低氧氮含量 K417G 镍基高温合金生产工艺

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摘 要:介绍了低氧氮含量 K417G 镍基高温合金的生产工艺,着重讨论了合金制备不同阶段的脱气处理方法,并阐述了不同工艺环节避免气体带入的措施。在合金熔炼前通过预脱气尽可能去除表面吸附气体;在化料期将化料功率设定为 300~750kW,并将单次加料量控制在 500kg 以下,使氧氮含量分别降至 0.0018%和 0.0014%;在精炼期控制合金熔液温度在 1582 ℃,并利用碳脱氧反应精炼 80min,使氧氮含量分别降低到 0.0006%和 0.0002%;精炼结束后加入活泼元素作为强脱氧剂,并维持 20min 以上,进一步将氧含量降低到 0.0003%,顺利完成了低氧氮含量 K417G 镍基高温合金的生产。

关 键 词:高温合金;K417G;真空感应熔炼;脱气处理

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Manufacturing Technology for Low O/N Content Ni-based Superalloy K417G

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Abstract: The manufacturing process of low O/N content K417G Ni-based superalloy is introduced. The degassing treatment methods at different stages of alloy preparation are emphatically discussed, and the measures to avoid gas introduction in different process links are described. The gas of surface adsorption on material is removed as much as possible before melting. During melting, the power is set from 300kW to 750kW, and the single weight of charging is limited to 500kg to reduce the content of O and N to 0.0018% and 0.0014% respectively. During the refining period, the temperature of molten bath is kept at 1582 ℃, and the reaction of deoxidization by carbon is used to reduce the content of O and N to 0.0006% and 0.0002% respectively after refining for 80min. The rare earth elements are added to molten bath as deoxidizer after refining to reduce the content of O to 0.0003%. At last, the production of low O/N content Ni-based superalloy is producted successfully.

Key words: superalloy; K417G; vacuum induction melting; degassing treatment

真空感应熔炼(Vacuum Induction Melting, VIM)是高温合金熔炼生产中最为常见的生产工艺,可以将金属元素、中间合金及其他物料熔炼、浇注成所需的合金。由于其良好的去气、去杂质效果,以及在真空下可有效避免活泼金属元素氧化的优点,因此被广泛应用于高温合金、功能材料和耐蚀合金等的生产。不同合金根据材料特性和工艺要求会采用双联(真空感应 VIM+真空自耗 VAR)或三联(真空感应 VIM+真空自耗 VAR+真空电渣 ESR)工艺,但是真空感应始终是首选工序,对整体熔炼流程具有重要意义[1]。

真空感应熔炼作业过程中,主要完成脱气、去杂质(低熔点元素)两个目标[2]。熔炼作业完成后,合金熔液中以氧、氮为代表的气体含量要达到 0.0020%以下,部分特殊的钢种要达到 0.0010%以下甚至更低,同时合金熔液中以铅、锡、砷、碲、铋为代表的低熔点元素要达到 0.0005%以下[3-4]。为了获得低氧氮含量的高温合金,需要重视合金的整个冶炼过程,从熔炼化料开始就要注重脱气处理,合金熔液在精炼过程中在高温高真空条件下通过多种方式的综合作用充分脱气。

K417G 镍基高温合金是国防工业最重要的材

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