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DIRECT CONVERTER EFFICIENCY WITH A 100:1 EXPANDER

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DIRECT CONVERTER EFFICIENCY WITH A 100:1 EXPANDER

ABSTRACT

We describe a 22-stage direct converter for use with a 100:1 magnetic expander. The small expansion ratio results in the rather low efficiency of 63%.

DIRECT CONVERTER EFFICIENCY

The DART code was employed to optimize the design of a 22-stage periodic-focusing direct converter for use with the mirror reactor design studied by R. Werner, et al.¹ The parameters that affect the direct converter are:

Power = 610 MW into the direct converter
Mean energy = 600 keV D^+ , T^+ and He^{++}
Expander length = 76 m
Angular spread = 240°
 $P/\ell = 1.916 \text{ MW/m}$
 $I/\ell = 3.19 \text{ A/m}$
Magnetic flux in expander = $150 \text{ kG} \times (0.65 \text{ m})^2$
Outer circumference = 318 m
Thickness of flux at exit = 0.14 m
Average mass of ions = 2.4

The parameters that were varied to optimize the direct converter were C, the focus-strength; V_o , the unit of potential; and ZFIN, half-width of the channel.

Fixed parameters were $L = 2 \text{ m}$ for the spacial period and $300 \leq W \leq 900 \text{ keV}$ for the flat-topped energy distribution.

The coefficient for the production of secondary electrons α varies with the impact energy as

$$\alpha = \begin{cases} 0.1 & W \leq 2 \\ 0.1 + 0.3841 \ln W/2 & 2 < W < 280 \\ 2 & 280 \leq W \end{cases}$$

¹R. W. Werner, G. A. Carlson, J. Hovingh, J. D. Lee, and M. A. Peterson, "Progress Report No. 1 on the Design Considerations for a Low Power Experimental Mirror Fusion Reactor," in Tex. Symp. on the Technol. of Contr. Thermonucl. Fusion Exp. and the Eng. Aspects of Fusion Reactors, Symp. Proc. (Austin, Texas, Nov. 20, 1972), to be published.

The results of the various computer runs are shown in the plots of efficiency η vs V_o , C , and $ZFIN$ (Figs. 1, 2, and 3). When secondary electrons are included, the results clearly indicate that $C = 2$ and $ZFIN = 0.5$ are best. The lowest voltages before efficiency is comprised is $V_o = 65$ kV; with these parameters the efficiency is $\eta = 63\%$. This low value results mainly from the large divergence angles after 100:1 expansion.

Other effects not included here are those caused by: (1) ionization and charge exchange, (2) coupling to the reactor, (3) power used by the vacuum pumps, and (4) losses in the inverter-rectifier system.

Fig. 1. Efficiency vs V_o , the voltage parameter.

Fig. 2. Efficiency vs C , the focus parameter.

Fig. 3. Efficiency vs ZFIN, the half-height of the channel.

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