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ULTRASONIC IMAGING FOR TUBE TO TUBESHEET WELD JOINT IN HEAT EXCHANGERS

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Introduction

Larsen & Toubro (L & T) Limited is a reputed manufacturer of heat exchangers for many industries. One of the critical areas in heat exchangers, which should be addressed by non-destructive examination, is the tube-to-tubesheet weld joint. So far the industrial practice is to qualify the welding procedure by metallography on mock-up samples. The finished welds are tested by Liquid Penetrant Test and leak test (Pneumatic, Hydro or Helium). The QA & NDE Group of L&T has developed an ultrasonic examination technique to detect flaws such as lack of fusion, root run defect, porosity, inclusions and wormholes in the weld pool, etc. A conventional flaw detector, which presents the data in the form of A-scan, was used for this purpose. The ultrasonic examination is based on scanning the entire volume of weld by immersion normal beam technique. The objective of the present study is to assess the feasibility of generation of ultrasonic images by digitizing, storing and processing the A-scan data using the ULTIMA 100 + Ultrasonic Imaging System, developed at

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BARC. This report describes the experimental set-up used for this study, the salient features of ultrasonic imaging system and the methodology used for generation of ultrasonic images. The results obtained during the above investigation are also discussed.

Ultrasonic Imaging Using ULTIMA 100+ System

The conventional flaw detector used for routine ultrasonic examination presents the data in the form of A-scan. It gives the information about the depth of the defect (X-axis) and amplitude of reflected wave from the defect (Y-axis) on an oscilloscope. The A-scan presentation is unique to a particular location, and with the conventional flaw detector this information is lost as the probe is moved to another location.

With the advancements in the electronics and computer technology, it is possible to present the ultrasonic data in the form of images. Ultrasonic imaging of components offers many advantages. The information regarding presence or absence of flaws in the inspected volume of the component is presented in the form of a single image. Sizing of defects or any other feature like weld length can be done more easily and accurately from ultrasonic images. However, special instruments are required for data collection and analysis. The ULTIMA 100+ ultrasonic imaging system, developed by Electronics Division, BARC, consists of (i) Pulser-Receiver module, (ii) 100 MHz Analog to Digital Converter (ADC), and (iii) Data Acquisition and Processing Software. The Pulser-Receiver module generates high frequency signals for exciting ultrasonic probes. The reflected signals from the component are amplified by receiver circuit and sent to Analog-to-Digital Converter. These A-scan signals are sampled at the rate of 100MHz (max.) and, if required, stored in computer's memory. The Data Acquisition Software generates ultrasonic images, viz. B-scan and C-scan from A-scan data.

The B-scan image is generated by moving the probe along a line (or circumference for tubular products). During this motion, A-scan data is collected at fixed intervals and stored in the computer's memory. The data acquisition software processes all the A-scans to form the B-scan image. In ULTIMA 100+ system, the horizontal axis on the B-scan image represents the probe travel and the vertical axis represents the depth. Since the B-scan image corresponds to the data collected along a line, it gives the cross-sectional view of the object. B-scan image gives information regarding depth of the defect, its size along the probe motion and amplitude of reflected signal in terms of colour or gray scale on the image. In ULTIMA 100+ system, the B-scan image can be collected by moving the probe either manually or through stepper motors. However, for sizing of the indications from the image (defect or any other feature), it is required that the speed of probe movement is same as the speed of data acquisition. This is achieved by using stepper motors for probe movement and interfacing the motor drivers with the imaging system.

The C-scan image is generated by moving the probe along several lines over the surface of the component in a raster-type manner. During the motion, B-scan data is collected and stored for individual lines. The data acquisition software processes all the B-scans to form a C-scan image.

Since the C-scan image corresponds to data collected over a surface, it gives the plan view of the object. It is similar to the view obtained in radiography. In ULTIMA 100+ system, the horizontal axis on the C-scan image represents the principal

direction of probe movement while the vertical axis represents the direction in which the increment is given. Unlike B-scan imaging, C-scan imaging requires movement of probe through stepper motors.

For tubular products, C-scan is generated by first moving the probe through 360°, then indexing it by fixed amount in axial direction and then again moving it by 360°. This cycle is repeated till the entire region of interest is covered. Alternatively, the probe can also be moved first in axial direction with the indexing in the circumferential direction. The amount of increment (indexing) is decided by the size of the ultrasonic beam and the overlap required.

Experimental Set-up

The ultrasonic examination of the tube-to-tubesheet weld joint is carried out from inside surface of the tube. During the examination, a constant water column was maintained between the probe and the tube inside surface. Fig. 1 shows the experimental set up used for carrying out present investigation. It consists of (i) ultrasonic normal beam immersion probe (15 MHz frequency, point focussed), which acts as both transmitter and receiver, (ii) acoustic mirror, which reflects the beam coming from the probe so that it is incident at 90° to the tube ID surface, (iii) sealed water jacket for providing water column between the probe and the tube ID surface, since this inspection is carried out in immersion condition, (iv) DC motor for rotation of the mirror, so that entire volume of the weld is inspected, (v) probe fixtures assembly for sealing and holding the probe, (vi) pulse-preamplifier for amplification of received signals, and (vii) ULTIMA 100+ system.

The tube used for this study was AISI 316 Stainless Steel, having 25mm OD and 2.7 mm wall thickness. It was welded to the tubesheet by TIG welding process. Four reference defects, viz. (i) three side-drilled holes of 0.8 mm dia., 1.5 mm dia. and 2.0 mm dia., and (ii) a flat bottom hole 2.0 mm dia., were introduced in the weld. In addition to this, the weld also had a natural defect got introduced in it during welding. These defects were at different circumferential orientations.

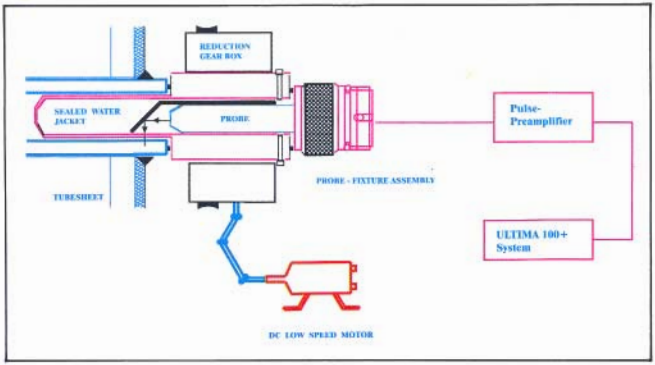


Fig. 1: Experimental set-up for ultrasonic imaging of tube to tubesheet weld joint

To begin with, A-scan data is collected at various locations in the tube. This also included the locations, where natural and artificial defects are present. This is done to set up the instrument parameters like sampling rate, amplifier gain, delay, averaging, high & low pass filters, etc. for getting a clear signal from the defects.

For B-scan imaging, the probe is moved axially along a line so that it intercepts the defect along its path. This movement is made manually. The B-scan image is collected both while pushing the probe into the tube and retracting it.

Results and Discussion

At any location in the tube, the ultrasonic beam first encounters the tube ID producing a strong interface signal on the screen. Any other indication, either due to defects in the weld or due to lack of fusion at tube OD, will appear after the interface signal. Fig.2 shows the A-scan presentation at an axial tube location away from the weld. The first indication is from tube ID and the successive indications (of smaller amplitude) are from tube OD. The distance between these indications represents the wall thickness of the tube. This presentation indicates that the probe is not in weld region. Fig.3 shows the A-scan presentation at the weld region. At this location, only the indication from tube ID is obtained. Since there is no other indication following the tube ID indication, it indicates that the weld is sound in this region. Fig.4 to 7 represent A-scan presentations at reference defects viz., 0.8 mm diameter side-drilled hole (SDH), 1.5 mm dia. side-drilled hole, 2.0 mm side-drilled hole and 2.0 mm flat bottom hole (FBH). In all these cases, a distinct indication is obtained after the tube ID indication.

Fig.8 represents A-scan display at the location of natural weld defect. This defect got introduced in the weld pool during welding. In this case too, a distinct indication is obtained after the tube ID indication. The depth of this defect from tube ID surface can be found out from the A-scan display with the help of cursors. In all the above cases, the defect indications were clearly resolved from the tube ID indication.

Fig.9 represents the B-scan image, when the probe is pushed from the location of weld to deep inside the tube. Fig.10 represents the B-scan image while retracting the probe from the tube. The A-scan display at flat bottom hole location is shown alongside. At any location during the probe movement, the first indication is from tube ID. This indication appears through out the scan length and is shown by the top line on the image. The step in this indication at some locations is due to the change in water path because of improper centering of the probe during movement. This change was observed to be of the order of 0.15 mm. Due to the high sampling rate of the system, this minor change was also evident on the image. Indication from flat bottom hole appears on the image as the probe is moved to this location in the weld. Similarly, indication from tube OD is observed when probe is taken out of the weld region.

Conclusion

The above study indicates that,

1. The ULTIMA 100+ system is able to detect the defects in the tube-to-tubesheet weld joint.
2. The indications from these defects are clearly resolved from the tube ID indication.
3. It is possible to generate B-scan image by using ULTIMA 100+ ultrasonic imaging system for tube-to-tubesheet weld joint.

Fig. 2 A-scan at tube location showing multiple reflections from tube OD

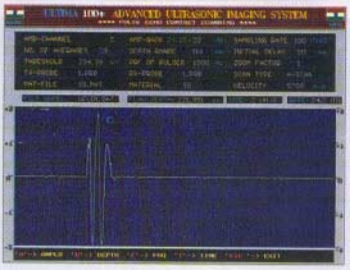


Fig. 3 A-scan in the weld region free of defects

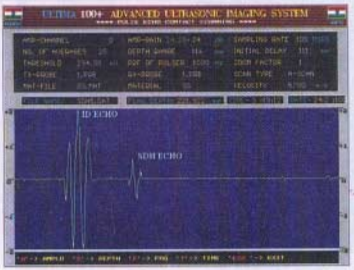


Fig. 4 A-scan at 0.8mm dia. SDH location

Fig. 5 A-scan at 1.5mm dia. SDH location

Fig. 6 A-scan at 2mm dia. SDH location

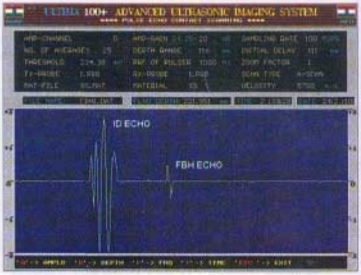


Fig. 7 A-scan at 2mm dia. FBH location

Fig. 8 A-scan at natural defect location

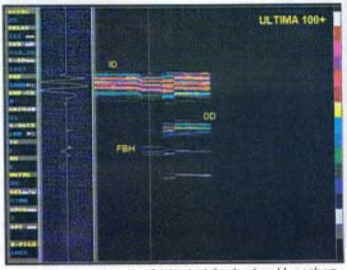


Fig. 9 B-scan image of tube to tubesheet weld mock-up showing 2mm dia. FBH

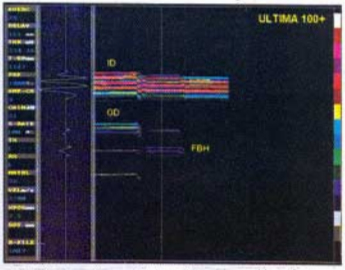


Fig. 10 B-scan image of tube to tubesheet weld mock-up showing 2mm dia. FBH

BARC'S CONTRIBUTION TO INTERNATIONAL EXPERIMENTS ON SEARCH FOR QUARK-GLUON-PLASMA – A NEW STATE OF MATTER

It is now well established that quarks and gluons which constitute the nucleons (neutrons and protons) are always confined inside the nucleons, and for this reason the free quarks have never been observed. According to theoretical predictions based on quantum chromodynamics, quarks and gluons can be deconfined at sufficiently high energy or matter densities. It is believed that such a state of matter had existed in the early universe one macro second after the Big Bang. Such a deconfinement over large nuclear dimensions is also expected to be produced during relativistic heavy ion collisions.

In order to carry out such experiments, CERN had taken up a programme in the early 1990's to upgrade their SPS machine to produce beams of

lead ions upto 33 TeV total energy. BARC/DAE had contributed in this upgradation programme in terms of developing and supplying control software for some of the accelerator sub-systems and also some hardware, mainly the vacuum manifolds. There was also participation from various institutions in India (VECC, IOP and several Universities) in one of the experiments at the SPS accelerator, CERN.

Recently, at a special seminar held at CERN on February 10, 2000, the spokespersons of seven experiments involving collisions of relativistic lead projectiles on lead target presented compelling evidence for the existence of the above mentioned new state of matter in which quarks are liberated to roam freely within the nuclear volume.

Prof. L. Maiani, Director - General, CERN, in his letters dated March 24, 2000 to Dr R. Chidambaram, Chairman, AEC, and Dr S.S. Kapoor, Director, Physics and Electronics & Instrumentation Groups, BARC, has acknowledged the contributions made by DAE/BARC to one of the CERN's most successful physics programmes, mentioned above.

Scientists from BARC are also involved in another experiment (PHENIX collaboration) which is aimed at the creation of quark-gluon plasma at still higher energy densities in colliding beam experiments using the Relativistic Heavy Ion Collider (RHIC) at BNL in USA. As a part of this scientific collaboration, BARC has fabricated and supplied the muon tracking detector parts for the PHENIX detector being installed at RHIC. BARC scientists have also participated in the development of computer simulation and analysis software, which have been integrated into the experimental off-line data analysis system for PHENIX at RHIC. The experiments at RHIC are scheduled to start during the second half of this year and the data taken with PHENIX detector is expected to provide much stronger evidence for the existence of the quark-gluon plasma produced in the relativistic heavy ion collisions.

A NEW DISCOVERY IN QUANTUM COMPUTING BY BARC SCIENTIST

Dr Arun Kumar Pati of Theoretical Physics Division, BARC, Mumbai, presently at the University of Wales, UK, as visiting scientist and Dr Samuel L. Braunstein of University of Wales, UK, have published a paper in the March 2000 issue of the international journal NATURE, describing a new principle for quantum computers which they call "quantum no-deleting principle". The work of Pati and Braunstein is considered to be quite important in the context of quantum computation and the Press Officer of the University of Wales has given a press release describing this as an important discovery. According to the Press release, in this paper they have made an important proposition that, while in a classical computer information can be deleted, the same task cannot be performed in a quantum computer.

It is gratifying to note that one of BARC scientists, Dr A.K. Pati of the Theoretical Physics Division, has made this contribution to the field of quantum computing which is considered to play a very important role in providing intrinsic security to quantum files in quantum computers, as well as in quantum cryptography and quantum teleportation.

NEW RADIOANALYTICAL HPLC FACILITY AT RADIATION MEDICINE CENTRE, BARC

Radiopharmaceuticals labelled with short-lived radionuclides are routinely used in nuclear medicine to diagnose and treat various diseases. In contrast to standard parenteral pharmaceuticals, radiopharmaceuticals have to be manufactured, quality tested and administered into patients within a short period of time, often times within minutes/ hours, as otherwise most of the radioactivity would have decayed to non-useful low levels or, at times, the chemical integrity might be compromised. This calls for a system of rapid and efficient quality control testing procedures of radiopharmaceuticals before they are released for use in a nuclear medicine clinic. Paper/thin-layer chromatography are the standard radioanalytical techniques employed to assay ^{99m}Tc-radiopharmaceuticals and these are extensively used in nuclear medicine. They are cheap but suffer from a few limitations, viz., time consuming, poor resolution of many a radiochemical species, etc. To overcome these lacunae, the better analytical capabilities of High Performance Liquid Chromatography (HPLC) were exploited. The isolated HPLC unit was procured from another section of RMC and made fully operational at first. The integrity of the system, in terms of separation, resolution and quantification, was checked with a wide variety of samples using its UV/VIS detector. For radiopharmaceutical work, however, one is compelled to have a radiometric detector to continuously monitor the radioactivity profile during the elution from the HPLC column. Therefore, a radiometric detection and monitoring system was developed indigenously.

The new radioanalytical High Performance Liquid Chromatography (HPLC) facility, re-engineered by Radiochemistry Division, BARC

The system consisted of a 3" x 3" well-type NaI (T1) gamma detector (ECIL) connected in series with the UV/VIS detector. The eluate in PTFE tubes carrying different radioactive components was made to pass through these detectors. The signal pulses from the detector were amplified and counted through a single channel analyzer set for the peak of interest, e.g. 142 keV of ^{99m}Tc, or 155 keV of ^{188}Re. The data acquisition and analysis comprised of a Personal Computer, an add-on card PCL830 (counter/timer) and the in-house developed user-friendly, menu-driven software package in C++. The gamma activity was continuously monitored and plotted on-line on the monitor against retention times of the components, during a typical HPLC run. The data was also stored in a file. The analysis program had facilities for detailed inspection and selection of the peaks, calculation of net peak area and percentage area, and transfer of the data file to Microcal Origin environment. To date the assay facility has been successfully employed to radioassay a few ^{99m}Tc and ^{188}Re radio-pharmaceuticals. This system is presently in use at RMC, Parel, and has been found to be a good import substitute for an expensive radiometric detection system. This is specially significant in the context of the present embargo imposed by a few countries in the wake of Pokhran II.

WORKSHOP ON ISOTOPE TECHNIQUES FOR HYDROGEOLOGICAL STUDIES

A workshop on "Isotope Techniques for Hydrogeological Studies" was organised by Central Groundwater Board (CGWB) on January 8, 2000, in collaboration with BARC in Science City, Calcutta. The workshop was inaugurated by Dr D.K. Chadha, Chairman, CGWB, and Dr S.K. Acharya, Director General, Geological Survey of India, was the chief guest.

Dr S.M. Rao, Associate Director, Isotope Group, BARC, giving his remarks during the inauguration of BARC/CGWB workshop on "Isotope Techniques for Hydrogeological Studies"

In the inaugural session, Dr S.P. Sinha Ray, Member (SML), CGWB, welcomed the delegates of the workshop, and Dr S.M. Rao, Associate Director, Isotope Group, BARC, stressed the importance of isotope techniques in hydrogeological studies. There were 80 delegates representing water resources development organisations and academic institutes in West Bengal.

In the 1st technical session, the following lectures were delivered :

(a) "Status of isotope studies related to groundwater in India : BARC experience," by Dr S.V. Navada , BARC.

(b) "Isotope studies in arsenic affected areas of Bangladesh," by Prof. A. Basu, University of Rochester, New York, USA.

(c) "Groundwater studies using isotopes: PRL case studies," by Prof. S.K. Bhattacharya, PRL, Ahmedabad.

In the 2nd technical session, future strategies for application of isotope techniques for hydrogeological studies in India were discussed.

The concluding session discussed the various recommendations of the workshop. Some of the recommendations were as follows :

- Since the workshop demonstrated that isotope hydrology is well established in India in the area of groundwater studies, professional hydrogeological institutes entrusted with groundwater development in the country should try to integrate isotope techniques alongwith other investigations.
- Central Groundwater Board and other groundwater organisations should aim to develop in-house capability to apply isotope techniques to field problems.
- BARC has been requested to provide technical support to the establishment of isotope hydrology groups in CGWB and similar organisations, including provision of training of professionals.

DIRECTOR, BARC, VISITS POTON PROJECT AT LASALGAON

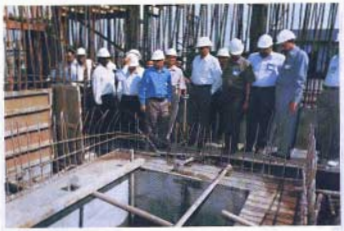
Dr Anil Kakodkar, Director, BARC, visited the Food Irradiation Facility (viz., POTON Irradiator) at Lasalgaon in Nashik district of Maharashtra on February 6, 2000. The POTON irradiator will be used for low dose irradiation processing of food items like potatoes, onions, rice, wheat, atta, maida, dried figs, dates and raisins.

Dr Anil Kakodkar, Director, BARC, and other BARC officers at POTON site office, Lasalgaon

Dr D.R. Bongirwar, Head, Food Technology Division, BARC, and Project Manager, FIP, welcomed Dr Kakodkar at the project site and Dr (Ms) A.M. Samuel, Director, Bio-Medical Group, BARC, honoured him by offering a bouquet. Dr Kakodkar inaugurated the substation building of the facility, performed the Bhoomi Pooja for erection of pantry for the staff of the plant, planted saplings at project site and addressed the gathering present at site office. Mr M.S. Ramakumar, Chairman, Steering Committee, POTON Project and Director, Auto & Manufacturing Group, BARC, Dr (Ms) A.M. Samuel, and Mr A.K. Gupta, Director, Engineering Services Group, BARC, also planted saplings and presented an overall view of the works to Dr Kakodkar.

Mr B.N. Maheshwari, Head, L&CM Section, BARC, and his staff took great pains in landscaping the area around the site office, by planting some decorative flower plants and making a small lawn.

Dr Kakodkar discussed the progress of civil, electrical and ventillation works with the concerned officers.



Dr Anil Kakodkar, Director, BARC, inspecting the Source Storage Well partially completed.

Dr Kakodkar was briefed about the steps involved in undertaking the installation of mechanical handling system for product boxes/carriers, source hoist mechanism, control console for irradiator along with interlocks and Co-60 source supply. Dr M.C. Abani, Head, RSSD, BARC, briefed him about the radiation shielding works being undertaken for cell area of the facility with arrangements for safety interlocks and access door to cell area. Dr D.R. Bongirwar, explained the efforts made in acquiring land from Maharashtra government for the facility and all the infrastructure arrangements made at site. After taking lunch at site office with staff and visitors present at site, Dr Kakodkar and Dr Bongirwar

visited the National Horticulture Development Foundation office at Lasalgaon.

Dr Anil Kakodkar, Director, BARC, at NAFED godowns, Lasalgaon

Shri G.K. Gupta, Branch Manager, NAFED, took Dr Kakodkar around NAFED storage godowns for onions and explained to him in detail the role of NAFED in the distribution of onions to public at large for domestic consumption and for export. A representative of Krishi Utpanna Bazar Samiti gave details about arrivals of onions at Lasalgaon to Dr Kakodkar when he visited their office. Dr Kakodkar also spent some 10 minutes in discussion with progressive farmers from Lasalgaon.

BARC CELEBRATES SCIENCE WEEK

BARC celebrated "Science Week" programme from February 27 to March 2, 2000, in commemoration of National Science Day which falls on February 28 every year, earlier known as Raman Day. The programme commenced with a Science Quiz contest for school students conducted in collaboration with Nehru Planetarium, in which 50 schools participated. An essay contest for degree college students on the topic, 'Why I want to become a Scientist?", and for college teachers on "How to create Interest and Excitement in Basic Sciences?" was jointly organised by BARC and the National Centre for Science Communicators (NCSC). Dr Y.S. Rajan, Jt. Director, Technology Information, Forecasting and Assessment Council, addressed the students and gave away the prizes for the essay and quiz contests.

Dr Y.S. Rajan, Jt. Director, Technology Information, Forecasting & Assessment Council, giving away prizes to winners of Science Quiz contest held at the Nehru Planetarium

The Science Week was formally inaugurated on February 28, 2000 by Dr Vijai Kumar, Head, Library & Information Services Division, BARC, at the Multipurpose Hall, Training School Hostel, Anushaktinagar. Navneet Publications collaborated and positioned on web site an Atom Quiz, and a few students qualified to receive the prizes. The first prize was bagged by a contestant from U.S.A.! Six hundred ninth standard students from AECS schools participated and viewed science films on "Properties of Matter", lent by the British Council. Dr M. Lavanya of Theoretical Physics Division of BARC interacted with the prize winners and answered their queries.

St Mary's School, Vashi, Navi Mumbai, was the venue for a programme on February 29, 2000 organised by BARC and the Indian Women

Scientists' Association (IWSA). Dr A.P. Jayaraman, Head, Media Relations, BARC, fascinated the students with a demonstration cum lecture on "What is Science and what is not Science?" Dr Susan Eapen of Nuclear Agriculture & Biotechnology Division, BARC, and Joint Secretary, IWSA, spoke on "Biotechnology". There was an active question - answer session and Dr Sunila Mathur (IWSA) presided over the function.

Dr Vijai Kumar, Head, Library & Information Services Division, BARC, distributing prizes to navneet.com Atom Quiz contestants

IWSA and BARC scientists greeted by Rev. Father Isaac, Principal, St. Mary's School, Vashi, Navi Mumbai

The "Magic of DNA" was unfolded for the eleventh standard students of Atomic Energy Junior College on March 1, 2000. It encompassed an illuminating talk by Dr Rita Mukopadhyay of Molecular Biology & Agriculture Division, BARC, a demonstration of a DNA model by Ms Manjula Mathur, Molecular Biology & Agriculture Division, BARC, and demonstration on the use of gel electrophoresis technique for DNA finger printing of plants by Dr Anjali Bhagwat, Nuclear Agriculture & Biotechnology Division, BARC, and human DNA by Ms Anu Ghosh and Shazia Ahmed of Cell Biology Division, BARC. Raman Memorial Lecture was delivered by Dr Ramola D'Cunha of Spectroscopy Division, BARC, at Nehru Science Centre.

Plant DNA fingerprinting being demonstrated by gel electrophoresis by Dr A.S. Bhagwat (NA&BTD)

A Journalists' workshop was held on March 2, 2000 on "Atom : Food, Farm and Health." Twenty participants represented a wide spectrum of media. Dr A.M. Samuel, Director, Bio-Medical Group, BARC, inaugurated the workshop. A topical meeting on "Science in Indian Ethos" was organised incollaboration with NCSC. Dr R. Chidambaram, Chairman, AEC, presided over the meeting.

A group of selected journalists were taken for an interactive session with Dr M.J. Gandhi, a senior cardiologist who uses BARC radioactive stent for coronary angioplasty.

DAE SYMPOSIUM ON NUCLEAR PHYSICS

The 42nd DAE Nuclear Physics Symposium sponsored by the BRNS, DAE, was held during December 27-31, 1999 at the Physics Department of Panjab University, Chandigarh. The symposium was inaugurated by Dr Raja Ramanna, Member of Parliament and former Chairman, Atomic Energy Commission. Prof. Ashok Sahni, Dean of University Instructions, Panjab University, presided over the inaugural function. Prof. V.S. Ramamurthy, Secretary, Department of Science and Technology, Dr S.S. Kapoor, Director, Physics and E & I Groups, BARC, and Dr B.K. Jain, Head, Nuclear Physics Division, BARC, were other guests of honour. The convener of the symposium was Dr A. Chatterjee and the secretary was Dr Bency V. John from the Nuclear Physics Division, BARC.

Dr Raja Ramanna, Member of Parliament and former Chairman, AEC, (centre) inaugurating the 42nd DAE Symposium on Nuclear Physics by lighting the lamp

There were about 250 participants from the universities and research institutions from all over India. The topics covered in the symposium included nuclear structure, low and medium energy nuclear reactions, physics with radioactive ion beams, intermediate energy nuclear reactions, sub-nucleonic degrees of freedom, relativistic nuclear collisions & QGP, hadronic structure, nuclear matter, nuclear astrophysics, accelerators and nuclear instrumentation. A total of 210 research papers were presented in the symposium. Apart from these, there were fifteen invited talks, six seminar talks and eight theses presentations. The seminar had indepth discussions on the physics and accelerator aspects of the radioactive ion beam facilities.

Among the poster papers, following three papers were given prizes for best poster presentation: (1) "Study of isotopic dependence in the sub-barrier fusion of ^{16}O + $^{112,116,120}Sn$ system," by Vandana Tripathi et al., NSC, (2) " Closed shell effects of parent and daughter nuclei via cluster decay studies," by M. Balasubramaniam, et al., PU, and (3) "SF_6 handling system for FOTIA," by S.K. Gupta, et al., BARC. The IPA award for the best thesis presentation was given to Dr Gopal Mukherjee of TIFR for his work on "High spin spectroscopy of nuclei in mass 70-80 region."

The symposium proceedings were summarized by Dr R.K. Chaudhury, BARC and Dr D.K. Srivastava, VECC.

THIRD SERC SCHOOL ON EXPERIMENTAL HIGH ENERGY PHYSICS

The third SERC school on Experimental High Energy Physics was held in the 'B' Block auditorium at BARC during February 1-15, 2000. The school was the last in the series of three schools funded by Department of Science & Technology during the last five years. The school was inaugurated by Dr Anil Kakodkar, Director, BARC, on February 1, 2000.

The welcome address was given by the course coordinator, Dr R.K. Choudhary. Dr B.K. Jain, Head, Nuclear Physics Division, BARC, gave introductory remarks and Dr S.S. Kapoor, Director, Physics and E&I Groups, BARC, gave the presidental address. Dr A.K. Mohanty proposed the vote of thanks.

Dr Anil Kakodkar, Director, BARC, inaugurating the "Third SERC School on Experimental High Energy Physics"

The purpose of the school was to impart the background training required by young researchers working in the fields of experimental high energy physics and nuclear physics. A total of 43 students selected from various universities and research institutions participated in the school. Lectures were given by 15 faculty members in the subjects of particle physics, heavy ion physics, detectors, accelerator physics, kinematics, statistical methods, detector simulation, event reconstruction and electronics, etc. One special feature of the school was the practical sessions, which were conducted everyday in the afternoon, where the participants were given hands-on experience in various hardware and software experiments. Apart from Nuclear Physics Division, many other Divisions, including NRL and Electronics Division, and also groups from TIFR took active role in the conduct and organisation of the school.

COURSE ON FLUID POWER CONTROLS

Refuelling Technology Division, BARC, conducted a course on "Fluid Power Controls" at Tractor & Agriculture Equipment Ltd. (TAFE), Chennai, from January 31 to February 4, 2000. About 15 engineers of TAFE attended the course. Most of them were having 5 to 15 years of field experience in fluid power controls.

Mr N.L. Soni of Refuelling Technology Division, BARC, delivering a lecture to the engineers of TAFE, Chennai

The course was developed to induct engineers for developing new designs for fluid power controls. The course was co-ordinated by Mr N.L. Soni. Mr R.G. Agrawal, Head, RTD, Mr A.K. Kohli, TT & CD, Mr Karunesh Kumar, Mr Abhijit Khuperkar and Mr Saurabh Goverdhan were associated in the preparation of the course material and delivery of lectures at TAFE, Chennai.

NATIONAL SYMPOSIUM ON WATER AND STEAM CHEMISTRY IN POWER PLANTS AND INDUSTRIAL UNITS

A three-day "National Symposium on Water and Steam Chemistry in Power Plants and Industrial Units (SWASCH-2000)" was organized during February 23-25, 2000 at the Multipurpose Hall of Training School Hostel, Anushaktinagar. The symposium was inaugurated by Prof. M.M. Sharma, FRS, while Dr.Y.S.R.Prasad, Chairman and Managing Director, NPCIL, gave the key note address titled, "Operational Experience, Evolution and Development in Water Chemistry in Indian Nuclear Power Plants". Around 250 delegates from various units of DAE, Universities, IITs and private companies attended this symposium. A special feature of this symposium was the participation of most of the senior erstwhile colleagues in the science and engineering disciplines who contributed immensely to this field. Wide ranging topics in Water and Steam Chemistry being pursued in this country like Chemical Decontamination, Activity Transport, Radiation Field Buildup, Steam-Water Chemistry on the secondary side, Bio-fouling, Bio-corrosion, Water Purification and Failure Analysis were discussed. The scientific sessions included 14 invited lectures and 95 contributed papers on the topics mentioned above.

Welcoming the delegates, Dr.N.M.Gupta, Convenor, SWASCH-2000 and Head, Applied Chemistry Division, BARC, remarked on the genesis of the symposium. In his presidential address, Dr Anil Kakodkar, Director, BARC, highlighted how the in-house R&D in this field has helped to

Dr Anil Kakodkar, Director, BARC delivering the Presidential Remarks during SWASCH-2000

decontaminate the Primary Heat Transport System of Pressurized Heavy Water Reactors (PHWRs) at the Madras Atomic Power Station (MAPS) and to take up shortly the Clean-up system decontamination at the Tarapur Atomic Power Station (TAPS). He also mentioned about the work on modelling of activity transport being carried out for the PHWRs. In his inaugural address, Prof. Sharma outlined many new areas for water chemistry research like novel methods of water purification and deoxygenation. He emphasized the need of water quality monitoring by highly sensitive instrumentation techniques. Dr .Prasad brought out the state-of-the-art of water chemistry activities being pursued in indian PHWRs. He stressed the importance of selection of materials for our future power plants, to control the corrosion, activity transport and radiation field buildup problems. Dr.G.Venkateswaran, Secretary, SWASCH-2000 and Head, Reactor Systems Studies Section of Applied Chemistry Division, BARC, proposed the vote of thanks.

FORTHCOMING CONFERENCE

An "International Conference on Microbial Biotechnology, Trade and Public Policy" will be held during July 15-17, 2000 at Osmania University. The conference is being organised by the Department of Microbiology, University College of Science, Osmania University, Hyderabad. The topics being covered are : Generally Modified Organisms, Biofuels, Bioprocess Technology, Fermentation Products, Environmental Microbiology, Bioprocess Improvement, Role of Microorganisms in Crop Improvement, Recombinant Vaccine and Antibiotics. One of the important focuses of this conference will be on microbial production of fuels such as ethanol, methane, hydrogen and hydrocarbons using cheap, renewable biomass and waste materials, that become more attractive as an alternative to limited petroleum resources. Development in finding the right strains of microorganism and use of inexpensive substrates will also be other topics of interest.

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BARC SCIENTISTS HONOURED

- Dr K.P. Mishra of Radiation Biology Division, BARC, has been elected as President of the Section of Biochemistry, Biophysics & Molecular Biology for 88th Session of Indian Science Congress Association scheduled to be held at the Indian Agricultural Research Institute, New Delhi, in the first week of January 2001. Dr Mishra has also been invited to be a member of the National Council of the Association for the year 2000-2001.

- Mr V.K. Srivastava of Desalination Division, BARC, was elected as Central Council Member of IIChE (Indian Institute of Chemical Engineers) from West Zone for the period 2000-2002 during CHEMCON-99 held at Chandigarh in December 1999.

- Dr S.F. D'Souza of Nuclear Agriculture and Biotechnology Division, BARC, was elected as a 'Fellow of the Association of Food Scientists and Technologists, India (FAFST)' for his contribution in the field of Food Biotechnology with special reference to Immobilized Enzyme and Microbial Technology. He is also a 'Fellow of the National Academy of Sciences' (FNASc).

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