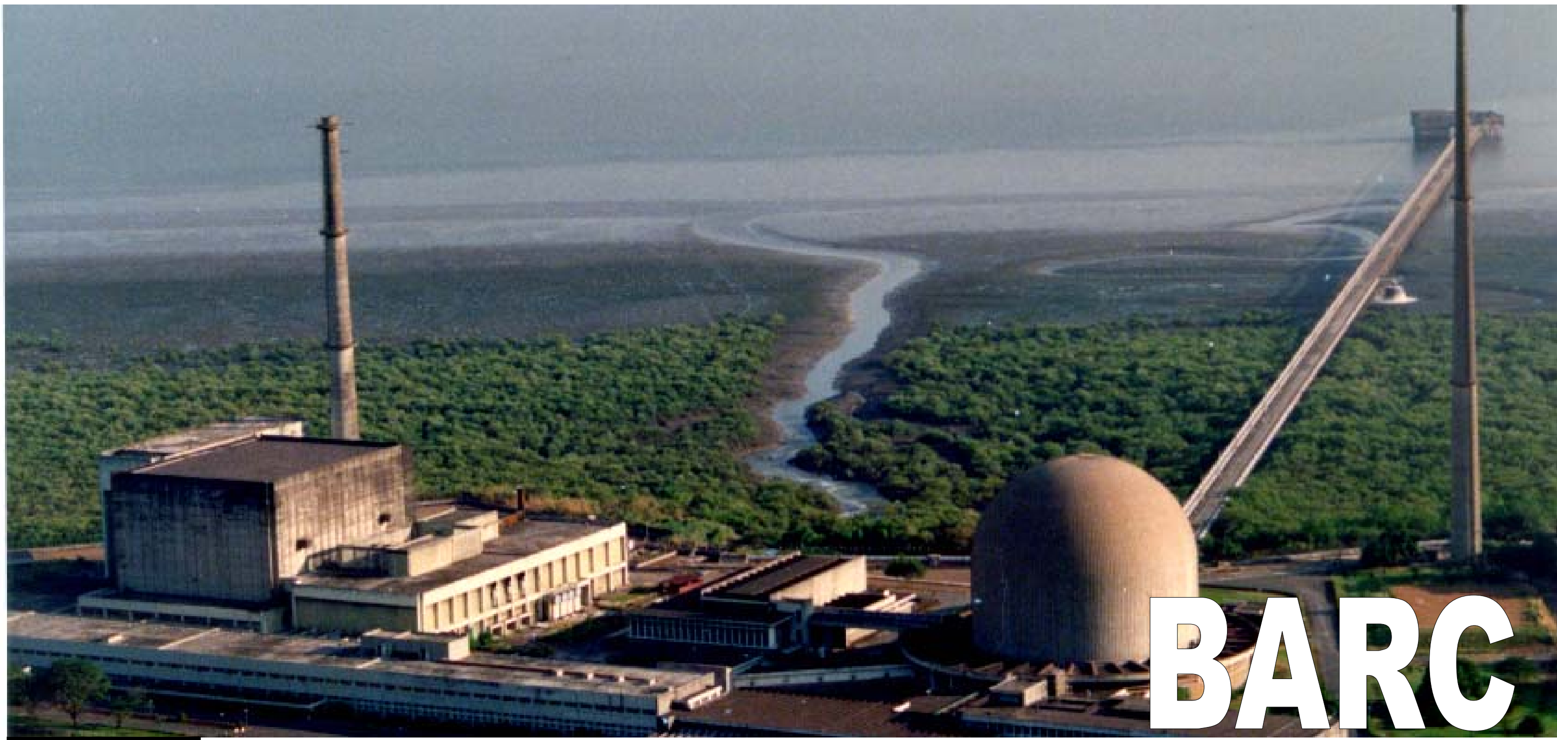

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Contents

BIOGRANULATION: SELF - IMMOBILISED MICROBIAL CONSORTIA FOR HIGH PERFORMANCE LIQUID WASTE REMEDIATION

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Introduction

Biotechnological applications based on immobilised cell technologies have been widely used since the eighties. Several cell immobilisation techniques have been developed over the last two decades. The cells can be engineered ones, naturally occurring strains or a combination of both. Similarly, the immobilised systems can be artificial or natural. In artificial systems, the cells are entrapped in suitable gel matrices (e.g. calcium alginate hydrogels), where they retain most of their viability and physiological activity. On the other hand, spontaneous adsorption of microbial cells to surfaces of carrier material results in colonization of the support material and leads to the formation of what is known as biofilms. In a biofilm, the micro-organisms are entrapped within a matrix of extra-cellular polymeric substances (EPS) secreted by themselves. Formation of surface-associated biofilms is a universal survival strategy adopted by bacteria. Biofilms have found extensive applications in environmental biotechnology, because biofilm-based reactors offer high biomass concentration. Quite often, undesirable biofilms develop on materials in environmental, biological as well as in industrial situations. The economic implications of such microbial biofilms are only too well-known for power plant operators, who have to deal with bacterial "slime" in condenser tubes, in order to maintain optimum heat transfer coefficient. The true significance of biofilms in industrial and human health realms has been only relatively recently recognized. In the last 8-10 years, there has been an explosion in the number of published investigations on such natural immobilised cell systems.

Immobilised Cell Systems

Since close packing of cells at high cell densities occur in immobilised cell systems, one can expect high volumetric reaction rates where such systems are employed for substrate conversion. In bioreactor operation, the use of cell biomass immobilised on surfaces or on particulate carriers ensures efficient biomass retention, minimizing cell loss through washout. This also simplifies downstream processing of the effluent coming out of the bioreactor. Cells growing in a biofilm mode are very much resistant to environmental stress (caused, for example, by toxic compounds, biocides, antibiotics or other residual treatment chemicals), when compared to their freely suspended counterparts. For example, biofilm bacteria can tolerate antimicrobials at concentrations of 10 to 1000 times that needed to kill genetically equivalent planktonic (freely suspended) bacteria. This enables the immobilised cells to tide over unfavourable environmental conditions in a very efficient manner. Immobilised systems can be repeatedly re-used, provided they can be efficiently regenerated.

Immobilised cell systems are extensively used in the production of enzymes (e.g., enzymes digesting cellulose, proteins and chitin), antibiotics, alcohols, complex polysaccharides, surfactants and food additives. Microbial communities in the form of biofilms, bioflocs or biogranules have been also employed in environmental bioremediation technologies (e.g., wastewater treatment for removal of COD, nitrogen, phosphorus, heavy metals, hydrocarbons and cyanide) and in biosensors.

Self-immobilised Systems

Some of the most commonly used immobilization techniques include use of cross-linked gelatin, porous ceramic beads and alginate or agarose beads. However, bacteria also have the ability to attach to one another and form self-immobilised granules, by a process known as biogranulation. These granules are dense, compact aggregates and consist of a consortium of different microorganisms held together in a common polymer matrix (Fig. 1). Granule development is mediated by auto aggregating or co-aggregating abilities of the various interacting bacteria.

Fig. 1 Aerobic microbial granules cultivated in the laboratory and used for biodegradation studies

Biofilm and granule based technologies are employed in wastewater treatment for removing organic and nutrient contaminants. These microbial granules have several advantages as compared to conventional activated sludge flocs, such as compact and dense microbial structure, good settling ability, high biomass retention in the bioreactor and the ability to withstand fluctuating organic loading rates. Ability of the granules to withstand substrate or organic shock is advantageous because fluctuating organic loading rate is quite common in real-life remediation scenario. Efficient aggregation of microbes to one another is of vital importance, since economic application of the technology depends on easy separation of biomass from the treated effluent.

Biogranulation

Biogranulation can be classified into anaerobic and aerobic granulation. Formation of anaerobic granules is relatively common and has been widely observed in upflow anaerobic sludge blanket (UASB) type reactor. A recent review reports that nearly 6000 industrial wastewater treatment plants based on this technology are in operation world wide. Anaerobic granulation technology, however, suffers from several disadvantages. It requires long start-up period (2 to 4 months) and relatively high operating temperature (30 to 35 °C for mesophilic UASB reactors). It is generally unsuitable for low-strength organic wastewater, characteristic of common municipal or industrial wastes. It is also not suitable for nutrient (nitrogen and phosphorous) removal from wastewater. In order to overcome these drawbacks, Mishima and Nakamura in 1991 developed microbial granules in aerobic upflow sludge blanket reactor. Even though granules have been cultivated successfully in bioreactors and the effect of bioreactor conditions on granulation process studied relatively well, the mechanism of microbial granulation is largely unknown. Biological factors such as aggregating abilities of individual bacterial strains, which provide the structural framework, the catabolic diversity of granules which gives the functional capability and the driving force for microbial cell aggregation are some of the areas which deserve serious attention.

Research on aerobic granulation has concentrated mainly in sequencing batch reactors (SBR) because the reactor operation conditions (cyclic feeding and starvation, high shear stress and short settling time) promote development of granules. Research in this area has led to the development of granules in laboratory scale SBRs on a wide variety of easily degradable carbon sources such as glucose, acetate and ethanol. Recently, granules have been cultivated by seeding SBRs with phenol degrading mixed culture. The developed granules had the ability to degrade high phenol concentrations. It demonstrated the potential of aerobic granules for treatment of waste containing toxic organic pollutants.

Development of granules requires aggregation of individual bacterial strains. Biogranulation is a process involving the development from seed sludge to compact aggregates, further to granular sludge and then finally to mature nearly spherical granules. This self-immobilization process involves clearly distinguishable (based on size and morphology) steps. Granulation may be initiated by self-adhesion of bacterial strains. This can be through auto-aggregation or co-aggregation among the bacterial strains. Auto-aggregation refers to the physical cell-to-cell interaction between genetically identical cells, while coaggregation refers to the interaction between genetically distinct bacterial cells. High shear and short settling time are employed in the reactor to select bacterial strains having aggregating ability and strains with poor aggregating ability get washed out. Development of granules may share similar events involved in multi-species biofilm development. Intercellular communication is also believed to play a definite role in organizing the three dimensional spatial distribution of bacteria in granules. Cell surface hydrophobicity and extracellular polymeric substances (EPS) facilitate the aggregation of bacteria and maintenance of the granular structure.

Biodegradation of Metal-Chelating Agents

Synthetic chelating agents are used in many industrial applications because of their capability of binding and masking metal ions. Aminopolycarboxylic acids (APCAs) are an important group of chelating agents that form stable and water-soluble complexes with many metal ions. Nitrilo triacetate (NTA) and ethylene diamine tetra acetate (EDTA) are two important APCAs widely employed in industrial applications. Such chelating agents have been used for a wide range of applications, including chemical decontamination of nuclear reactors, chemical cleaning of steam generators and nuclear waste processing. These chelating agents are also used in detergent formulation, food, pharmaceutical, cosmetic, metal-finishing, photographic, textile and paper industries. Co-disposal of heavy metals and radionuclides along with synthetic organic chelating agents raise concern because chelating agents may promote undesirable movement of toxic metals and radionuclides away from their primary waste disposal site. The remediation of mixed wastes is much more complex and challenging than dealing with individual pollutants. One organism able to degrade one component may be completely inhibited by another toxic component. This has been realised in waste containing mixture of organic substances, particularly chelating agents and metal ions/radionuclides. Bioavailability of pollutants to micro-organisms is one critical factor for successful bioremediation. Chelating agents of APCA type (e.g., NTA, EDTA) and their metal complexes are usually recalcitrant to microbial degradation and only a few bacterial strains are able to degrade them albeit at low rates. Studies on microbial degradation of nitrilotriacetic acid and other chelating agents revealed that metal complexation has a significant effect on biodegradability. There is great research interest in developing effective biological treatment process for degrading synthetic chelating agents.

Biodegradation of Chelants and Chelant - Metal Complexes by Aerobic Granules

Microbial granules were successfully cultivated in laboratory scale sequencing batch reactor (Fig. 2) by seeding with activated sludge collected from a wastewater treatment plant at Kalpakkam. The reactor was fed with synthetic wastewater containing NTA and acetate as carbon sources. Microscopic examination of seed sludge (Fig. 3a) showed filamentous bacteria typical of activated sludge. The filamentous bacteria gradually disappeared during the biogranulation process and granules started appearing after about 2 weeks of reactor operation. Mature granules developed after 3 weeks and they had a very regular nearly round shaped outer structure (Fig. 3b). Confocal laser

Fig. 2 Close up of a laboratory sequencing batch reactor (SBR) with cultivated aerobic granules

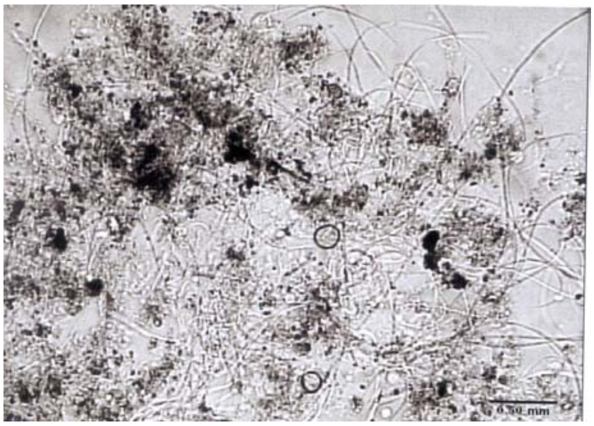


Fig. 3(a) Filamentous growth in seed sludge used for reactor inoculation

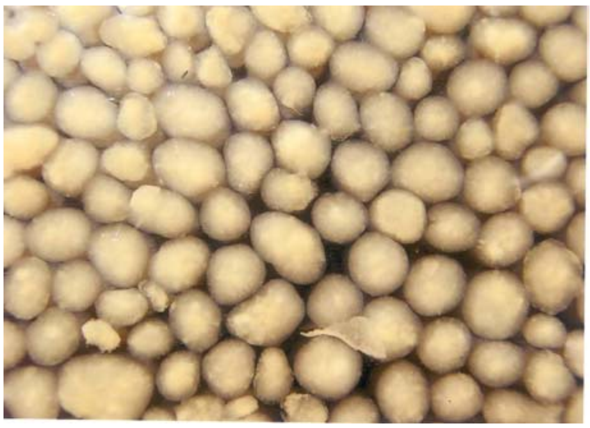


Fig. 3(b) Close-up of aerobic granules scanning microscopy of the granules revealed that they had a very compact microstructure in which cells (mostly rods and cocci) were packed together (Fig. 4). Optical sectioning of several weeks old granules showed that the bacteria were spatially organized into clusters within the granule. (Fig. 5 and 6).

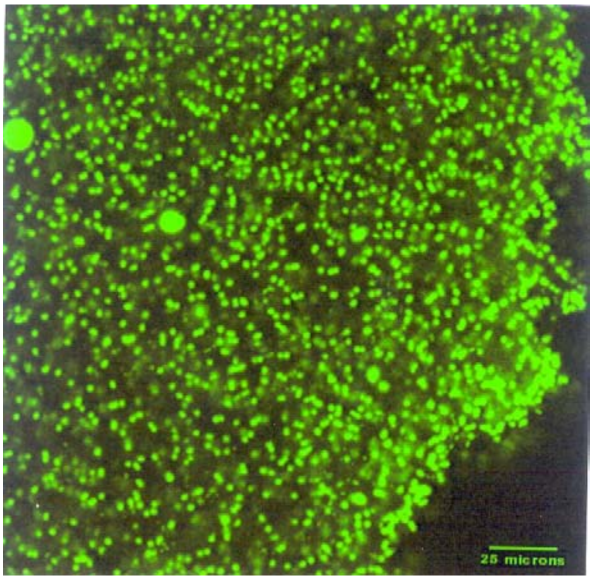


Fig. 4 Confocal microscope image (xy section) of microbial granule

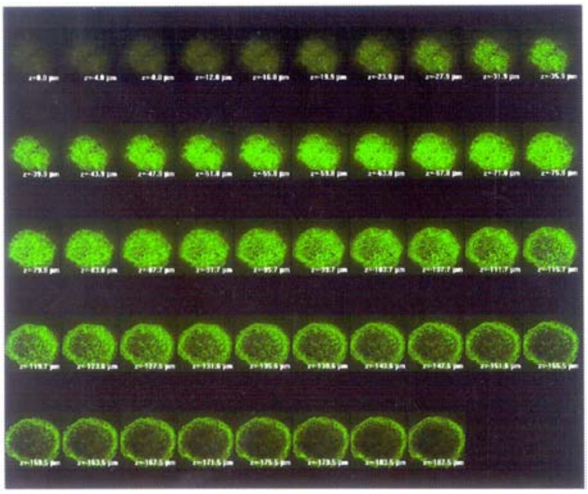
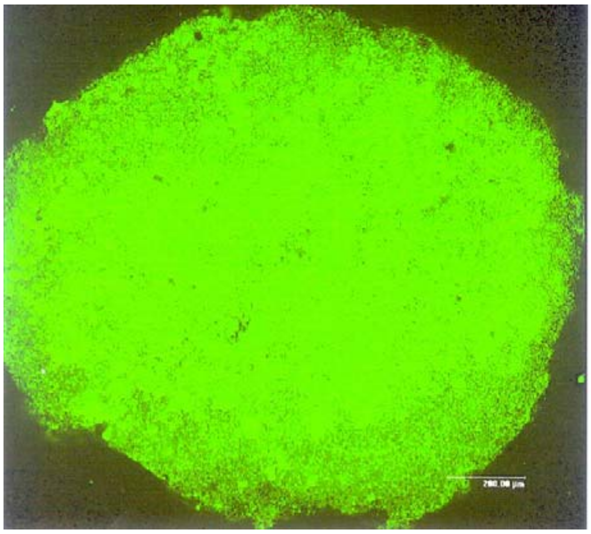
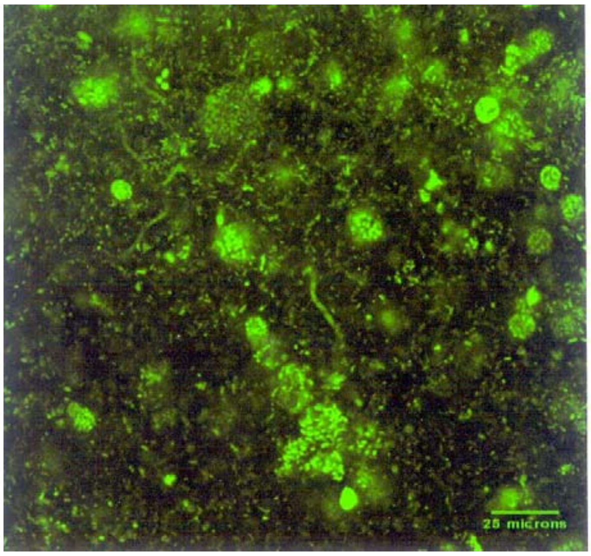


Fig. 5 Gallery of confocal slices (xy images) of an aerobic microbial granule

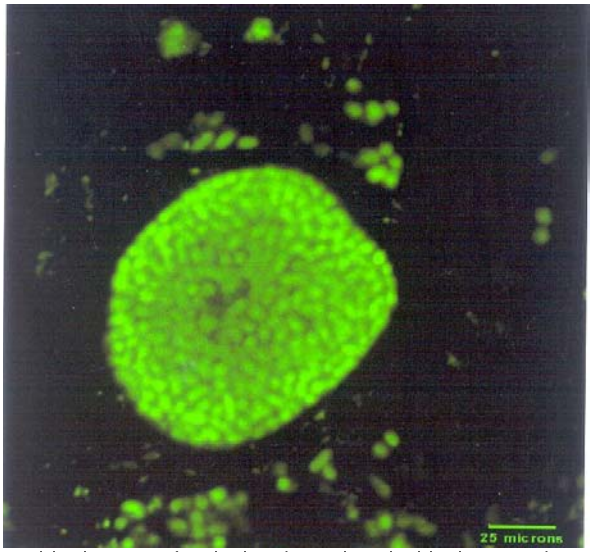
The pre-cultivated microbial granules were used in biodegradation studies using 1.0 l glass cylinders. Samples were retrieved at regular intervals and NTA concentration was monitored using spectrophotometry and HPLC. Figure 7 shows the degradation of various initial concentrations of NTA by the microbial granules. Initial concentrations of up to 600 mg/L (3.12



(a) Maximum intensity projection of confocal slices



(b) A single xy slice showing distribution of micro-colonies



(c) Close-up of a single microcolony inside the granule

Fig. 6 Internal microstructure of an aerobic granule as revealed by confocal microscopy mM) free NTA were degraded completely. The granules could be used repeatedly for degradation of NTA (Fig. 8). The data suggest that the granules could be used for up to four consecutive cycles of NTA degradation, without losing degradative capability. The degradative ability could be regenerated by acetate treatment. The granules retained structural integrity and settling ability even after repeated cycles of degradation. Figure 9 shows the degradation of free NTA and Fe-NTA complex by aerobic granules. The aerobic granules degraded both free NTA and ferric-NTA using them as sole sources of carbon, nitrogen and energy. However, Fe-NTA degradation was sluggish and associated with a longer lag phase as compared to free NTA. The delay could be due to lag time involved in the induction of specific metal-NTA degrading enzymes, or due to additional time required for efficient transport

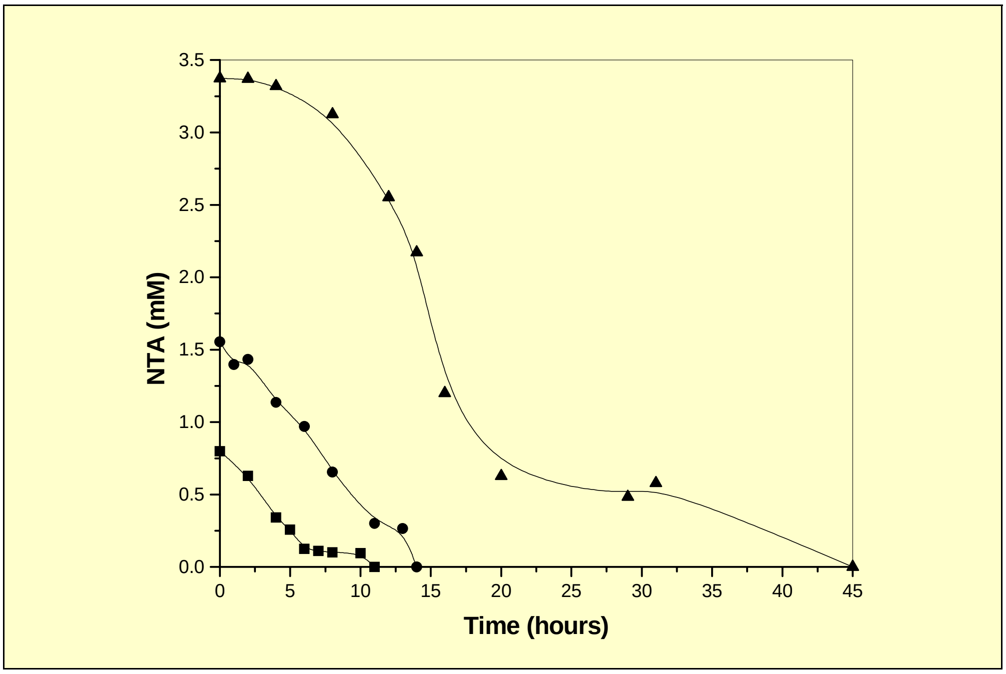


Fig. 7 Biodegradation of nitrilo triacetate (NTA) by aerobic granules

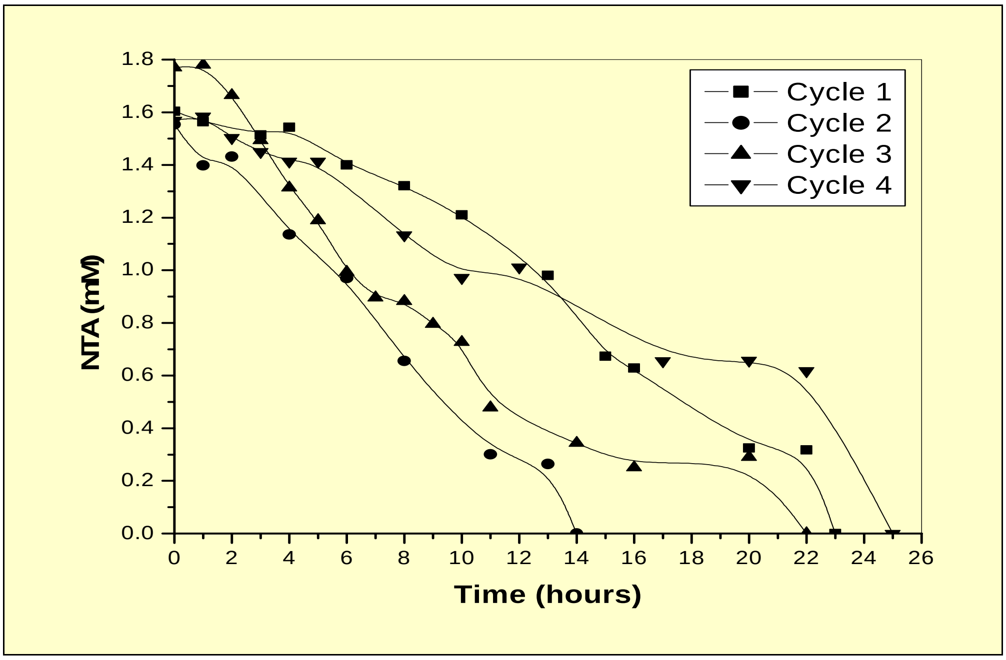
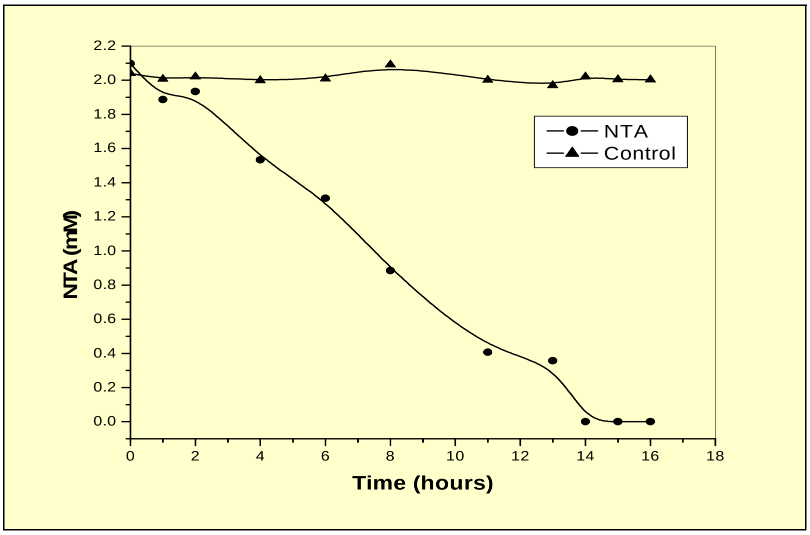
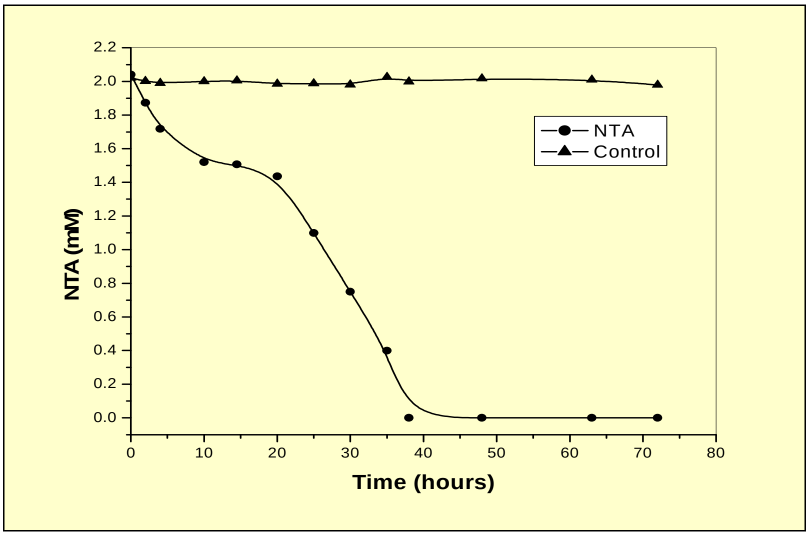


Fig. 8 Repeated cycles of biodegradation of NTA by aerobic granules

systems to be made available. Complete degradation of the chelant and its complex achieved in distilled water suggests that



(a) Degradation profile of free NTA



(b) Degradation profile of ferric-NTA complex

Fig. 9 Biodegradation of free and ferric - NTA by aerobic granules

treatment process may not require addition of other essential nutrients necessary for supporting microbial growth. During the biodegradation of ferric-NTA, a gradual increase in dark orange-red precipitation (of iron released from the degraded Fe-NTA complex) was observed in the glass cylinders.

Complete degradation of chelating agents and their metal complexes may be mediated by one or many different types of bacterial strains. Due to the compact granular form of biomass, large number of micro-organisms can be maintained in the bioreactor. This in turn means that pollutant transformation is rapid and large volumes of waste can be treated using compact bioreactors. Moreover, the large size and relatively high specific gravity (about 1.5) of granules cause them to settle rapidly, leading to easy separation of treated effluent from the biomass. Efficient degradation rates of NTA and ferric-NTA by aerobic granules observed during the present study points to the possibility of developing efficient technologies for rapid biodegradation of dilute industrial wastes using compact bioreactors.

However, there is a need for further exploration of the degradation capability to handle other metal-NTA complexes (e.g, Co-NTA) and ability to handle waste streams containing radioactivity. Interestingly, the ability of microbial granules to remove heavy metals by biosorption has been demonstrated by other researchers. Nevertheless, it is necessary to elucidate the degradative strain diversity in the granules using molecular (e.g., 16S rRNA) methods. It also needs to be examined to what extent aerobic microbial granules are amenable to bioaugmentation, whereby special natural or engineered catabolic strains could be integrated into pre-cultured degradative granules for further enhancement of their substrate conversion capabilities.

UNDER WATER CUTTING MACHINE

Centre for Design and Manufacture (CDM), BARC, has designed and developed a semi automatic under water cutting machine for dismantling the absorber rod bundles.

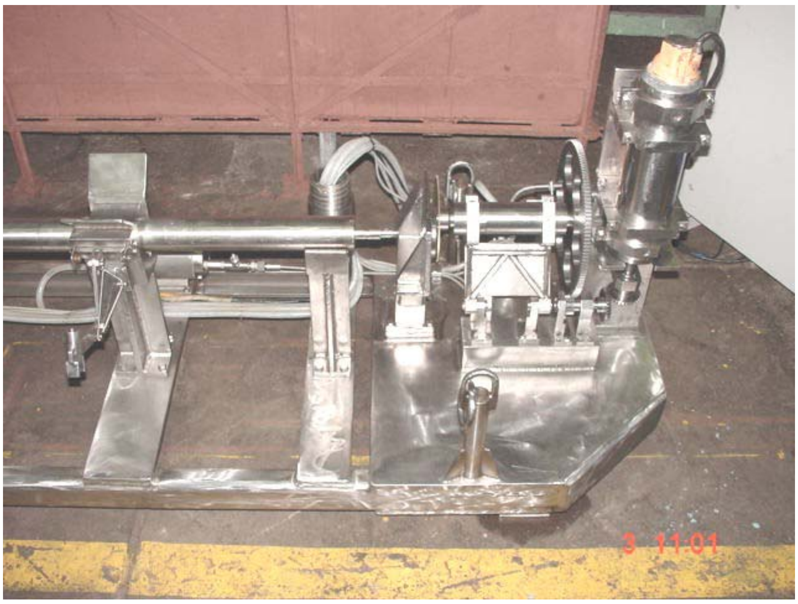
Under water cutting machine

The absorber rod bundles are assembled around a central rod with the help of an end spring and a lock nut, which is locked by a split pin. When absorber rods complete their irradiation time, they are removed from the reactor.

The irradiated Co-60 bundles need to be separated from the central rod by cutting the rod very close to the lock nut. Due to high radiation levels, the rod has to be cut under water.

The 3 meter long and 700mm wide cutting machine consists of a feed mechanism for radial feed of the slitting saw and clamping mechanism for clamping the bundle assembly. A single-phase submersible A.C. motor gives rotation to the slitting saw.

The 2 meter long absorber bundle assembly is kept on the machine, which is kept under water. After that, the clamping cylinder will push the central rod against the end spring, allowing the nut end of the rod to protrude out of the bracket. The protruded part of the rod will be cut by HSS slitting saw driven by 1 H.P. single-phase submersible motor. The design of the mechanism is such that feed and rotation to the cutter can be given simultaneously. A duplex cylinder having an accumulator, in between the air and oil, gives the controlled feed to the cutter. The cylinders are actuated by pressurized air at 6 bar. All the operations are controlled through the common control console through a PLC and by direction control valves. Proximity switches are given for inter-locking the operations and for positive display of all movements. CDM has successfully carried out the cutting trials and mock-ups. The machine has been delivered to the user.



Feed Mechanism

NATIONAL WORKSHOP ON "ADVANCED METHODS FOR MATERIALS CHARACTERISATION"

Material Research Society of India (MRSI) is an interdisciplinary professional body dedicated for the growth of indigenous research and development in the area of material science and engineering. Its Mumbai Chapter organised a National Workshop on "Advanced Methods for Materials Characterisation (NWMC-2004)" during October 11-15, 2004 at the Multi-purpose Hall, Training School Hostel/Guest House of BARC at Anushaktinagar. The workshop was convened by Dr S.K. Kulshreshtha, Head, Novel Materials & Structural Chemistry Division, BARC, and Dr A.K.Tyagi, Head, Solid State & Surface Chemistry Section of Applied Chemistry Division, BARC was its Secretary. The objective of this workshop was to impart basic knowledge of the advanced techniques used for material characterisation to the research scholars, teachers and the scientists working in different types of industries and research centres. A number of demonstrative experiments were also carried out to give the participants a feeling of the experimental details and instrumental facilities.

The fascinating and ever growing world of materials is very vast and the characterisation of such a wide variety of materials demands an interdisciplinary knowledge involving chemistry, physics, biology and technology. Different techniques need to be used for the complete characterisation of such materials, which involve phase analysis, compositional characterisation, structural elucidation, micro-structural analysis and surface characteristics. Due to the diminishing size of the materials (Nano-regime), characterisation techniques with better resolution have to be employed so as to get the structural information at atomistic level.

This workshop attracted a significant attention and about 175 delegates from different parts of the country participated in it. In addition to this, about 25 speakers and 20 volunteers also participated in this workshop. The faculty was mainly drawn from BARC and IIT Bombay. The technical sessions of the workshop were divided into three broad categories, namely, Structural & Imaging Techniques, Composition & Surface Characterisation Techniques and the Spectroscopic Methods.

The workshop was inaugurated by Prof. Ashok Misra, Director, Indian Institute of Technology, Bombay. In his inaugural address, Prof. Mishra emphasised the need for such educative programmes under the banner of MRSI Mumbai Chapter and suggested that such events should be held every year and efforts should be made to have focused workshops providing advanced training on specific techniques/topics. He also released the souvenir/abstract book and the proceedings of this workshop. Dr Srikumar Banerjee, Director, BARC and Chairman, MRSI Mumbai Chapter, delivered the presidential address. He strongly emphasised on the importance of characterisation techniques in developing the advanced functional materials.

The topics covered in this workshop included X-ray and Neutron Diffraction, Imaging Techniques like AFM, STM, SEM, TEM & EPMA, Positron Annihilation, ESCA, ESR, NMR IR and Raman Spectroscopy, Applications of Synchrotron Radiation, Dynamic Light Scattering Mass spectroscopy, Ion Beam Analysis, ICPAES, and Neutron Activation Analysis. Each lecture was followed by a highly interactive question-answer session. In addition to lectures, few demonstrative experiments on X-ray Diffraction, Transmission Electron Microscope, Scanning Electron Microscope, Electron Probe for Microanalysis, Mass Spectroscopy, IR Spectroscopy were also conducted for the benefit of participants. Several representatives from the industries, including three overseas delegates, also participated in this workshop in form of exhibition of their products and by delivering short

Dr Srikumar Banerjee, Director, BARC, giving his Presidential address

Prof. Misra releasing the Proceedings of the Workshop and Dr Banerjee having a look at it.

presentations on the global advances on some of the characterisation techniques.

The other highlight of this workshop was the special lectures by two of the most eminent scientists of the country. Dr R Chidambaram, Homi Bhabha Professor and Principal Scientific Advisor to the Government of India, delivered a special evening lecture on "Recent trends in high pressure physics". Dr S. Banerjee, Director, BARC, also delivered a special lecture on materials characterisation over different length scales. Both these lectures were attended by a number of invitees and were highly stimulating and they motivated young participants. A popular lecture, dealing with the preparation and characterisation of Nano-materials was delivered by Dr Kulshreshtha. The workshop ended with a valedictory function, and a certificate of participation was given to all the delegates of the workshop.

49TH ANNUAL DAE - SSP SYMPOSIUM

The 49th DAE-SSP symposium sponsored by BRNS was held at Guru Nank Dev University campus at Amritsar, Punjab, during December 26-30, 2004. It was inaugurated by Dr S.K. Sikka, Scientific Secretary, Office of Principal Scientific Advisor, Government of India, who was the Chief Guest on the occasion. In his address, Dr Sikka impressed upon the young delegates to strive hard to publish good quality papers in International journals, so that their work gets due attention. For this, they have to use the new tools like the synchrotron radiation for better insights into the fundamental behaviour of materials being investigated by them.

Dr S.K. Sikka, Scientific Secretary, Office of Principal Scientific Advisor, Government of India, delivering the inaugural address.

In his address, the Chairman of the National Advisory Committee of the Symposium, Dr V.C. Sahni, Director, Physics Group, BARC, and Director, Centre for Advanced Technology, Indore, traced the growth and evolution of the Solid State Physics Symposium which is now acclaimed as a national scientific event every year by the community of condensed matter physicists. He also had a word of appreciation for the organisers for having put together a very good topical mix of sessions, encompassing both applied and basic areas of research.

The inauguration function was presided over by Prof. S.P. Singh, Vice-Chancellor, Guru Nanak Dev University, who underlined the efforts made by his university to cater to the complete growth of young students, emphasising sports and culture as much as the formal education. Prof. R.K. Bedi, Local Convener of the symposium, welcomed the delegates and dignitaries present to grace the occasion.

Dr J.V. Yakhmi, Head, TPPED, BARC, and Convener of the symposium, underlined that the symposium this year has provided a forum for encouraging the borderline areas of research, such as Soft Condensed Matter including Biological Systems, Liquid Crystals, Polymers, Self-assembly, Surfaces and Interfaces which overlap with topics in chemistry, biological sciences and novel materials, and thus will foster the growth of device-oriented research in the country.

The symposium was attended by over 450 delegates, who presented more than 500 papers. The number of younger participants from Indian universities and laboratories was noticeably large and the symposium generated great interest and excitement among them. There were 22 Invited talks, including by guest-speakers from Japan, Korea, Germany, France, USA and from physicists drawn from Indian universities, IITs, and national laboratories. The topics ranged from Quantum Computers, Spintronics, MEMS, Superconductors, Nanophase Materials, Organic LEDs, etc. to Biophysics. There were a large number of poster, sessions and the poster, 'Entropy driven self-association of block co-polymers' by Dr V.K. Aswal and colleagues from BARC won the Best Poster award. About 20 thesis presentations were made by young researchers who had completed their Ph.D. work at different universities during 2004. From among them, the best thesis, award was given to the thesis, 'Magnetic and transport properties of charge ordered and layered manganites' by Dr Sunil Nair from Indore, now working at TIFR.

BARC TRANSFERS TECHNOLOGY OF "ACCELERATION - DECELERATION CONTROL VALVE AND CIRCUIT FOR HYDRAULIC LIFT "

During exchange of Agreement with M/s. Experts Pvt. Limited, Thane, Mumbai, seen from left to right are Mr A.M. Patankar, Head, TT&CD, BARC, Mr R.G. Agrawal, Head, RTD, BARC, Dr N.L. Soni, Head, FPTS, RTD, BARC, Mr V.K. Upadhyay, TT&CD, BARC, Mr T.R.C. Menon, Managing Director, M/s. Experts Pvt. Ltd., Thane, Mumbai, and Mr Arvind T. Menon, Director, M/s. Experts Pvt. Limited, Thane, Mumbai.

BARC transferred the technology on "Acceleration-Deceleration Control Valve and Circuit for Hydraulic Lift" developed by Refueling Technology Division to M/s. Expert Equipments Pvt. Ltd., Thane, Mumbai. The Technology Transfer Agreement was signed on October 28, 2004. This technology is new and useful for the Indian Industry.

The Acceleration-Deceleration Control Valve is a simple and cost effective alternative for controlling the acceleration and deceleration of hydraulic actuator while starting and stopping. It reduces the jerk while starting and stopping the actuator. On the demand by Technical Services Division, BARC, for getting perfectly smooth operation of the lift, Refueling Technology Division, has developed this device, specifically for the visit of Honourable Prime Minister of India. It was in fact a demand - based innovation and transfer of technology.

Technology Transfer and Collaboration Division, BARC, coordinated all activities related to the transfer of this technology, such as preparation of Technical Brochure, Technology Transfer Document, Advertisement of the technology, Technology Transfer Agreement preparation and the signing of Agreement in collaboration with RTD, BARC.

BARC HANDS OVER FIRST INDIGENOUS SLUDGE LANCING EQUIPMENT TO NPCIL

A Sludge Lancing Equipment (SLE) developed for the first time in the country by BARC was handed over to NPCIL on January 5, 2005. This equipment will ensure long service life of steam generators of nuclear power plants by periodic removal of corrosion products from steam generator.

Steam generator is a vital and complex component of a nuclear power plant. During years of plant operation, corrosion products and other solids deposit in the form of sludge on the tube sheet of steam generator. The sludge formation not only adversely affects the steam generator performance but also diminishes its service life if left unchecked. Although the plant operators take utmost care to reduce sludge formation, periodic sludge removal from steam generator is an essential part of the strategy to ensure high availability and service life of the equipment.

In the SLE developed by BARC, high velocity narrow water jets or water lances are used for dislodging and removal of hard and strongly adhesive sludge from the steam generator tube sheet. This goes a long way in preserving the integrity of tube to tube sheet joint as well the steam generator as a whole.

NPCIL has used SLE procured from foreign suppliers in the past. However, due to uncertain after-sales service, the availability and performance of the imported SLE have not been satisfactory. In view of this, it was decided to develop the SLE indigenously in BARC, in response to a tender floated by NPCIL. The cost of Indian SLE is around Rs. 2 crores. An imported SLE would have been three times costlier.

The SLE built by BARC incorporates a remotely operated state-of-the-art robot, technically called Jet Manipulator Assembly (JMA), with sophisticated computerised controls. The JMA directs high velocity water jets to dislodge sludge from the steam generator tube sheet. A remotely operated camera called Remote Visual Inspection System (RVIS) provided to carry out visual inspection of the steam generator, displays images of steam generator internals before and after lancing. The dislodged sludge remains suspended in water and is separated by passing the water containing the sludge through a series of increasingly fine filters. The sludge-free clean water is recycled in a closed loop system and is pumped back to steam generator in the form of continuous high velocity water jets or lances.

The SLE developed by BARC was formally handed over by Dr S. Banerjee, Director, BARC, to Mr S.K. Jain, Chairman and Managing Director, NPCIL, at a simple get together organised at Engineering Hall No.3 in BARC campus on January 5, 2005. Director BARC, Chairman & Managing Director, NPCIL and Mr R.K. Sinha, Director, Reactor Design & Development Group of BARC addressed the gathering. The handing over ceremony included technical presentations on the subject and concluded with a live demonstration of the sludge lancing equipment. Dr Anil Kakodkar, Chairman, Atomic Energy Commission and Secretary, Department of Atomic Energy later witnessed the demonstration of SLE and complimented the team of engineers involved in the development work.

IAEA TECHNICAL MEETING ON "INTEGRATED NUCLEAR DESALINATION SYSTEMS"

An IAEA Technical Meeting on "Integrated Nuclear Desalination Systems" was held at Hotel Savera, Mylapore, Chennai, during December 13-16, 2004. Mr D.S. Shukla, Director, Chemical Engineering & Technology Group, BARC, inaugurated the meeting. During his inaugural address, he underlined the importance of nuclear desalination for societal needs and described the various possibilities by which nuclear power plants can be coupled to desalination systems. Dr P.K. Tewari, Head, Desalination Division, BARC, welcomed the participants. Dr B.M. Misra, the IAEA Scientific Secretary, briefed the participants and invitees about the technical meeting. Dr S. Prabhakar, Head, Separation Technology Section, Desalination Division, BARC, proposed the vote of thanks. There were ten participants from member states of Argentina, China, Egypt, France, India, Indonesia, Israel, Russia and Saudi Arabia. In addition, there were 4 observers from India and two from UAE. Invitees from MAPS and IGCAR, Kalpakkam, also attended the inaugural function.

The objective of the technical meeting was to discuss various aspects of Integrated Nuclear Desalination Systems pertaining to:

1) Design aspects of nuclear desalination plants, including seawater intake/outfall, reactors and coupling with desalination plants, product water distribution and quality.
(2) Techno-economic aspects of nuclear desalination projects/plants.
(3) Socio-environmental aspects and public acceptance of nuclear desalination.
(4) Innovations in reactor and desalination technologies and cost reduction strategies.

Mr D.S. Shukla, Director, Chemical Engineering & Technology Group, BARC, delivering inaugural address. Others from right (sitting) are Dr P.K. Tewari, Head, Desalination Division, BARC, Dr B.M. Misra, IAEA, and Dr S. Prabhakar, Head, Separation Technology Section, Desalination Division, BARC.

The objective of the technical meeting was to discuss various aspects of Integrated Nuclear Desalination Systems pertaining to:

1) Design aspects of nuclear desalination plants, including seawater intake/outfall, reactors and coupling with desalination plants, product water distribution and quality.
(2) Techno-economic aspects of nuclear desalination projects/plants.
(3) Socio-environmental aspects and public acceptance of nuclear desalination.
(4) Innovations in reactor and desalination technologies and cost reduction strategies.

The four day programme consisted of technical presentations, visit to Nuclear Desalination Demonstration Plant (NDDP) at Kalpakkam and panel discussions. Integrated nuclear desalination system, preheat reverse osmosis, value addition through recovery of strategic materials and utilisation of waste heat from the reactors were discussed in detail. The participants visited NDDP and Fast Breeder Test Reactor (FBTR) at Kalpakkam on December 15, 2004.

Recommendations and suggestions for further course of action was prepared on the last day. While presenting his remarks about the technical meeting, Dr B.M. Misra, IAEA, thanked BARC for hosting the meeting as well as for the excellent arrangements made which was endorsed by the participating member states. The meeting ended with concluding remarks from Dr P.K. Tewari, Head, Desalination Division, BARC.

REGIONAL TRAINING COURSE ON "PHYSICAL PROTECTION OF NUCLEAR INSTALLATIONS"

Department of Atomic Energy, Government of India, and International Atomic Energy Agency (IAEA) organised a regional training course on ‘Physical Protection of Nuclear Installations’, during October 4-12, 2004, at Hotel Sea Princess, Juhu, Mumbai.

The course was arranged with 16 lecture sessions, 2 workgroup sessions, one workgroup presentation session by course participants, plenary session and a field visit to Kakrapar Atomic Power Station. The course was inaugurated by Mr S. C. Hiremath, Chairman and

During the inauguration session, on the dais, from left are Dr K. Raghuraman, Head ISD, DAE, Mr Arvydas Stadalnikas (IAEA,Vienna), Mr S. C. Hirernath, Chairman & CE, HWB, Mr G. Govindarajan, Director, A&M and E&I Group, BARC (Course Director), Mr G. P. Srivastava, CMD, ECIL, and Mr S. Bhattacharya, Head, CnID, BARC.

Chief Executive, Heavy Water Board, and the concluding session was chaired by Mr S. K. Jain, Chairman and Managing Director, NPCIL.

There were 25 participants in the course – 13 foreign participants and 12 Indian. Foreign participants were from Bangladesh, China, Indonesia, Malaysia, Philippines and Thailand.

Indian participants were from different units of DAE and Ministry of Home Affairs. A total of four foreign faculty members were arranged by IAEA, 2 were IAEA staff members, one was from Sandia National Laboratory, USA and one from ARPANSA (Australian Radiation Protection and Nuclear Safety Agency), Australia. 10 faculty members from India took part in this training course.

Wide ranging topics under Nuclear Security like Nuclear Fuel Cycle activities and their physical protection concern, design basis threat, design and evaluation of physical protection system, International Physical Protection Regime, IAEA activities in nuclear security, security technologies, security and control of radioactive material and response were covered in this course. The course also included several emerging areas of nuclear security like safety-security interface, nuclear material control and security, security culture, etc.

Two volumes of course material along with a CD were provided to all the participants. The course was very well received by all participants and feed back from them was very encouraging. Agency members were also satisfied with course organisation, course material and faculties.

भा.प.अ. केंद्र के वैज्ञानिक को सम्मान / BARC SCIENTIST HONOURED

डॉ. विवेकानन्द कैन, पदार्थ विज्ञान प्रभाग, को इंडियन नयूक्लियर सोसाइटी द्वारा संक्षारण के क्षेत्र में उनके योगदान के लिए आई एन एस पदक 2003 से अलंकृत किया गया है । यह पदक उन्हे मुंबई में दिनांक नवंबर 15, 2004 को डॉ. मोहम्मद-अल-बरादै, महानिदेशक, अन्तर्राष्ट्रीय परमाणु ऊर्जा एजेंसी द्वारा प्रदान किया गया ।

उन्हे संक्षारण विज्ञान के क्षेत्र में अभूतपूर्व योगदान के लिए नेशनल एसोसिएशन ऑफ कोरोजन इंजीनियर (NACE) इंन्टरनेशनल इंडिया सेक्शन से "कोरोजन अवेयरनेस अवार्ड 2004" भी मिला । यह पुरस्कार ओएनजीसी द्वारा प्रायोजित किया गया । उन्हें यह पुरस्कार नई दिल्ली में दिसम्बर 2-4, 2004 के दौरान संक्षारण (CORCON- 2004) पर आयोजित संगोष्ठी में पुरस्कार समारोह के दौरान दिनांक दिसंबर 2, 2004 को प्रदान किया गया।

Dr Vivekanand Kain of Materials Science Division, was bestowed with the INS Medal 2003 for his contributions in the field of corrosion by the Indian Nuclear Society (INS) and it was given by Dr Mohamed El-Baradei, the Director-General of International Atomic Energy Agency (IAEA) on November 15, 2004 at Mumbai.

He has also received the National Association of Corrosion Engineer (NACE) International India Section's "Corrosion Awareness Award 2004" for excellence in corrosion science. The award was sponsored by the ONGC. The award was given on December 2, 2004 at the Award Ceremony during the Conference on Corrosion (CORCON - 2004) held during December 2-4, 2004 at New Delhi.

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