CO3-1 Development of In-reactor Observation System Using Cherenkov Light (VII)

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INTRODUCTION: On-line surveillance system which can visualize and quantitatively evaluate reactor statuses will contribute to reactor operation management. Development of an on-line reactor core imaging system using Cherenkov light was started in 2009. Previously, the total reactor power of the KUR was successfully estimated from RGB brightness components of the Cherenkov light at the core using a commercial CCD camera[1]. On the other hand, significant difference of changing rate of brightness with total reactor thermal power was observed between the TC and D2O side of a fuel element[2]. In this study, in order to assess of applicability of Cherenkov light to acquisition of the reactor thermal power distribution, the image brightness of the Cherenkov light from several fuel elements was compared to the thermal power calculated by SRAC code system[3].

EXPERIMENTS: The CCD camera (AEC-100ZL, Q·I Inc.) has been inserted into core-observation pipe of KUR during increasing the reactor power thermal from 1 to 5 MW. The output of the CCD camera has been collected as a movie file by a video recorder. Figure 1 shows the CCD camera image of the core of KUR. The Cherenkov light from the fuel elements of the 3rd to 7th column at the "Ho" row[4] has been analyzed. Since the G and B brightness components have caused halation at the higher reactor thermal power than about 1 MW, the R component has been used to correct the total image brightness.

RESULTS: Table 1 shows the comparison of the thermal power of the fuel elements estimated from the brightness of the Cherenkov light with the thermal power calculated from the SRAC code system. The comparison was performed at 1 and 5 MW of the total reactor thermal power. From the results, for the "Ho"-3, 4, and 5 fuel elements, the thermal power evaluated from Cherenkov light was almost the same as the one calculated from SRAC code. On the other hand, for the "Ho"-6 and 7 fuel elements, about 15 % and 35% differences were observed, respectively. The possible causes were that shadow of the equipment around the core and/or anisotropic emission of Cherenkov light affected on the brightness of the CCD images. In order to improve the estimation accuracy, installation of a number of cameras at various positions and analysis of the image brightness with taking account of emission angle of Cherenkov light.

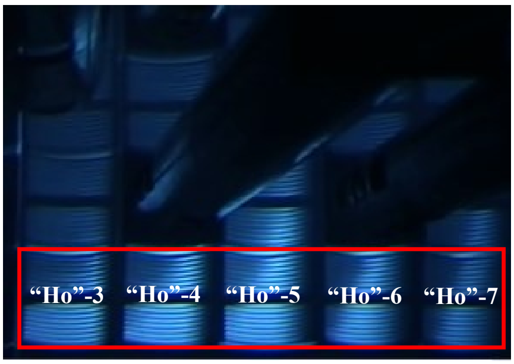

Fig. 1. The CCD camera image of the core of KUR. The fuel elements of the 3rd to 7th column at the "Ho" row were indicated by a red box.

CONCLUSION: As part of the development of the visible on-line core surveillance system, the thermal power estimated by brightness of Cherenkov light was compared with the one calculated by the SRAC code system. The results indicate that installation of a number of cameras at various positions and analysis of the image brightness with taking account of emission angle of Cherenkov light are required to precisely obtain the distribution of the thermal power by analysis of Cherenkov light.

REFERENCES:
[1] N. Ohtsuka, *et al.*, KURRI Progress Report 2013 (2015), P. 215.
[2] T. Takeuchi, *et al.*, KURRI Progress Report 2014 (2015), P. 108.
[3] K. Okumura, *et al.*, JAEA-Data/Code 2007-004 (2007), P. 313.
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	Reactor thermal power [MW]	Thermal power of fuel element [kW]		Cherenkov light / SRAC
		Cherenkov light	SRAC	
"Ho"-3	1.0	34.3	35.7	0.96
	5.0	175.2	178.0	0.98
"Ho"-4	1.0	41.2	40.8	1.01
	5.0	200.0	203.3	0.98
"Ho"-5	1.0	44.8	41.3	1.09
	5.0	196.7	205.4	0.96
"Ho"-6	1.0	31.9	38.4	0.83
	5.0	164.9	190.8	0.86
"Ho"-7	1.0	21.2	31.1	0.68
	5.0	100.3	154.6	0.65

Table 1. Comparison of the thermal power of the fuel elements estimated from the brightness of the Cherenkov light with the thermal power calculated from the SRAC code system.