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WATER QUALITY MONITORING OF MULTIPURPOSE TRIGA MARK-II REACTOR, SAVAR, DHAKA, BANGLADESH

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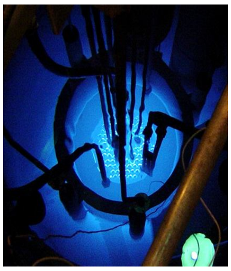
Introduction

Nuclear reactors have made valuable contributions to the development of nuclear power, basic science, materials development, education, training, and radioisotope production for medicine and industry from over 60 years. In Bangladesh, a research reactor named TRIGA MARK- II has been operated by Bangladesh Atomic Energy Commission (BAEC) since 1986. It is an open-pool type reactor, cooled and moderated by light water, graphite reflected, designed for steady-state and square wave power level of 3 MW (thermal) and for pulsing with maximum power level of 852 MW [1,2]. Chemistry control in nuclear reactors is important at least from six different perspectives: material integrity, plant radiation levels, deposit build-up, fuel performance, environmental impact and safety [3].



View of the Cherenkov Radiation

Aim

To investigate water quality and maintains the water chemistry to the required specifications at all times in order to ensure longevity and performance of the reactor system.

Study Area

Two primary water samples like, Reactor Pool Water (**RPW**), Make-up Sampling Valve Water (**MSVW**) and three secondary water samples such as Secondary Make-up Water (**SMW**), Cooling Tower Standby Water (**CTSW**) and bleed of Line Water (**BOLW**) are examined.

Materials and Methods

Digital Analytical Balance (Sartorius, CP 225 D), Magnetic stirrer with hot plate (Stuart, Great Britain), pH meter (Orion 4 star), Conductivity meter (Hanna instrument), Flame Atomic Absorption Spectrometer (Shimadzu, AA6800), UV-VIS (Shimadzu-3401) spectrophotometer were employed in the experiment. The measurements were carried out in an air/acetylene flame.

The digestion procedure for water samples were carried out by transferring a measured volume (50 ml) of well mixed acid preserved water sample to a flask. Then 5 ml of conc. HNO_3 and a few boiling chips were added into the flask. The mixture was boiled and evaporated on a hot plate to the lowest volume possible. Continue heating and adding conc. HNO_3 as necessary until digestion is complete as shown by a light color clear solution [5]. After this the flask was wash down with de-ionized water, cooled and filtered through Whatman 44 filter paper.

Results and Discussion

Table-1: pH, EC and TDS concentration of the primary and secondary water samples in various years.

Parameter	Primary water				Secondary water			
	2015	2016	2017	Std. [4]	2015	2016	2017	Std. [4]
pH	5.2-6.8	4.3-7.6	4.9-6.5	5.5-6.5	6.7-8.5	6.9-8.4	7.0-7.6	6.5-8.9
EC (μS/cm)	0.3-1.0	0.3-1.6	0.3-0.8	0.2-1.5	122-340	105-315	102-293	< 400
TDS (mg/L)	0.3-0.7	0.2-1.2	0.15-0.4	1-3	61-170	49-162	51-146	< 500

Table 2: TH, TA and SiO_2 concentration of different water samples in various years

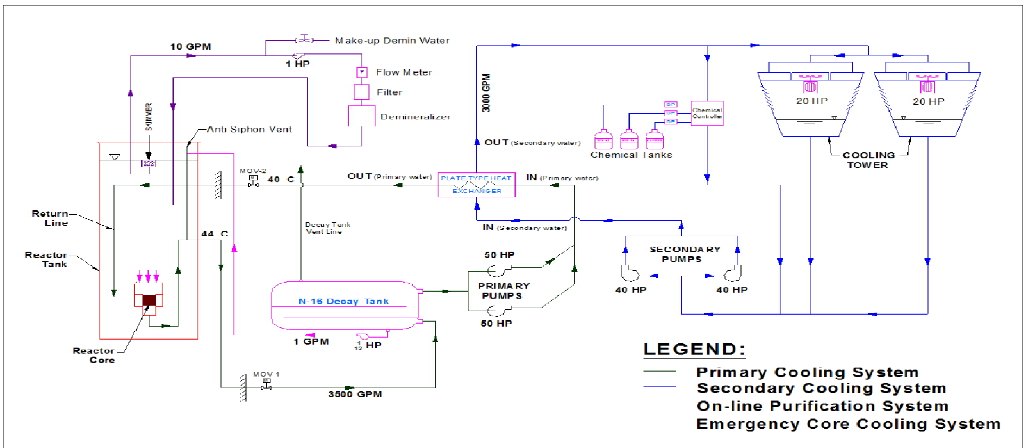
Parameter	Primary water				Secondary water			
	2015	2016	2017	Std. [5]	2015	2016	2017	Std. [5]
TH (mg/L)	N.D	18.0	N.D	20	67-153	58-122	68-122	<300
TA (mg/L)	6.0	1.0	19.0	N.A	32-81	30-72	86-156	<300
SiO_2 (mg/L)	N.M	N.M	35	0.2-0.5	N.M	N.M	25- 114	< 15

Table 3: Concentration of different cations in water samples in different years

Cations	Primary water				Secondary water			
	2015	2016	2017	Std.[4-5]	2015	2016	2017	Std.[4-5]
Ca (mg/L)	0.44	0.54	0.40	<0.05	7.7-11.4	7.8-17.4	42.5-140.4	10-16
Mg (mg/L)	0.32	0.44	0.32	<0.05	3.6-7.5	2.4-7.7	11.3-30.3	< 8.0
Fe (mg/L)	0.30	1.60	0.24	0.10	0.15-0.55	1.1-1.5	0.23-0.29	< 2.0
Mn (mg/L)	0.02	0.02	0.02	0.01-0.02	0.01-0.02	0.02-0.03	0.2-0.4	< 1.0
Cu (mg/L)	0.003	0.07	0.01	<0.05	0.005-0.007	0.05-0.06	0.1-0.9	1-3
Zn (mg/L)	0.03	0.11	0.14	<0.05	0.006-0.009	0.13-0.15	0.23-0.69	< 5.0
Co (mg/L)	0.04	0.03	0.04	<0.05	N.D	0.02-0.05	0.3-0.6	< 1
Ni (mg/L)	0.07	0.05	0.06	<0.01	0.2-0.5	0.14-0.19	0.12-0.34	0.5-0.6

Table 4: Anionic concentration of different water samples of research reactor in various years

Anions	Primary water				Secondary water			
	2015	2016	2017	Std. [5]	2015	2016	2017	Std. [5]
Cl (mg/L)	0.21	0.7	0.03	<0.05	0.3-0.4	0.8-1.5	0.4-0.6	6-10
NO_3 (mg/L)	N.D	N.D	N.D	< 0.05	1.6-3.8	0.2-4.6	0.3-0.6	<10
SO_4 (mg/L)	0.06	0.07	N.D	< 0.1	0.9-4.3	0.5-2.2	N.D	<10
PO_4 (mg/L)	0.08	0.05	N.D	< 1.0	0.2-1.84	0.07-0.2	0.02-0.2	<15



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Results and Discussion– Con't

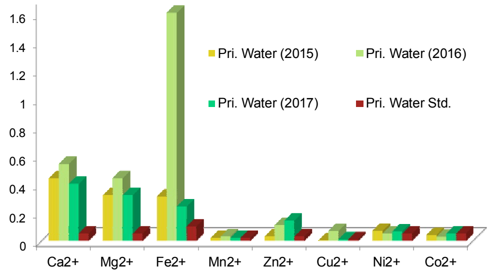

Fig 1: Variation of different metal concentration of primary water with standard in the measuring year.

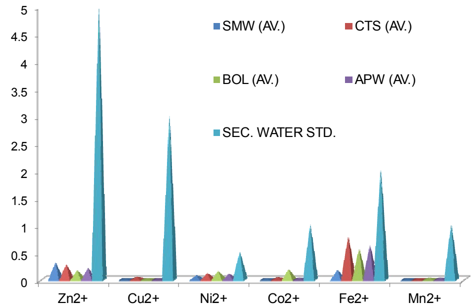

Fig 2: Metal concentration average (yearly) changes of secondary water with standard.

Conclusions

In summary of the obtained result it has emerged that the concentration level of most metals, chloride, and silica of primary water were above the critical maximum levels. Some metals (Ca &Mg), SiO_2 concentration of secondary water in 2017 is also crossing the maximum levels. From this point of view the reactor water was not suitable for safe reactor operation in the long run. That is why it is high time to take proper steps and strong monitoring regarding this parameter for optimal reactor operation.

References

1. M. A. Zulquarnain, M. M. Haque, M. A. Salam, M. S. Islam et al., Experience with the operation, maintenance and utilisation of the 3 MW TRIGA Mark-II research reactor of Bangladesh, Int. J. Nuclear EnergyScience and Technogy, 4(4), 2009.

2. M. A. Zulquarnain, et. al., BAEC,"Rectification Work on the Primary Cooling System of the 3 MW TRIGA Mk-II Research Reactor of Bangladesh Atomic Energy Commission", Proceedings of the 5th Asian Symposium on Research Reactors, Taejon, Korea, 1995.

3. IAEA -TECDOC-1666, Optimization of Water Chemistry to Ensure Reliable Water Reactor Fuel Performance at High Burn- up and in Ageing Plant (FUWAC), 1, 2011.

4. J.W. Bialas, Experience with water technology and corrosion protection in the cooling system of nuclear reactor in Poland, Proceedings of the Symposium on Water Chemistry and Corroision Problem in Nuclear Power Plant, International Atomic Energy Agency, 22-26 November, Vienna, pp. 313-323.

5. IAEA NUCLEAR ENERGY SERIES-NP-T-5.2, Good Practices for Water Quality Management in Research Reactorsand Spent Fuel Storage Facilities, 70-76, 2011.