**5.2.12** **Burn for 45 minutes in a muffle furnace at 982ºC.**

**5.2.13** **Cool crucibles to room temperature. Carefully empty ash on keyboard, balance pan, and weigh.**

**5.3** **CALCULATION**

**The percent of the silicon content will be calculated as follows:**

$$\%Si = \frac{(\text{weight } SiO_2 - \text{blank})\ (0.4672)\ (100)}{\text{Sample Weight}}$$

**or use Silicon chart (1.0 G samples only). See Table 1.**

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**RDG:w**

**Attachment**

## TABLE 1
## S I L I C O N

| WT ASH | %Si | WT ASH | %Si | WT ASH | % Si | WT ASH | %Si | WT ASH | %Si | WT ASH | %Si |
|---|---|---|---|---|---|---|---|---|---|---|---|
| .0010 | .05 | .0031 | .14 | .0052 | .24 | .0073 | .34 | .0094 | .44 | .0115 | .54 |
| .0011 | .05 | .0032 | .15 | .0053 | .25 | .0074 | .35 | .0095 | .44 | .0116 | .54 |
| .0012 | .06 | .0033 | .15 | .0054 | .25 | .0075 | .35 | .0096 | .45 | .0117 | .55 |
| .0013 | .06 | .0034 | .16 | .0055 | .26 | .0076 | .36 | .0097 | .45 | .0118 | .55 |
| .0014 | .07 | .0035 | .16 | .0056 | .26 | .0077 | .36 | .0098 | .46 | .0119 | .56 |
| .0015 | .07 | .0036 | .17 | .0057 | .27 | .0078 | .36 | .0099 | .46 | .0120 | .56 |
| .0016 | .08 | .0037 | .17 | .0058 | .27 | .0079 | .37 | .0100 | .47 | .0121 | .57 |
| .0017 | .08 | .0038 | .18 | .0059 | .28 | .0080 | .37 | .0101 | .47 | .0122 | .57 |
| .0018 | .08 | .0039 | .18 | .0060 | .28 | .0081 | .38 | .0102 | .48 | .0123 | .57 |
| .0019 | .09 | .0040 | .19 | .0061 | .28 | .0082 | .38 | .0103 | .48 | .0124 | .58 |
| .0020 | .09 | .0041 | .19 | .0062 | .29 | .0083 | .39 | .0104 | .49 | .0125 | .58 |
| .0021 | .10 | .0042 | .20 | .0063 | .29 | .0084 | .39 | .0105 | .49 | .0126 | .59 |
| .0022 | .10 | .0043 | .20 | .0064 | .30 | .0085 | .40 | .0106 | .50 | .0127 | .59 |
| .0023 | .11 | .0044 | .21 | .0065 | .30 | .0086 | .40 | .0107 | .50 | .0128 | .60 |
| .0024 | .11 | .0045 | .21 | .0066 | .31 | .0087 | .41 | .0108 | .50 | .0129 | .60 |
| .0025 | .12 | .0046 | .22 | .0067 | .31 | .0088 | .41 | .0109 | .51 | .0130 | .61 |
| .0026 | .12 | .0047 | .22 | .0068 | .32 | .0089 | .42 | .0110 | .51 | .0131 | .61 |
| .0027 | .13 | .0048 | .22 | .0069 | .32 | .0090 | .42 | .0111 | .52 | .0132 | .62 |
| .0028 | .13 | .0049 | .23 | .0070 | .33 | .0091 | .43 | .0112 | .52 | .0133 | .62 |
| .0029 | .14 | .0050 | .23 | .0071 | .33 | .0092 | .43 | .0113 | .53 | .0134 | .63 |
| .0030 | .14 | .0051 | .24 | .0072 | .34 | .0093 | .43 | .0114 | .53 | .0135 | .63 |

$$\%Si = \frac{(Wt.\ Ash)\ (.4672)\ (100)}{Wt.\ Sample}$$