

Technological Advancement of Redox Flow Battery at Sustainable Environenergy Research Lab

Manshu Kapoor, Rajeev K. Gautam, Anil Verma*

*anilverma@iitd.ac.in

Introduction

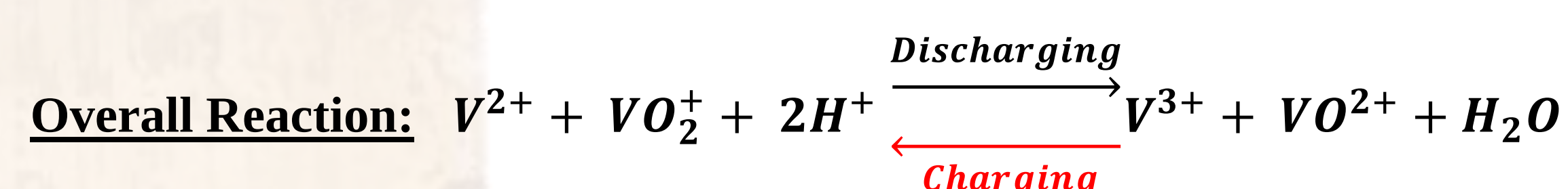
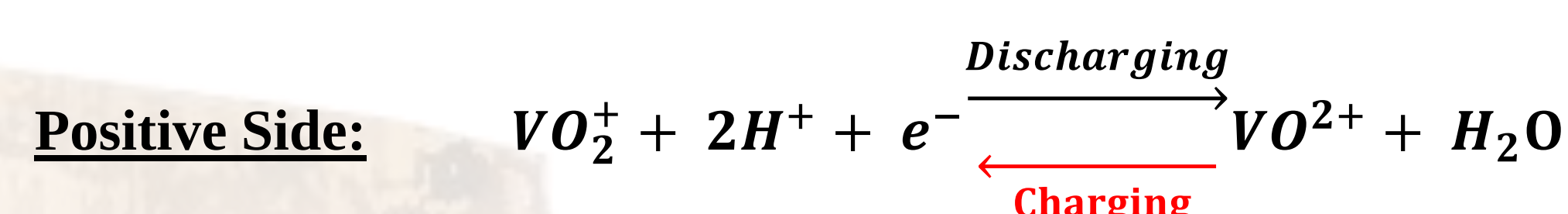
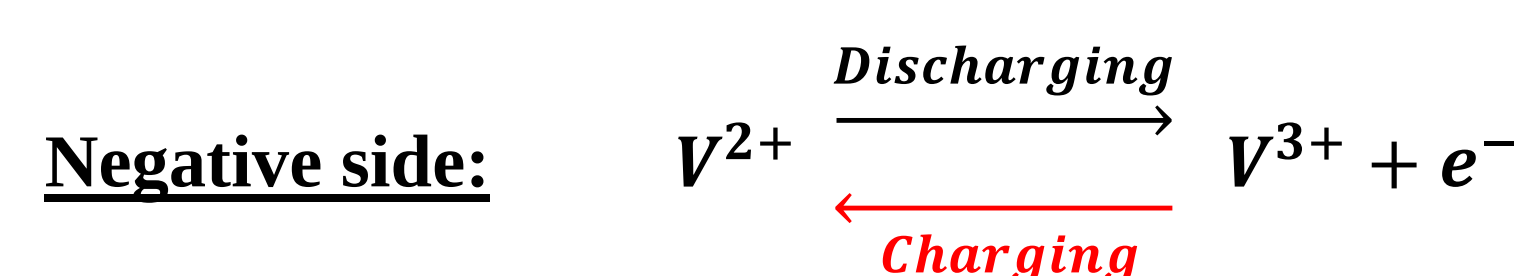
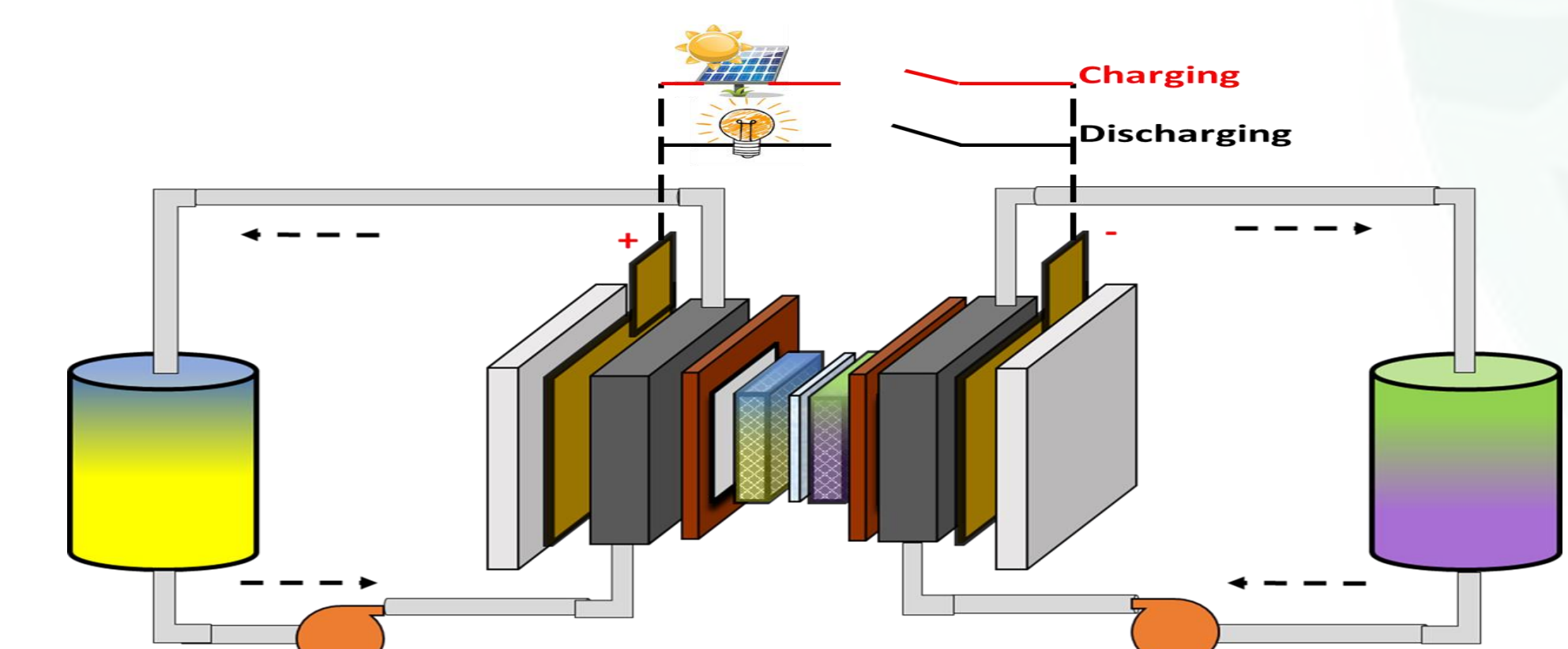
- Intermittent nature of renewable energy sources, dictates the need to develop energy storage devices.
- VRFB comes with attractive features like long cycle life and independent scalability of power and energy density
- Among prominent energy storage technologies Vanadium redox flow battery (VRFB) is a potential candidate for specific applications.

	Lead Acid Batteries	Li-ion Batteries	Vanadium Redox Flow Battery
Energy density (Wh/L)	60-110	250-693	30-47
Specific energy (Wh/kg)	33-42	100-265	26-45
Average cycle life	700-1200	750-3000	15000-20000
Normalized cost (₹/kWh.cycles)	4-12	9-56	6-12

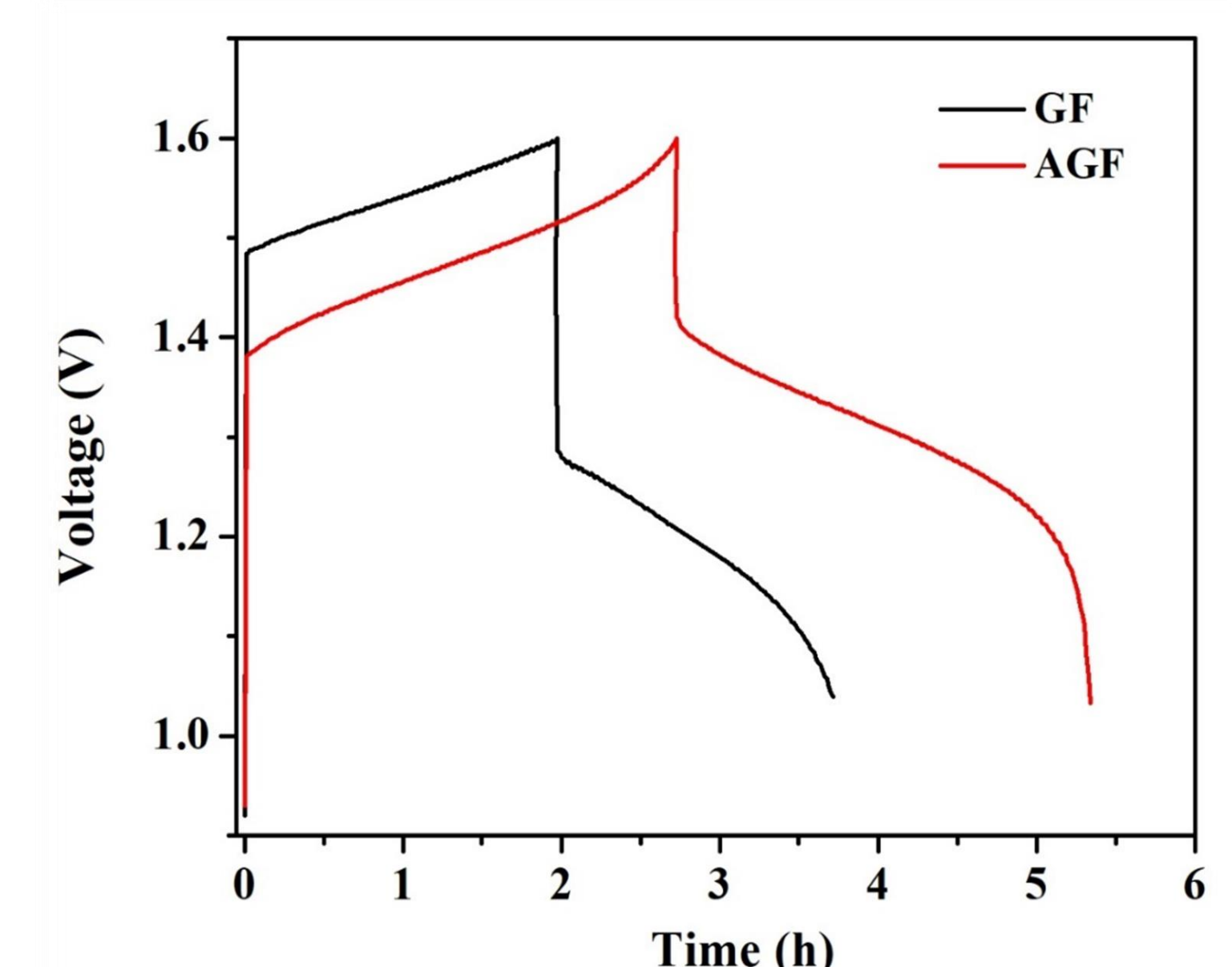
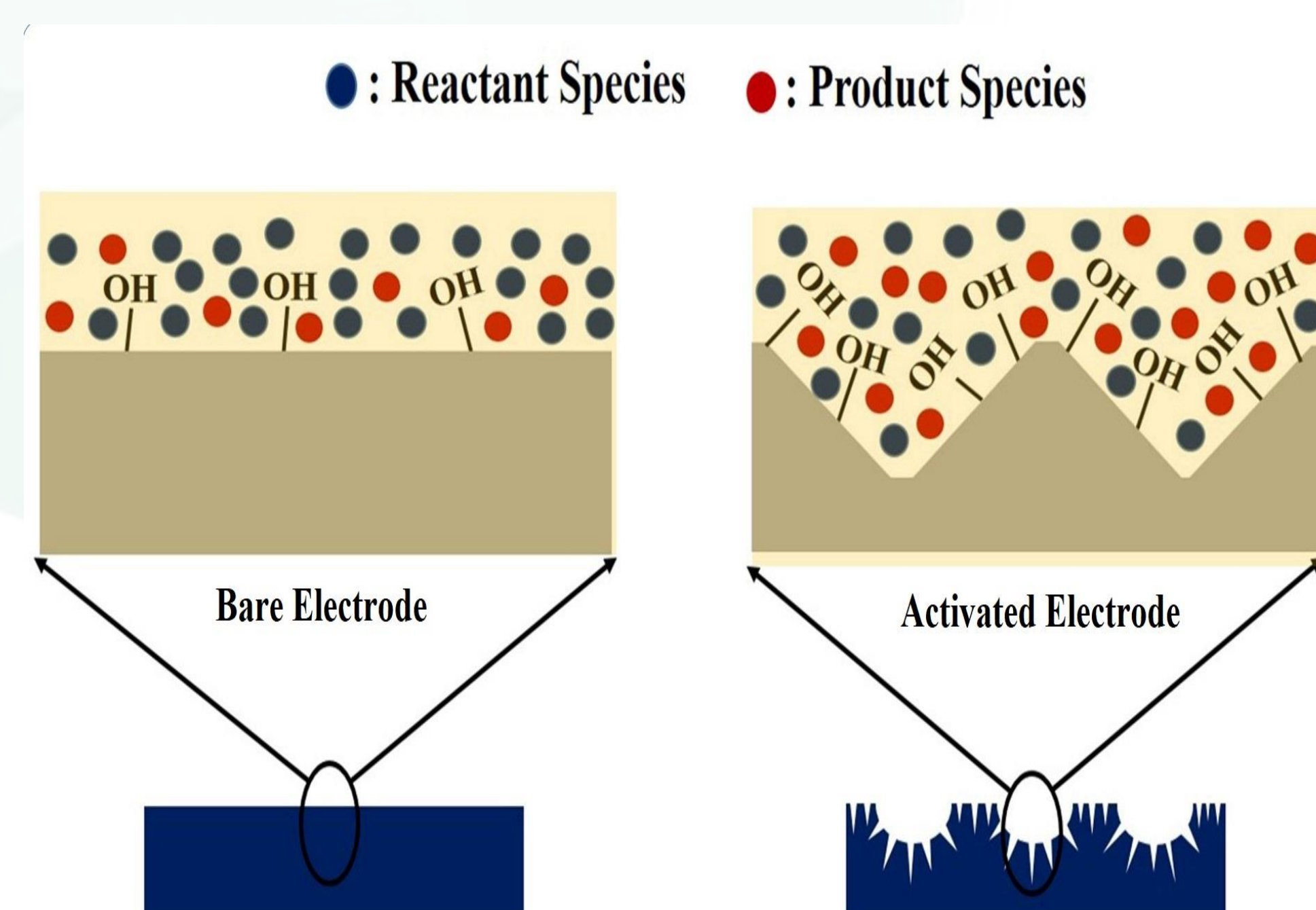
Applications of VRFB

- Instant Power Source for Remote Areas, Telecom Towers
- Auxiliary Power Supply for Industries
- Vehicular Applications
- Grid Scale Energy Storage

Working Principle



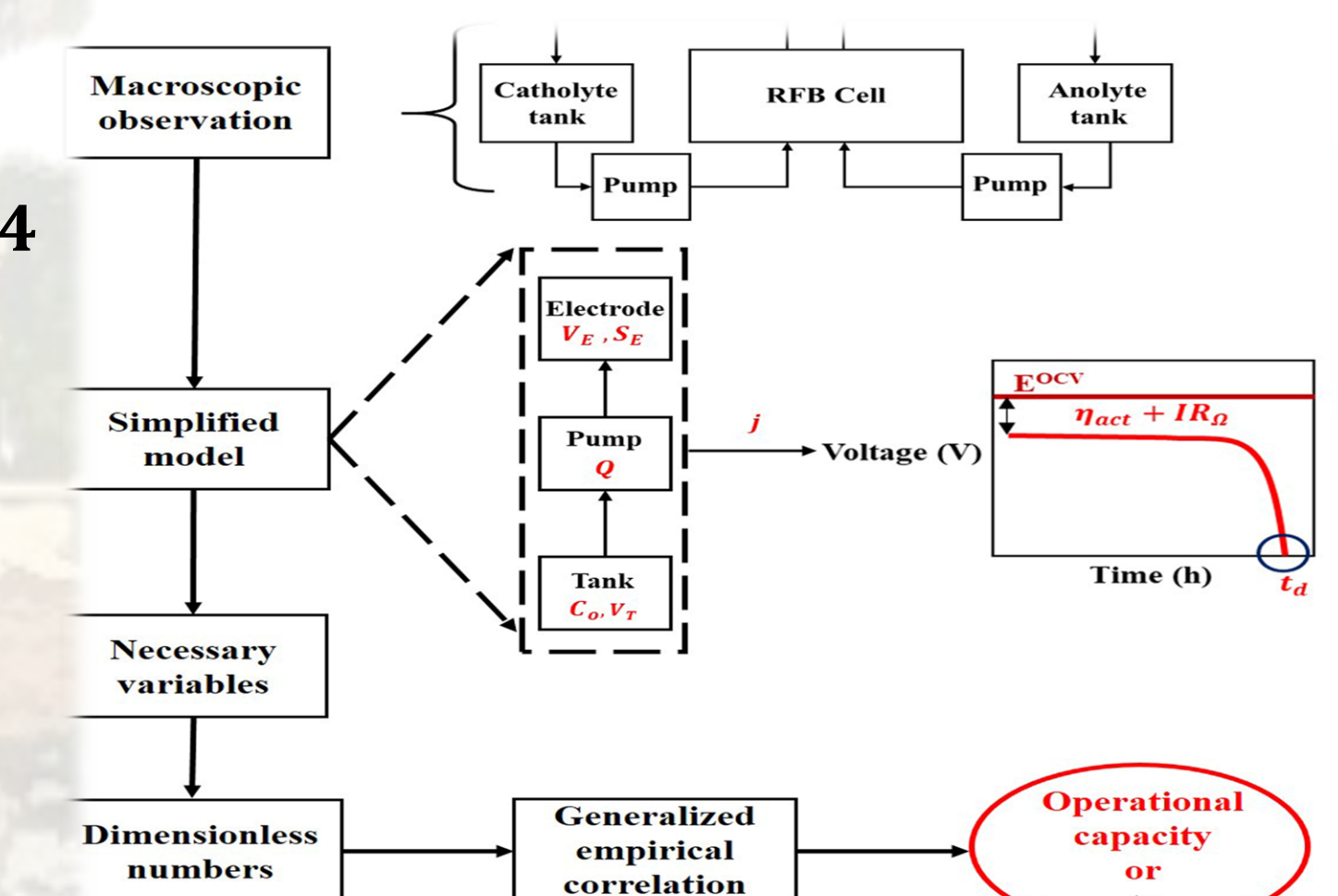
- Development of an activation approach to develop highly efficient 3-D graphite felt electrode for vanadium redox flow battery².



- In comparison to bare graphite felts (GF), the activated graphite felts (AGF) imparted:
 - ✓ Stable operation of VRFB at high current densities ($> 100 \text{ mA cm}^{-2}$).
 - ✓ Enhanced utilization of theoretical capacity (89%).
- Development of an empirical correlation capable of predicting the operational capacity of a redox flow battery¹.

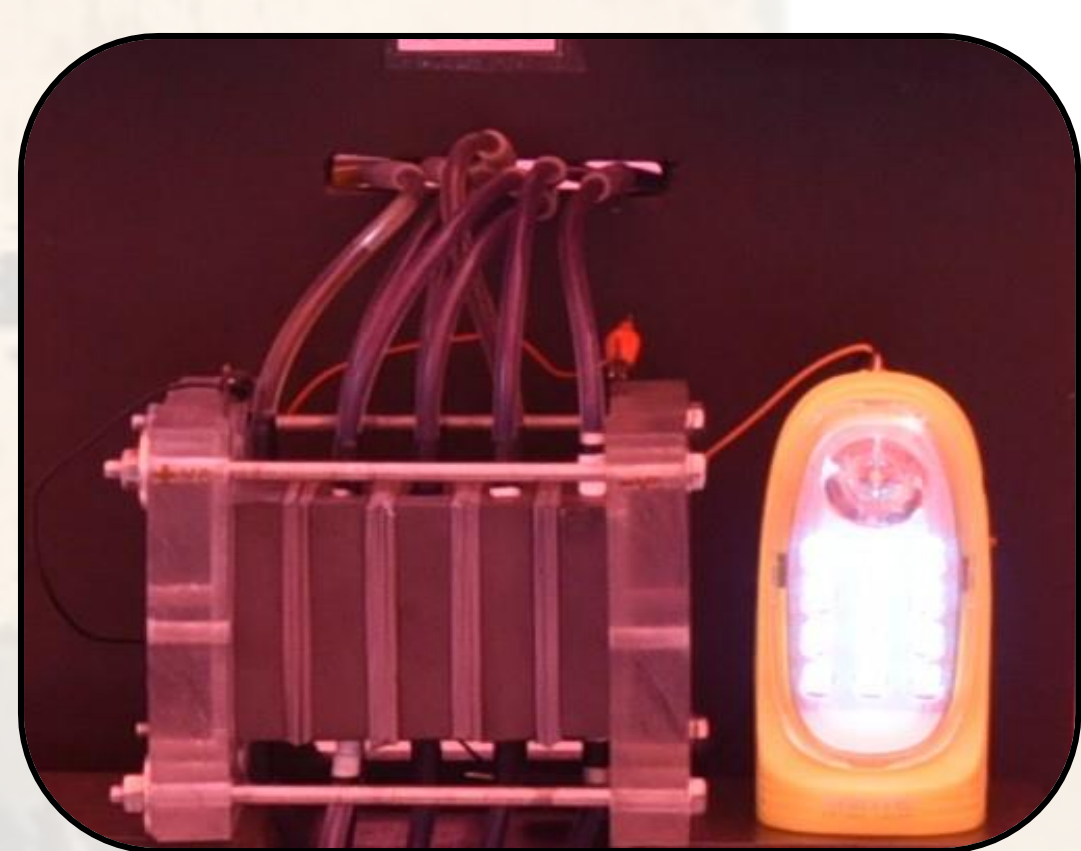
$$TCU = 0.6535 (NVU)^{-0.207} (Wa)^{0.119} (RDa)^{0.024}$$

- ✓ TCU: Theoretical capacity utilization
- ✓ NVU: Number of volume units
- ✓ Wa: Wagner number
- ✓ Rda: Reciprocal of Damköhler number



Technological Advancements

- Indigenous development and demonstration of a VRFB stack¹.



- Successful indigenous fabrication of kW-scale stack.

Patents

- Indian Patent Application No.: 201711018872 dated May 29, 2017 “Redox Flow Battery System with Improved Energy Efficiency and Method of Operating Thereof”.
- Indian Patent Application No.: TEMP/E-1/373/2019-DEL dated January 21, 2019 “A Novel Process to Develop Efficient Electrode for Efficient Vanadium Redox Flow Battery”.

Publication

- M. Kapoor, R.K. Gautam, V.K. Ramani, A. Verma, “Predicting Operational Capacity of Redox Flow Battery using a Generalized Empirical Correlation Derived from Dimensional Analysis”, Chem. Eng. J. 379 (2020).

Acknowledgements

The authors acknowledge the financial support from, Department of Science and Technology (DST) and Ministry of Human Resource and Development (MHRD).

Technology Readiness Level

Experimental trials of kW-scale in progress.