

**CIHM  
Microfiche  
Series  
(Monographs)**

**ICMH  
Collection de  
microfiches  
(monographies)**



**Canadian Institute for Historical Microreproductions / Institut canadien de microreproductions historiques**

**© 1999**

## Technical and Bibliographic Notes / Notes techniques et bibliographiques

The institute has attempted to obtain the best original copy available for filming. Features of this copy which may be bibliographically unique, which may alter any of the images in the reproduction, or which may significantly change the usual method of filming are checked below.

- Coloured covers / Couverture de couleur
- Covers damaged / Couverture endommagée
- Covers restored and/or laminated / Couverture restaurée et/ou pelliculée
- Cover title missing / Le titre de couverture manque
- Coloured maps / Cartes géographiques en couleur
- Coloured ink (i.e. other than blue or black) / Encre de couleur (i.e. autre que bleue ou noire)
- Coloured plates and/or illustrations / Planches et/ou illustrations en couleur
- Bound with other material / Relié avec d'autres documents
- Only edition available / Seule édition disponible
- Tight binding may cause shadows or distortion along interior margin / La reliure serrée peut causer de l'ombre ou de la distorsion le long de la marge intérieure.
- Blank leaves added during restorations may appear within the text. Whenever possible, these have been omitted from filming / Il se peut que certaines pages blanches ajoutées lors d'une restauration apparaissent dans le texte, mais, lorsque cela était possible, ces pages n'ont pas été filmées.
- Additional comments / Commentaires supplémentaires:

L'institut a microfilmé le meilleur exemplaire qu'il lui a été possible de se procurer. Les détails de cet exemplaire qui sont peut-être uniques du point de vue bibliographique, qui peuvent modifier une image reproduite, ou qui peuvent exiger une modification dans la méthode normale de filmage sont indiqués ci-dessous.

- Coloured pages / Pages de couleur
- Pages damaged / Pages endommagées
- Pages restored and/or laminated / Pages restaurées et/ou pelliculées
- Pages discoloured, stained or foxed / Pages décolorées, tachetées ou piquées
- Pages detached / Pages détachées
- Show through / Transparence
- Quality of print varies / Qualité inégale de l'impression
- Includes supplementary material / Comprend du matériel supplémentaire
- Pages wholly or partially obscured by errata slips, tissues, etc., have been refilmed to ensure the best possible image / Les pages totalement ou partiellement obscurcies par un feuillet d'errata, une pelure, etc., ont été filmées à nouveau de façon à obtenir la meilleure image possible.
- Opposing pages with varying colouration or discolorations are filmed twice to ensure the best possible image / Les pages s'opposant ayant des colorations variables ou des décolorations sont filmées deux fois afin d'obtenir la meilleure image possible.

This item is filmed at the reduction ratio checked below / Ce document est filmé au taux de réduction indiqué ci-dessous.

10x		14x		18x		22x		26x		30x	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	12x		16x		20x		24x		28x		32x

The copy filmed here has been reproduced thanks to the generosity of:

University of Toronto Archives

This title was microfilmed with the generous permission of the rights holder:

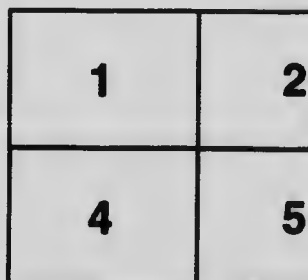
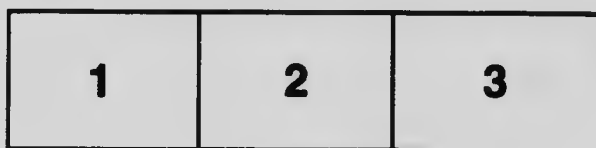
James D. Bain

The images appearing here are the best quality possible considering the condition and legibility of the original copy and in keeping with the filming contract specifications.

Original copies in printed paper covers are filmed beginning with the front cover and ending on the last page with a printed or illustrated impression, or the back cover when appropriate. All other original copies are filmed beginning on the first page with a printed or illustrated impression, and ending on the last page with a printed or illustrated impression.

The last recorded frame on each microfiche shall contain the symbol → (meaning "CONTINUED"), or the symbol ▼ (meaning "END"), whichever applies.

Maps, plates, charts, etc., may be filmed at different reduction ratios. Those too large to be entirely included in one exposure are filmed beginning in the upper left hand corner, left to right and top to bottom, as many frames as required. The following diagrams illustrate the method:



L' exemplaire filmé fut reproduit grâce à la  
générosité de:

University of Toronto Archives

Ce titre a été microfilmé avec l'aimable autorisation  
du détenteur des droits:

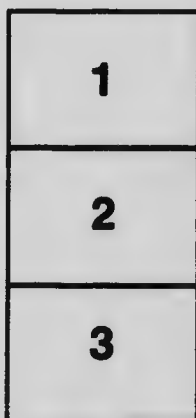
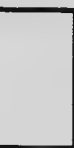
James D. Bain

Les images suivantes ont été reproduites avec le  
plus grand soin, compte tenu de la condition et de  
la netteté de l'exemplaire filmé, et en conformité  
avec les conditions du contrat de filmage.

Les exemplaires originaux dont la couverture en  
papier est imprimée sont filmés en commençant  
par le premier plat et en terminant soit par la  
dernière page qui comporte une empreinte d'im-  
pression ou d'illustration, soit par le second plat,  
selon le cas. Tous les autres exemplaires origi-  
naux sont filmés en commençant par la première  
page qui comporte une empreinte d'impression ou  
d'illustration et en terminant par la dernière page  
qui comporte une telle empreinte.

Un des symboles suivants apparaîtra sur la  
dernière image de chaque microfiche, selon le cas:  
le symbole → signifie "A SUIVRE", le symbole ▼  
signifie "FIN".

Les cartes, planches, tableaux, etc., peuvent être  
filmés à des taux de réduction différents. Lorsque  
le document est trop grand pour être reproduit en  
un seul cliché, il est filmé à partir de l'angle  
supérieur gauche, de gauche à droite, et de haut  
en bas, en prenant le nombre d'images  
nécessaire. Les diagrammes suivants illustrent la  
méthode.



UNIVERSITY OF TORONTO  
STUDIES

PAPERS FROM THE CHEMICAL  
LABORATORIES

No. 78: LOSS OF CARBON DURING SOLUTION OF STEEL  
IN POTASSIUM CUPRIC CHLORIDE, BY E. P. MOORE AND  
J. W. BAIN

(REPRINTED FROM THE JOURNAL OF THE SOCIETY OF CHEMICAL INDUSTRY, VOL. XXVII)

THE UNIVERSITY LIBRARY: PUBLISHED BY  
THE LIBRARIAN, 1908



University of Toronto Studies  
COMMITTEE OF MANAGEMENT

---

*Chairman:* ROBERT ALEXANDER FALCONER, M.A., LL.D., LL.D., D.D.  
President of the University

PROFESSOR W. J. ALEXANDER, Ph.D.

PROFESSOR W. H. ELLIS, M.A., M.B.

PROFESSOR A. KIRSCHMANN, Ph.D.

PROFESSOR J. J. MACKENZIE, B.A.

PROFESSOR R. RAMSAY WRIGHT, M.A., B.Sc., LL.D.

PROFESSOR GEORGE M. WRONG, M.A.

*General Editor:* H. H. LANGTON, M.A.

Librarian of the University





REPRINTED FROM THE JOURNAL  
OF THE  
**Society of Chemical Industry.**

**CANADIAN SECTION.**

AUGUST 31 1908.

**LOSS OF CARBON  
DURING SOLUTION OF STEEL IN  
POTASSIUM CUPRIC CHLORIDE.**

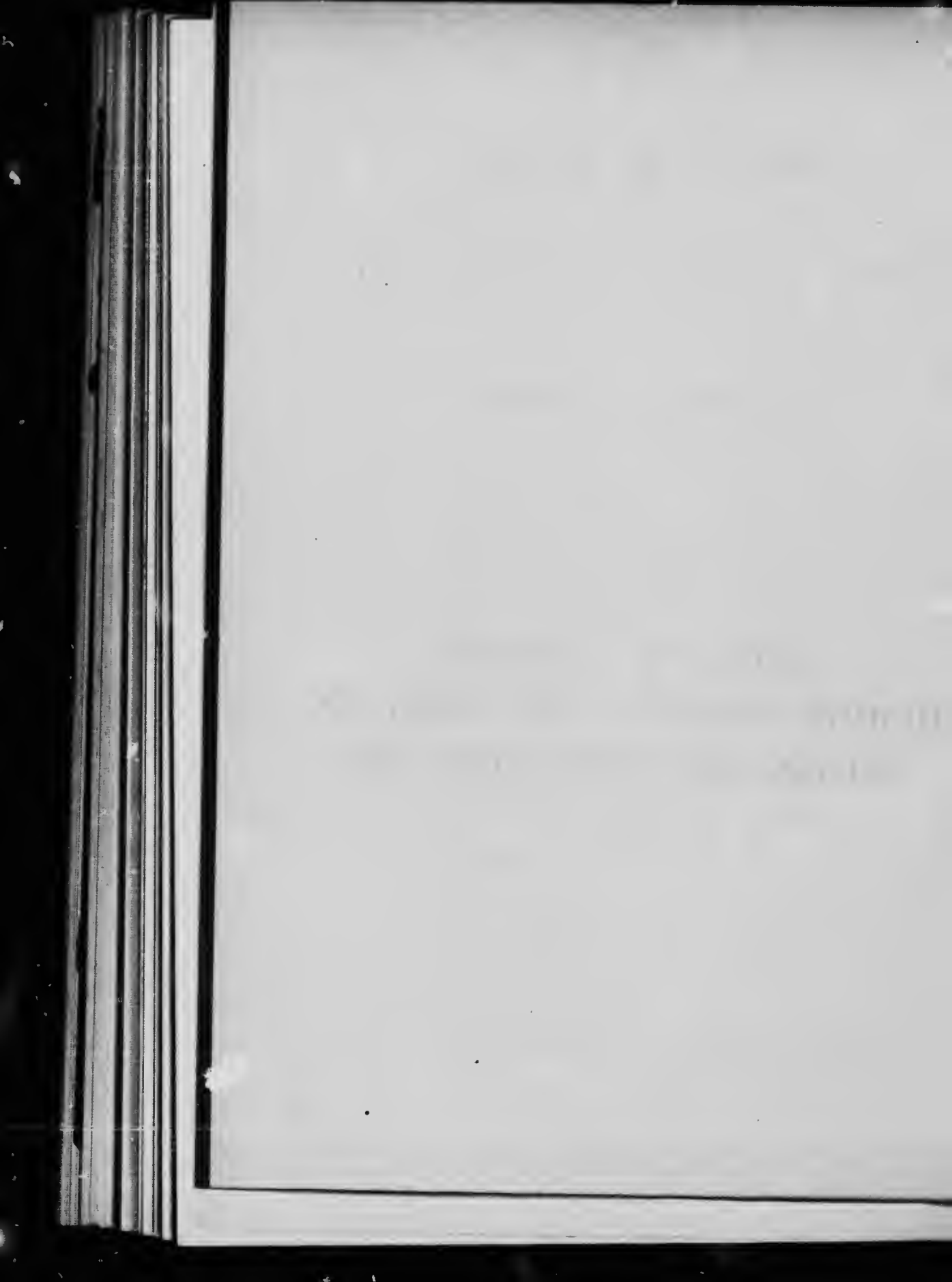
BY  
E. P. MOORE AND J. W. BAIN.

LONDON :  
VACHER & SONS, WESTMINSTER HOUSE, GREAT SMITH STREET, S.W.

1908.

(17292)





## Canadian Section.

Meeting held at Toronto on Thursday, May 16, 1908.

PROF. W. H. ELLIS IN THE CHAIR.

### LOSS OF CARBON DURING SOLUTION OF STEEL IN POTASSIUM CUPRIC CHLORIDE.

BY E. P. MOORE AND J. W. BAIN.

There has been much uncertainty as to whether carbon is lost by the evolution of gaseous hydrocarbons during the solution of steel in acid potassium cupric chloride solution when this method is used for the determination of carbon in steel. Dillner<sup>(1)</sup> remarks, "As is well known a loss has been pointed out on several occasions by various authorities, there is always an evolution of hydrocarbon gases when steel dissolves in cupric chloride, which escape"; accounting in this way for the lower results obtained from the indirect process. He also refers to some observations made by Ledebur<sup>(2)</sup>, but unfortunately the publication was inaccessible. Arnold<sup>(3)</sup> states that he has seen distinctly bubbles rising through the liquid during the solution of steel in copper chloride.

The problem has hitherto been attacked from the following standpoint. Samples of steel are dissolved in various solvents of various concentrations and the carbon estimated as usual. The highest percentage obtained is selected as a standard and the discrepancies between this and the other results are ascribed to losses during solution. True, these results are confirmed by determinations made by the volatilisation of the iron by chlorine or by direct combustion, but even in these cases the uncertainty of a numerical difference between two results, each burdened with experimental errors, is obvious. For these reasons it appeared to be desirable to determine, by a direct process if possible, whether any carbon was lost during the solution of iron or steel in the solvent so commonly used—potassium cupric chloride.

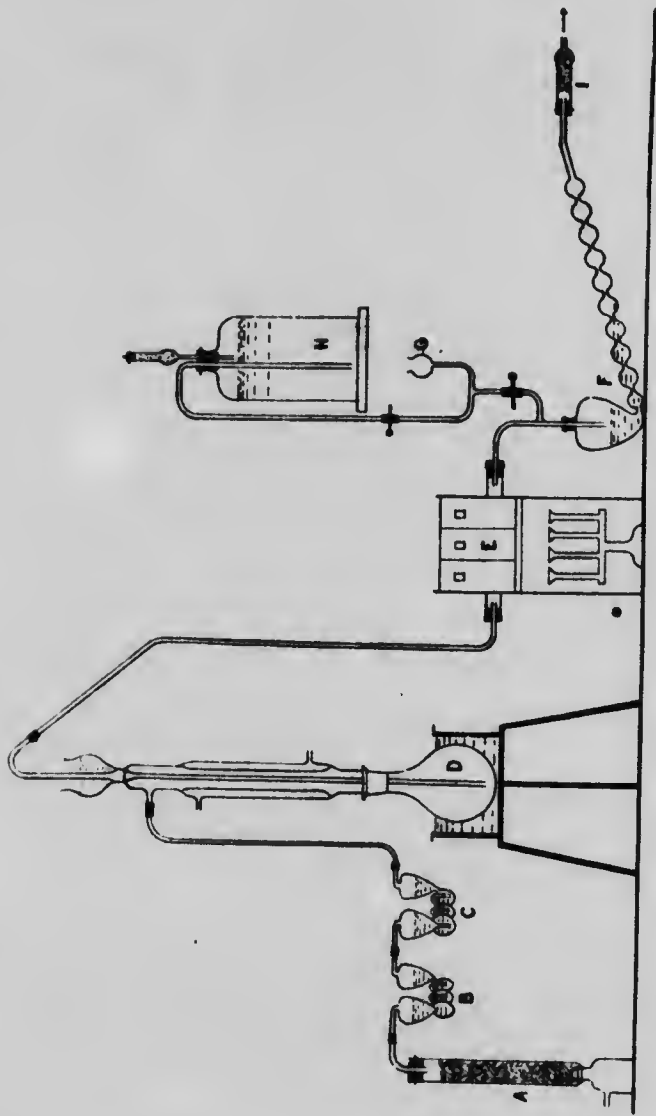
The following apparatus was used (see figure):—  
A, A drying tower filled with potassium hydroxide in sticks. B, An absorption bulb filled with potassium hydroxide solution. C, An absorption bulb filled with barium hydroxide solution. D, A Rheindorf<sup>(4)</sup> flask for estimation of carbon, immersed in a water bath maintained at a temperature of 65° C. E, A piece of combustion tubing filled with cupric oxide, heated to redness in a small gas furnace. F, A ten bulb absorption apparatus charged with barium hydroxide. G, A small thistle

tube sealed to a glass T as shown. H, A stock bottle containing barium hydroxide. I, A guard tube filled with soda-lime. The introduction of barium hydroxide into the absorption bulb is the only feature which calls for remark. A current of air free from carbon dioxide having been drawn through the bulb, F, for some time, a suitable quantity of barium hydroxide solution was siphoned over, being clarified in transit by passing through a filter of ignited asbestos (not shown). In the first experiments a slight precipitate formed on the inner surface of the delivery tube which protrudes into the bulb, F; by pouring into the funnel, G, a small quantity of recently-boiled distilled water and allowing it to wash down, it was found that this could be entirely avoided.

The flask, D, was charged with a solution of potassium cupric chloride made by dissolving 300 grms. of the salt in 1 litre of water and adding 75 c.c. of concentrated hydrochloric acid. Blank tests were made by placing in the flask, D, the quantity of potassium cupric chloride solution usually employed, and after aspirating for some time to clear the apparatus of carbon dioxide, filling the bulb, F, with barium hydroxide solution, and proceeding to heat the flask, D, to 65° C. After aspirating for two hours, in no case was there more than a very faint cloud of barium carbonate to be observed in the tube, F; efforts were made to collect and weigh this precipitate, but without success. Three grms. of steel were then placed in the solution flask, 200 c.c. of potassium cupric chloride solution added, and the water bath maintained at a temperature of 65° C.; air was also slowly aspirated through the apparatus, the cupric oxide having been previously brought to red heat. When the steel had dissolved completely, the ten bulb tube was removed, and a stopper carrying a soda-lime tube placed immediately in the larger end, while the other opening was connected by rubber tubing to the glass tube in the cork of a filtering funnel. The barium carbonate was transferred as completely as possible to the filter and washed with recently-boiled distilled water; the absorption tube and the filter were then treated with dilute hydrochloric acid, the asbestos filtered off, and the barium precipitated as sulphate and weighed.

Two samples of steel were employed; the one containing 0.653 per cent. of carbon, the other 1.18 per cent. Four determinations were made on each of these, 3 grms. being used in each case; the results are expressed as grms. of carbon escaping from the flask.

0.653 per cent. Steel.		1.18 per cent. Steel.	
	GRM.		GRM.
	0.00176		0.00115
	0.00112		0.00121
	0.00142		0.00100
	0.00159		0.00103
Mean . . . . .	0.00147		0.00110
Loss on 1 gm.	0.0005		0.0004



In the case, therefore, of the 0.633 per cent. steel, a quantity of carbon corresponding to 0.05 per cent. has been lost during solution, making the true percentage 0.703; with the other the true percentage will be 1.22.

These losses are comparatively large, although not much greater than some of the discrepancies between the results obtained by various members of the International Committee. In view of the difficulties in manipulation the authors do not profess that their figures represent the actual loss, but they believe that they have proved that a loss does take place under the conditions given above, and also that the amount approximates fairly closely to the figures given.

---

(1) J. Iron and Steel Inst., 66, 255.

(2) Verein zur Beförderung der Gewerbewissenschaften, Vols. 6, 7.

(3) Steel Works Analysis, 2nd ed., p. 29.

(4) Zeits. angew. Chem., 1904, 467.









