

技术及应用

HL-2A MW级中性束注入系统弧流电源设计

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摘要 中性束注入是磁约束受控核聚变实验装置中加热等离子体最有效的方法之一。针对中国环流器2号中性束大功率离子源的特点, 从系统功能、主电路拓扑结构、控制硬件及控制时序等方面对弧流电源进行设计。整个电源由低位移相交流调压、高压隔离降压变压器、整流滤波和电流快速转移电路4部分组成。IGBT与电阻串联组成电流快速转移阵列电路, 与离子源并联, 可实现电流单次或多次快速转移、参数远程设定, 有效用于强流离子束的引出和保护。选用DSP和CPLD电路技术实现低位与高位控制器。实验数据显示, 该电源最大输出为200 kW/1 000 A, 纹波小于2%, 开关上升下降时间达 μ s级。目前, 该电源已安全运行3年, 可靠性高, 完全满足装置离子源及系统要求, 也可应用于其它等离子体技术应用场合。

关键词 [中国环流器2号](#) [中性束注入](#) [弧流电源](#) [强流离子束](#) [高电压](#)

分类号

Technical Design of Arc Power Supply for MW Neutral Beam Injector System on HL-2A Tokamak

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Abstract Neutral beam injection (NBI) is one of the most effective ways to heat plasma in Tokamak. The arc discharge ion source of NBI on HL-2A Tokamak is the bucket cusped multiple magnetic field ion source. According to the characteristics of the ion source and requirements of system, the technical design of the arc power supply was expounded from several aspects of its function, main circuit topology, control hardware circuits and control sequence. The apparatus includes phase-shifted AC low-voltage regulator, high-voltage isolated step-down transformer, and rectifier with an output filter and the notch circuit. IGBT in series dummy resistance load and parallel with ion source was implemented in the notch circuit, and it can shift the current instantaneously single or multiple times to make the NBI system operating safety in the process of intense current ion beam extraction or to protect arcing in grids. The low-level-voltage and the high-level-voltage controller adopted the high performance digital signal processor and complex programmable logic device. The experimental waveforms prove that the maximum output capacity specification of the arc power supply is 200 kW/1 000 A, ripple is less than 2%, turn off time can achieve several microseconds. The arc power supply has operated safely for three years, and it meets the requirements of the system and the ion source device.

Key words [HL-2A](#) [neutral](#) [beam](#) [injection](#) [arc](#) [power](#) [supply](#) [high](#) [intensity](#) [ion](#) [beam](#) [high-voltage](#)

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