Part VI. Flame Spectra of Metal Aluminum Composition

ABSTRACT

The previous Parts showed the effect of magnesium powder as a fuel in high temperature compositions. In this Part the effect of aluminum powder is examined. In general aluminum melts and is sprayed as sparks out of the flame. It is not as easily vaporized because of its high boiling point. With aluminum the intensity of the spectrum of color-producing bands is not as high as with magnesium.

1. Introduction

In the foregoing Parts the author reported on the flame spectra of high flame temperature compositions using magnesium as the fuel. In this paper the author tried to examine the flame spectra using aluminum metal powder as the fuel in a few experiments. The method of experiments and the construction of the sample specimens were the same as before.

The flame using aluminum was quite different from that using magnesium. In the aluminum flame, many small liquid particles were generated in the flame and dispersed in the air as fine sparks. This might be due to the fact that aluminum has a much higher boiling point (2767 °C) than magnesium (1110 °C), and the vaporization of aluminum in the flame is not complete. Therefore, when a color agent is mixed into the composition, its effect is not clearly observed.

Table 1. Effect of Adding Color Agent to an Aluminum Fuel Composition.

Composition (84)	%
Ammonium perchlorate	*x*
Aluminum	*y*
Shellac	10
Color agent	10

No.	Color Agent	*x*%	*y*%	ω	Δ	ν	*L*	*E*	SrO_α	SrO_β
193	Strontium carbonate	60	20	9.0	1.18	1.84	160	871	3.0	4.0
194	Strontium carbonate	30	50	8.0	1.05	1.82	160	880	0.0	weak
									Na-D	
195	Sodium carbonate	60	20	9.3	1.22	1.62	160	1032	8.4	
196	Sodium carbonate	30	50	8.3	1.09	2.16	320	1735	5.8	
									$BaCl_{\alpha1}$	$BaCl_{\alpha2}$
197	Barium carbonate	60	20	9.3	1.18	1.80	160	960	4.2	4.2
198	Barium carbonate	30	50	8.3	1.09	2.85	160	656	3.9	3.8
									$CuCl_\alpha$	$CuCl_\beta$
199	Basic copper carbonate	60	20	9.1	1.20	2.69	320	1270	5.1	3.4
200	Basic copper carbonate	30	50	8.0	1.06	2.91	160	1320	4.0	weak

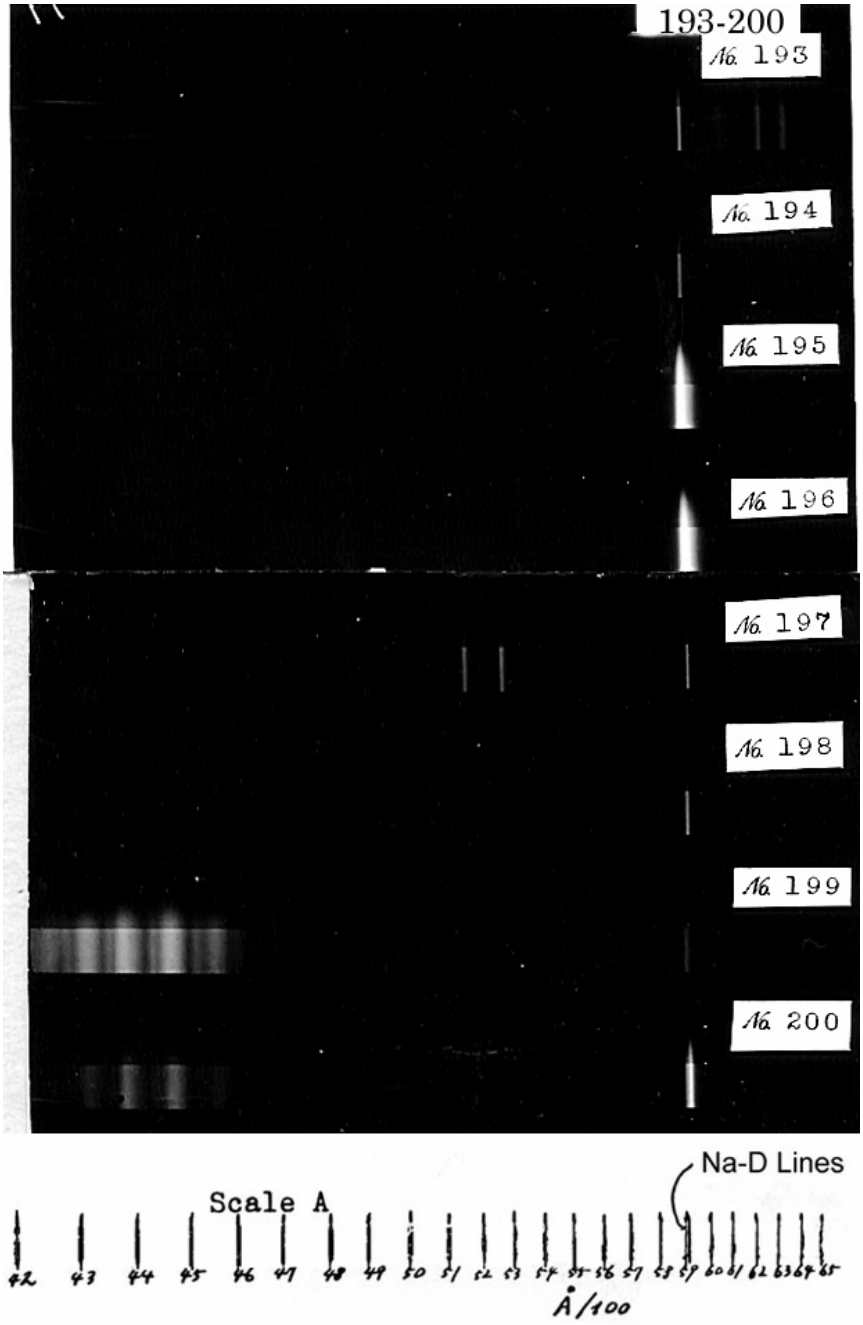

Photo 1. Flame spectra obtained from Composition No. 84 that contained aluminum as fuel.

2. Experimental Results and Examination of the Effects

An experiment was carried out with Composition (84). The results are shown in Table 1. The flame spectra corresponding to Table 1 are shown in Photo 1.

The following effects in the flame were observed with the naked eye. The flame of No. 193 was slightly reddish at the base of the flame. With No. 194 no red appeared, but pretty sparks were produced. In Nos. 195 and 196, the flame produced sparks; the sparks of No. 196 were very beautiful. In No. 198 the flame went out. The sparks from No. 199 were also very pretty.

When we examine Photo 1 of the flame spectra, we can understand that the lower aluminum percentage compositions produced a relatively stronger spectral band, which produces a better color effect than the higher aluminum percentage. Therefore, the lower aluminum percentage gives a better effect when seen with the naked eye. However the effects are much less than when magnesium is used in the compositions. The 20% aluminum sample is near the low flame temperature, and the effect of shellac in this experiment, like in general cases, appeared to aid in the deoxidation of the metal oxide.

3. Conclusion

The effective band spectra are very weak. The larger the percentage of aluminum, the weaker the band. Therefore it is difficult to obtain good colored flame when using aluminum as the fuel.