WESTERN MILL AND SMELTER METHODS OF ANALYSIS: A PRACTICAL LABORATORY HANDBOOK FOR THE ASSAYER AND CHEMIST, DESCRIBING THE METHODS OF ANALYSIS IN EVERY-DAY USE IN WESTERN MILLS, SMELTERS AND CUSTOM ASSAY OFFICES

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(THIRD EDITION.)

A Practical Laboratory Handbook for the Assayer and Chemist, Describing the Methods of Analysis in Every-day Use in Western Mills, Smelters and Custom Assay Offices.

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PREFACE.

In May, 1904, I presented, in part fulfillment of the requirements for the degree Master of Arts in the University of Colorado, a thesis entitled "Smelter and Mill Methods of Analysis in Use in the West." This thesis was later published in Volume II., No. 1, of the University Studies, and though primarily intended for the use of students in the University, it has been found to be of considerable help to practical chemists in all parts of the West.

This treatise, revised and enlarged from the thesis, is intended for the use of practical chemists and assayers, and presupposes a thorough knowledge of chemistry. Hence no attempt is made to explain the nature of the chemical reactions that take place, a simple and clear outline alone is given. The methods of analysis given are those in every-day use in lead and copper smelters and in cyanide mills.

Acknowledgment is due Mr. J. E. Clennell for the description of a number of determinations in connection with the cyanide process from his paper "Analytical Work in Connection With the Cyanide Process," which was read before the Institute of Mining and Metallurgy in London on May 21, 1903; and to Mr. Philip Argall for much of the material in the chapter on "Ore Testing by the Cyanide Process."

Other authors have been freely consulted and due credit is given when any method so obtained has been used in this treatise.

To-day the metallurgical chemist almost entirely relies on volumetric methods for the analytical determinations required in metallurgical work. The operations of mill and smelter are being more and more directed according to the results obtained in the laboratory and the metallurgical chemist is now required to

make daily a number of determinations that would appall his predecessor of even a few years ago. The time allowed for making individual determinations is also being steadily reduced. Hence, the chemist is debarred from making the slower, but possibly more accurate, gravimetric determinations. He is driven, therefore, to using volumetric methods as far as possible. The speed and the comparatively small amount of attention required by individual assays in volumetric work also makes for the adoption of these methods. A few years ago furnace and gravimetric methods of analysis were standard; today, except for gold and silver, volumetric methods are used almost exclusively.

The standard solutions used are made up in large quantities at a time, and are kept, as far as possible, in a cool, dark place. Most of the solutions used maintain their standard for a considerable length of time.

Selby Works, March 1st, 1905.

The second edition of this book has made possible the correction of errors in the former edition and has enabled me to add some new methods and to include others overlooked in the first instance. Very little that is actually new has turned up in the ordinary smelter routine in the past three years, but a gradual uniformity in methods, which did not exist then, has come about, and in changing from one laboratory to another now one has no new methods to learn.

The first edition of this work was very favorably received, and I hope that this will be no less so, for, while many shortcomings will be found, I believe that the ground covered has been thoroughly gone over.

Selby Works, September, 1908.

CHAPTER 1.

Standard Solutions.

The following standard solutions are in general use in the lead and copper smelters of the West:

Name of Solution.	Amount of Salt in One Litre. Theoretical.	Practical.	Approximate Standard.	Used for Determining.
Potassium Bichromate	4.381	4.4	1cc=.005 Fe.	Fe.
Sodium Thiosulphate	12.59	20.0	1cc=.005 Cu.	As, Cu, I, Sb. Mn, CaO.
Potassium Permanganate	5.643	5.6	1cc=.005 CaO.	Fe, Sb.
Potassium Ferrocyanide		22.5	1cc=.005 Zn.	Zn.
Ammonium Molybdate		4.28	1cc=.005 Pb.	Pb.
Potassium Cyanide		44.5	1cc=.010 Cu.	Cu.
Oxalic Acid	11.25	12.46	1cc=1cc K MnO_4. =1cc .01 Fe.	Mn.
Potassium Sulphocyanate	8.981	10.0	1cc=.01 Ag.	Ag, As, S.
Barium Chloride	76.25	76.25	1cc=.01 S.	

Ammonium Oxalate	40	grams	per litre
Barium Chloride	20	"	" "
Mercuric Chloride	50	"	" "
Sodium Phosphate	100	"	" "

Stannous chloride, made by saturating hydrochloric acid with tin, diluting with an equal volume of water, and adding a slight excess of water from time to time. A strip of metallic tin is kept in the bottle.

From the potassium permanganate solution above