§10. Direct Energy Conversion in LHD (LHD-DECX) - Cusp DEC -

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A double-cusp type direct energy converter (Cusp DEC) was proposed from thermal energy out of confined plasma to electricity.1) The method of guiding magnetic field lines out of LHD configuration and the particle and heat flux at the cusp DEC were investigated.

One of the method in order to guide magnetic field lines out of LHD was proposed by use of adding an octapole magnetic field.2) The location of octapole field coils is radii of 2.0,4.0, and 6.0 m, and heights of 0.0 and $\pm$2.0 m with -6.5 MA currents. There are eight guided points in each symmetric ten sections because of $\ell = 10$ configuration of LHD (Table 1). In Table I, θ, ϕ, R, Z, and L_d are poloidal angle, toroidal angle, major radius, vertical position, and toroidal length of guided points, respectively. The magnetic field B_r and B_z indicate the direction of magnetic field at the guided points. One can see the position #1 is the favorable one in order to guide magnetic field to Cusp DEC. The estimated plasma parameters at the positions #1 and DEC are tabulated in Table II in cases of lower and higher heating power, where T_{core}, T_{div}, and q_{div} are core plasma temperature, plasma temperature, heat flux at divertor section and P_{DEC} , q_{DEC}, Γ_{DEC}, and n_{DEC} power input, heat flux, particle flux, and particle density, respectively. Here the widths of plasma at divertor section and DEC sec-tion are assumed 1.5 cm and 5 cm, respectively. At DEC section the strength of magnetic field is decreased up to 0.1 of divertor section. The decreased heat flux and particle density at DEC section make charge separation and energy conversion possible. Near future preliminary experiments for proof of principle of Cusp DEC will be carried out at Kyoto University.

	D-plasma	D-plasma
heating power	3 MW	20 MW
T_{core}	1 ~ 1.5 keV	6 keV
T_{div}	0.5 keV	2 keV
q_{div}	1 MW/m^2	7 MW/m^2
P_{DEC}	20 kW	140 kW
q_{DEC}	30 kW/m^2	200 kW/m^2
Γ_{DEC}	6.2×10^{20} /s	4.3×10^{20} /s
n_{DEC}	4.0×10^{15} m^{-3}	1.4×10^{15} m^{-3}

Table II. Estimated plasma parameters at DEC section in cases of lower (3 MW) and higher (20 MW) heating power.

Reference

1) H.Momota, et al., Proc. 14th Int. Conf. Plasma Physics and Controlled Nucl. Fusion Research, Wüerzburg, Germany, September 1992, Vol.3 p.319, IAEA (1993).
2) H.Takase and N.Ohyabu, Nucl. Fusion **35**, (1995) 123.

no.	θ (deg.)	ϕ (deg.)	R (m)	Z (m)	L_d (m)	B_r (T)	B_z (T)
#1	30	12 ~ 24	6.0	1.16	1.26	-1.46	0.08
#2	60	- 6 ~ 6	5.16	2.0	1.08	- 0.64	0.78
#3	120	- 6 ~ 6	2.85	2.0	0.60	- 0.53	- 2.79
#4	150	12 ~ 24	2.0	1.16	0.42	- 1.64	- 1.88
#5	210	12 ~ 24	2.0	- 1.16	0.42	1.64	- 1.88
#6	240	- 6 ~ 6	2.85	- 2.0	0.60	0.53	- 2.79
#7	300	- 6 ~ 6	5.16	- 2.0	1.08	0.64	0.78
#8	330	12 ~ 24	6.0	- 1.16	1.26	1.46	0.08

Table I. Guided points of magnetic field in each symmetry section of LHD by use of octapole field coils.