

OBSERVATIONS ON FERRO-TUNGSTEN.

BY WM. H. WAHL.

[Read at the stated meeting of the Chemical Section, held November 15, 1892.]

In the course of an investigation carried on during the past two years by the writer, in conjunction with Dr. William H. Greene, with the object in view of producing pure ferro-alloys, we made a number of experiments with ferro-tungsten.

These tungsten alloys exhibited similar physical properties possessing considerable hardness and toughness, an extremely fine crystalline texture, with a fracture resembling that of tool-steel, and a specific gravity ranging between 9.3 and 10.14.

Some of the fractures, however, exhibited the fact that the alloy was not entirely homogeneous, disclosing under the glass and in places to the eye, the presence of what are apparently smooth cleavages of imperfect crystals scattered through the finely-crystalline matrix of the alloy. The specimen shown you will illustrate my statement.

A sample of the alloy of 10.14 specific gravity was analyzed at my suggestion, by Mr. J. F. de Benneville in the laboratory of Dr. Genth. The result of the analysis exhibited a very high percentage of tungsten in the sample, and its behavior towards liquid and fused solvents proved the interesting fact that a large proportion of the tungsten was present in the uncombined condition, as metallic tungsten, crystallized in the matrix of the alloy. The facts upon which Mr. de Benneville has founded this observation will appear in the following extract from a letter describing briefly the method pursued in his analytical work.

"*Aqua regia* attacked it, although not energetically, and by decanting and adding fresh portions of acid from time to time a residue was obtained which resisted further action by acids, or by fusion with Na_2CO_3 and KNO_3 . It was a heavy, black, pulverulent substance, and in its negative

action towards solvents answered to tungsten, which I took it to be. It gave 22.54 per cent. of the original material. A second portion of the material (powdered in a steel mortar) was fused with a mixture of Na_2CO_3 and KNO_3 , lixiviated and the residue weighed. This was fused again and the residue weighed, the second weighing being practically the same, and yielding 22.80 per cent. of the original material, using strong HCl (1.20 Sp. gr.) in successive portions, decanting, igniting the residue and treating again with acid, gave me 21.74 per cent."

The foregoing extract appears fully to justify the conclusion that the undissolved residue represents the metallic tungsten present in the alloy in the uncombined state.

The composition of the metal analyzed by Mr. de Benneville is as follows :

	<i>Per Cent.</i>
C,	0.85
P,	0.041
Si,	0.14
Mn,	trace
Fe,	42.28
W (metal),	22.54
W (alloy),	34.35
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A study of these figures reveals another interesting fact to which I desire to call your attention.

Taking the figures of the iron and combined tungsten (42.28 : 34.35) and calculating the percentage of tungsten which this ratio represents, we obtain 44.82 per cent. tungsten. A calculation shows also that the figures representing the compound Fe_4W are almost identical with the ratio above-named, to-wit :

<i>Fe₄W</i> <i>Found.</i>	<i>Fe₄W</i> <i>By Theory.</i>	<i>Difference.</i>
Fe, 55.18 per cent.	Fe, 54.91 per cent.	
W, 44.82 "	W, 45.09 "	- 0.27
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100.00	100.00	

The conclusion would seem to be justified by the facts above noted, that the saturation point of iron for tungsten

is represented by the ratio exhibited in the compound Fe_4W , and that any excess of tungsten, above this ratio, present in a tungsten iron will remain uncombined.

I wish to express this statement as *probably* the correct interpretation of the facts, for it is hazardous to make a generalization of this kind on the results of a single analysis.

It may be interesting to note in conclusion that Howe, in his "Metallurgy of Steel," refers to several cases of ferro-tungsten indicating the composition Fe_3W , and that the works on metallurgy as a rule accept without question the dictum that iron and tungsten will unite in all proportions. In the light of the facts given in this paper, this last statement requires qualification.