

论文

液氮冻结管内沸腾段分布特征的试验研究

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摘要:

为获得液氮冻结管内沸腾段的分布特征, 采用在供液管上开孔的冻结管结构, 进行了现场冻结试验, 通过布置在冻结管内的测温管, 测试了液氮冻结过程中冻结管内的温度, 获得了冻结管内沸腾段的分布特征, 得出以下基本结论: 采用供液管上开孔的冻结管结构, 冻结管内出现液氮沸腾状态时, 冻结管出口氮气温度较传统液氮冻结的出口温度低。随着液氮灌注量的增加, 在供液管开孔段上部位置首先出现液氮沸腾段, 并逐渐向下延伸, 直至下部冻结管全部进入沸腾段, 而上部未开孔的范围内较难获得液氮沸腾状态。由于不同位置液氮气化量的差异, 造成液氮沸腾段内形成的冻结壁均匀性较差。研究结果表明, 调节供液管上的开孔范围和液氮供应量, 可以有效控制冻结管内沸腾段分布范围, 提高液氮利用效率, 发挥液氮快速冻结的优势。

关键词: 液氮冻结; 液氮沸腾段; 冻结管结构; 温度分布; 原型试验

Experimental study on the distribution of boiling sections in liquid nitrogen freezing pipe

Abstract:

In order to obtain distribution characteristics of liquid nitrogen boiling sections in freezing pipe, an in situ liquid nitrogen freezing experiment was carried out in this study. There are opened holes on the liquid nitrogen supplying tube. The temperature and distribution of liquid nitrogen boiling sections can be obtained through the temperature measuring tube installed inside the freezing pipe. The study shows that firstly, the export temperature of the freezing pipe with opening holes on supplying tube is lower than that of traditional pipe when liquid nitrogen boiling sections appear in the freezing pipe. Secondly, with the increase of liquid nitrogen perfusion, liquid nitrogen boiling sections appear initially on the top of opening holes supply pipe, and gradually extend down the pipe. It is difficult to obtain the boiling situation on the sections with no opened holes in the upper freezing pipe. Thirdly, the frozen wall is non uniform because of the amount difference of liquid nitrogen gasification in different positions. The test results show that the adjustment on the open holes sections of the supply pipe and the amount of liquid nitrogen supply can effectively determine the distribution characteristics of the liquid nitrogen boiling sections. The adjustment of liquid nitrogen boiling sections, which may improve the efficiency in liquid nitrogen usage, can enhance the rapid freezing.

Keywords: liquid nitrogen freezing; liquid nitrogen boiling section; freezing pipe structure; temperature distribution; prototype experiment

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