Abstract

The most widely used joining method in metallurgy is brazing. The high temperature vacuum brazing process, at the steel austenitization temperature makes it possible to carry out simultaneously the brazing of DIN 1.2379 steel – cold drawing lama and heat treatment. The advantages of this process are increased strength of brazed joints and toughness of the part, optimum hardness and cutting edge strength for a given combination working part/cutting tool. In this study the use of vacuum brazing to combine two different steel at the paper cutting blade ensure both reduced cost and increased durability. The process is economical when used in modern mass production methods, irrespective of the number of metals to be joined and heat treated. The adaptability makes the process so economical.

1. Introduction

Brazing is a process for joining two metals with a filler material that melts, flows and wets the metals’ surfaces at a temperature that is lower than the melting temperature of the two metals [1]. Protection from oxidation of the metal surface and filler material during the joining process is achieved using a covering gas or a flux material.

Brazing has long since been used as a technique for joining metals, a technique indispensable for our lifestyles. Even in today’s manufacturing industry, where many operations are carried out automatically using machines, brazing, both mechanized and automated, continues to be an indispensable technique [2].

Furnace brazing is another widely used technique. Manufacturing companies today are looking to improve production efficiency, reduce manufacturing steel and cold drawing lama with simultaneous heat treatment were investigated. Two brazing alloys based on copper were applied as filler metals.

Costs and replace energy and space inefficient furnaces while improving product quality. Brazing devices include various types of furnaces, such as vacuum brazing furnaces, atmosphere brazing furnaces, multi-chamber furnaces, and single chamber furnaces [3].

The purity level of the atmosphere (vacuum) can be precisely controlled; atmospheres of much higher purity can be achieved than can be obtained in regular atmosphere furnace, in effect; there is less residual oxygen to contaminate the work piece. Oxide layers on the part surface are decomposed in a vacuum at high temperature, which improves base metal wetting resulting in better joint properties (e.g., increased strength, minimum porosity, etc.). Part distortion is minimized due to heating and cooling at precisely controlled heating/cooling rates. In addition, the repeatability and reliability of brazing in modern vacuum makes it suitable for a lean/agile manufacturing system [4].

In this study, vacuum brazing was used in paper cutting blades. The high temperature vacuum brazing of DIN 1.2379 steel with simultaneous heat treatment is performed in single chamber vacuum furnaces, with uniform high-pressure gas quenching at the austenitization temperature of DIN 1.2379. In this work high temperature brazed joints of DIN 1.2379
2. Experimental procedure

Vacuum brazing is usually a high temperature (typically 1700 - 2250°F, or 930 - 1230°C) fluxless process using nickel-base, pure copper, and, less frequently, precious-metal composition BFM (Brazing filler metal).

Figure 1. Schematic of vacuum brazing furnace assembly

2.1. Main Steps in Vacuum Brazing

Following are the main steps to be followed in vacuum brazing:

- Clean and Compatible Vacuum Furnace
- Cleaning of the components/Assemblies
- Joint Design and Types of Joints
- Good Fit and Proper Clearance
- Assembly and Loading of the Job
- Heating Cycle of Furnace/Job

2.2. There are several advantages to brazing under vacuum conditions:

- The purity level of the atmosphere (vacuum) can be precisely controlled. There is less residual oxygen to contaminate the work piece.

- The vacuum condition at high temperature results in a decomposed oxides layer, and by doing so improves the base metal wetting properties. Improved wetting will result in better joint properties (e.g. increased strength, minimum porosity, etc.)

- Reduced to a minimum distortion because all parts are heated and cooled uniformly at precisely controlled heating/cooling rates.

- Repeatability and reliability of the brazing process in modern vacuum furnaces, ideally suitable for Lean/Agile manufacturing system.

2.3. Braze Filler Materials

Nickel brazing and copper brazing are classified as high-temperature brazing and use heating mechanisms designed to heat materials to high temperatures, around 1200°C. Since, unlike aluminum brazing, products will oxidate if they are cooled at atmospheric pressures, they need to be allowed or forced to cool in a vacuum atmosphere or gas atmosphere within the furnace until the temperature falls to around 100°C, before taking them out of the furnace. In these respects, nickel and copper brazing furnaces differ greatly from aluminum brazing furnaces. Powdered brazing materials as well as amorphous foil brazing materials have been developed for nickel brazing. However these materials are expensive, and powdered materials mixed with paste are most often used. In this study copper paste was used as brazing filler material.

3. Results and Discussion

Experiments were performed on high temperature vacuum brazed joints of the DIN 1.2379 steel and cold drawing lama with simultaneous heat treatment. Copper paste was used as the filler metal (Table 1, Fig 2a). The brazing temperature was 1100°C for blades brazed with the filler copper paste. After diffusion the heat treatment were cooled in nitrogen flow at the pressure under 3.5 bar and then double tempered at 550°C. Brazing thermal cycle and brazing parameters are presented on Figure 3 and Table 2.

Figure 2a) Paper blades manufactured by high temperature vacuum brazing with simultaneous heat treatment process to achieve a hardness of 62 Hrc
in a variety of printing machines. These blades wear out over time which results in high expensive re-sharpening maintenance. With vacuum brazing rapid prototyping of tools for various purposes is possible. In this study new paper - cutting blade was developed using the brazing of DIN 1.2379 steel and cold drawing lama with heat treatment. The developed blade has been found to have the desired strength and hardness. The lifetime of paper cutting blades has been extended and a problem has been solved industrially.

Acknowledgement

The authors would like to thank the Oruc Bileme Industry

References


Table 2. Parameters of brazing used in the experiment

<table>
<thead>
<tr>
<th>Brazing filler metal</th>
<th>Isothermal stop while heating up °C / min</th>
<th>Temperature and duration of brazing °C / min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cu</td>
<td>650/30</td>
<td>1100/20</td>
</tr>
<tr>
<td></td>
<td>850/30</td>
<td></td>
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<tr>
<td></td>
<td>1030/30</td>
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4. Conclusion

Cutting blades for printing press applications are used