§11. Cs Consumption of LHD-NBI H-Ion Source

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Cesium seeding technology used too in the LHD-NBI H- source improves absolutely the source parameters. Notwithstanding, much amounts of Cs lead to contaminate the ion source and even introduce the impurities into the plasmas. So it should be necessary to control optimized amounts of Cs for optimal performances of the large ion source.

We evaluated Cs consumption [i.e., Cs weight loss] of LHD-NBI high current source for cases of real NBI-ion sources. The change in the Cs-oven weight during the LHD-experimental cycle was measured.1) The Table lists the consumption of six ion sources (i.e. 18 ovens) for the LHD experimental cycle. Column 5 is Cs consumption per oven. Column 6 is total Cs consumption per source. Column 7 is total shots of cesiated discharges. Column 8 is the consumption rate per shot per source.

The cesium consumption for half-year operation is from 3.9 gr to 10.6 gr. Ion sources in BL-1 for Run No.10-b consumed cesium at a rate of 1.5 mgr/shot, ion source in BL-2 consumed ~0.6 mgr/shot, and ion sources in BL-3 consumed 0.17-0.31 mgr/shot. Cs consumption (of 0.17 – 1.5 mgr/shot/source) varied widely even though sources were mostly operated at similar currents (about 25A of H^-).

In BL-1 source operation, much Cs for Run No. 10-b was introduced, to generate fairly uniform H^- emission with a new accelerator and new plasma chamber. In BL-3, ion sources seem to be operated with a minimum amount of Cs consumption, which is about one third of that in BL-2 sources, although these four ion sources are of similar design. In previous experiments with the 1/3 scale ion source with 1/5 scale accelerator on the test stand, a consumption of ~0.7 mg/shot for 0.6 sec pulse duration of the beam was obtained. It is close to the consumption rate in BL-2 source.

- The Cs consumption of each ion source on the same beam line is almost same, especially for BL-1 and BL-2. Each oven at three positions tends to consume the similar amount of Cs.
- The Cs consumption rate is converted to Cs deposition of 0.11-1.0 mono-layer per shot per source over the inside area of the plasma source. It may be noted that this deposition per shot after several shots is similar to the optimized surface coverage of ~0.7 mono-layer for surface production of negative ions.
- Cs is operable over 2 x 10^4 shots, while the filament was operable for ~10^4 shots. As a result of this, the filament lifetime cycle in present LHD-NBI H^- source determine the maintenance cycle.

Reference,

1) Oka, Y. et al, Rev. Sci.Instrum. vol.75, 1803(2004)

TABLE II. Cs weight loss/loss rate of LHD-NBI H^- ion sources.

Beam line	Ion source & oven location	Run No.	Filled (g)	Weight loss (g/oven)	Total loss (g/one source)	Total shots	Loss rate (mg/shot/one source)
BL-1	1A(top)	10-a	2.56	1.83	4.07	9926	0.40
	1A(center)		2.95	1.48			
	1A(bottom)		2.82	0.78			
BL-1	1B(top)	10-a	2.87	1.5	~6.57	···	···
	1B(center)		3.14	2.17			
	1B(bottom)		3.1	2.9			
BL-1	1A(top)	10-b	6	3.62	10.16	6435	1.58
	1A(center)		6	3.61			
	1A(bottom)		6	2.93			
BL-1	1B(top)	10-b	6	3.33	10.1	···	1.57
	1B(center)		6	3.25			
	1B(bottom)		6	3.52			
BL-2	2A(top)	10	6	3.21	10.63	17 127	0.62
	2A(center)		6	3.7			
	2A(bottom)		6	3.72			
BL-2	2B(top)	10	6	3.57	10.55	17 309	0.60
	2B(center)		6	3.54			
	2B(bottom)		6	3.44			
BL-3	3A(top)	10	6	1.2	3.92	22 029	0.17
	3A(center)		6	1.78			
	3A(bottom)		6	0.94			
BL-3	3B(top)	10	6	2.47	7.06	22 229	0.31
	3B(center)		6	1.98			
	3B(bottom)		6	2.61			