DEGASSING EFFECT ON NICKEL ALUMINUM BRONZE ALLOY CASTINGS

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I hereby declare that I have checked this thesis, and, in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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DEDICATION

My Beloved Parents

MR. KALAISELVAN A/L SUBRAMANIAM

MRS. SANTHI KALAISELVAN

My Dearest Brother and Sisters

KANNAN A/L KALAISELVAN

KAYATHRI A/P KALAISEL

VANKARTHIGA A/P KALAISELVAN

My Respected Supervisor

Ir. DR. MOHD RASHIDI BIN MAAROF

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ABSTRAK

Kuprum telah digunakan semenjak ribuan tahun dahulu sebagai asas pemprosesan material dan kegunaan kejuruteraan. Ia digunakan kerana relatifnya mudah dibentuk, tidak tinggi suhu leburnya dan boleh dialoi untuk ketahanan terpilih seperti tahan karat.Salah satu bahan kejuruteraan berasaskan aloi kuprum adalah Nickel Aluminum Bronze (NAB). Komposisi aloi NAB telah disediakan dengan kombinasi beberapa elemen logam yang telah ditentukan campurannya dan dicairkan menggunakan dapur pencairan logam. Bagi mengurangkan potensi gas terperangkap di dalam mikrostruktur aloi, ejen pembuangan gas perlu diperkenalkan. Selepas itu, kesan penggunaan ejen pembuangan gas dan jumlah penambahannya ke dalam cairan aloi di analisa dan dikaji. Keputusan menunjukkan ejen ini mempengaruhi secara langsung lengkuk penyejuk pemejalan, mikrostruktur dan kekuatan bahan logam aloi. Kesemua sampel menunujukkan kesan reaktif terhadap titik suhu pemejalan iaitu titik berhenti pemejalan (TAL), nuclei eutektik (TES), penyejuk lampau (TEU), kenaikan suhu sementara akibat perubahan struktur kristal logam (TER) dan titik pergerakan eutektik berhenti (TEE). Bagi setiap peningkatan penggunaan 0.5 sehingga 1.1% ejen pembuangan gas, setiap titik suhu pemejalan menurun di antara 9 sehingga 11^{o} Celsius. Secara dasarnya peningkatan penggunaan ejen ini akan mengurangkan suhu pemejalan aloi. Kesan penurunan suhu ini menyebabkan mikrostrukutur aloi dan bentuknya berubah. Secara keseluruhannya, parameter bentuk, saiz dan serakan mikrostruktur telah dikaji perubahannya menggunakan peralatan mikroskop electron (SEM). SEM berjaya mendedahkan jarak lengan dendritik (DAS) dan ranting penduanya (SDAS). Saiz ukuran DAS mengecil dari 263 µm ke 165µm dan bagi SDAS mengecil dari 45 ke 40 µm bagi setiap peningkatan penggunaan 0.5 sehingga 1.1% ejen pembuangan gas. Adalah didapati bahawa penurunan suhu pemejalan menyebabkan semakin kecil saiz DAS dan SDAS yang diakibatkan oleh berkurangnya jeda masa pagi fasa pengembangan jirim. Kekurangan masa ini mengekang tumbesaran jirim sel untuk membesar. Kerja-kerja eksperimen turut menyaksikan apabila penggunaan ejen pembuangan gas mencecah nilai 1.1% dari keseluruhan jisim peleburan, ia meningkatkan kekuatan tegasan dan kekerasan aloi. Keputusan eksperimen turut mencadangkan sifat-sifat bahan aloi campuran ini ditentukan oleh keadaan mikrostruktur. Fenomena ini dipengaruhi oleh perubahan pemejalan akibat campur tangan ejen pembuangan gas.

ABSTRACT

Copper was used years ago as basic processing material and engineering used. Copper was choosing because it offers shaping flexibility, low melting point and also alloying capability to achieved selected properties such as corrosion resistance. One of selected copper alloy in engineering usage is Nickel Aluminum Bronze (NAB). The composition of NAB was prepared by mixed of several elements addition during furnace melting. During solidification, to prevent gas residue which probably reside inside its alloy microstructure, a degassing agent must be added. So, molten metal was poured into the sand cast mould with a different combination of degassing volume. Later the melt was let solidified towards room temperature. The effect of degassing volume on the composition addition of NAB was studied. The results show that degassing influence directly the solidification cooling curve, microstructure and mechanical properties. All samples show degassing volume influenced the solidification temperature point namely liquidus arrest (TAL), eutectic nucleation (TES), undercooling (TEU), recalescence (TER) and point of eutectic stop (TEE). Between 0.5 to 1.1% addition of degassing agent, each of temperature point drop around 9 to 11^{o} Celsius. Increasing degassing volume generally decreasing the solidification temperature point. The fall of the temperature will encourage the changes of composition's microstructure and its shape after solidification phase was finished. Most of the microstructure shape, size and its distribution evaluation was studied by means of Scanning Electron Microscope (SEM). SEM reveal the Dendritic Arm Spacing (DAS) and its secondary (SDAS) branch. Between 0.5 to 1.1% addition of degassing agent, each of the DAS and SDAS dropped from 263 µm to 165µm, and 45 to 40 µm respectively. The lower the solidification temperature, the smaller the DAS and SDAS morphology due to a lesser time for its growth phase. Less time permit limitation for grain size to evolve. Experimental works showed the degassing agent addition up to 1.1% increased the tensile and hardness value as well. The result from this experimental works suggested the mechanical properties of composition addition depended on its microstructure morphology. This phenomenon is directly influenced by solidification that affected by the degassing addition.

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