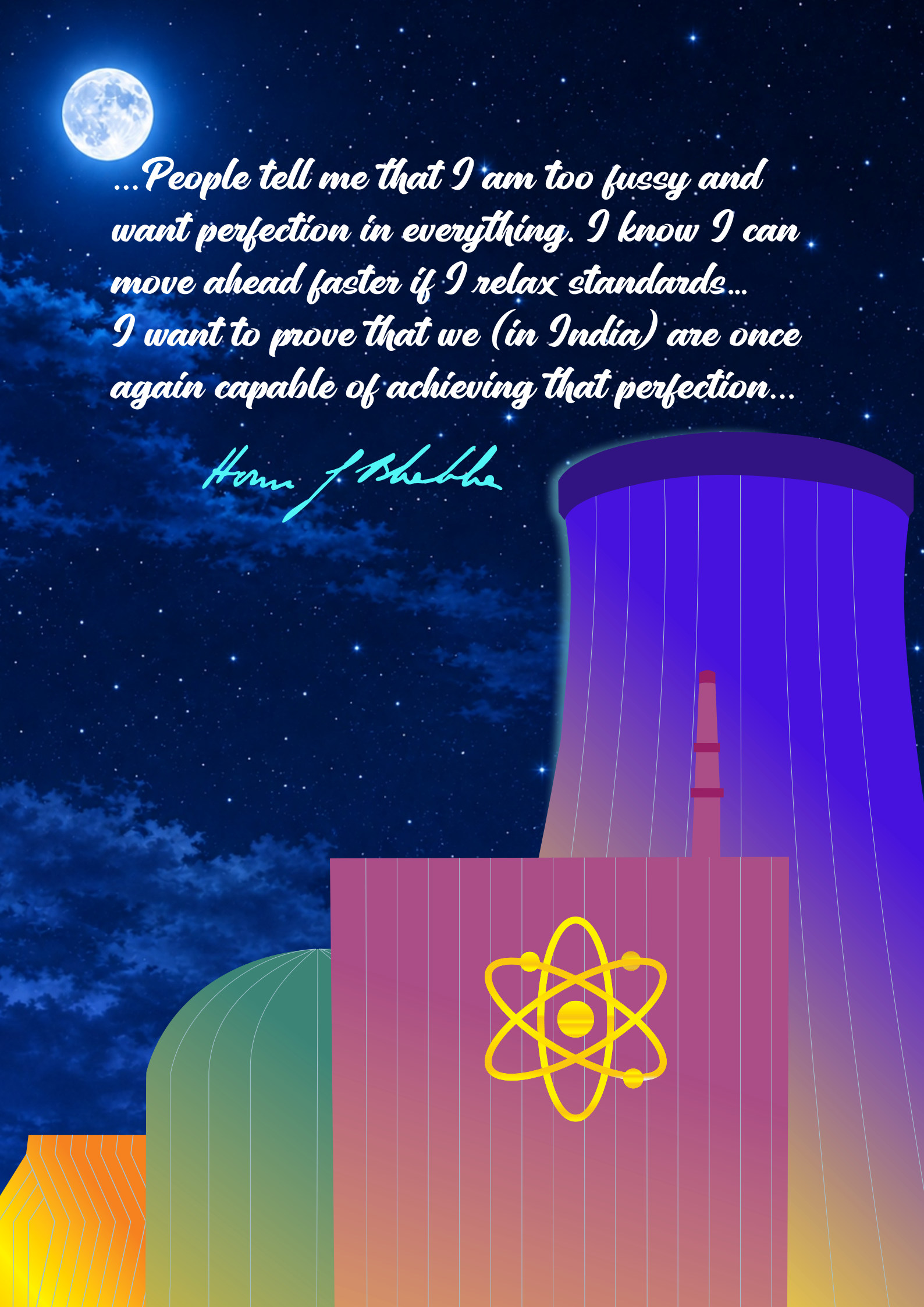

...People tell me that I am too fussy and want perfection in everything. I know I can move ahead faster if I relax standards...
I want to prove that we (in India) are once again capable of achieving that perfection...
Homi J Bhabha

ADVANCED Technologies

Engineering new solutions for cutting edge nuclear technologies

प्रगत प्रौद्योगिकियां: अत्याधुनिक नाभिकीय प्रौद्योगिकियों हेतु नव अभियांत्रिकीय समाधान

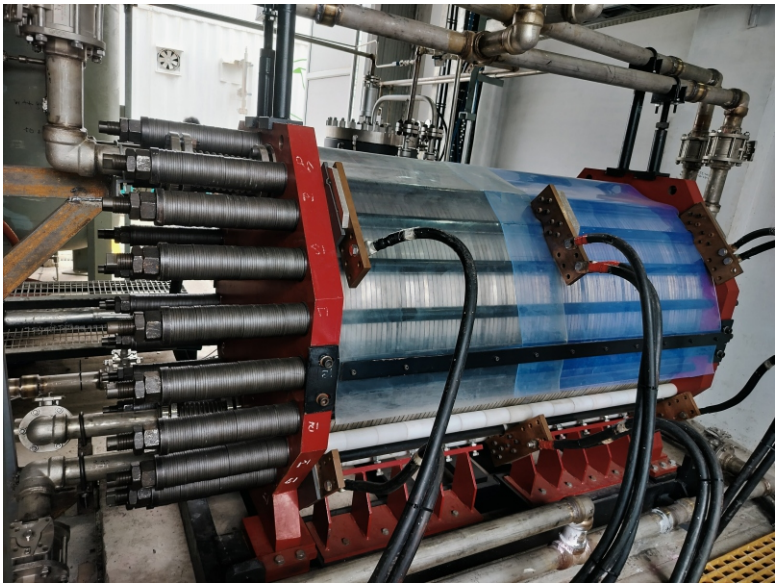
Cu-Cl Thermochemical Cycle Integrated with FBTR: A copper-chlorine (Cu-Cl) facility was integrated with the secondary sodium loop of the Fast Breeder Test Reactor (FBTR) for nuclear heat driven hydrogen production. Following pre-commissioning, the closed-loop facility operated round-the-clock at its design capacity of 50 NL/h. Approximately 85 hours of operation established safe functioning and performance according to design requirements. This was the first facility of its kind worldwide.

Pulsed Disc and Doughnut Columns (PDDCs): PDDCs are passive, maintenance-free contactors that intensify solvent extraction in front-end and back-end processes. Their advantages include reduced plant footprint and solvent inventory, faster start-up and shutdown, solids-handling capability, and enhanced mass transfer, reducing equipment height for desired separation. A pilot plant demonstrated sustained uranium refining, while a 6-inch-diameter facility generated scale-up data. Computational models for multiphase hydrodynamics and mass transfer were developed and validated using experimental data.



Copper-Chlorine thermochemical cycle pilot plant of BARC coupled with secondary sodium system of FBTR.

Indigenous 0.5 MW Alkaline Water Electrolyser: An advanced 0.5 MW alkaline water electrolyser (AWE) stack was designed, fabricated, and assembled using a non-conventional bipolar configuration. Integrity and leak testing confirmed its mechanical robustness and sealing. Integrated with the 1 MW electrolyser plant developed with BPCL at Cochin International Airport, the stack successfully completed an operational campaign at rated capacity. This demonstrated the readiness of indigenous technology for larger-scale green hydrogen production and marked the first demonstration of a large-scale electrolyser stack designed and fabricated entirely indigenously.



Thermal cycling of the advanced 0.5 MW AWE stack in progress.

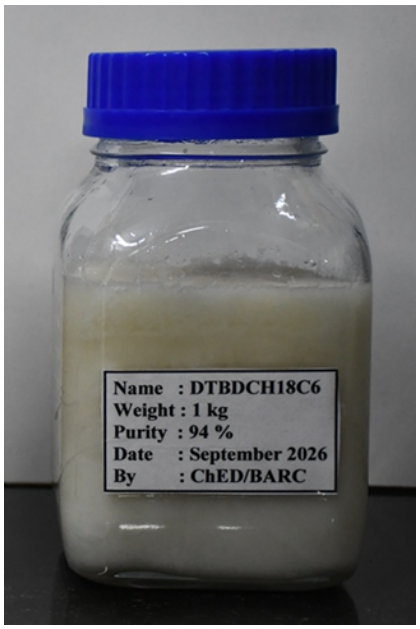
Indigenous Synthesis of DTBDCH18C6: Pilot-scale production of the strontium-selective crown ether 4,4'(5')-di-tert-butyldicyclohexano-18-crown-6 (DTBDCH18C6) was demonstrated for selective recovery of strontium (Sr) from high-level waste (HLW). Recovered Sr is used in radiomedicine, radioisotope thermoelectric generators (RTGs), and radiation heater units (RHUs). Indigenous production was demonstrated at 1 kg per batch, with product assay exceeding 90%. A total of 3 kg was supplied to INRP, NRB, Kalpakkam.

Membrane Distillation and Hydrophobic Membranes: Membrane distillation (MD) technology advanced from laboratory development to pilot-scale demonstration for high-recovery desalination and zero liquid discharge (ZLD). A single-effect hollo w-fibre vacuum membrane distillation (VMD) unit treated brine with conductivity of 50–80 mS/cm at 60–80°C and 100–200 mbar absolute vacuum. It achieved distillate production of 7–11 LPH, permeate fluxes of 1.8–3.9 LMH, and salt rejection above 99.9%. Results supported the design and experimental validation of an energy-efficient multi-effect VMD system.

An indigenous pilot-scale plate-and-frame air gap membrane distillation (AGMD) unit using commercial PTFE membranes produced 1.2–1.5 LPH of distillate with 99.9% salt rejection. Indigenous hydrophobic PVDF nanocomposite membranes were also developed using vapour-induced phase separation, incorporating 2 wt.% carbon black or 4 wt.% graphene. These membranes exhibited enhanced hydrothermal stability, water contact angles up to 117°, and pure-water permeability up to 93.6 LMH. Laboratory AGMD testing achieved vapour fluxes of 2.5–3.5 LMH and solute rejection above 99.2%.



6" diameter PDDC facility.



Product – DTBDCH18C6.



Forced Circulation Crystallizer Unit at BARC.



BARC's OSCOM Plant: Supplying potable water to Odisha Villages.

ZLD Desalination and NaCl Recovery: A near–ZLD process recovered high-purity sodium chloride (NaCl). A 10 kg bench-scale batch with purity exceeding 99.8% was produced through reactive precipitation, filtration, ion-exchange polishing, and rotary evaporation. A pilot-scale forced circulation crystallizer (FCC), designed for 10 kg/h salt recovery, was integrated with steam, seawater, and vacuum utilities. Pre-commissioning included leak testing and verification of control logic and process interlocks. FCC testing demonstrated distillate production of 50 kg/h at 55 mbar vacuum.

5 MLD Seawater Desalination Plant: BARC's OSCOM Odisha plant comprises 4.5 MLD indigenous seawater reverse osmosis (SWRO) and 0.5 MLD multiple-effect distillation with thermal vapour compression (MED-TVC) facilities. Operating round the clock, it supplies potable water to OSCOM facilities. Following stable performance, IREL signed an MoU with the State Government to supply 1.5 MLD to Matikhalo and Aryapalli villages. Public distribution of SWRO water was inaugurated by the Union Minister on 10 August 2025. BARC continues to provide technical support, troubleshooting, and maintenance guidance.