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IN THIS ISSUE

भाभा परमाणु अनुसंधान केंद्र
Bhabha Atomic Research Centre

पंडित जवाहरलाल नेहरू द्वारा परमाणु ऊर्जा संस्थान, ट्रॉम्बे (जिसका बाद में श्रीमती इंदिरा गांधी द्वारा दिनांक 12 जनवरी 1967 को भाभा परमाणु अनुसंधान केंद्र के रूप में पुनर्नामन किया गया) का दिनांक 20 जनवरी 1957 को औपचारिक उद्घाटन किया गया था.

Atomic Energy Establishment Trombay (later renamed as Bhabha Atomic Research Centre on 12 January 1967 by Smt. Indira Gandhi) was formally inaugurated by Pandit Jawaharlal Nehru on 20 January 1957.

बी एआरसी न्यूज़लैटर
BARC NEWSLETTER

CONTENTS

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बी एआरसी न्यूज़लैटर
BARC NEWSLETTER

AUTOMATED GAMMA SCANNING SYSTEM FOR ON-LINE INSPECTION OF INDUSTRIAL PROCESS COLUMNS

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Introduction

Modern petrochemical and chemical process industries, routinely employ gamma-scanning technique, for on-line inspection of various types of columns for troubleshooting, process optimization and process vessel design modifications. The technique is reliable and gives accurate results, which otherwise cannot be obtained by any other method. This helps in the diagnosis of plant inefficiency which, in turn, reduces the plant shut-down time, resulting in huge economic savings.

In this technique, a collimated gamma ray beam from ^{60}Co, ^{137}Cs or ^{192}Ir, of suitable activity, based on column configuration, is used. The radiation beam is passed through the process column. The modified transmitted beam is then analyzed, to obtain information about the column internals. Diameters of process columns may vary from 0.5 meter to 9.5 meters and the height from a few meters to 100 meters.

Gamma-Scanning Technique

The technique utilizes simultaneous movement of collimated source and radiation detector, which are placed opposite each other in the same horizontal plane. Both the source and the detector assembly are then moved along the height of the process tower. The radiation intensity (counts) is recorded at appropriate intervals and is plotted against the column elevation.

The intensity of transmitted gamma radiation through a material between the radioactive source and the detector is given by:

$$I = I_0 \cdot \exp(-\mu \cdot \rho \cdot x)$$

Where

- I : Intensity of radiation transmitted through the material
- I_0 : Intensity of incident radiation
- μ : Mass absorption coefficient of the test material for radiation energy used
- ρ : Density of material
- x : Thickness of material

This relationship forms a basis for experimental design, measurement, data processing and interpretation of detector output. To generate reliable and accurate data, proper source selection, source intensity, collimator design, source and the detector alignment and movement in the same horizontal plane are essential. Alignment in the same horizontal plane can be made, using reference to structural frame of process tower or using water-filled PVC tube. Fig.1 shows a typical tray-type column and its gamma scan.

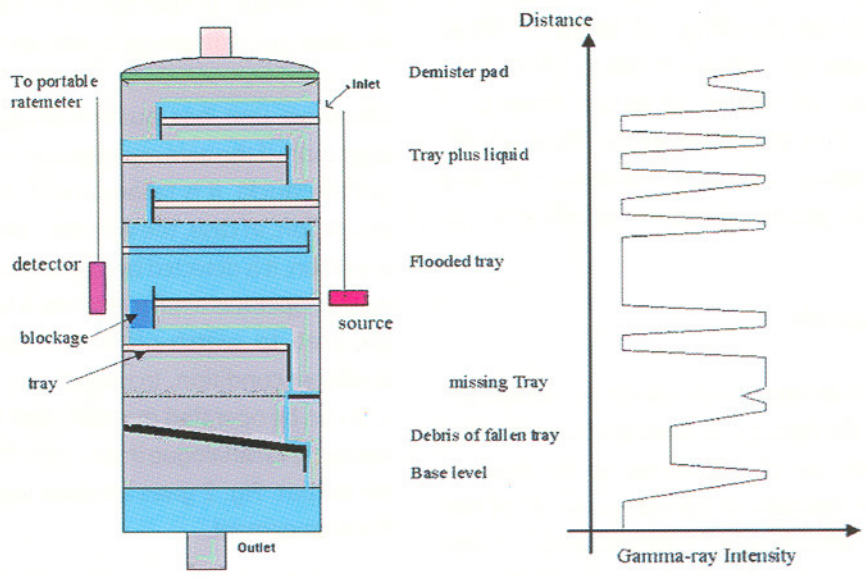

Fig. 1: A typical gamma scan of a tray-type column

Gamma Scan Can Detect

- Location and extent of flooding
- Presence or absence of trays and other internals
- Liquid level on trays and packed columns
- Location and severity of entrainment
- Liquid level in downcomers
- Presence of liquid weeping
- Location and density characteristics of foaming
- Position of packed beds
- Integrity of mist eliminators
- Liquid level in reboilers, reflux drums, etc.
- Extent of liquid maldistribution in packed beds

Need For Automated System

Due to increased awareness over the years, in the process industry, about the usefulness of the gamma scanning technique, a need has been felt for an automated gamma scanning system, which would reduce the overall time from IAD, inspection time of columns and other operating problems at plant sites. The system would also be useful in generating signature scans under different plant operating conditions. Hence, it was felt, that an automated gamma scanning system would be an appropriate solution to these problems. Moreover, this system could also be used under harsh environmental operating conditions.

Prototype System

The prototype system was designed and developed jointly by Division of Remote Handling and Robotics (DRHR) and Isotope Applications Division (IAD), BARC. Field testing of this unit was carried out on cold tower CT-1 of unit number 2 at the Heavy Water Plant (HWP), Manuguru. The tower is about 4.5 m in diameter and 54 m height. ^{60}Co source of about 180 mCi strength was used.

Drive Unit Assembly

A rope and drum arrangement is used to convert the rotary motion of the motor, into linear motion of source/detector assembly, which moves over to the column, height-wise. The mechanical assembly consists of two stainless steel drums, floating pulley assembly, guide pulleys, steel wire rope assembly, rope-slackness detector assembly, base frame, geared servomotor unit controlled by PLC and SCADA based system.

The geared motor, through a custom-built worm gear reduction unit, is coupled to the drum shaft. Both the drums are attached to the shaft through spline coupling, which gives flexibility of rotating one drum with respect to the other, to accommodate the wire rope or for coarse alignment (about 260 mm and its multiples) of source/detector unit. Floating pulley assembly utilizes screw-nut arrangement to release the wire rope on one drum with respect to the other drum. With a floating pulley arrangement, rope length adjustment of about 0.5 mm to 200 mm can be done. A stainless steel wire rope (3/32" diameter, 7x7 construction, breaking strength of about 400 Kgs.) is used to attach source/detector assembly with the drum. Wire rope end is attached to source/detector through screw-nut arrangement, which further gives flexibility in aligning the two assemblies on process tower side, if required (upto a maximum of 40 mm).

Special explosion-proof AC servomotor is used to drive the unit, which has built-in high resolution encoder. This motor is fed through an automated PC-based controller, giving flexibility in the operation of the unit. The drive unit gives very high positional accuracy. Detector position and its output in real-time are displayed on the monitor (both graphical as well as numerical values).

The drive unit has built-in safety features. During operation, if the wire rope tension increases (due to unit getting stuck), it is taken care of through drive motor protection. In case, the wire rope becomes slack during operation, it is detected by rope slackness detector, which, in turn, operates a micro-switch. Micro-switch contacts are used to switch-off the motor under wire rope slackness condition. In case of any requirement, drive unit can be operated manually and the detector is connected to an analogue instrument for measuring detector output. Fig. 2 gives a typical line diagram showing the arrangement.

By controlling the motor speed, linear speed of the source/detector can be varied upto a maximum of about 100 mm/sec (6 m./min). As such, during scanning, the source/detector are moved at a linear speed of 10-50 mm/sec. At the required position, the detector is moved in finer steps and radiation counts are measured. During scanning, the portion of the process tower, where data acquisition is not important, the detector can be moved at a faster speed, to reduce total scanning time. Fig. 3 and 4 show photographs of the drive unit.

Data Acquisition And Display

The drive unit is coupled to an AC servomotor having high-resolution built-in encoder, for accurate position control of source and the detector unit. The system utilizes a fully automated control system, for synchronous movement of gamma source and detector, simultaneously, over the entire length of the column to be scanned.

A three-tier architecture is used for the system:

- The bottom layer controls the servomotor in position control loop and also acquires data of position from encoder and counts from detector.

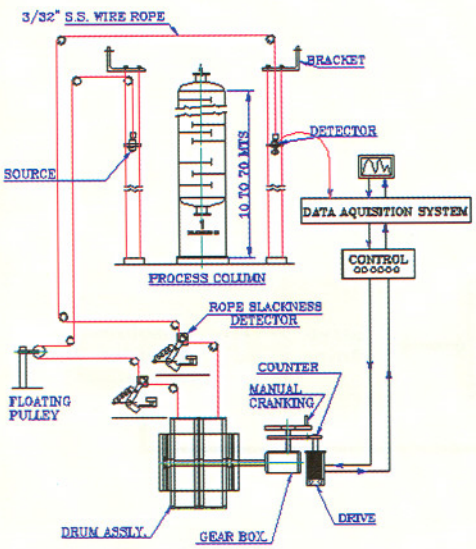

Fig. 2 : Typical line diagram showing the Gamma Scanning unit

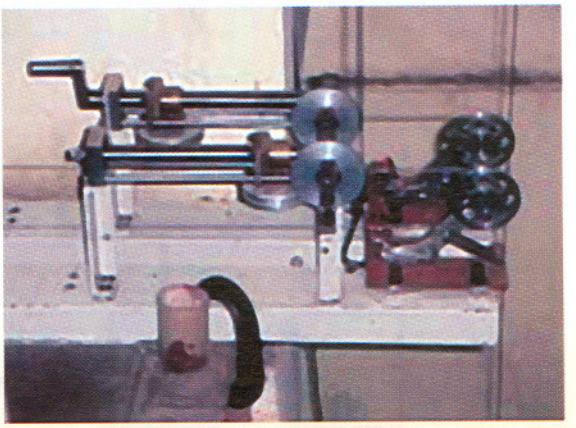

Fig. 4 : Floating pulley assembly and rope slackness detector assembly

- The middle layer is the PLC which processes the data from the bottom layer and presents it to the top layer and vice-versa.

- The top layer is SCADA based software for interfacing with PLC and facilitates user-friendly GUI.

Fig. 5 gives the block diagram of the automated gamma scanning control system.

The Encoder has the resolution of 131072 ppr, which enables an accuracy of less than one micron of linear movement. Motion can be performed in two modes.

- Incremental mode : in which the user specifies the incremental steps and the time for which the counter counts.

- Absolute mode : in which the motor moves from user specified initial position, to final position.

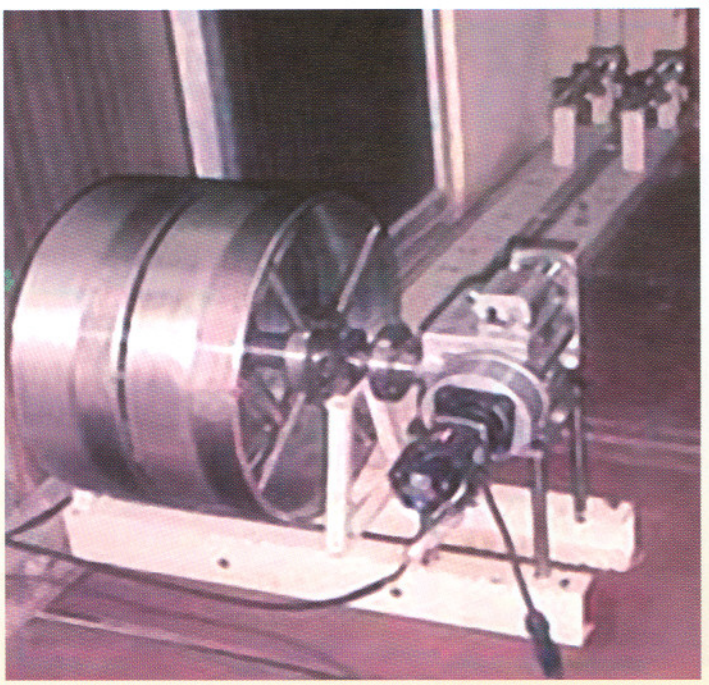

Fig. 3 : Drive unit

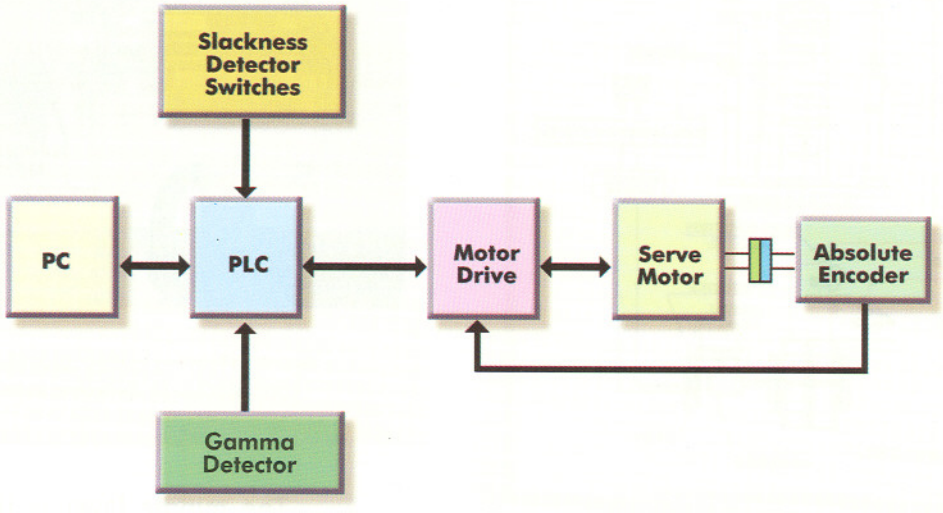

Fig. 5: Automated Gamma Scanning Control System: block diagram

Fig. 6: Drive Motor with the Controller (explosion-proof construction)

During the scanning process, the system gives real time plot of radiation counts vs column height. However, the system supports date-wise data storage in MS-EXCEL for off-line analysis.

During field trial testing at the HWP (Manuguru), system operation was successfully demonstrated by operating from the control room of the plant, using about 500 m. of twisted pair cable length with RS-422 converters.

The system is built with explosion-proof construction for work in hazardous areas. (Fig. 6).

Typical Scan Results

Field testing of the drive unit for automated gamma scanning of the chemical exchange process tower, was successfully carried out at the HWP (Manuguru), during October/November 2005.

Fig. 7 shows a typical gamma scanning plot for CT-1 of unit 2 of HWP (Manuguru).

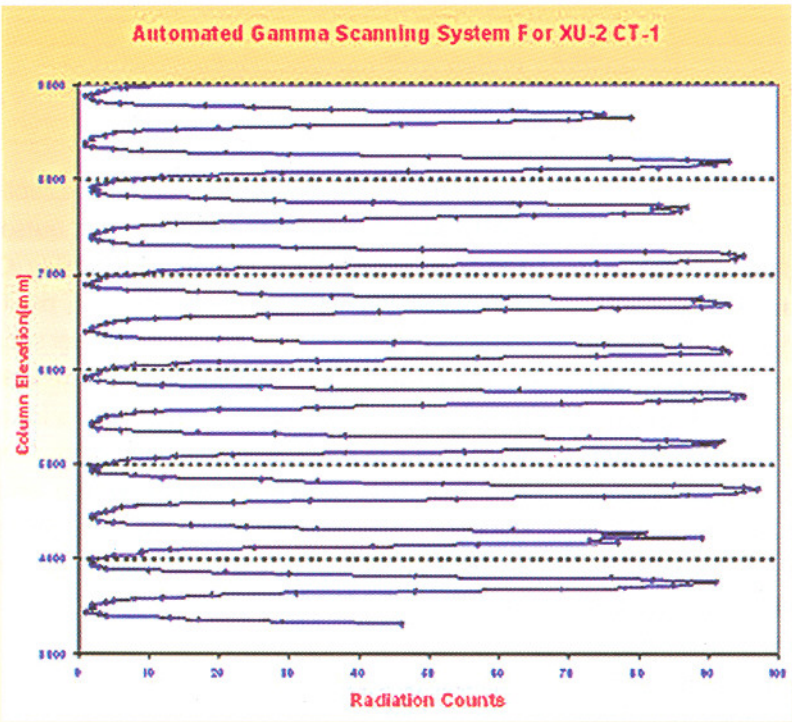

Fig. 7: Typical gamma scanning plot for CT-1 of unit-2 of HWP (Manuguru)

Conclusion

- Gamma scanning results are in agreement with the tower internals. Scan results indicate, that the column is healthy and operating satisfactorily.
- Prototype automated gamma scanning system has been successfully demonstrated from the control room, using around 500 m of cable length. This establishes the system's worthiness.
- It is planned to test the usefulness of this system in a few other industries, before making a commercial model.
- Availability of this system will meet the long felt need, to reduce the overall inspection time, for gamma scanning of process columns.

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बीएआरसी न्यूज़लैटर
BARC NEWSLETTER

FAULT-TOLERANT POWER SUPPLY FOR SAFETY SIGNIFICANT NUCLEAR INSTRUMENTATION AND CONTROL

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Introduction

For a nuclear power station, instrumentation and control (I&C) systems are classified as per deterministic approach, using a set of rules given in IEC1226. However, the modern reliability assessment approach based on probabilistic safety assessment (PSA) gives a unified pragmatic approach to considering safety significance for all the systems (may be graded as per requirement : high and low). Nevertheless, treatment of nuclear plant I&C systems as "safety significant" in the design phase, gives confidence to the operator working on these systems. Irrespective of the control systems : reactor protection, reactor regulation, fuel handling or boiler turbine control system, treating them uniformly is to enhance overall plant safety. *The power supply to run all these systems, has high significance for overall plant reliability, maintainability and availability*. A decade ago, this aspect was realized and the design of rugged fault-tolerant hot-pluggable power supply was developed and then deployed to run I&C for recent nuclear reactors. This article describes the basic issues of stability, current sharing, redundancy, duty-cycle jitter etc. Experience suggests that commercial off-the-shelf power supplies, catering to large volume commercial requirements do not measure up to the mark in nuclear reactor I&C applications. Recent deliberations at the Third International Conference on Reliability and Safety Hazards, Mumbai, reiterates that, outsourcing and commercialization are against reliability. Custom design keeping "fit for purpose" in mind, provide the required reliability demanded on the power supplies in nuclear power plants. Most I&C Engineers generally take power supplies for granted. They waste a lot of time searching for faults elsewhere, during system down time and look into power supplies at the end. The standard 100W modules are for 5V, 12V, 15V and 24V available from ECIL, Hyderabad and are trademarked as ECPS™.

Modular Design

Modulebased power supplies offer a number of benefits that ultimately result in economy of inventory. Output power capability can be achieved by paralleling required number (say M) of standard modules. A number (say N) of modules, can be further added, to achieve fault-tolerance (generally known as M+N configuration). With hot-plugging feature, one can have on-line maintenance. System down time is lowered and serviceability is enhanced with lower maintenance cost and maintenance of the power supplies without requiring to switch them off and thus reducing, if not eliminating, the system down time.

Previous Experience

Prior to the development of these current sharing power supplies, switch-mode power supplies were used as commercial off-the-shelf products. These did not have current sharing capability, resulting in a unit with higher output voltage, delivering current beyond its rating, getting overheated and then failing quickly. Also the excessive heating lowered the dynamic stability of the supplies, resulting in malfunctioning of I&C systems, powered by them. The absence of dynamic current sharing feature, results in poor response of these supplies to load transients, even in cold conditions.

Feed Back Control System: Inherent Assured Stability

Employing current mode control method, instead of prevailing voltage mode control method, the pulse-by-pulse current limit, makes feed forward block (Fig.1), a voltage-controlled current source. The change in control voltage, changes the output current. The output voltage is compared against set point and the error becomes the set point for the voltage- controlled current source. Due to the inherent nature of the power supply as current source, the output inductor goes out from the control system calculations. The basic feed forward block is *single pole* system. This (compared to earlier voltage mode systems, which were *double pole* systems), is easier to control and assures inherent stability. In spite of inherent basic single-pole structure, by design, enough phase angle margins are to be ensured, for all loading conditions.

Stability Analysis Of Fault - Tolerant Power Supply

Fig. 1 presents a simple block diagram of the entire power supply block. For 5V system, K=1. The analysis shows, how the basic technique is followed to give a suitable pole-zero cancellation, which makes the overall loop *absolutely stable*, at all load conditions. While designing the components, the aspect of de-rating has been taken into consideration, to achieve high MTBF

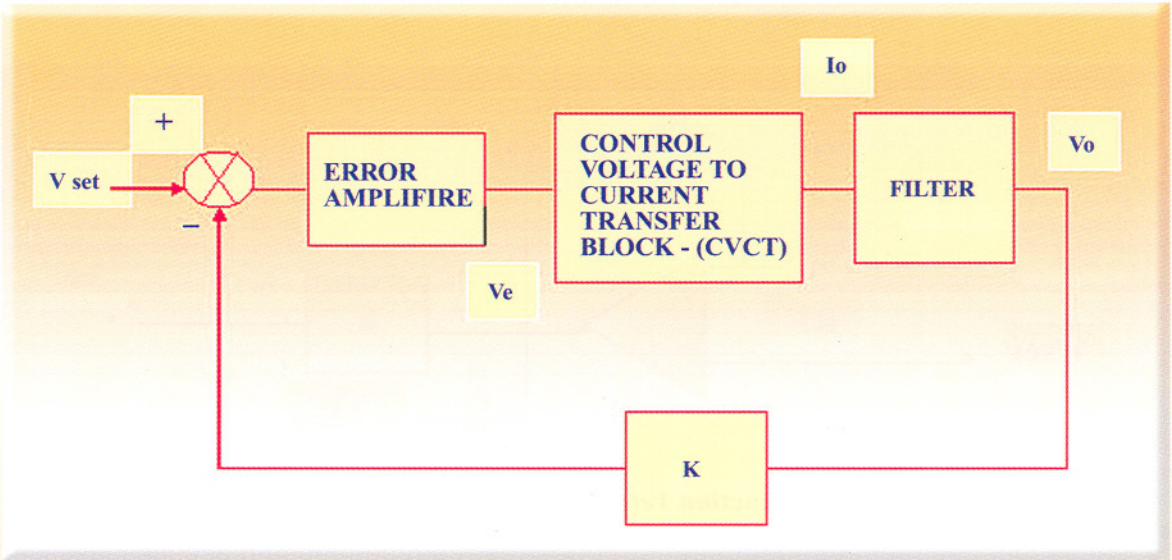

Fig. 1 : Simplified block diagram of power supply

(mean time between failures). The calculations given in the following subsections to make a Bode-plot, are for 1.5MHz switcher design for 100W, 5V model with 230V AC input. The pole zero cancellation takes place at a much lower than the switching frequency (around 200 KHz). The pole-zero cancellation makes the overall open loop transfer function (TF) to cross 0 db at f<<1.5 MHz with ample phase margin, with all loads.

Error Amplifier Block

Fig. 2 gives the error amplifier diagram. The TF of this block is

$$Ve(s)/Vo(s) = -(sR2C2+1)/(sR1C2)$$

Error amplifier zero is thus at $fz=1/(6.3R2C2)$. The value of product of R2 and C2, is chosen as equal to the pole of the combine Control Voltage to Current Transfer (CVCT) and output (filter & load) block. Gain of the amplifier at fz is $-R2/R1$, equal to the negative of db value of corner gain of CVCT block. This technique of pole-zero compensation by design, gives required gain and phase margin for all load conditions and avoids any oscillations, during hot-plug and current sharing.

Control Voltage to Current Transfer (CVCT) block

Fig. 3 represents the block diagram of CVCT. However, this CVCT is a representation of what is happening at each pulse duration, pulse-by-pulse regulation. At each pulse duration, the output peak current is compared with the error voltage (output of the error amplifier Ve). When the two are equal the switch is turned off and energy discharge takes place, the cycle repeats with energy charging (switch on) at the beginning of the next cycle. Cycle times are determined by fixed frequency oscillator. The primary transformer current is proportional to the output load current of load. For 1.5 MHz system, the pulse duration is fixed at 670nS. The TF of this block is thus $Io(s)/Ve(s)=Ipri(Np/Ns)/Ve=constant$

Ve is variation of the control input voltage which varies as 0.85V makes the output current to 100% (2A-20A).

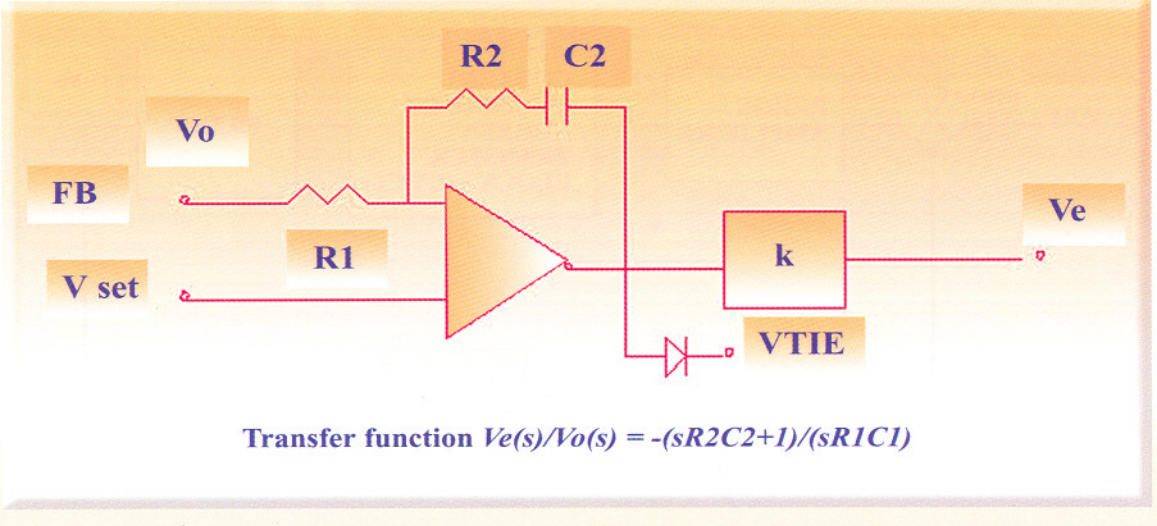

Fig. 2 : Error amplifier block

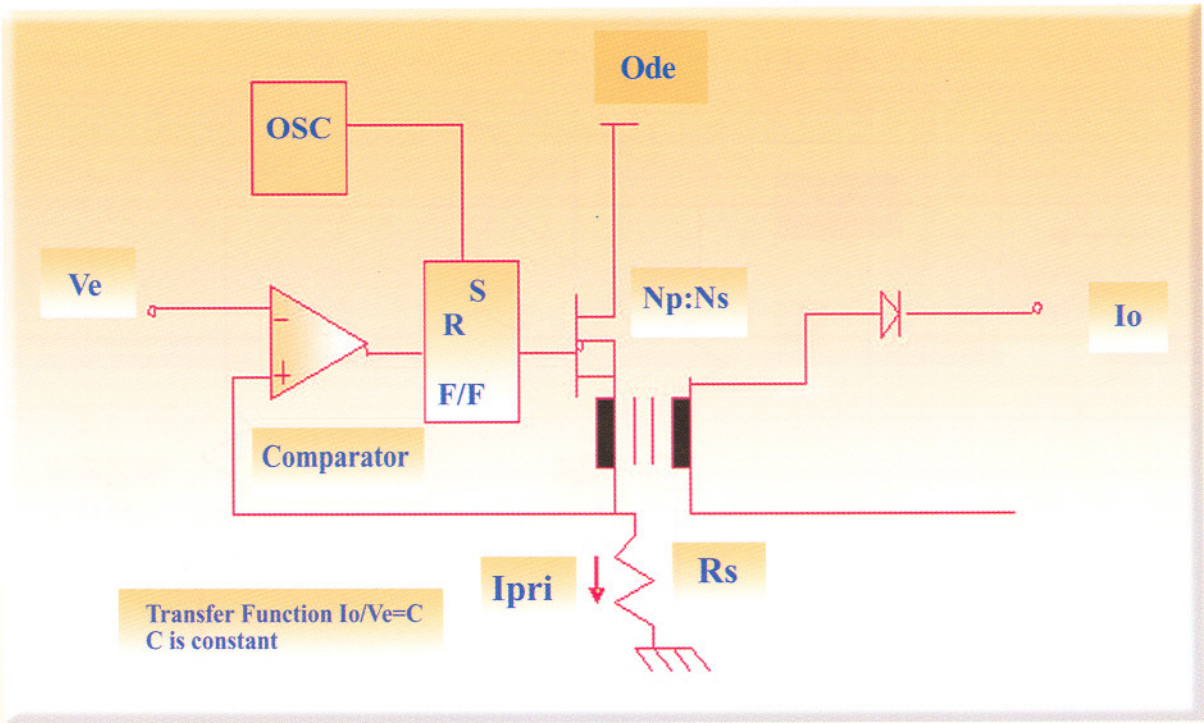

Fig. 3 : CVCT block diagram

Ipri= Idc/Duty-cycle, and Idc=Pin/Vin(min). All these are constant by design of 100W 5V output with 230V AC input with 85% duty cycle for 100W. Therefore, the CVCT transfer function is a constant.

Output (filter and load) block

The constant gain of CVCT in conjunction with this block, gives overall TF of the feed forward block. This output block determines the pole and zero of the feed forward block, which is to be compensated by feed back technique. Fig.4 gives the output(filter and load) block (*Ro* variable from 2.5 ohms to 0.25 ohms for 2A-20A full load). This Io passing through inductor *Lo* and through the ripple filter equivalent series resistor (ESR) and the capacitance C and the load Ro gives Io to Vo transfer function with pole and zero. Taking ESR $r<<Ro$, we get TF of this block as

$Vo(s)/Io(s)=Ro(srC+1)/(srC+sRoC+1)=Ro(srC+1)/(sRoC+1)$, this gives pole at $fp=1/(6.3.RoC)$ and zero at $fz=1/(6.3.rC)$. The pole is dictated by load and output capacitor and the zero is dictated by ESR and the output capacitor.

From the 100W design of 1.5MHz switcher for 5V output system, various values are Np:Ns=31:1, Idc=650mA, Duty Cycle=0.85, Ro=2.5-0.25 ohms (2A-20A), ESR r=0.016 ohms at 1.5Mz and filter capacitor C=3uf gives:

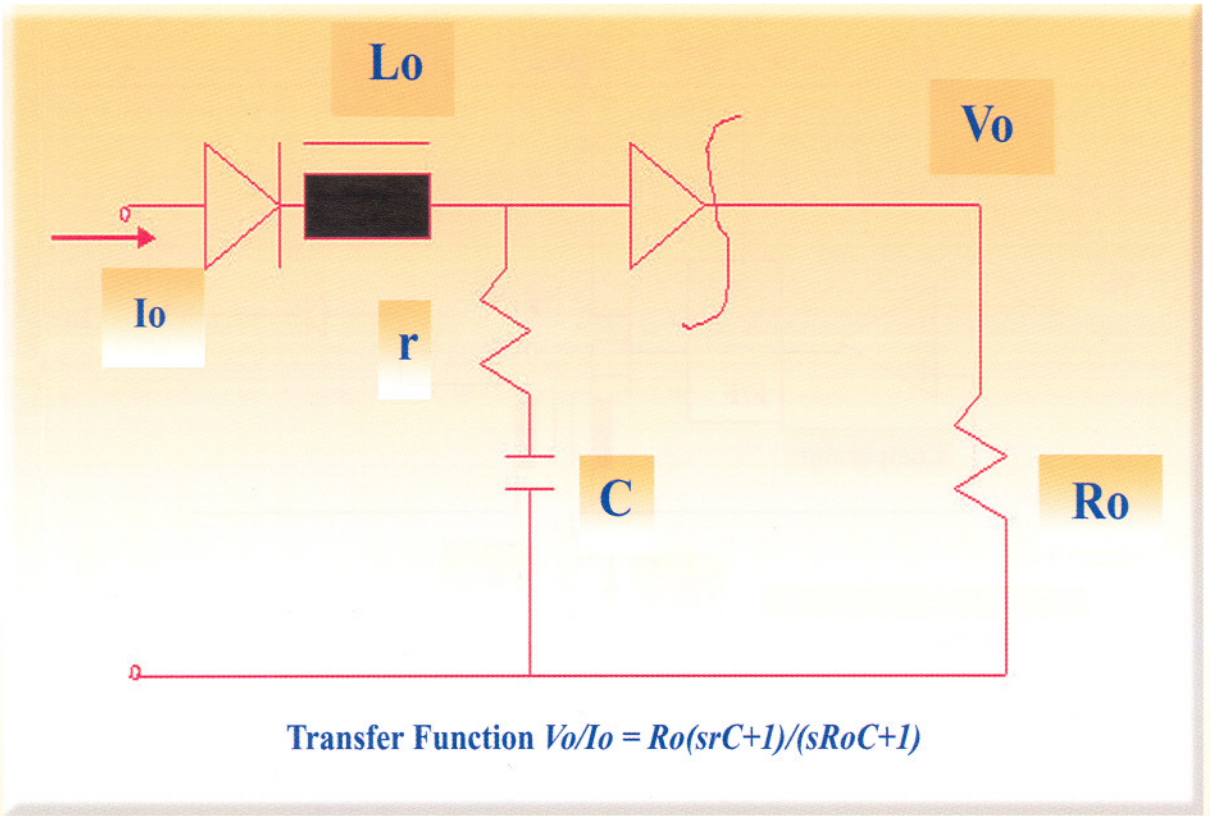

Fig. 4 : Block diagram of output (filter and load block)

Gain at 2A as 37db, Gain at 20A as 17db, pole at 2A is 21.2KHz, pole at 20A is at 212KHz and zero is at 3.13MHz is overall TF of the feed forward block.

Pole-zero cancellation

Closure of the loop by error amplifier is the art of pole-zero cancellation, thereby achieving stability at all load conditions. The 20A pole of feed forward block is at 212KHz and gain of 17db. So the error amplifier zero is placed 212KHz and at that point the error amplifier if given a gain of –17db will give a *rate of loop closure of* –20db/decade. Referring to section 6.1 the fz=1/(6.3 R2 C2). Selection of R2 as 3.3K ohms was done for amplifier drive consideration, gives value of C2 as 240pf at fz of 212KHz. Now for gain selection R2/R1=0.014 (i.e.-17db) gives value of R1 as 23K ohms.

Bode-plots for gain and phase with various load

Fig. 5 gives magnitude and phase angle plots for 2A load and 20A load. The Bode plots are compensated overall open loop gain and phase with perturbation frequency, showing that the *system moves towards extra stability as the loads are increased*. At the light or no-loads, the rate of loop closure though is –40db/decade, the phase margin of about 35 degrees exists and hence

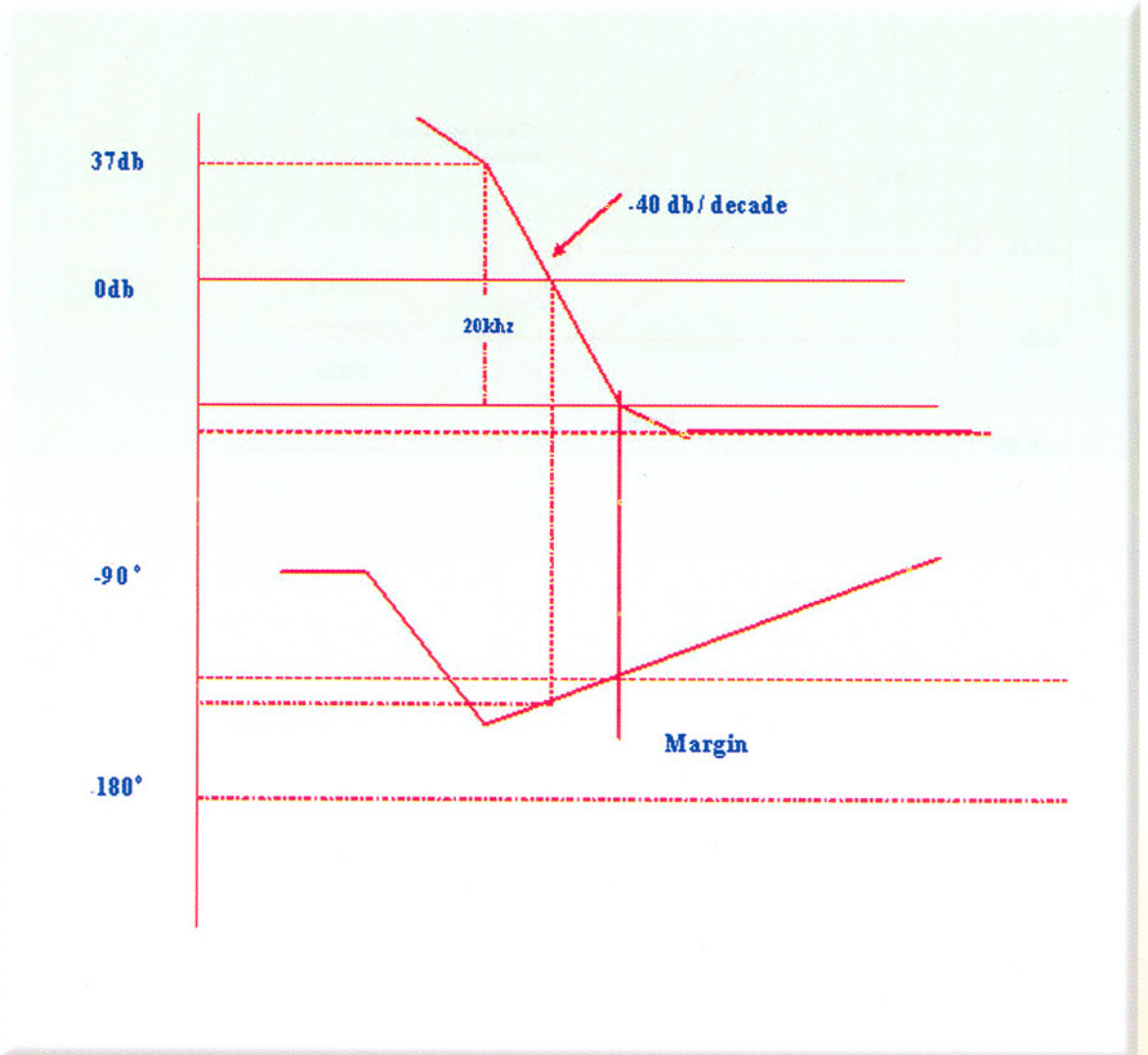

Fig. 5a : Ro=2.5 ohms for 2A loads overall compensated TF , superposition of EA, CVCT and output (filter and load) block

the system is stable. The compensated plot shows that at 20A the phase margin increases towards 90 degrees and the rate of loop closure is –20db/decade. This shows that at all load conditions the system remains *absolutely stable*. This also is verified practically by switching the loads at various frequencies. The above phenomenon of *phase-boosting* with load increment, is advantageous for hot-plug applications and load share applications.

Inherent Load Share

The above discussion of basic design being proven

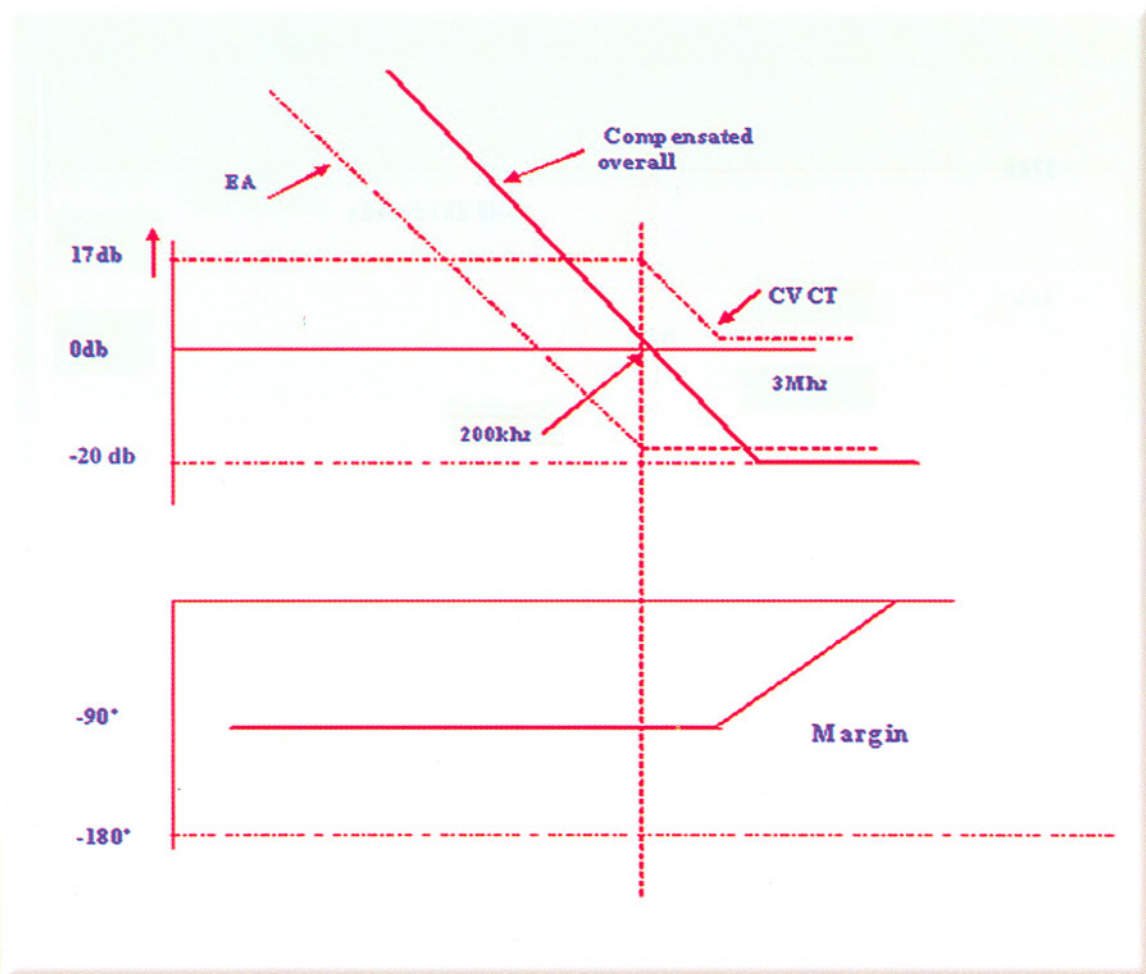

Fig. 5(b) : Ro=0.25 ohms for 20 A loads compensated TF, superposition of CVCT and EA P-Z cancellation

theoretically and practically as absolutely stable, enables us to utilize the same power supplies as to share the load almost equally, inherently. If the output voltages are trimmed within one fourth of regulation band (5mV) it gives almost equal sharing load. As the stability margin does not vary significantly even with large load variation, no instability arises during plugging-in or plugging-out of any module. This configuration is not the usual master-slave shared system.

Forced Load Share

The V-TIE pin, shown in Fig. 2, comes out through the connector. When the V-TIE pins of modules are shorted together, it forces equal current sharing, by all modules without requirement, of close adjustment of individual output voltages. Also no module is a master nor any a slave.

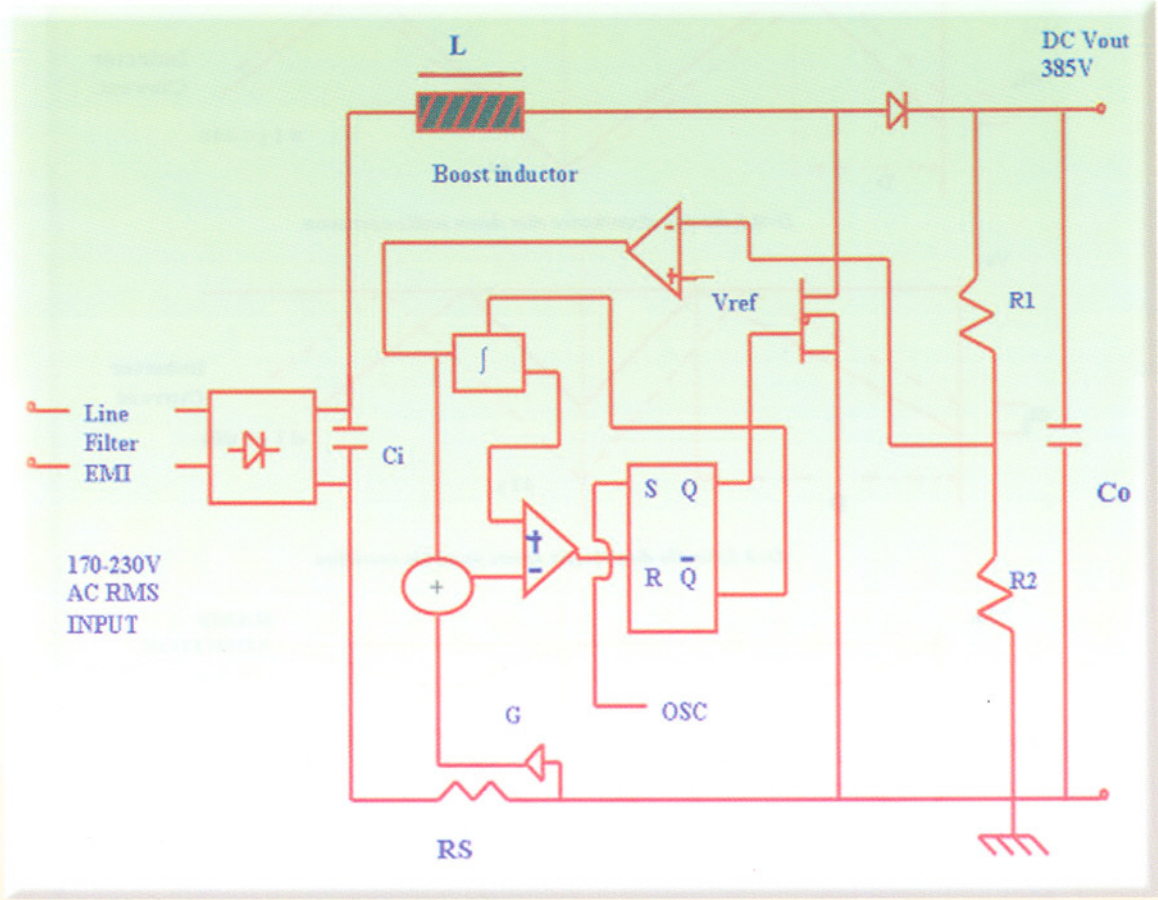

Fig. 6: Pre converter with OCC for PF=0.999 and TDH 4% Control

Further Development and Upgradation

The active power factor correction scheme with total harmonic distortion (THD) reduction circuit for enhancing pre-converter circuit is being developed. This will conform to recent EN61000-3-2 standard of clean AC power. Presently static VAR compensator upgrades the power factor, but with the one-cycle control (OCC) technique of pre-boost converter, THD will be improved. Fig. 6 gives the concept of re-settable integrator in OCC method of boosted pre-converter.

The other area of improvement in magnetic circuit, is to master and use of broad band, high Tesla magnetic core H7C4 material, to make very high power density. This will not only make the size of each unit smaller, but will also be a step forward in making MHz resonant power modules.

Circuit optimization to decrease the circuit components, further enhances the basic unit reliability. Also design improvement has been adopted for a self start circuit with bleed resistor and boot-strap technique, to remove

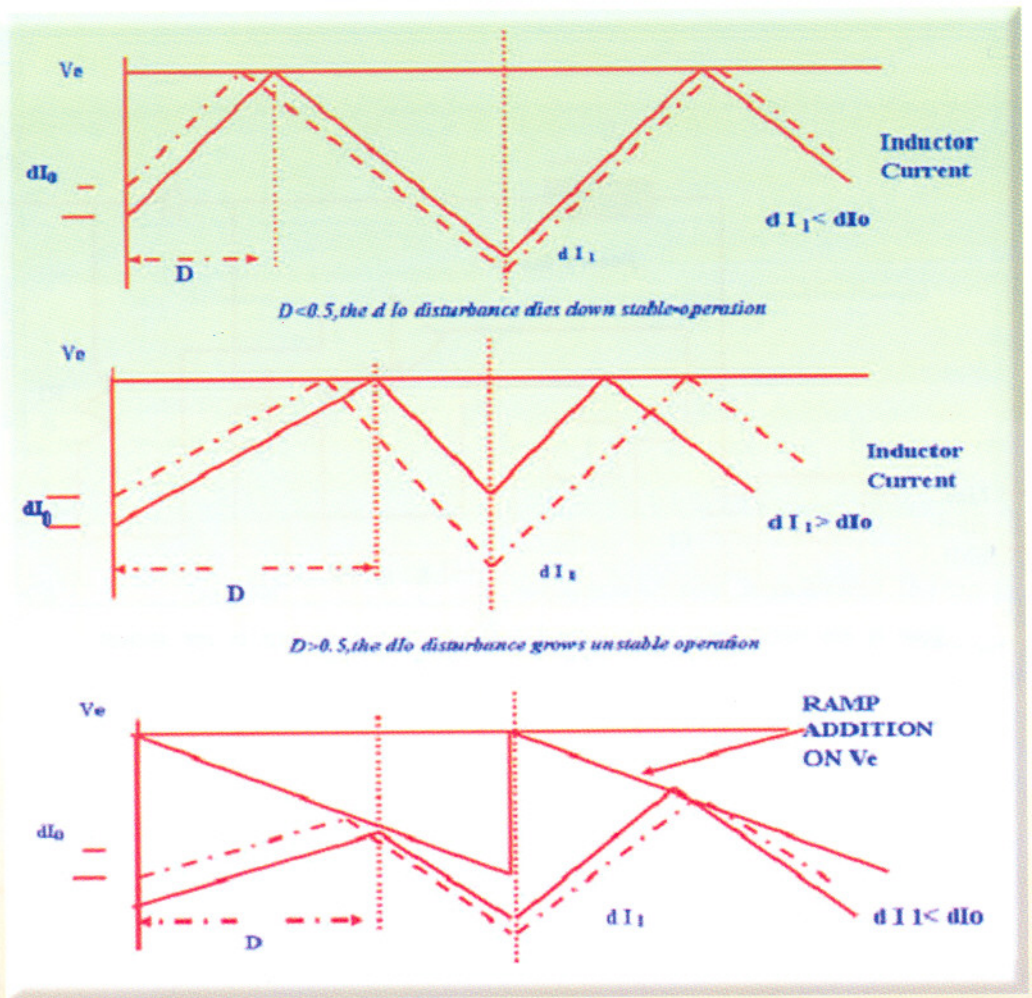

Fig. 7: Duty cycle instability for D>50% and ramp compensation

the transformer powering control card. Now the control and alarm cards are fabricated by HMC (hybrid micro circuit) technique. This gives size reduction and space for internal cooling. Also front display for unit voltage/ current is being provided.

Employing duty cycle > 50% for better utilization of volume of magnetic circuit is achieved. Earlier design with <50% duty cycle for 100% power was made for 80KHz switchers and restriction was due to stability criteria. To ensure stability for more than 50% duty cycle in MHz design, a circuit is added in the error loop for ramp addition. This improvement gives better utility of energy transfer per volume. Fig.7 shows the duty cycle stability and Fig.8, the ramp compensation for 85% duty cycle.

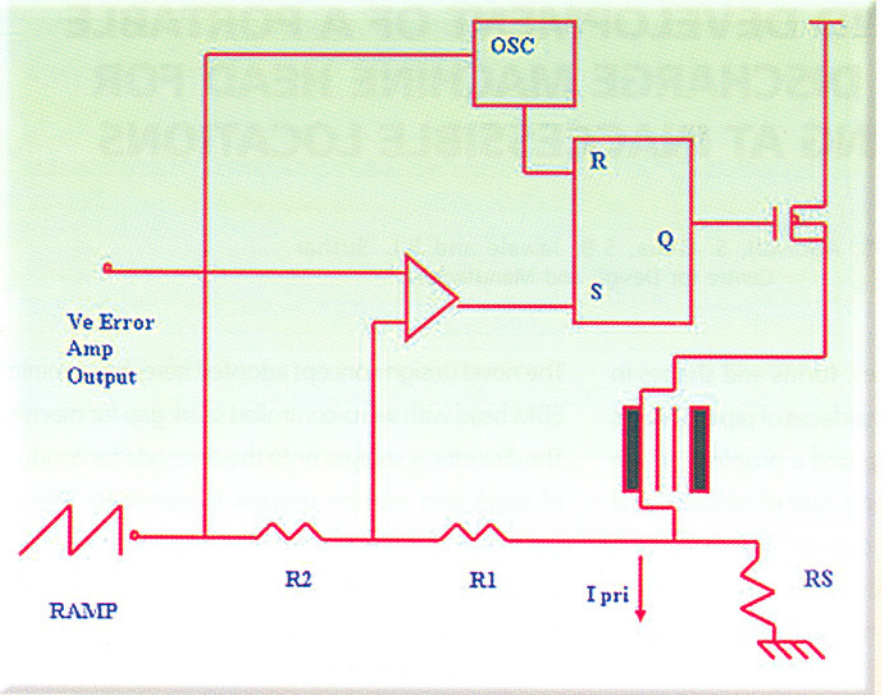

Fig. 8 : RAMP is added to primary current to compensate for instability due to D>0.5

The pole zero compensation is presently done by normal control theory perhaps *fractional order controller* may be handy in future, with fractance to finely compensate in error amplifier.

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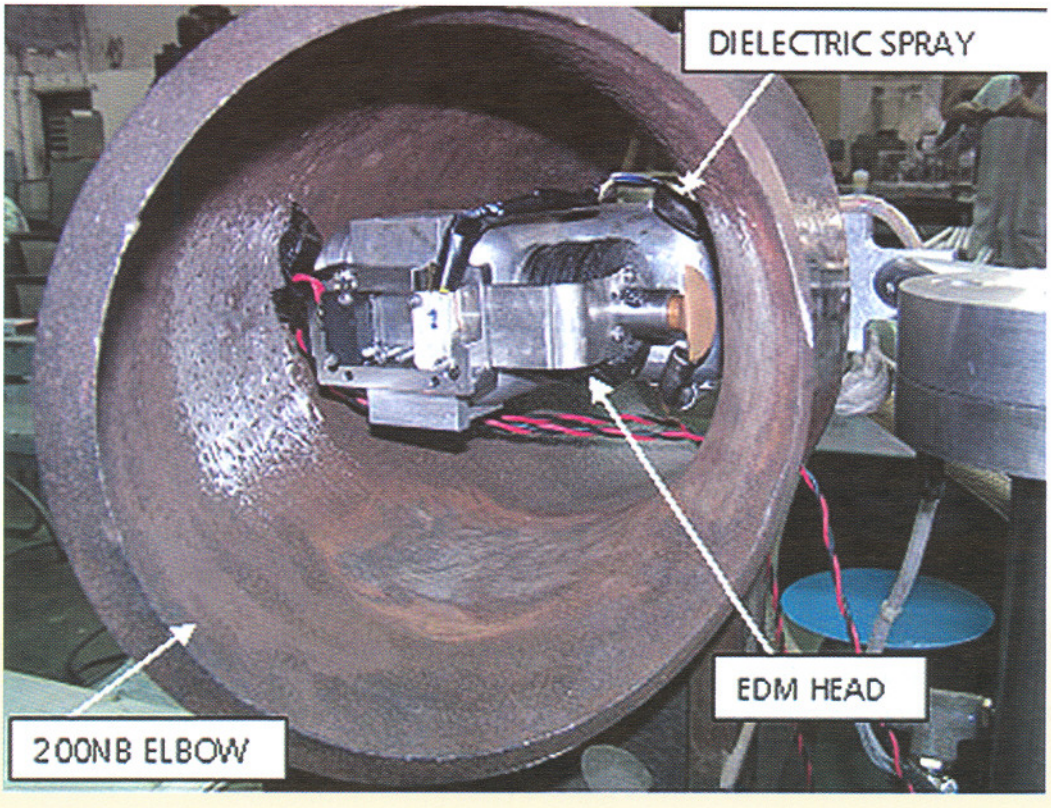
बीएआरसी न्यूज़लैटर
BARC NEWSLETTER

DESIGN AND DEVELOPMENT OF A PORTABLE ELECTRO DISCHARGE MACHINE HEAD FOR MACHINING AT INACCESSIBLE LOCATIONS

S. Agrawal, S. Guha, S.B. Jawale and R.L. Suthar
Centre for Design and Manufacture

Machining of cavities / notches, forms and shapes in inaccessible locations viz., inner surfaces of pipes, elbows and other objects has always posed a problem, in the area of manufacture engineering. Use of conventional EDM machines is ruled out, due to manoeuvering problem in cramped spaces. Also complete immersion of the EDM head in dielectric medium is not possible.

The novel design concept adopted here, has a miniature EDM head with servo-controlled spark gap for machining. The dielectric is sprayed onto the electrode for conduction of spark and erosion process to continue. The pulse generator is isolated from the machining head and it makes the system more compact. Accurate positioning is done by a swiveling arm mounted with EDM head on an outer location of the object. Use of a CCD camera



with proper illumination, can further enhance the inspection of the feature, during and after machining. The concept may have wider applications for remote machining of desired features in inaccessible locations.

EDM Head : As described earlier, machining at cramped spaces / inaccessible areas is always a challenge. These problems can be solved by using portable EDM Head. This EDM head is approximately 100mm X 100mm X 70mm in size. Total Travel of the Ram (Electrode) Head is 14mm currently and can be increased up to 50mm with slight modification. To give movement to the electrode, stepper motor is used which in turn drives the ball screw through a timing belt. Electrode head is mounted on a linear slide, which is connected to ball screw nut.

Sealing of EDM Head : EDM head assembly (including stepper motor, ball screw and linear slide etc.) is mounted inside a special enclosure, which seals motor and ball screw to protect them from dielectric i.e. Kerosene. For sealing purposes, suitable O-Rings, gaskets and rubber bellows are used. All holes for screws and fasteners are made blind, so that dielectric medium cannot enter inside the EDM Head.

Dielectric System : In normal EDM operation the job is submersed inside the dielectric. In portable EDM head, two 12mm size nozzles are provided to spray dielectric at electro discharge zone and covers the spark. Dielectric is stored in double chamber tank, separated by a filter unit, having 50 litre capacity and pumped to EDM zone via two 12mm nozzles attached to EDM head. Flow rate of di-electric at finishing operation is 5 litres per minute.

Locating Fixture Design : Successful trials have been carried out with portable EDM head to check the feasibility of machining. A locating fixture is made for machining notch inside a pipe and an elbow of 200 NB size. For these, EDM head is mounted on an Arm, which in turn is mounted on a X-Y Slide. Total travel of X- axis is 400mm and Y- axis is 300mm. Pipe is placed on V-Blocks and using XY slide, EDM head is entered inside pipe / elbow and fixed at the desired location. Once desired position is reached, slide is locked in position. The trial for generating an elliptical notch (0.5mm wide x 4mm deep), inside a 200mm size pipe is successfully completed for materials testing program for RSD and the same attempt for other object is in progress. For this, EDM head is mounted on a swivel arm, which in turn is mounted on X-Y Slide.

To measure the depth of cut, two micro switches are mounted on electrode head, which are adjusted as per depth requirement. To view the spark pattern, a CCD camera is attached at EDM head. Electrode used is made of ETP copper. Dielectric used is additive mixed kerosene, with a flash point of more then 80 °C. Results obtained in this trial are as follows :

- Positioning accuracy of Electrode Head: 25 microns
- Profile accuracy generated : 100 microns
- Surface finish in finishing mode : 0.2 micron RMS
- Max MRR (Material Removal Rate) : 500 mm^3 / min
- Electrode wear rate : 3% of MMR

This EDM Head is a basic unit, having single axis motion. With minor changes, rotary motion of electrode head can be used, for profiling or generating cavity of revolution. This machine can also be used for generating micro holes with large aspect ratio.

HANDING OVER OF ANTENNA PLATFORM UNIT FOR LCA-MULTI-MODE RADAR

The Antenna Platform Unit (APL) developed by BARC and ECIL, for the Multi-mode Radar of LCA, was handed over to the Scientific Advisor to the Raksha Mantri by Dr Anil Kakodkar, Chairman AEC, during a ceremony at ECIL, Hyderabad on March 25, 2006. The function was attended by Dr S. Banerjee, Director, BARC, Mr G.P. Shrivastava, Chairman & Managing Director, ECIL and many dignitaries from DRDO, BARC and ECIL. The function was organized in the aftermath of successful completion of safety-of-flight tests of APL. APL will now be integrated with the Radar before initiating aircraft integration and flight tests.

The development of APL for LCA multi-mode Radar was taken-up by BARC and ECIL in the year 1999, under a contract between the Aeronautical Development Agency, Bangalore and ECIL. The Control Instrumentation Division, BARC, tookup the responsibility for design, development and manufacturing of the control electronics hardware and software for the first three units. The design and development of all mechanical hardware, including the pedestal and gimbal box, procurement and project management functions, were handled by ECIL.

The primary function of the APL is to support scan mode of operation of the LCA MMR, by accurately positioning the flat-plate antenna at the commanded angles. The antenna which is a large, compliant, unbalanced load is stabilized against aircraft body rates (pitch, roll and yaw) and is held in position in the presence of torque disturbances, due to varying linear acceleration (g) and vibrations of the aircraft.

Dr Anil Kakodkar, Chairman AEC and Secretary, DAE, handed over the Antenna Platform Unit to Mr Natarajan, Scientific Advisor to the Raksha Mantri at ECIL Hyderabad. Also seen in the picture are Mr A.K. Gupta, Advisor, ECIL, Dr S. Banerjee, Director, BARC and Mr P.S. Subramanyam, Director, ADA.

The APL is madeup of three sub-assemblies- flat-plate antenna, gimbal box and pedestal. The gimbal box and pedestal are investment-cast, preci-

Mr G. P. Srivastava, C&MD, ECIL explaining the functioning of the APL during a live demonstration.

sion- machined Al structures.

The gimbal box houses two-axis steering mechanism along with gears, bearings, motors, resolvers, rotary joint, cable-wrap, wires, cables and connectors. The pedestal houses card-cage, line filter and associated wiring. All the control electronics is packaged as three cassettes and housed in the card-cage with vents for forced-air cooling.

The gimbal position is measured by a pair of precision resolvers. Each axis is driven by a pair of geared brush-less servo motors. The two motors of each axis are arranged in counter torque mode for eliminating the effect of gear back-lash. Each of the four motors is driven by four-quadrant PWM torque amplifier, using vector control technique. These motor controllers are realized on ADMC 401 DSPs. The current command to the Motor controller originates from the SHARC DSP-based servo controller, which communicates with the Data Processor via Mil-STD-1553B bus and implements position and rate loops for both axes. The DSP software also supports configuration, testing, tuning, diagnostics and trouble-shooting functions. At the same time, hardware and software, ensure safety of the antenna at all times. A PC-based tester station is developed by BARC to facilitate factory testing and tuning.

Development of air-worthy APL was a challenging ende-avor calling upon expertise in the areas of controls, electronics, software, drives, structural analysis, fabrication technology, thermal engineering, quality assurance and software verification and validation. During the recently concluded safety-of-flight tests at Hyderabad, one unit was tested for compliance to performance, EMC, acceleration, vibration and temperature specifications.

Development of the APL is a significant indigenous contribution to the LCA program. The projected cost of (about Rs. 2.5 crores per unit) is substantially less than similar imported systems. With the total requirement of APLs and its variants expected to be a few hundreds over the next few years, this is a precursor to a new product line and technology base at ECIL. Under the recent MOU, BARC will be assisting ECIL, in the series production of these units.

NATIONAL SCIENCE DAY-2006 : PROGRAMMES CONDUCTED BY BARC

Dr S. Banerjee, Director, BARC, addressing a gathering of students from various colleges, Mumbai, during the National Science Day 2006 at the Central Complex auditorium

The announcement on February 28, 1928 of what is now known as the Raman Effect, provided not only a rare insight into the phenomenon of scattering of light, but it also marked the beginning of a powerful new spectroscopic technique, to probe the structure of matter. Innumerable applications of the Raman effect have emerged and continue to emerge even to date. This discovery, made in the laboratories of the Indian Association for the Cultivation of Science, Kolkata, fetched Prof. C.V. Raman, the Nobel Prize in Physics, in 1930. The mention of Raman and his effect, has since been, an inspiring influence on generations of Indian scientists. In order to perpetuate this memory, the Indian scientific community observes February 28, as the National Science Day. It is celebrated over a fortnight or more, starting either on February 28 or culminating on February 28. The celebrations consist of programmes, aimed at inculcating scientific temper in the students, to motivate them to take up science as a career and to spread awareness about various scientific issues involving common people.

The year 2006 being the Golden Jubilee Year of BARC, the theme of the National Science Day celebrations in BARC this year, was interwoven with the message of the glorious contributions of BARC, to the country. The celebrations consisted of Science Awareness Programmes at three different Colleges in the city, on three different days, culminating in the visit to the BARC campus at Trombay, by students and teachers from various Science and Engineering colleges.

The three colleges in which the programmes were conducted were (i) Vivekanand Education Society's College, Chembur on February 11, 2006 (ii) St Xavier's College on February18, 2006 and (iii) Fr. C. Rodrigues Institute of Technology, Vashi on February 25, 2006. The programme consisted of three popular lectures by BARC Scientists and screening of a film on the activities

Students from various colleges, Mumbai, listening to the lecture at Central Complex auditorium on the National Science Day Celebrations 2006

of BARC, in each of the three colleges. The topics of the lectures ranged from addressing people's misconceptions about environmental and biological effects of nuclear radiation to genomics.

On February 28, 2006, over 400 students and teachers from twelve Science and Engineering colleges from all over Mumbai, visited the BARC campus at Trombay. They had the rare privilege of visiting the Dhruva Reactor and the new Computer Centre. They also had an interactive session with the Director, BARC and other senior scientists in the Central Complex auditorium.

Going by the feedback received from the students and the faculty at the colleges, the National Science Day celebrations appeared to have served the purpose of arousing the interest of the students in Science in general and in the programmes of BARC, in particular. It also helped in removing any misgivings from the public mind, about the effects of nuclear radiation and food irradiation.

MoU BETWEEN NPCIL AND BARC FOR FUEL HANDLING TRAINING SIMULATOR FOR TAPS-3&4 AND RAPS-3&4

Seen in the photograph are Mr Umesh Chandra, Sr. Executive Director, NPCIL with Mr G. Govindrajan, Director, E&I and A&M Groups, BARC at the signing of the MoU

Two MoUs were signed on 30th January 2006 between BARC and NPCIL. One MoU was for the development of a 220 MWe PHWR Fuel Handling Training Simulator (FHTS) for installation at Nuclear Training Center (NTC), Kota. The other MoU was for the development of a 440 MWe PHWR fuel handling training simulator for installation at NTC, Tarapur.

The Fuel Handling Control Section (FHCS), BARC has been responsible for the development work on fuel handling computer control system, for Indian PHWRs and for test facilities at the Refuelling Technology Division (RTD), BARC. The FHCS was awarded the development, installation and commissioning work on the first FHS training simulator, for Kaiga Generating Station (KGS). NPCIL has been using the simulator training facility at KGS, for training on fuel handling, for main plant engineers. The proposed training simulator for Tarapur and Kota would be designed, using feedback from NPCIL, to enhance training capabilities as the simulator uses latest hardware and software.

The development envisages 'initial phase' and 'upgradation phase'. Completion of initial phase will provide the training simulator with capability for full-auto and semi-auto refuelling operations, with reasonable on-line mimics. Completion of upgradation phase will provide, final training simulator configuration, having full manual mode operation, with extensive on-line mimics. The two systems are configured around a network of 14 and 16 PCs respectively. NPCIL would provide the hardware and BARC would develop the requisite software.

3RD REGIONAL TRAINING COURSE ON PHYSICAL PROTECTION OF NUCLEAR INSTALLATIONS

The third Regional Training Course on Physical Protection of Nuclear Installation was jointly organized by the Department of Atomic Energy, Government of India and the International Atomic Energy Agency (IAEA), during 7 – 18 November, 2005 at Hotel Sea Princess, Juhu, Mumbai. The course was inaugurated by Mr. S. A. Bhardwaj, Director(Technical), NPCIL and the concluding session was chaired by Mr. S. K. Sharma, Chairman, AERB. The two week course included 35 lecture sessions, 5 workgroup sessions, plenary session and a field visit to KAPS.

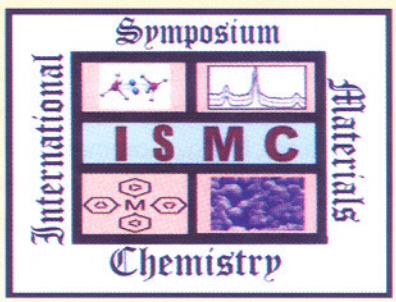
In the photograph from left to right are : Dr K. Raghuraman, Head, ISD, DAE, Mr Arvydas Stadalnikas, IAEA, Vienna, Mr S.A. Bharadwaj, Director, (Technical), NPCIL, Mr G. Govindarajan, Director, A&M and E&I Groups, BARC, Mr Jose Rodriguez, SNL, USA and Mr S. Bhattacharya, Head, CnID, BARC, during the inaugural session

Wide ranging topics on nuclear security like nuclear fuel cycle activities and their physical protection concern, Design Basis Threat (DBT), design and evaluation of physical protection system, international physical protection regime, IAEA activities in nuclear security, security technologies, security and control of radioactive sources etc. were covered in depth, in this training programme. It also included several emerging areas of nuclear security like safety-security interface, interface between nuclear material control, accounting and security, security culture etc. Working group exercises were carefully designed to cover different aspects of designing of physical protection system for nuclear facilities including designing of sub-systems, evaluation and upgradation of design.

There were 25 participants in the training programme: 17 from 8 foreign countries and 8 from India. Foreign participants were from Indonesia, China, Malaysia, Korea, SriLanka, Thailand, Vietnam and Myanmar. In addition to these 9 Indian observers and one foreign observer from US, DOE, also participated in the course. Two of the faculty members were from Sandia National Laboratory, USA; one from IAEA and one each from France and Indonesia. 13 faculty members from India were involved in this training course.

Announcement

FORTHCOMING SYMPOSIUM ISMC-2006



The International Symposium on Materials Chemistry, ISMC-2006, is being organized by the Chemistry Division, Bhabha Atomic Research Centre, Mumbai, India, during December 4-8, 2006. The symposium is sponsored by the Board of Research in Nuclear Sciences (BRNS), Department of Atomic Energy (DAE).

This Symposium, would focus on contemporary research in the field of materials chemistry. The deliberations of the symposium would cover :

Thermophysical, thermodynamic and transport properties; Nuclear waste materials, Fission products, Glasses and Synroc; Oxides and Intermetallics; Fuel cells; Materials for energy conversion and hydrogen storage; High purity materials; Thin films; Nano materials; Magnetic materials; Polymers and carbon composites; Catalysts; Surface chemistry; Chemical sensors.

For further information please contact :

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WORKSHOP ON RADIATION AND PHOTOCHEMISTRY : A REPORT

A three-day workshop on Radiation and Photochemistry was held at the Homi Bhabha Centre for Science Education, Mankhurd, during January 2-4, 2006. This workshop was jointly organised by the Indian Society for Radiation and Photochemical Sciences (ISRAPS) and the Radiation and Photochemistry Division of BARC. The objectives of the workshop were to introduce research students to these twin thrust areas of research, to emphasize the complementary nature of the two areas and to introduce the participants to the realm of fast chemical reactions. Dr Hari Mohan (ex BARC), Member ISRAPS Executive Council and Dr D.B. Naik, Secretary ISRAPS acted as workshop conveners. The workshop consisted of 14 talks and a half-day laboratory demonstration session. The talks were given by eminent scientists in their respective fields of research from BARC (Dr T. Mukherjee, Dr D.B. Naik, Dr (Mrs.) S. Dhanya, Dr S. Sabharwal, Dr H. Pal, Dr D.K. Maity), TIFR (Prof. S. Wategaonkar), IIT Bombay (Prof. Anindya Datta), Dr A.V. Sapre and Hari Mohan (Ex. BARC) and Prof. B.S.M. Rao (Pune University). Two of the distinguished scientists from abroad: Dr. E. Janata from Hahn-Meitner Institute, Berlin and Dr J. Wishart, Brookhaven National Laboratory, USA also gave talks and encouraged young researchers. During the laboratory visit, participants showed keen interest in knowing more about various fast kinetic techniques used by the Chemistry Group, BARC.

A total of 33 participants attended the workshop. Most of them were research students from different universities and institutes. Apart from a few research students from Radiation and Photochemistry Division, there were participants from other divisions of BARC too.

In the concluding session, Chief Guest Dr J.P. Mittal (Former Director, Chemistry and Isotope Group, BARC), briefly reviewed the importance of research in Radiation and Photochemistry. Dr J.P. Mittal gave away the certificates to all the workshop participants.

A group photograph of the participants at the workshop on Radiation and Photochemistry

TROMBAY SYMPOSIUM ON RADIATION AND PHOTOCHEMISTRY (TSRP-2006)

The eighth biennial "Trombay Symposium on Radiation and Photochemistry" (TSRP-2006) was conducted from January 5-9, 2006. It was organized by the Chemistry Group, BARC, under the auspices of DAE-BRNS, in collaboration with the Indian Society for Radiation and Photochemical Sciences (ISRAPS) at the Central Complex auditorium, BARC. The objective of TSRP is to bring together national/international experts in Radiation and Photochemistry on a single platform. Since its inception in 1992, TSRP has been playing a unique role, in bringing together not only the experts but also fresh researchers in both research areas, resulting in fruitful discussions and setting the course for future research.

Dr. Anil Kakodkar, Chairman, AEC & Secretary, DAE, inaugurated the symposium. In his inaugural address, Dr. Kakodkar stressed upon different areas where fundamental research is required, for the next cycle of the Indian nuclear power program. The Director,

On the dais from left to right are
Dr J.P. Mittal, Former Director, Chemistry & Isotope Group, BARC,
Dr S. Banerjee, Director, BARC,
Dr Anil Kakodkar, Chairman, AEC & Secretary, DAE
and Dr T. Mukherjee, Director, Chemistry Group, BARC

BARC, Dr. S. Banerjee congratulated the scientists for the excellent research carried out in BARC and advised them to utilize the knowledge for the benefit of the society. There were about 250 delegates, out of which, more than thirty were from abroad. Current trends and latest results in radiation and photochemistry were extensively discussed during the 46 invited talks and poster presentations (approx. 150). The theme of the symposium was fundamental and applied research in radiation and photochemistry. The symposium covered recent trends in fast and ultra fast processes, inorganic, organic and polymer radiation and photochemistry, gas phase photochemistry and dynamics, charge, electron and energy transfer processes. It also covered the role of radiation and photochemistry in biology and medicine, drugs and antioxidants, nanoscience, advanced materials and its applications in industry as well as for environmental protection. It also covered : radiation and photochemistry of ionic liquids, supercritical water, role of H bond network in the radiation chemistry of hydrated systems, radiation technology for material processing and environmental remediation, radiation induced protein damage, antioxidant activity of curcumin and its copper complexes. Radiation-induced degradation of organic nuclear wastes was also dealt with. Generation of nano particles and their applications is a current thrust area of research. Radiation chemical techniques offer a unique means to obtain metal and alloy nano particles. Important aspects of this type of research were discussed during TSRP-2006.

Use of femtosecond lasers to understand ultrafast processes, such as inter and intramolecular energy, electron and proton transfer in bio molecules, dynamics of solvation and hydrogen bond formation in excited molecules are some of the important current topics in chemical dynamics which were also discussed in the symposium. Study of chemical reactions at molecular level to understand their dynamics, with a view to control and produce select products, generation and characterization of metal and molecular clusters were highlighted in the symposium. Invited talks on laser micro/nano chemistry, nanoscience of composite materials, single molecule fluorescence spectroscopy and the dynamics of host-guest complexation which can lead to better and photostable sensor systems, were discussed in depth.

Poster presentations by younger participants were evaluated and best poster awards were given by ISRAPS, both in radiation chemistry and photochemistry front. TSRP-2006 also provided a platform for the award ceremony of the P.K. Bhattacharya Memorial Award for young scientist in the field of radiation and photochemistry. For the year 2005, Dr. Sandeep Banthia of the University of Hyderabad, got this award. ISRAPS also honoured Prof. S.P. Mishra (Banaras Hindu University), Prof. B.S.M. Rao (University of Pune), Dr. Hari Mohan and Dr. R.D. Saini (BARC) for their lifetime contributions in the areas of radiation and photochemistry.

DISCUSSION MEET ON "DESALINATION AND WATER PURIFICATION TECHNOLOGIES"

A one day discussion meet on "Desalination and Water Purification Technologies" was organised on February 27, 2006, at the Multipurpose Hall of BARC Guest House and Training School Hostel, Anushakti-nagar. There were about 140 invitees from industries, R&D institutions, academia and user sectors from different parts of the country. Participating institutions included BARC, CSMCRI, Defence Laboratory, CGCRI, NCL, RRLs, RRCAT, Office of PSA, DST, IITs, universities, Gandhigram Rural Institute, SASTRA, CMWSSB, TNEB, BPCL, RCF, BHEL, NTPC, Ion Exchange, ROCHEM, Technochem, Alfatech Water Systems, Akar Technocrats, SONADKA, Sarita Agutek, Filfab Corporation etc.

Introductory remarks by Dr S. Banerjee, Director, BARC. Others sitting on the dais from left to right are Dr P.K. Tewari, Head, Desalination Division, BARC, Dr S.K. Sikka, Scientific Secretary, Office of Principal Scientific Advisor to the Government of India and Mr D.S. Shukla, Director, Chemical Engineering and Technology Group, BARC

The national level discussion meet was the follow-up to the brain storming session on 'desalination and water purification, initiated by Dr R. Chidambaram, Principal Scientific Advisor to the Government of India. Position papers were prepared by different groups, on seawater desalination, brackish water desalination, water recycle and reuse, water purification technologies and R&D thrust areas.

Dr. Srikumar Banerjee, Director, BARC and Chairman Organising Committee, highlighted the role of desalination and water purification technologies in water security. He mentioned that the sole source of fresh water is nature. In addition to the limited quantity of water in lakes, rivers, underground etc., we have an unending source of water i.e. the sea. Increase in fresh water demand, calls for exploration of new resources. Thermal and membrane based desalination technologies can produce large amount of water from the sea, suitable for drinking and other process requirements. Seawater desalination is no longer limited to the Middle East and Caribbean. Significant seawater desalination projects have been announced in India, Australia, Western USA and other parts of the world. Water pollution is increasing with increase in industrial development. Recovering good quality water from effluents, through membrane processes, not only helps in recovering reusable water, but also in conservation of existing resources from pollution.

Dr S. Banerjee, Director, BARC, visiting the exhibition during the discussion meet

Water purification technologies can play an important role in rural areas. Identification of R&D thrust areas in the field of desalination and water purification technologies is required. It is essential to provide water of end-use quality, at affordable cost.

Dr. S.K. Sikka, Scientific Secretary, Office of the Principal Scientific Advisor to the Government of India, stated that, in order to prepare a road map for the desalination activities, Dr. R. Chidambaram Principal Scientific Advisor to the Government of India, convened a meeting on 23rd August 2005, in Delhi with the representatives of organisations working in the field. The objective of the meeting was to finalise a programme for a national level discussion meeting, to identify current status of technology and the areas where development efforts are to be intensified, for obtaining government support. It was decided in the meeting to prepare position papers on the desalination and water purification technologies and present them in the discussion meeting, organised by BARC.

Mr D.S. Shukla, Director, Chemical Engineering and Technology Group (BARC) welcomed the participants. He pointed out that this national level discussion meet, aims to bring together the technologists from government sector, industries, R&D institutions and academia from all over the country, to share their views on the present scenario, global standards, mechanism for industry academia interaction, business model, rural applications, environmental protection and pollution prevention aspects.

Dr. P.K. Tewari, Head, Desalination Division, BARC and Convener, Organising Committee, proposed the vote of thanks. He added that the discussion meet would be an excellent forum for exchanging experiences and drafting recommendations for water security in India.

Position papers on sea water desalination, brackish water desalination, water recycle and reuse, water purification technologies and R&D thrust areas in desalination and water purification were presented by the lead persons: Dr. P.K. Tewari (BARC, Mumbai), Dr. (Ms.) S.V. Joshi (CSMCRI, Bhavnagar), Mr Ajay Popat (Ion Exchange, Mumbai), Dr S. Khuntia (RRL, Bhubaneshwar) and Mr D.S. Shukla (BARC, Mumbai). A rich mix of participants from associated industries, educational institutes, R&D institutions and user sectors ensured good interaction and lively discussions, during the meet. Recommendations were prepared, which would be sent to the Office of the Principal Scientific Advisor to the Government of India.

भा.प.अ. केंद्र के वैज्ञानिकों को सम्मान
BARC SCIENTISTS HONOURED

डॉ ए.के. त्यागी, अध्यक्ष, ठोस अवस्था एवं संरचनात्मक रसायनिकी अनुभाग, रसायनिकी प्रभाग, भा.प.अ. केंद्र को दिनांक 3 से 5 फरवरी, 2006 के दौरान इण्डिया इंस्टीट्यूट ऑफ टैक्नोलॉजी में CRSI के वार्षिक सम्मेलन में वर्ष 2006 हेतु केमिकल रिसर्च सोसाइटी ऑफ इण्डिया (CRSI) का पदक प्रदान कर सम्मानित किया गया । यह पदक ठोस अवस्था रसायनिकी के अग्रणी क्षेत्रों में उनके विस्तृत अनुसंधान कार्यकलापों हेतु प्रदान किया गया । उनके द्वारा किए गए कुछ महत्वपूर्ण अनुसंधान कार्यों में नाभिकीय पदार्थों, नेनो सिरेमिक्स, असामन्य ताप प्रसारण व्यवहार युक्त फ्रेमवर्क ठोसों, विरल मृदा आधारित अकार्बनिक फ्लोराइडस्, चरमपरिस्थितियों के तहत ठोस अवस्था रसायनिकी तथा विकिरण प्रतिरोधक पदार्थों के क्षेत्र में किए गए कार्यों का समावेश है ।

Dr A.K. Tyagi, Head, Solid State and Structural Chemistry Section, Chemistry Division, BARC, was conferred with the Chemical Research Society of India (CRSI)'s Medal for the year 2006, at the annual conference of CRSI at the Indian Institute of Technology, Mumbai, during February 3-5, 2006. This medal was conferred on him, in recognition of his wide ranging research activities, in the frontline areas of Solid State Chemistry. Some of the important research activities pursued by him are in the field of nuclear materials, nano-ceramics, framework solids with unusual thermal expansion behaviour, rare-earth based inorganic fluorides, Solid State Chemistry under extreme conditions and radiation resistant materials.

सुश्री अदिती चक्रवर्ती, पर्यावरण मूल्यांकन प्रभाग, भा.प.अ. केंद्र ने सर्वोकृष्ट युवा अनुसंधानी प्रस्तुतीकरण पुरस्कार प्राप्त किया। यह पुरस्कार उनके "सेडीमेंटेशन रेट ऑफ नागार्जुन सागर डैम यूजिंग एनेच्युरल रेडियोट्रेसर" नामक शोध-पत्र हेतु प्रदान किया गया जो उन्हें दिनांक 23 से 27 जनवरी, 2006 के दौरान साहा नाभिकीय भौतिकी संस्थान में साहा नाभिकीय भौतिकी संस्थान तथा अंतर्राष्ट्रीय परमाणु ऊर्जा एजेंसी द्वारा रसायन, पर्यावरण एवं जैवकीय विज्ञान में रेडियोट्रेसर के अनुप्रयोग पर संयुक्त रूप से आयोजित अंतर्राष्ट्रीय सम्मेलन के दौरान प्रदान किया गया । यह शोध-पत्र ए.चक्रवर्ती, एस.के. झा, एस.गोठणकर, आर.एम.त्रिपाठी, ए.एच. खान एवं वी.डी. पुराणिक द्वारा लिखा गया । इस शोध-पत्र में नागार्जुन सागर बाँध के समीप लाम्बापुर एवं पेड्डागट्टू में प्रस्तावित यूरेनियम खान स्थलों के संधान मूल्यांकन हेतु आधारभूत आकड़ों संबंधी कार्य का वर्णन किया गया है ।

Ms Aditi Chakrabarty of Environmental Assessment Division, BARC, received the best young researchers presentation award for the paper entitled "Sedimentation rate of Nagarjuna Sagar Dam using a natural radiotracer" presented at the International Conference on Application of Radiotracer in Chemical, Environmental and Biological Sciences, organized jointly by the Saha Institute of Nuclear Physics and the International Atomic Energy Agency held at Saha Institute of Nuclear Physics, during January 23-27, 2006. The paper was authored by A. Chakrabarty,

S.K. Jha, S. Gothankar, R.M. Tripathi, A.H. Khan and V.D. Puranik. The paper describes the work pertaining to

base line data for impact assessment of the proposed uranium mining sites at Lambapur and Peddagattu near the Nagarjuna Sagar dam.

सुदूर हस्तन एवं रोबोटिकी प्रभाग के श्री आर.के.पुरी को सिस्टम्स इनोवेशन एण्ड डेवलपमेट के क्षेत्र में उनके योगदान के लिए दिसंबर 2005 में इंडिया सोसायटी फॉर नॉन डिस्ट्रक्टिव टेस्टिंग (ISNT) द्वारा कोलकाता में आयोजित राष्ट्रीय सम्मेलन NDE-2005 के दौरान राष्ट्रीय NDT पुरस्कार 2005 प्रदान किया गया ।

श्री आर.के. पुरी बीएआरसी शीतलक वाहक निरीक्षण प्रणाली (BARACIS) के विकास कार्य से सक्रिय रूप से जुडे रहे । उन्होंने शीतलक एवं कैलेंड्रिया नलियों के सैग प्रोफाइल मापा हेतु सैग मापा प्रणाली का विकास एवं शीतलक एवं कैलेंड्रिय नलियों की आंतरिक सतह के सद्रुश परीक्षण , भुक्तशेष ईंधन भंडारण ब्लाक्स, कैलेंड्रियां वॉल्ट एवं हॉट सेल्स हेतु भूजलीय विकिरण प्रतिरक्षी सीसीटीवी कैमरा का भी विकास किया ।

सुदूर हस्तन एवं रोबोटिकी प्रभाग के श्री बंद्योपाध्याय को भी सिस्टम्स इोवेशन एण्ड डेवलपमेट के क्षेत्र में उनके योगदान केलिए दिसंबर 2005 में इंडिया सोसायटी फॉर नॉन डिस्ट्रक्टिव टेस्टिंग (ISNT) द्वारा कोलकाता में आयोजित राष्ट्रीय सम्मेलन NDE-2005 के दौरान राष्ट्रीय NDT पुरस्कार 2005 प्रदान किया गया।

श्री बंद्योपाध्याय नाभिकीय विद्युत संयंत्रों के सेवाकालीन निरीक्षण हेतु NDT तकनीकों के विकास एवं विभिन्न DAE परियोजनाओं के कार्य करते रहे हैं । वे NDT के प्रयोग द्वारा पदार्थ अभिलक्षणन एवं NDT कार्मिक के प्रशिक्षण एवं प्रमाणन से भी सक्रिय रूप से जुड़े रहे हैं।

Mr R.K. Puri of the Division of Remote Handling and Robotics was presented the National NDT Award 2005 in recognition of his contribution in the field of Systems Innovation and Development, by the Indian Society of Non Destructive Testing (ISNT) during its National Seminar NDE-2005, held at Kolkata, in December 2005. Mr Puri has been actively involved in the development of BARC Coolant Channel Inspection System (BARACIS). He has also developed sag measuring systems for measuring sag profile of coolant and calandria tubes and underwater radiation-resistant CCTV camera system, for visual examination of inner surface of coolant and calandria tubes, spent fuel storage blocks, calandria vault and hot cells.

Mr Bandyopadhyay of the Division of Remote Handling and Robotics was also presented the National NDT Award 2005, by ISNT in recognition of his contribution in the field of Systems Innovation and Development, by the the Indian Society of Non Destructive Testing (ISNT) during its National Seminar NDE-2005, held at Kolkata in December 2005. Mr Bandyopadhyay has been working in the development of NDT techniques for in-service inspection of nuclear power plants and various DAE projects. He has also been actively involved in material characterization using NDT and in training and certification of NDT personnel.

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