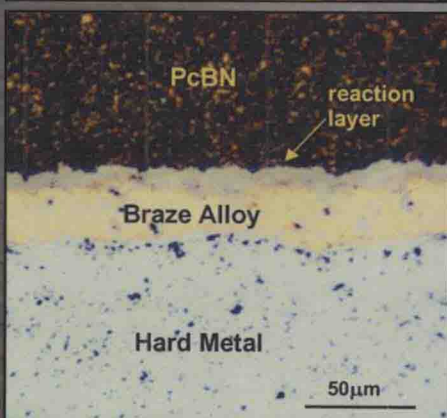
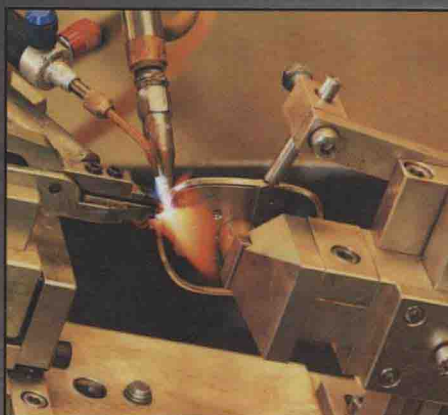


Introduction to
BRAZING
TECHNOLOGY



P.M. ROBERTS

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Preface

When a visitor to a major museum in any of the world's capital cities chooses to visit one which contains a number of ancient Egyptian or Sumerian artefacts, they will almost certainly see examples of both jewellery and gold drinking vessels. Close examination by the visitor of the point where the handles of a drinking vessel are attached to its body will show the presence of a streak of metal that is slightly lighter in colour than that of both the handle and the body. The presence of that streak is incontrovertible evidence that the handle has been attached to the body by brazing, the streak being the witness of the filler material that was used to make the joint!

It is an important fact that experienced archaeologists can often date the manufacture of such vessels as being around 4000 BC, and so today they are slightly more than 6000 years old! It is therefore reasonable to claim that brazing is the oldest metal-joining process known to humankind. No one can be certain of the precise date of the discovery of the brazing process by early humans, and it has been postulated that the first brazed joints were made when a forest fire resulted in two drinking vessels, one gold and one silver, being accidentally joined together when the fire destroyed the hut where they were being kept.

This conclusion can be justified on the basis that such a fire would have certainly contained a moderately large amount of carbon monoxide (a reducing gas), and gold in contact with silver in such a high-temperature environment would bond them together due to the mutual inter-diffusion of the gold and silver. Consequently, it is a strong possibility that the first examples of brazing can actually be described as examples of reducing-atmosphere furnace brazing. Interestingly, reducing-atmosphere furnace brazing is the process that is widely used today by the automotive industry when constructing state-of-the-art stainless steel fuel-injection rails.

Clearly, the technology of the brazing process, and our understanding of how and why it works, has expanded greatly in the past 6000 years; this short text highlights *one* of the fundamentals that lies at the heart of the brazing process, and that is when two metals are joined to each other *by brazing* they must not melt, but they must be able to diffuse into each other in order that a joint can be made!

The author of this book has been active as a technical consultant specialising in the promotion of the application of brazing technology in industry for more than 50 years, and has observed some dramatic changes in its application as an industrial joining process during that time. These changes have resulted in the situation where large numbers of companies who use the process as their preferred metal-joining procedure are singularly failing to use it to best effect. This is because there is no one

within their organisation who really *understands* the finer points of the *detail* of the technology and so is unable to take advantage of its inherent versatility! This book has, therefore, been written to provide current users, and also newcomers to brazing, with a reference work that will help them deal with the problems they face in their day-to-day application of the brazing processes used in their production processes.

Acknowledgements

It is an unpalatable fact that no matter how much one thinks that they know about brazing there are literally dozens of important things that one does not know. I can say with complete honesty that if, over the 50 years that I have been giving advice to users of brazing, I had been given a £1 coin every time that I could say to myself at the end of a technical discussion, 'That was something new that I have learned today', I would now be driving a Mercedes Benz AMG rather than my recently purchased C-180 Blue Efficiency model.

So it has proved in the writing of this book. Half-truths are the nightmare that awaits one when setting out plans to put one's recommendations on paper – there is always someone who knows more about the topic than you do, and this person, particularly if he is a friend, can easily turn your half-truth into the real facts if you take the initiative to ask him to comment on the text you have just finished.

Fortunately, over the years I have been lucky enough to have built up a core of friends who are truly experts in their individual fields of brazing, and who have been willing to discuss matters with me where I felt I was right, but had to ask them to give their expert opinion on my views *before* they appeared in print in articles or this book!

I am particularly grateful for the comments and advice I have received from my contacts within Johnson Matthey Metal Joining, BrazeTec GmbH, Mahler GmbH, Schmetz GmbH, Innobraze GmbH, VerMoTech GmbH, and Element 6 GmbH, for the help that each has provided to me during the preparation of this book. Without their knowledge being available to me on a variety of certain very specialised aspects of a number of matters discussed in the book, it is certain that it would have contained a number of small inaccuracies. Though not critical in themselves, the inaccuracies could have been the cause of production problems had I just used my original text. However, where I felt I might be on *shaky ground* on a matter of the procedure to be adopted to achieve a best-practice result, I have taken the time to cross check those points with one or two of my friends.

Naturally, the information in this book is based on data I have gleaned during my globe-trotting years. Since much of it has been gathered from literally dozens of diverse sources, I find it impossible to be 100% sure of the actual source of some items of importance; consequently, to all those people and organisations who have helped me over the past 50 years to learn the ropes of the fascinating technology of brazing, many thanks indeed for donating your time to help me make life easier for others facing problems similar to those which you faced, and solved, 'n' years ago!

Finally, anyone who has been kind enough to purchase any of the other books that carry my name will already know that while I might be reasonably competent at dispensing information on brazing, I have a very strong aversion to gardening, but it currently looks as though my wife feels that she needs to initiate a training programme for 'recalcitrant persons' like me, one who cannot tell the difference between the use of a garden fork or a hoe, by recruiting me as someone whom she can use as a guinea pig for her training programme!

I begin to think that perhaps I should try my hand at writing a very lengthy novel?

Author

The author first encountered the brazing process when he joined Johnson Matthey and Company Limited in 1956 to train as an assayer of industrially used silver alloys and silver-containing brazing filler materials. In 1958 he changed departments and trained as a process control metallurgist, and studied the intricacies and the technology of the subject at Battersea Polytechnic, the forerunner of Surrey University. In 1963 an opportunity arose for him to join the Sales Technical Services Department of Johnson Matthey Metals to be trained as a specialist brazing engineer.

During the next 30 years he held a sequence of technical posts that provided support to the customers of three of the four leading producers of brazing materials in the Western world, and gained hands-on practical experience in the specification and use of automated brazing equipment and continuous-conveyor brazing furnaces. Between 1993 and 1996 he was the manager of the Precious Metals Division of the UK Branch of Degussa AG. He took early retirement on his 60th birthday in 1996, and created Delphi Brazing Consultants, a small, but specialised, business that is still in operation. This change of role on his retirement has been instrumental in his being able to help clients solve brazing problems in the United Kingdom, Mainland Europe, North America, South Africa, and Australia, New Zealand, Mexico and China, and having the time to both write and subsequently revise *Industrial Brazing Practice*, as well as some 25 technical articles, many of which having been published in *Welding and Cutting*, the journal of the DVS (The German Welding Society).

In 1971 he was a founder member of the British Association for Brazing and Soldering (BABS), and became its second chairman for the period 1973–1975. In 1995 BABS changed its name to The European Association for Brazing and Soldering (EABS), and he acted as its chairman between 1998 and early 2014.

In 2006 he was nominated by BSI to be the Principal UK Expert to the ISO Committee TC44-WG3, and joined the band of international brazing experts that were already on that committee. Interestingly, he found that many of the fellow members of the committee were already friends, and still remain so. They are mostly people with whom he has worked in various countries around the world while engaged in his current business role as a brazing consultant. However, and although he still has a great interest in the ongoing codification and standardisation of matters of concern to the people involved with the use of brazing as their joining method of choice, he began to wish he had only a periphery role in regard to future projects, one where he could express his views in writing rather than presenting them verbally at a meeting, particularly if to do so involved the need to undertake long-haul air travel.

In May 2010 he was elected chairman of the Technical Brazing Committees of both the United Kingdom and the European Union, posts from which he has recently resigned. He felt that since on his next birthday he would attain four score years of age, it was due time that a new broom should be appointed to clear out '*those things that were not done that ought to have been done*'!

Introduction

This book is intended to be an aid to people who plan to join materials together by means of the brazing process. Its objective is to be informative without the confusion of unnecessary procedural detail. Naturally, it contains details of the fundamental technical concepts that form the basis of the brazing process, and describes many of the recent advances that have taken place in the technology. However, since this book is intended to be one of reference that provides the basic and fundamental information about a whole host of brazing matters, it does not include detailed information on every aspect of brazing that is mentioned in its pages. Fortunately, the data that is not provided in this book is to be found in *Industrial Brazing Practice*. That book was written by the author of this current work, and is obtainable from the same sources as the one you are reading.

Clearly, a good working knowledge of the terminology of the brazing process is also desirable since it will make it easier to engage in an ongoing discussion of the details of the technology with colleagues and other workers in the field. It is self-evident that an appreciation of the basic terminology used in brazing is a necessary prerequisite for success. It is for this reason that a glossary of the terms employed in brazing technology cover this fundamental facet of brazing as a references document and is to be found at the end of this book.

One of the important features of the glossary is that it is believed to include all terms that relate to the brazing process that are not adequately defined in current dictionaries. Because this book is a comprehensive compilation of brazing terminology, some non-standard terms are included with cross referencing to the corresponding standard terms – bold typeface indicates *standard terms*; the use of plain typeface indicates terms that are *non-standard*.

Readers should be aware that if an EN or ISO Standard (e.g. ISO 17632:2010) is mentioned in this book it refers to its most recent version.

EUROPEAN (EN) AND ISO REFERENCES

The following standards contain provisions which, through references in this text, constitute mandatory provisions of this document. In cases where the reference is undated, the most recent edition of the referenced standard applies.

A. Current ISO and EN Documents

Identification Number	Title of Standard
EN 12797	Brazing – Destructive testing of brazed joints
EN 12799	Brazing – Non-destructive testing of brazed joints
EN 13133 ^a	Brazing – Operator qualification
EN 13134 ^a	Brazing – Procedure qualification
EN 14276-1	Pressure equipment for refrigeration systems and heat pumps
EN 857-2	Vocabulary – Soldering and brazing process related terms

ISO 4063	Welding, brazing, soldering and braze welding of metals Nomenclature of processes and reference numbers for symbolic representation on drawings
ISO 17672	Brazing – Standardised filler materials
ISO 18297	Brazing – Imperfections in brazed joints

^a Currently being revised and updated by ISO-TC/44-SC13.

B. American Welding Society (AWS) Documents

AWS A3.OM/A3.0:2010 Standard Welding Terms and Definitions

AWS A1.1, Metric Practice Guide for the Welding Industry

C. Other Document

The New Oxford Dictionary of English 1998

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TERMS AND DEFINITIONS

For the purposes of the glossary, the following definitions apply:

Definition: A statement of the exact meaning of a particular word or phrase, especially ones found in a dictionary.

N.B.: A glossary of the terms often encountered when brazing technology is being written about or discussed between colleagues will be found at the end of this book just before the main index to its contents.

Non-standard term: A word or phrase that is used colloquially to refer to one of the definitions given in this specification. In such instances the fact that the entry in this specification is a non-standard term will be signified by the use of italicised plain typeface.

Standard term: A word or phrase recognised by this standard as the preferred terminology to use in either oral or written language when communicating with a third party on matters that relate to a particular subject in the lexicon of brazing technology. When used in this document, ‘standard terms’ are identified by the use of an italic typeface.

Term: A word or phrase used to describe a thing, or to express a specific concept, especially in a particular branch of study; such as brazing technology for example.

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