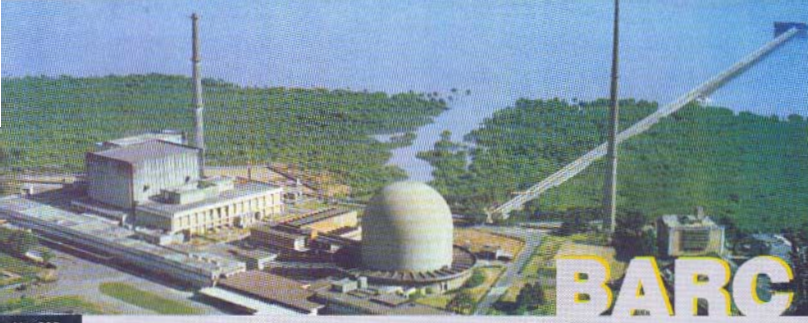

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NEWSLETTER

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HORMONE-POTENTIATED CROP GROWTH AND PRODUCTIVITY

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In view of the ever increasing national population (over 1 billion by December 2000) and depleting natural resources (reduced cropping area and water supply in coming decades), a quantum jump in food production is a most desired goal. Our visionaries have enabled us to achieve the marvels of Green-Revolution by best organic practices, intensive land use and high yielding crop varieties. Any further demand of additional food production must be met by better and integrated management practices. This is particularly true in food-sector, wherein increasing resistance to GMOs (Genetically Modified Organisms) and GM-Foods are felt. Hence, there is an immediate need to enhance the yield potentials of crops by managerial amendments. Although high yielding hybrid-crop varieties do extremely well under normal management practices, very seldom their full gene potential is realised. Faced with such constraints, application of Plant Growth Regulators (PGRs), for higher yields, is gaining momentum. PGR-induced higher yields are due to altered photosynthate distributive patterns within the plant and as such do not require any additional agricultural inputs.

When we look around, we find that various types of plants arise from very tiny seeds. They grow abundantly (at times, especially in temperate zones, exhibiting autumnal colour changes), differentiating into flowers and fruits, followed by seed formation and its eventual desiccation for perpetuity. Conjecturally, one may ask, what

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may be the cause of such happenings? In simple terms, every facet of plant growth, from germination through differentiative growth and senescence (death), is controlled by endogenously found plant hormones. Plant hormones are secondary metabolites of low molecular weights (at times, being as low as 30), having diffused distributive patterns (unlike the glandular ones in the animal kingdom),are extremely low in endogenous concentration (a few mg in tonnes of plant biomass) and vary from plant to plant and within the same plant.

Vegetative and/or reproductive plant growth is nothing but an interplay of hormonal balance, which are modifiable either by *in situ* manipulations (depetiolation, demidribbing, detopping, defruiting etc), and/or by exogenous hormonal supplementations. Hormones (besides being effective *in situ)* are quite often synthesised in one part of the plant and are transported away from the site of production to the distant and active targeted sites. Plant hormones are classified into five groups, viz. Auxins, Gibberellins, Cytokinins, Abscisins and Ethylene. They are also known to act in concert with each other. Some PGR-like substances of plant origin, e.g. Triacontanol, Sterol, Agrostamin, etc, having strong promotory effects, are still awaiting to be listed as plant hormones.

Plant Growth Substances and their synthetic analogues are collectively called as Plant Growth Regulators (PGRs). The synthetic analogues are generally preferred for agri- and/or horticultural uses over their natural counterparts. This is probably because of their greater biostability, resistance to enzymatic degradation, cost effectiveness and availability. These compounds either imitate the natural hormones by structural similarity and/or act by interfering with the biosynthesis, translocation and metabolism of plant hormones. These substances offered ample opportunities for controlling plant developmental processes that could not be readily regulated by any other means. The development and application of this biotechnology provided a better tool for understanding plant metabolism and modified assimilative processes, right from germination to the senescence. As a consequence, they improved the agricultural productivity *vis a vis* cropping efficiency.

The emergence of synthetic analogues of hormones overcame fully the cost constraints, as mentioned earlier, but they had many undesirable side effects. In view of such impediments, search for natural and neo-natural sources of PGRs is being made. As of now, all the five groups of plant hormones can be obtained, at a very low cost, from the microbial sources (IAA from *Rhizopus suinis*, GA from *Gibberella fujikurai*, Ethylene from several fungal sources, ABA from *Cercospora cruenta* and the Cytokinins from *Pseudomonas syringae* pv. Sayastanoi). One of the potentials of PGRs' utility is their effectiveness at extremely low concentrations ($\leq 10^{-10}$ M, at times) and the resultant high cost-to-benefit ratios (1:20 to 1:100).

Since PGRs' use, as early as six decades ago, there seems to be tremendous scope for yield potentiation in various agri-/horti-cultural crop plants. For example, GA enhanced the yield in grapes (Maharashtra) and chillies (Andhra Pradesh) by 30%-40% and annually many quintals of GA formulations are used nationwide. Thus, PGRs have enabled us to remove and/or circumvent many barriers imposed by hereditory and environmental factors.

Potentials of PGRs

PGRs have the potential to further improve the yield of even high yielding crop varieties. It is common knowledge that, under normal circumstances, full potential of genes is not realised. For example, the gene for monellin (sweet protein,100 times sweeter than common sugar) production in tomato was 10 times over-expressed, only when treated with ethylene. PGR-induced increments of sugars, oils, proteins, rubber and quality enhancement of seeds, fibres, flowers, fruits, etc are now common knowledge. Further, PGR-potentiated yield

increments of 15-20% are very common. Even a modest 10% increment by PGR application in the projected total mass of 212 million tons for this year may substantially increase our food tonnage by 19-20 million tonnes. In this regard, it is worth quoting Jonathan Swift (1667-1775) who said, *"Whoever could make two ears of corn or two blades of grass to grow upon a spot of ground where only one grew before, would deserve better of mankind, and do more essential service to his country, than the whole race of politicians put together"*.

Low application cost at less than Rs 100 per acre, without any demand for additional agricultural inputs, make PGRs capable of further potentiating the yield, even in the high yielding cultivars, exclusively by affecting the distributive patterns within the plants. Some of our experiments with PGRs, using established crop varieties *vis a vis* BARC-evolved high yielding mutants and cultivars, have further substantiated the above contentions. Some of the noteworthy experimental findings are enumerated below :

1. Delaying of flag leaf senescence in cereals by PGRs: The flag leaf in cereals, contributing over 30% to the total grains' dry weight and being chronologically the youngest, senesces earliest at the crucial juncture of grain filling. Foliar spray of PGRs (GA_3, Kinetin, TRIA) at flag leaf senescence initiation stage (III) gave 15-20% higher grain yield (Fig. 1A). Such an effect seems to be due to improved grain formation in the marginal 5th tiller and terminal florets at the either end of the ear/spike (Fig. 1B). Such yield increments were due to improved chlorophyll retention and were closely associated with increased and prolonged RuBPCase (CO_2 fixing enzyme) activity. The latter events helped enhanced ^{14}C- translocation to the developing grains. Further, it was also worth noting that the low yielding variety of Huskless Barley (*Hordeum vulgare L* cv 292) registered higher PGR-potentiated yield increments than the high yielding Wheat variety Kalyan Sona (Fig. 1B). Also, within the organs of the same plants, the tillers/ear portions, having lower potentials, responded most favourably.

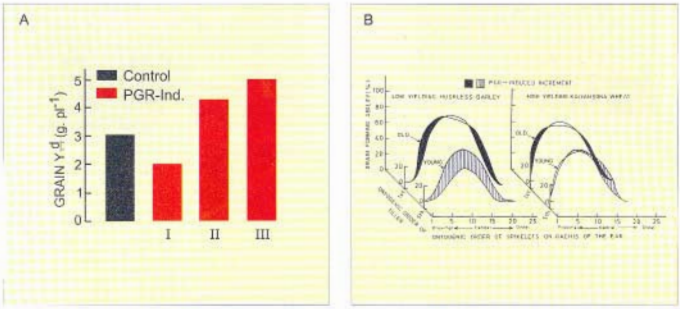


Fig. 1: Stage-specific effect of PGR spraying on the grain yield of huskless barley.
A. Flag leaf sprayed with PGR at various stages of development [Appearance (I), Fully Developed (II) and Senescence (disappearance of chlorophyll) Initiation (III)].

B. PGR-induced differential grain forming ability (GFA = Grain Number / Total Florets X 100, in a spike) in high (Wheat var KS) & low (Huskless Barley) yielding genotypes and different plant organs (1st vs 5th Tiller and Central Floret vs Terminal ones).

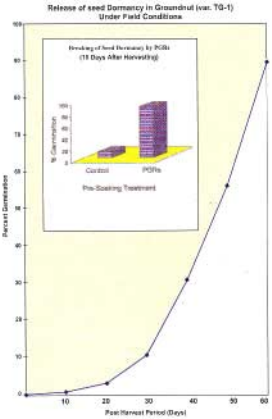


Fig. 2 Pattern of seed dormancy release in Groundnut var TG-1, under field conditions. Seeds, immediately after harvest, were sown and germination was recorded up to 60 days (expiry of dormancy). ***Inset:*** *Early release of dormancy by PGRs. Post-harvest, 10 day old, air dried dormant seeds were pre-soaked for 16 hrs in various PGR solutions, which induced > 90% germination in dormant seeds, within 24hrs of treatment. Water soaked dormant seeds served as control.*

Fig.3 Bayletone-induced changes in the yield potential and its attributes in Groundnut variety TAG-24. The seeds were pre-soaked for 6 hrs in Bayletone solutions (5B=10^{-5}M and 2B=10^{-2}M) before sowing. Water soaked seeds served as control (DC). A: Concentration dependent change in hypocotyl length. [Elongated and shortened & thickened hypocotyl zones in 5B and 2B respectively). B: Field grown plants, showing 5B induced higher, early and synchronous pod formation. C: Pods from 77 day old, field grown plants, showing early development & maturity and reduction in the underdeveoped pods in 5B treated sets.

2. PGR-potentiated high yield in pulses and oil seeds: BARC-evolved high yielding groundnut variety TG-1, having 60 days of dormancy (Fig. 2), is not suitable for immediate sowing, in a double cropping system. Therefore, seed pre-soaking for 16 hrs with PGRs (Benzyl Adenine and Etherel) not only terminated the seed dormancy (Fig. 2, Inset) but preponed the flowering by 7days, resulting in increased pod yield and quality of seeds. Similarly, seeds of another high yielding groundnut var, TAG-24, pre-soaked for 6hrs in Bayletone (B, 10^{-5}M and 10^{-2}M) solutions, showed early germination, early flowering (2 days) and 15 days early maturity (cutting down completely the requirement of one irrigation). It was also accompanied with 20% high pod yield, without affecting the seed and oil qualities (Fig. 3). Similar effects were also noted in other Groundnut (TGS-1 & TG-26), Urid (TAU-1, TPU-4), Tur (TAT-10), Soybean (TAS-9220 & TAS-9325) and Mustard (Fig. 4A and B) varieties.

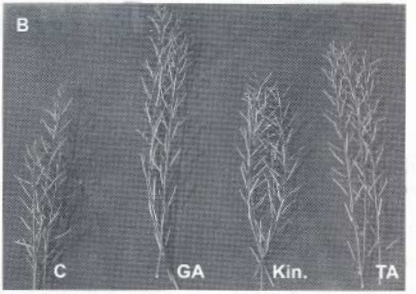


Fig. 4: PGR enhanced pod formation and development in Soybean (A & A-I) and Mustard (B). Various PGRs used were Bayletone (5B=10^{-5} M), Ethrel (5E=10^{-3}M), Kinetin (Kin 10^{-4}M) and Tnacontenol (TA 10^{-6}M). They were sprayed at 50% flowering stage. Water, containing surfactant (0.1% Tween-20), was sprayed on control plants.

3. PGR-modulated flowering in ornamentals: PGR applications have shown species- and stage-specificity in various ornamentals. Pre-bloom GA spraying on *Coreopsis tinctoria* induced early flowering and also increased 3-4 fold flower numbers (Fig. 5). GA spraying on *Portulaca grandiflora*, at various stages, showed differential effects on flower colouration and sizes (Fig. 6).

Fig. 5: Pre-bloom GA_3 (10^{-4}M) treated plants of Coreopsis tinctoria at 40 days, showing early flowering and increased flower numbers.

When GA was sprayed at bud initiation stage (I) and bud opening stage (II), it changed qualitatively the flower colour from crimson red to complete white and mosaic, respectively. Contrarily, when sprayed at fully opened flower stage (III), there was 20 -40 % increase in the size of flowers (Fig. 6, Bottom Panel). However, change in flower colours, being species-specific, were noted only in four cultivars (Fig. 7 A and B). It was also noted that, in certain varieties, although flower colour did not change, the flower sizes were almost doubled (Fig. 8).

Limitations of PGRs

Although PGRs have great potentials, their applications and accrual assessments have to be

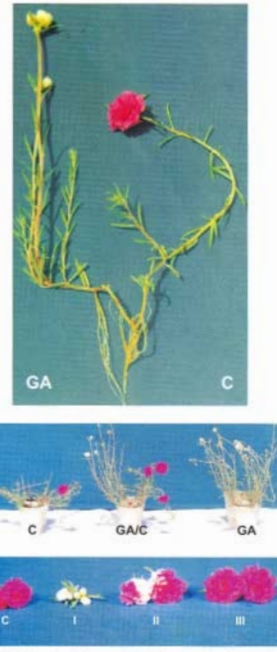


Fig. 6: GA_3-induced changes in the flower colour & size vis-a-vis internodal length in Portulaca grandiflora cv NL-CR-PyP. Bottom Panel : Stage-specific changes in the flower colour and sizes. From left to right: Control (C), GA-induced complete White (I), Mosaic (II) and >40% enlarged Crimson Red (III) flowers. Middle Panel (left to right) Control (C), bifurcated GA-treated left side branches, showing White flower (GA/C), treated whole plant (GA). Top Panel : Closer view of the plants from the middle cup (GA/C), showing elongated internodes vis-a-vis white flowers on the treated left branch.

judiciously planned in terms of concentration optimalities, stage (Fig 1A and 6) and species specificity (Fig. 6, 7 and 8). These may constitute some of the greatest impediments in PGRs' applicabilities. Also, unlike the grandular animal hormones, the PGRs have diffused dispersion

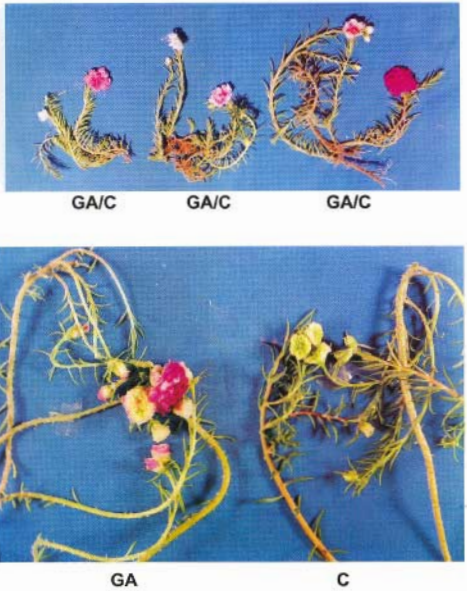


Fig. 7: GA-induced change in flower colour in different narrow leaved polypetaly cultivars of Portulaca grandiflora.Top Panel: The varieties from left to right are Pink, Mosaic and Crimson red, wherein left branches were treated with GA_3 (10^{-4}M), while right side branches sprayed with water, served as control. Bottom Panel: P. grandiflora cultivars Narrow-Leaf Dull White Polypetaly, showing GA-induced Crimson Red and Mosaic flower colours (left side) compared to Dull-White right side control plants.

within the plant and parts thereof. In general, each group of hormone, with slight variability, affects similar parameter in the majority of plants, right from germination to growth and senescence. Such behaviour of PGRs impose a rigorous selection pressure for identifying the proper type of PGR for a given purpose. Further, PGR treatments are physiological in nature and are expressed immediately without any carry-over effect to the next generation. Hence, for the desired effects, plants have to be treated with PGRs from time to time. It may also be noted that, although there is better understanding of morphophysiological changes, induced by hormones, the molecular mechanism, controlling hormone-mediated responses, is very much lacking.

Mechanism of Hormone Action

The mechanistics of PGR action, although elucidated to some extent at macromolecular levels, is not yet fully understood. Whether the PGRs are always interacting with the genomic material (DNA), on a solitary gene basis (ethylene induced intensification of single gene for monellin production in tomato) or on a group of genes/gene families at cytosolic, subcellular levels, as per situational demands, is no way nearer to any generalisation.

Fig. 8 GA (10⁻⁴M) spraying increased flower size in different Portulaca grandiflora cultivars (pink, white, crimson red and yellow).

In view of the parametric (plant height, branching behaviour, yielding capacity, etc) potentiations, which are based on multigenic traits, it seems that exogenously applied PGRs activate a battery of genes, associated with a particular trait or a character (simultaneously or in a spatially regulated manner), that may remain repressed otherwise. Alternately, they may interact with the expression of a single gene linked with a specific function (GA-potentiated ∝-amylase activity). It is also known that all major groups of plant hormones, overlappingly (synergistic/antagonistic effects) regulate the diverse set of genes, affecting the final morphophysiological expressions. Further, the concept of proteinaceous hormonal receptors at membraneous, cytosolic and nucleoplasmic levels are quite fractious, specially in view of the PGRs' stage-specific responses in a spatially regulated manner. The mechanistic understanding of PGR action, besides being mostly on single gene basis, necessitates still more in-depth probing on their multigenic expressions. Several stretches of DNA sequences that are either directly or indirectly associated with PGR induced gene expression are being discovered. For example, in the case of *Arabidopsis*, cis-acting DNA elements, called ABRE (ABA Responsive Elements) have been identified that mediate the PGR effect during drought. Plant Growth Regulators, besides being effective at transcriptional level for mRNA genesis, might also be affecting generally the stability of different RNA species (especially the half-life of mRNAs) at post-transcriptional stages.

Thus, identification of PGR modulated genic/multigenic expressions could be a key factor in achieving the Evergreen Revolution in the coming decades. As such, PGR research could be an important tool of biotech advancement, especially at a time when other conventional technologies are at their bottleneck stage.

SPECIAL MULTI-PIN GLASS TO METAL SEALS

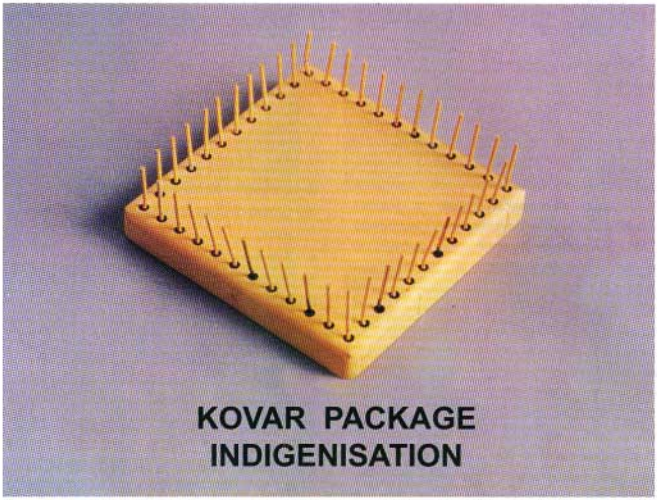
P.A. Wagh, B.B. Sawant, M.R. Joshi, V.K. Shrikhande, S.R. Halbe, G.P. Kothiyal and V.C. Sahni
Technical Physics and Prototype Engineering Division

Glass to metal (GM) seals play an important role in many specialised applications, be it hermetic sealing of electronic microcircuits aboard satellites or miniature cryo-coolersl/cryostats or filament assembly of a thermal ionisation mass spectrometer (TIMS), etc. At times, electronic circuits also need to be protected from moisture and other corrosive ambient for stable, reproducible and long term performance. In addition, in electrical and electronic technology applications, one needs to communicate electrically between normal ambient on one side and vacuum or high pressure on the other side. For all such applications, different types of glass-to-metal seals, prepared on metal housings/covers provide the only solution. A typical GM seal for such an application consists of an external metal part, a glass base having one or more metal pins. The contact area of outer metal part and the pins with the glass provides vacuum/pressure sealing interfaces. The metal pins provide the means to make electrical contacts while glass acts as a good insulator. The seals can be of both types: with either matched thermal expansion coefficients (α) of metal and glass, or an arrangement such that only compressive stress is exerted on the glass. The important parameters related to GM seals are insulation resistance, flash over voltage, current carrying capacity, hermeticity, temperature load capacity, pressure load capacity, mechanical strength, corrosion resistance, solderabilty, etc. For some strategic applications, even very stringent dimensional constrains have to be met.

Technical Physics and Prototype Engineering Division (TP&PED), BARC, has carried out indigenous development of many high precision multi-pin GM seals/packages of both matched as well as unmatched type. The development involves several steps, such as:

1. Preparation of glass beads, metal pins, kovar/ss cups/plates, graphite jigs,
2. Chemical cleaning of metal parts,
3. Growth of oxide layer(hydrogen firing) on metal parts,
4. Assembly of different seal components,
5. Seal fabrication and annealing, and
6. Testing of seal.

Some details of the procedures adopted are as follows: Beads are prepared from the capillaries (0.6 mm id and 1 mm od) drawn in-house by controlled pull rate and temperature of glass. For cutting the metal pins with flat ends, a special cutting die has been designed and used. The kovar cups/ss plates have been fabricated using a CNC machine to maintain the dimensional accuracy from the point of view reproducibility. Metal pins, cups and plates are supported on graphite jigs prepared using high density (8.5-9 g/cc) graphite material. All metal parts are first degreased using soap solution and organic solvents, and given acid dip before washing in deionised water followed by blow drying. These parts are then heat treated in wet hydrogen at around 950 °C to grow a desired thickness of oxide layer. The assembly of pins and metal cup/plate in graphite jigs is carried out in a very careful manner avoiding any finger prints, etc. The fabrication of seal was done under controlled inert atmosphere using induction heating. After a seal is prepared, it is annealed at around 560°C for 30 min. Upon receipt, GM seals are cleaned of graphite dust, etc by blowing, followed by wet sand blasting in some cases. All seals are examined under a microscope for bubbles/pin holes and micro-cracks in glass before leak testing on helium leak detector. To prevent corrosion of kovar cups/pins, they are plated with nickel or gold.



KOVAR PACKAGE INDIGENISATION

Fig.1 Forty-four pin GM seal for microcircuit encapsulation

From amongst several types fabricated by TP&PED, three GM seals recently developed in different configurations are shown in Figs. 1-3. Development of GM seal shown in Fig.1 was initiated at the request of ISRO, Bangalore, and was required for microcircuit encapsulation. It is a matched seal having 44-pins on a square kovar cup of 32mm x 32 mm size with 1 mm wall thickness. The kovar pins of 0.5 mm diameter are fixed by GM sealing at regular intervals of 2.54 mm (centre to centre pin distance) on 27.94 mm square. The crucial steps in the development are related to making of kodial glass beads (of 0.6 mm id x 1mm od and 1.6 mm length), flat ended kovar metal pins of 0.457 ± 0.05 mm diameter and 8.5 ± 0.05 mm length.

The GM seal shown in Fig.2 is being developed for SPL, Delhi, and would be used for mounting IR detector arrays inside a cryostat. It is also a

Fig. 2 Seventy-six pin GM seal for providing electrical linkages to IR detector array inside a cryostat

matched type 76-pin seal. In this case, there is a kovar housing of 30 mm diameter, 1.3 mm wall thickness and 4 mm height. 0.5 mm diameter and 8 mm length pins are arranged on two different

circles, having diameters of 23 mm and 26 mm respectively. On each circle, 38 GM seals are fabricated. As in the case of GM seal for microcircuit encapsulation, here also, fabrication of beads and flat ended pins is quite critical. GM seal of Fig. 3 has been specially designed for mounting three filaments in a special geometry for use in a thermal ionization mass spectrometer that TP&PED has built for use at KARP, Kalpakkam. It is unmatched type seal. In this case, six 1.5 mm diameter ss pins are sealed on a ss plate of 18 mm X 23 mm X 3 mm size using lead glass beads. Out of six pins, four are bent at an angle of 127 degrees and they are arranged and sealed on to metal plate with a high precision so as to maintain a gap of 2 mm between the end faces of the bent pins and 1.5 mm from the top of the corresponding centre pin.

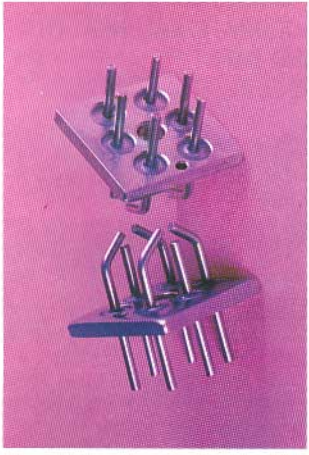


Fig. 3 Special bent pin GM seal for filament mounting in TIMS, developed at TP&PED

The seals shown in Figures I and 2 have had to undergo a variety of reliability tests before acceptance by users. These include vacuum integrity (leak rate of less than 10^{-10} std. cc/s), insulation resistance > 1000 MΩ, 45 degree bending(lead fatigue test), 77 to 400 K temperature cycling, vibration test (50gm, 20 to 2000 Hz, three axes). The seals made by TP&PED have successfully passed these tests. Efforts are now on to produce them in large numbers. The seals developed by TP&PED for use in TIMS are already being produced in bulk quantities.

DIRECTOR, BARC, VISITS POTON SITE

Dr Anil Kakodkar, Director, BARC, visited the POTON irradiator project site at Lasalgaon in Nashik district of Maharashtra on October 1, 2000.

Dr Anil Kakodkar, Director, BARC, addressing senior personnel of DAE connected with the POTON project.

Dr D.R. Bongirwar, Head, Food Technology Division, BARC, & Project Manager, Food Irradiation Project (FIP), accompanied and introduced the Director to various agencies and briefed him about the various activities going on in the project area and also the progress achieved till date.

Dr Kakodkar inspected the progress of civil, electrical and mechanical works at site and inaugurated the Guard house for security staff of the plant. Dr Kakodkar inaugurated the 11 kVA

Dr D.R. Bonginwar, Head, Food Technology Division, BARC, briefing the audience about the progress of the POTON project.

power supply substation, complete with transformer, meters, 250 kVA diesel generator and UPS system. He also inaugurated the 48 line telephone exchange (EPABX) for this project. After seeing the progress of work, he addressed the gathering consisting of the staff working at site, contractors undertaking works, and special invitees. He complemented everyone for the good progress of various work being undertaken at site. Dr Bhonde, Jt. Director, National Horticulture Research Foundation (NHRDF), Nashik, Mr Mishra, Asst. Director, NHRDF, and Mr Patil, Serpanch of Kotamgaon village, were present on this occasion.

Dr Anil Kakodkar, Director, BARC, inspecting the source storage well at the site.

Following personnel were present from BARC to brief the director about their respective activities and progress of work : Mr A.K. Gupta, Director, ESG; Mr S. Ramanujam, Head, A&CED; Mr P.B. Kulkarni, Head, TSD; Dr M.C. Abani, Head, RSSD; Mr B.N. Maheshwari, Head, L & CM; Mr Y.D. Parmar, BRIT; Mr R.K. Modi, DRHR; Mr M.G. Radake, DRHR; Mr K.B. Mehra, Project Engineer; Mr Alok Agrawal, CED; Mr S.K. Kelkar, FIP; and Mr S.P. Shastri, FIP.

About 95% of the civil and electrical works of the plant have been completed at site. Construction expenditure to the tune of Rs. 350 lakhs have already been incurred and payment commitments of remaining amount of Rs. 350 lakhs is expected to be incurred before the completion of the project.

TRAINING COURSE ON 'ACCIDENT PREVENTION AND PROMOTION OF OCCUPATIONAL HEALTH AND SAFETY'

Participants and faculty members of the training course

A training course on 'Accident Prevention and Promotion of Occupational Health and Safety' was conducted by the Industrial Hygiene and Safety Section, Radiation Safety Systems Division (RSSD), BARC, during September 18-29, 2000. This was the 21st course with participation of a total of fifty four persons in the middle management/ supervisory level from BARC and other DAE Units. In his welcome address, Dr M.C. Abani, Head, RSSD, BARC, gave a brief resume of the training

course. Dr V. Venkat Raj, Director, HS&E Group, BARC, while inaugurating the course, stressed the importance of accident prevention; he desired that employees should aim for accident-free environment by constantly being aware of safety at all work situations. He said that safety has gained top priority at BARC in the light of the new safety setup. Dr Venkat Raj also gave away the prizes to the winners of the safety slogan contests held on National Safety Day. Mr S. Narayan, Head, Industrial Hygiene and Safety Section, proposed a vote of thanks.

BARC SIGNS MoU WITH SNDT WOMEN'S UNIVERSITY

Shreemati Nathibai Damodar Thackersey (SNDT) Women's University, Mumbai, has signed a Memorandum of Understanding (MoU) with BARC for collaboration to promote Post Graduate and Ph.D. Programmes in Computer Science and Technology (CST), Electronics & Telecommunications (ECT) and Information Technology (IT) at SNDT Women's University, Mumbai.

Dr Anil Kakodkar, Chairman, Atomic Energy Commission, signing the Memorandum of Understanding (MoU) with SNDT Women's University, Mumbai. Others seen in the picture (from right to left) are : Mr A.M. Patankar, TT&CD, Dr (Ms) M. Vargis, Vice Chancellor, SNDT Women's University, Dr S. Krishnamoorthy, Principal, ITW, SNDT Women's University and Dr A.G. Bhalwarkar, Registrar, SNDT Women's University.

Under the collaboration with SNDT, BARC will provide technical guidance and co-operation for Post Graduate & Ph.D. programmes by offering them experts to deliver lectures in specialised areas. BARC will also provide expertise for development of Laboratories, Research Projects, Application Development Centre and Centres of Excellence in frontier areas of technology listed in the MoU. BARC will provide support in curriculum and courseware development. In the past also, SNDT had been seeking guidance from BARC in technical education.

SHORT TERM COURSE ON 'ADVANCED COMPUTER AIDED DESIGN AND DRAFTING'

Central Workshops, BARC, organised a short term course from November 20, 2000 to December 01, 2000 on "Advanced Computer Aided Design & Drafting (Advanced CADD)" for the benefit of engineers of the Centre. Only 45 from among the 120 officers nominated by various Divisions of BARC could be included for participation in the course.

The course was inaugurated by Mr Umesh Chandra, Associate Director, Automation & Manufacturing Group (A&MG), BARC. Mr A. Manjunatha, Head, Central Workshops, while welcoming the participants, advised them to take full advantage of the programme and emphasised the need for a positive attitude, apart from knowledge and skill, and a willingness to share the knowledge among the colleagues for the growth of the organisation.

The course covered advanced topics on CADD, such as 3D rendering, Feature based design, Parametric design using Auto-desk products viz.

Auto CAD, Mechanical Desk Top (MDT), Ideas software, etc. Demos were also held on other CADD softwares such as MDT-4, 3D Max, Inventor and Solid Works presented by M/s Hindustan Office Products Limited (HOPE) and M/s Addonix Technologies, Mumbai.

Advanced CADD course held at Central Workshops, BARC.

The inhouse expertise of four faculty members - Mr Sandip Guha and Mr M. Ilango of Central Workshops, Mr S.S. Bhattacharya of Spectroscopy Division, and Mr Vivek Mahadevan of Division of Remote Handling & Robotics - were utilised.

While giving away certificates to the participants, Mr G. Govindarajan, Director, A&M and E&I Groups, BARC, in his concluding remarks, urged the participants to utilize their knowledge for the benefit of the organisation.

This Course will be repeated in due course of time to include the remaining nominated officers.

SYMPOSIUM ON 'ELECTRON BEAM TECHNOLOGY AND APPLICATIONS'

A symposium on 'Electron Beam Technology and Applications', sponsored by Board of Research in Nuclear Sciences (BRNS), was held during November 22 to 24, 2000 at the Multipurpose Hall, Training School Hostel, Anushaktinagar.

The topics covered were thermal and non-thermal processing by Electron Beam. The thermal processing included welding, melting and evaporation, while non-thermal processing included end uses for plastics modifications, cross linking of cables, and medical therapy.

Dr Anil Kakodkar, Director, BARC, releasing the proceedings during the inaugural function of the symposium.

Dr Anil Kakodkar, Director, BARC, inaugurated the symposium. About 260 delegates from DAE, National Laboratories like DRDL, HAL and GTRE, ISRO, industries and universities attended the symposium.

A special session was devoted to the Operation and Maintenance experience of various user laboratories. The delegates actively participated in the discussions during the deliberations.

A total of seven invited and twenty-nine contributed papers were presented in the symposium. The high quality of the papers was greatly appreciated by the participants. These papers have been included in the proceedings, which was brought out and distributed to the participants in advance. There was a general consensus that this type of symposium should be repeated at regular intervals.

EXPERIMENTAL FACILITY FOR STUDY OF NATURAL CIRCULATION FLOW DISTRIBUTION

BARC has initiated many R&D activities focussed on the design of the proposed Advanced Heavy Water Reactor (AHWR). An innovative design feature of AHWR is core cooling by natural circulation of water. The Primary Heat Transport (PHT) system of AHWR is designed to remove core heat at all power levels, including reactor start up and shut down, by thermo-siphoning. In this context, the importance of understanding and visualising behaviour of such a system consisting of several coolant channels connected in parallel cannot be overemphasised since the core integrity and safety squarely rests on effective cooling under various reactor operating conditions.

Experimental facility to study flow distribution in a natural circulation driven system

With this in view, the Reactor Engineering Division has recently constructed and commissioned an experimental facility to study flow distribution in a natural circulation driven system like the PHT system of AHWR. This experimental facility consists of ten parallel flow channels, each with its own controlled heat source. Being largely transparent, this set-up facilitates visualization of the phenomena like thermal hydraulic instability, flow pattern transition, flow reversal, etc. associated with two phase flow in water at atmospheric pressure and 100°C temperature. This set-up is primarily designed to study sensitivity, to different process parameters, of flow sharing among parallel coolant channels. However, modular construction makes this facility readily amenable to modifications. This characteristic makes it a versatile tool for studies in other areas like reactor start up procedure, flow transients during on-power fuel handling, effects of changes in system configuration and performance of stability control devices. The experimental set up has been provided with appropriate instrumentation and data processor with mimic based online display and data logging.

DAE RUSHES RELIEF TO BHACHHAU FOR EARTHQUAKE VICTIMS

A team of staff members from the Department of Atomic Energy, led by Dr Prakash Joshi, BARC, rushed to Bhachhau taluk near Bhuj in Gujarat state on January 30, 2001, to participate in the on-going earthquake relief operations. The team consisted of experienced mountaineers and trekkers of Nature & Adventure Circle of BARC Staff Club. The team carried tents, ration and medical kit along with 100 blankets for donating to the victims of the earthquake. The team members included Dr Prakash Joshi, Mr Abhijeet Burman, Mr Ravi Wadaskar, Mr Vivek Ganpule, Mr Subhash

Gawarikar, Mr Amar Bhagat, Mr Vilas Raje, Mr A.G. Tole, Mr Shailesh Katwankar, Mr Prashant Patil, Mr P.Y. Bhosale, Mr Prashant Worlikar, Mr S.G. Angarak and Mr S.V. Nandurkar, in addition to Civil Defence personnel.

Members of the DAE team that went to Bhachhau taluk in Gujarat for relief operations

The team worked jointly with the Civil Defence Unit of Maharashtra stationed at Bhachhau earthquake relief camp. The team did relief and rescue operations in Vondh, Adhoi, Nanicharai, Chaubari, Krishnanagar and Moticharai villages for about a week. Houses in most of these villages had collapsed and what was left was huge heaps of debris. Around 100 dead bodies, mostly of animals, buried under the debris were recovered and burnt. During the course of the operation, a bull, a buffalo and two goats were rescued from the debris. A couple of LPG cylinders with gas were recovered from the debris and removed to a safe place. The team also helped the villagers in taking out their personal belongings, and making a path for the earthmovers by removing the huge objects like cars, trees and boulders.

A few solar lamps were brought by the Power Ministry of Gujarat State for distribution in the villages. Operation of these lamps was demonstrated to the villagers by the BARC team. In many places, it was not possible to work due to huge debris. In the village Chaubari, the team cleared the roads and recovered 52 dead bodies on a single day. The relief team returned to Mumbai after completion of the job in the six allotted villages.

BARC SCIENTIST HONOURED

Dr Narendra Mohan Gupta, Head, Applied Chemistry Division, BARC, has been selected for the award of first prize of Rs. 10,000/- of Hari Om Asram Prerit Shri S.S. Bhatnagar Research Award 1998 on CATALYSIS. This award to Dr N.M. Gupta is in recognition of his contributions during the period of 1993-1997 in the field of Heterogeneous Catalysis, both the Applied and Fundamental aspects. Development works undertaken by Dr Gupta and his team during this period pertain to (i) Catalysts for mitigation of H_2 in Nuclear Power Reactors under severe accident conditions, (ii) Long-life sealed-off CO_2 methanation catalyst, and (iii) Development and characterization of a low-temperature CO_2 methanation catalyst for application in life-support system for long-haul manned space stations. Contributions of Dr Gupta to fundamental research in catalysis and surface science include: (i) Encapsulation and anchoring of small molecules in zeolitic cages, (ii) Transient species involved in catalytic reactions, (iii) Catalytic hydrogenation and dehydrogenation reactions using inter-metallic compounds, (iv) Catalytic poisoning, (v) Role of morphology in supported metal catalysts, and (vi) Catalytic properties of perovskites and mixed metal oxides.

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