

Key aspects in flame brazing aluminium

By

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Brazing of aluminium can broadly be classified into two main areas.

- Brazing in an enclosure i.e. Furnace brazing either in a Vacuum furnace (without flux) or Controlled Atmosphere Brazing CAB (with flux)
- In air brazing i.e. brazing with a flux in open air by Flame or Induction

What is common to all these processes is the need to understand the technical detail of each type of application method and importance of collecting process data and then learn how to read the data.

The author has been involved in flame brazing aluminium since 1991 and delivered many theoretical, practical training sessions, plus troubleshooting on many different flame brazing applications'.....on various complexity of machine designs from many different "flame brazing equipment manufacturers" around the world.

During which I have been asked many times "what are the most common problems associated with flame brazing?"my answer is also the same.....PEOPLE..... first not fully understanding the basic rules and then not knowing how to apply them to their application.

The presentation will concentrate on the key aspects of flame brazing including.

1. Service condition and environment
2. Material selected
3. joint design and tolerances
4. alloy and flux selection
5. flame selection
6. flame process complexity scale of 0 to 10 (open and closed loop temperature control)

"PEOPLE"

People make decisions, but they don't really intentionally set out to make wrong decisions. They might not have all the data necessary to make the right decision at the time they need to make some initial decisions.

The different stages of a project can be

Concept.....design.....development.....specification.....manufacturing

And it's very common for different people to make decisions as the project moves from concept right through to manufacturing.

When I get asked to troubleshoot it is normally later on in the project when lots of decisions have already been made.....at this stage the first thing to do is start collating process data....

In a 30 min presentation it is impossible to go into all the detail regarding flame brazing. Therefore, I have selected a few slides which I use when delivering Flame brazing training seminars for the European Association for Brazing and Soldering ..EABS (more slides will be used during the presentation)

The **six** fundamental rules for successful brazing

N.B. There are only **six** 'rules':

1. Have a **clean surface**
2. **Heat** the joint **evenly** to brazing Temperature
3. Choose the right **brazing alloy** for the job
4. Select the appropriate means of **removing the oxide skin** from the faying surfaces of the joint
5. Use a capillary gap of the **appropriate size**
6. Apply the brazing alloy to the **last part of the joint to reach brazing temperature.**

Follow these rules and you **will** achieve the results you want!

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It's easy to say but how do we get started.....

Process Analysis

What are the four critical parameters of your requirements?

- To **identify, and then prioritise** your **needs**.
- To **identify the variables** that are present.
- To **identify any particular parameter of your process that will impose a limit** on the actions that you can take
- To **determine the level of process complexity** that you actually **need** in order to meet your production objectives.

With these parameters determined you can move on the final, and vital, stage:

➤ **YOU** can develop an '**Action Plan**' that will enable you to implement the 'best practice' solution to your brazing problem.

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The Process Analysis Format

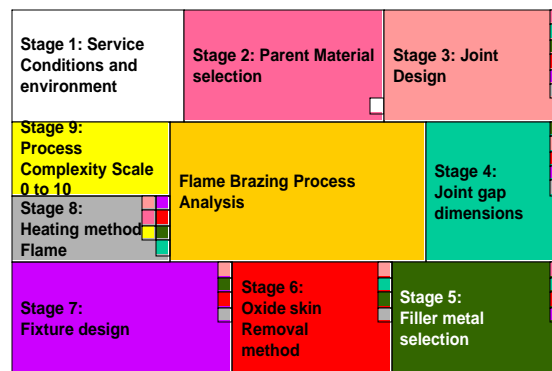
There are nine steps in the Analysis.
These are as follows.....!

1. The **Service conditions** and **environment** !
2. The **parent materials** that are to be brazed !
3. The **joint design** that will be used !
4. The **dimension** of the joint gap **at brazing temperature** !
5. The selection of the **filler material** !
6. The **method** to be used **to remove the surface oxides** in the joint area !
7. The **design of the fixture** that will cradle the assembly during brazing !
8. The **heating method** that will be used to raise the joint to brazing temperature !
9. The level of **process complexity needed** to achieve the production objectives !



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Using the Process Analysis Format



Remember.....a change in **any** of the Stages of a Process Analysis Procedure will almost certainly mean that **changes will have to be made in others!!**

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As we start to collate process data we need to put it some where.....create a simple file/portfolio and simply index it 1-9.

Start to look for potential variables in each section.....if you don't look you won't find any! And there will potentially be quite a few!

Then ask the question if I change anything in one section what effect will this have in others sections.....simple colour coding can illustrate this very well.

Brazing is a time temperature process, and our objective is to heat the surfaces of two components uniformly so the flux melts and removes the surface oxides allowing the filler metal to form a joint between these two surfaces.

Terminology

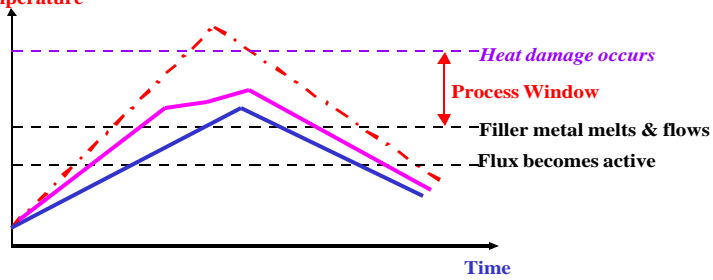
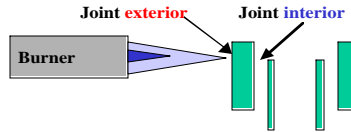
Process Window

Temperature of exterior surface - - - - -

Temperature of interior surface —————

Ideal heat pattern —————

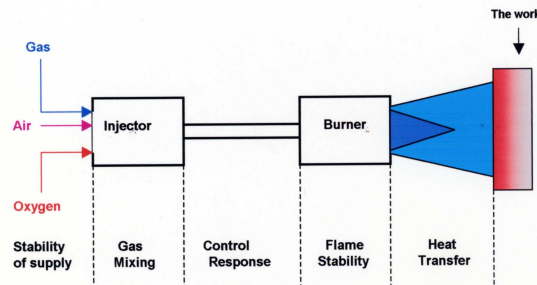
Temperature



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The flame is the heat source touching the external surface of the parent material to transfer heat to the surface then conduction transfers the heat through the material to the internal surfaces of the joint.....carefully ensuring you do not melt the external surface of the parent material while waiting for the internal surface to reach brazing temperature.

The flame needs to be stable on the burner head and there are many relationships upstream of the flame

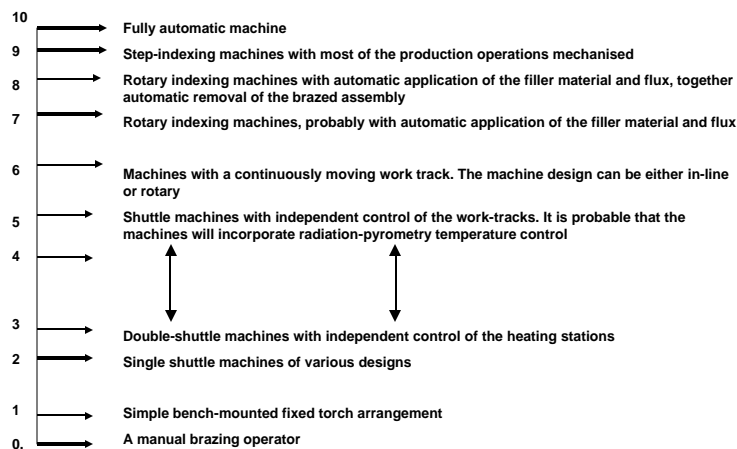


Flame Process Relationships

Any equipment used will fall within the simple complexity scale of 0 to 10
0 being manual operation with a hand torch....10 being the most complex machine possible.....

Process Analysis

Stage 9: The process complexity scale



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When selecting equipment the question is how to control the process?

Time control?

Temperature control? With non contact temperature measuring device.... pyrometer for example?

Combining time and temperature control?

In direct temperature control?...use of camera to check if filler metal has melted

Special wire feed unit to sense pressure of wire feed when temperature hot enough to melt wire?

They can all work if they are set up correctly and variables associated with each device are known to the end user!

Which materials?.....reference books do vary in the technical information and figures.

Several ref books have simple methods of indicating suitability to join.....i.e.

E = excellent V = very good G = good F = fair N = not recommended

Or

A = Readily brazed by all techniques

B = brazed with a little extra care

C = require special care and effort

X = not recommended

Material Selection

		Solidus	Liquidus
Tube	3003 V, A	643	654
Block	6063 V, A	616	652
Block	6061 A, G, B	580, 616	650
Block	6082 G	575	650
Filler alloy	4047	577	582
Corrosive Flux	Melting range Approx 500		
Non-Corrosive Flux	Melting range 565 - 572		

Care must be taken when selecting material due to close range of melting temperatures.
Material might be brazable but very difficult to control.

Filler metal and flux options

Separate alloy and flux

- Solid wire, manual or wire feed or solid ring?
- Flux, corrosive or non-corrosive, application by brush or manual/auto dispense?

Combined alloy and flux

- Flux cored or composite material, alloy +flux (non-corrosive only) wire or ring?
- Braze paste, alloy + flux + binder (corrosive or non-corrosive) manual/auto dispense?

Selection very dependant on actual application

Summary

- Need to understand the technical details.
- Importance of collating process data.
- Identify variables then control them.
- Look for interrelationships between variables and limiting parameters.
-Go on, have a play like Mr "0"

Thank you for your attention