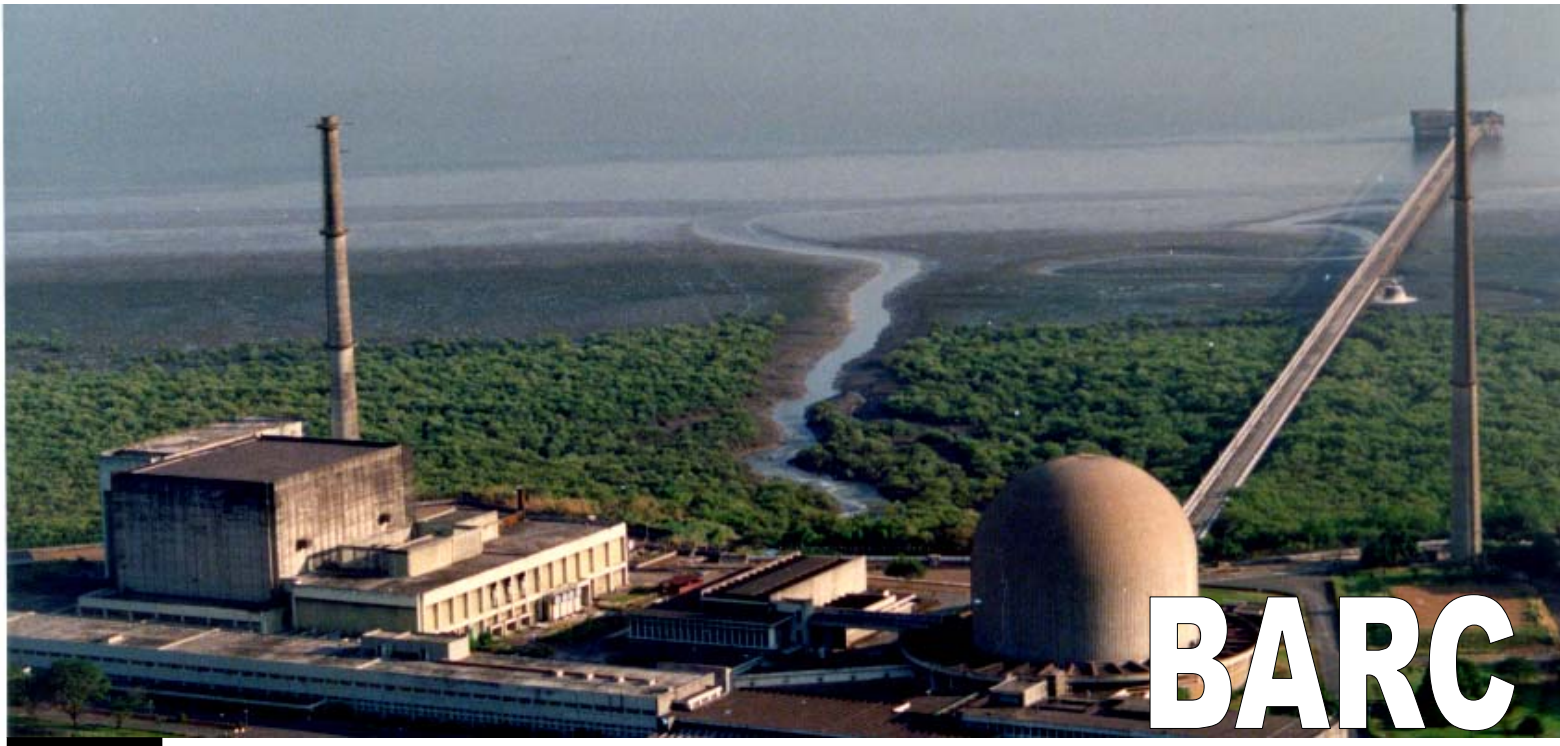

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TECHNOLOGY OF HIGH CURRENT ION BEAM SOURCES : A BARC SCENARIO

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Impact of Ion Beams

Like electrons, ion beams are also playing crucial roles in our lives. These beams with energies ranging from a few hundred keV to a few TeV and currents ranging from a few pico-ampere to a few hundred milli-ampere, are being employed in almost all the areas. Ion beam accelerators like TEVATRON, HERA, SIN, SIS, RHIC, etc., have contributed vastly towards the advancement of our knowledge. Apart from the valuable contributions made towards the basic sciences, ion beams have percolated into the applied fields as well. The industrial, medical, metallurgy and power sectors as well as strategic areas, like defence, are the fields that have been immensely benefited by these beams.

Semiconductor industry is among the first ones which has used ion beams extensively. In this case, low energy, high current, heavy ion beams of boron, phosphorous, etc., are implanted in Si, As and Ga to change their physical and electrical properties. The devices thus produced have totally transformed the vacuum tube based electronics industry into a solid state one. This, in turn, has brought in the much needed ruggedness and reliability in this industry. Focused Ion Beams (FIB) are used for tailoring the ICs & Memories. Ion cluster deposition, ion milling, buried conductors, deep amorphous layers and ROM program are some of the other areas where ion beams have made a big mark. Now, MeV beams are

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even being used for ion implantation. Bombardment of a few MeV proton beam on Si, produces GTO Thyristors having much more improved characteristics [1].

Xenon beams with energy as high as 10 MeV / nucleon are being used for making micro porous membranes [1]. These membranes have wide applications in the filter industry.

Medical field is another area where ion beams have made a big impact. Accelerated ions are used for producing radio-isotopes like C^{11}, N^{13}, O^{15}, F^{18}, Ga^{67}, In^{111}, I^{123}, Co^{55}, etc. These isotopes are employed for investigating the functioning of human organs like lungs, heart, brain, throat, bones etc. Ion beams are also being used for the treatment of cancers and tumours. For this purpose, proton beams of about 200 MeV and heavy ion beams of 500 MeV/ nucleon are being commonly employed [2].

Ion beams are also used for producing secondary beams like neutrons and γ rays. Neutrons, in addition to being used for radiography, are also being employed for therapy [2] and detection of explosives [1], buried in mines.

Accelerator Driven Subcritical Systems (ADS) are being conceived worldwide as viable sources for producing electrical power, breeding of fuel and transmutation of nuclear waste. These systems [3-6] need proton or deuteron beams of about one GeV with beam current of 50 mA to 100 mA. For ADS to be a commercially viable venture, the accelerator efficiency should be close to 50 %. If achieved, not only a clean source of power, but also a good breeder of fissile material will become available.

Accelerator based Heavy Ion Inertial Fusion is another mechanism through which the production of power is being contemplated [7]. For this process, heavy ion beams of Bismuth / Lead, with energy as large as 10 GeV and current as high as 25 kA, are being conceived.

The sphere of utilization of ion beams is expanding at a fast pace with more and more avenues opening up daily.

Ion Beam Technology

Since 1930, along with the inception and growth of accelerators, Ion Beam Technology has also gone through a drastic change and transformation. In the beginning, ion sources of protons & deuterons were developed. The demand for higher energy and higher beam current, pushed the development to new and different types of ion sources. The arrival of heavy ion beams with multiple charge states boosted the energy of the accelerators. The entry of Tandems ushered in a new era of negative ion beam technology. As per the present scenario, ion sources for light and heavy ions with positive, negative and multiple charge have been developed with currents varying anywhere from a few pico - ampere to a few 100 mA. Duoplasmatron, PIG, Duopigatron, Cusp field, EBIS (Electron Beam Ion Source) and ECR (Electron Cyclotron Resonance), SNICS, are some of the ion sources which have been developed to meet the diverse needs.

In India too, extensive efforts are being put to establish this technology. Among all the organisations, DAE has taken a major lead. Different types of ion sources are being developed at BARC-Mumbai, TIFR-Mumbai, VECC-Kolkata and CAT-Indore. NSC-Delhi (under UGC) has also initiated steps in this direction.

BARC Scenario

At BARC, the first attempt towards this direction was made by designing and developing a high current duoplasmatron ion source followed by a compact, microwave cathode plasma source. The experience, thus gained, is being utilised to develop an ECR source which will deliver 50 mA of proton beams at a voltage of 50 kV. The present article is a brief account of the efforts being made by BARC in establishing the high current ion beam technology.

Building a base

Realising its importance, Accelerator & Pulse Power Division, BARC initiated an elaborate programme in this direction about a decade back. Development of high current Duoplasmatron Ion Source was the first step.

Duoplasmatron Ion Source: The source was designed to deliver proton/deuteron beams with a current of 20 mA [8, 9] at an energy of 20 keV. Figures 1 & 2 give the glimpses of this source.

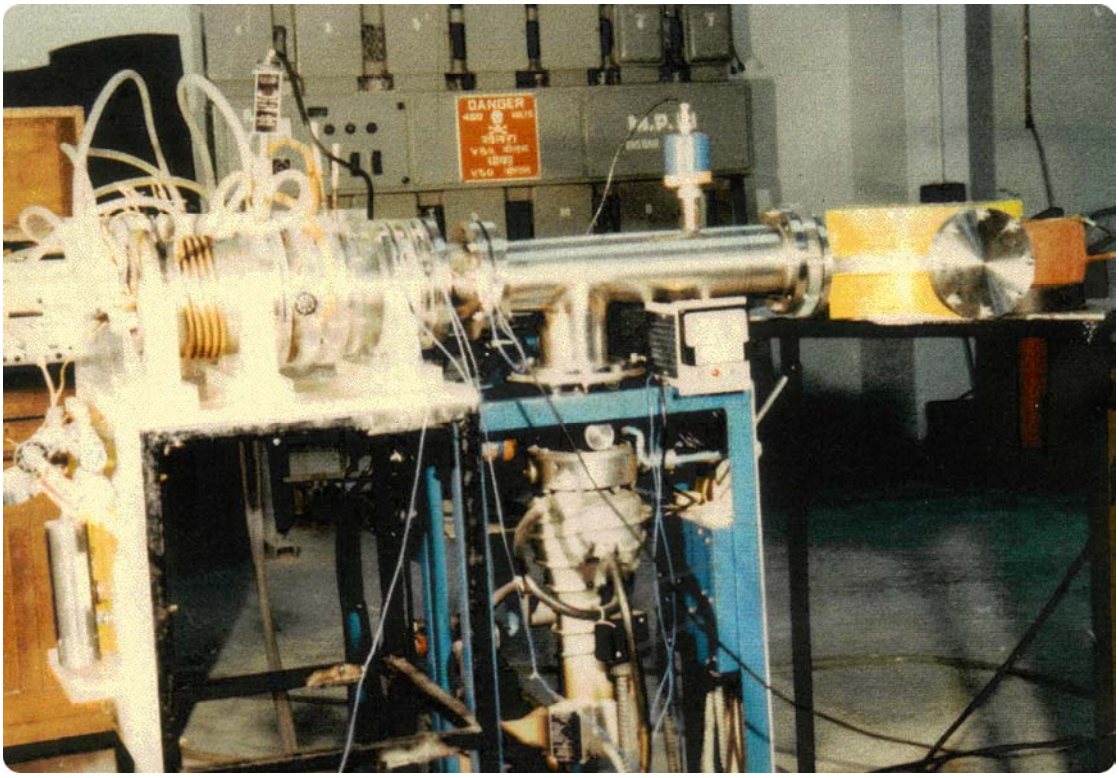

Fig. 1 A close up view of the Duoplasmatron Ion Source

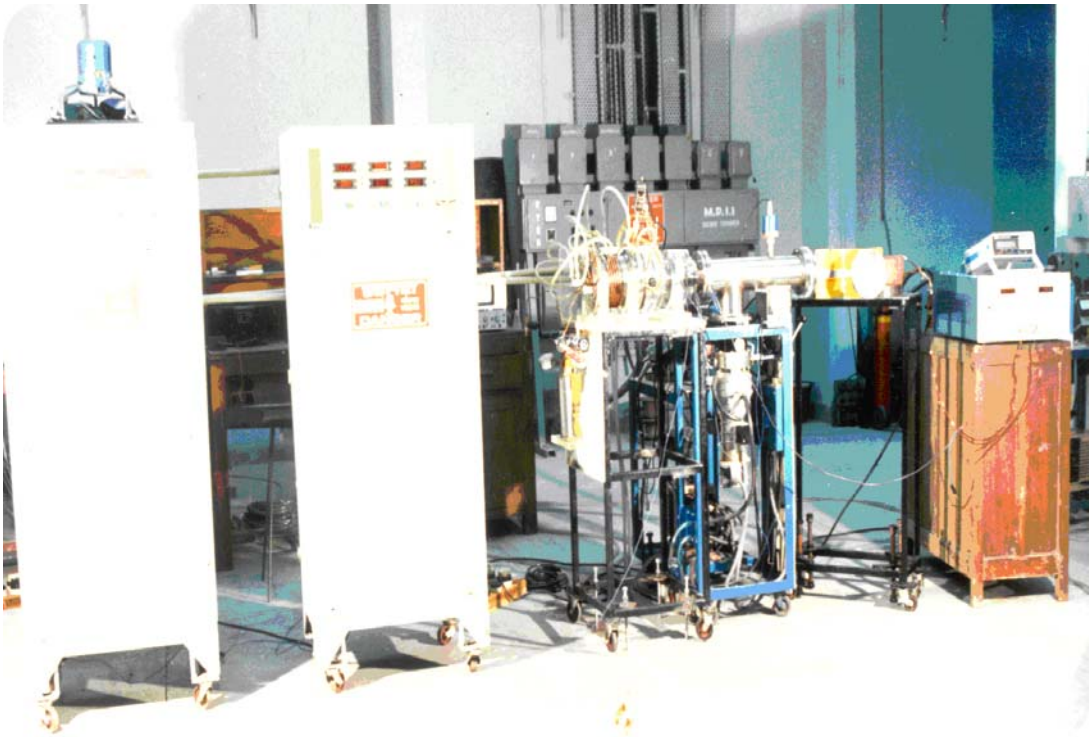

Fig. 2 Characterisation of the Duoplasmatron Ion Source

The source was used as an injector to the Low Power RFQ (LPRFQ) [10]. It is a filament based source consisting of two plasma chambers. For damping the oscillations, the beam was allowed to expand and cool in an expansion cup. The beam properties and the transmission was controlled through a set of five electrodes. To focus the beam downstream, a pair of einzel lens was employed. The emittance characterisation was done by using a slit and wire detector. This source was tested up to a voltage of 15 kV and yielded about 12 mA of proton beam at an arc current of 2.5 A and magnetic field of 1.7 kG. The beam was found to be highly space charge limited. This is the only indigenously developed ion source in the country which can yield proton beams as high as 12 mA.

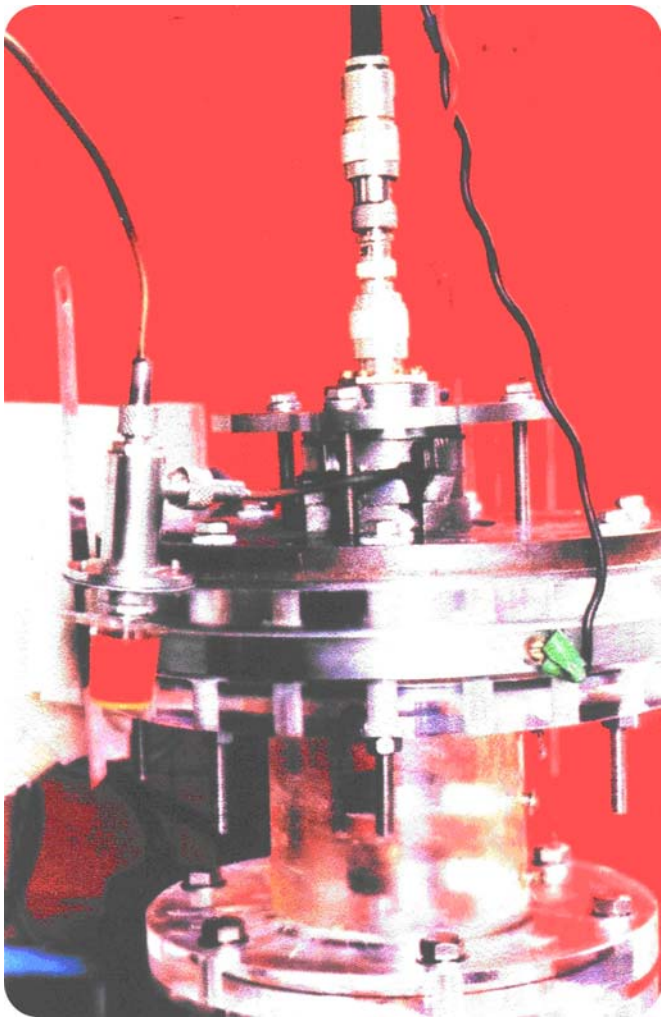

Fig. 3 A view of the MCPIS

Microwave Cathode Plasma Ion Source (MCPIS): The filament based sources have short life. Duoplasmatron ion sources fall in this category. For a long operation time of a few days, weeks or even months, one has to look for filamentless ion sources. The first indigenous attempt in this direction was made by developing a compact permanent magnet based, microwave cathode plasma ion source [11]. A close up view of this source is shown in Figure 3. Figure 4 shows the characterisation set up for the same. A 2.45 GHz, 100 Watts, microwave generator in conjunction with Sm-Co permanent magnets was used for initiating the plasma. At a meagre 4 kV extraction voltage, the deuteron current of

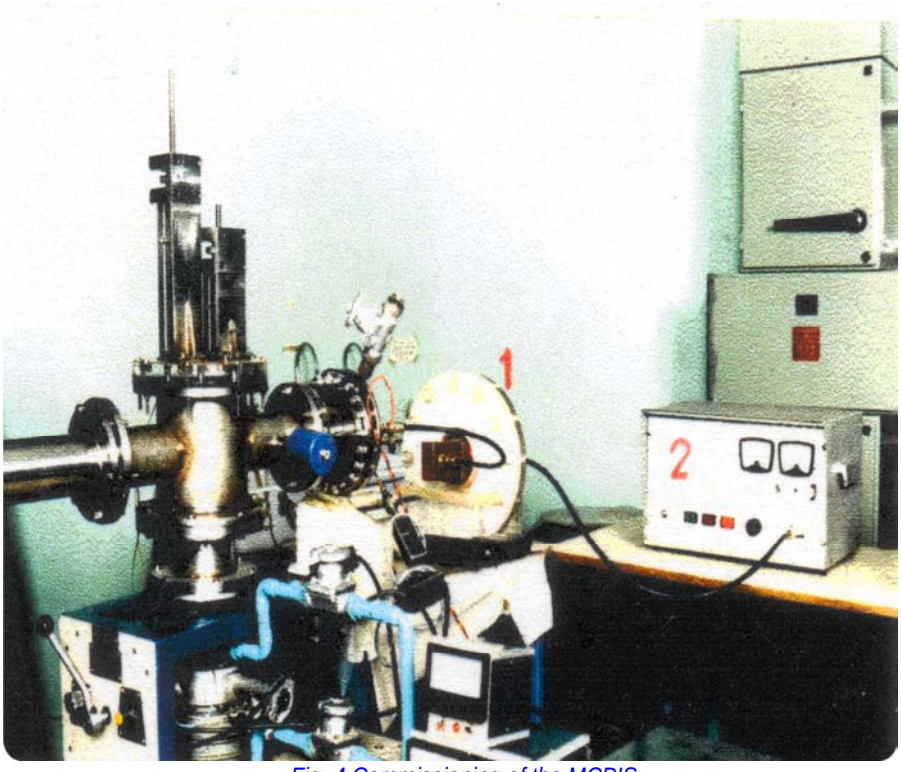

Fig. 4 Commissioning of the MCPIS

about 0.6 mA was obtained. For this, a microwave power of 60 Watts was consumed. The proton and helium beams of about 0.5 mA, and 0.2 mA respectively, were also obtained.

The experience thus gained in commissioning these two sources was extremely useful. It gave us the confidence to take up the task of designing and developing a 50 kV, 50 mA, DC, ECR proton ion source. Again, this will be the only indigenously developed source in the country, capable of delivering as high as 50 mA of proton beams.

Design & development of a 50 mA proton ECR source

The detailed design features of this source are described in references [12] & [13]. The major design parameters are given in Table I & its schematic is shown in Figure 5. The source consists of : 1) Microwave generator, 2) Microwave transmission components, 3) Plasma chamber, 4) Solenoids, 5) Ion extraction assembly, 6) Vacuum systems, 7) Gas injection assembly, 8) Beam diagnostics, 9) Einzel lenses, and 10) Power supplies. The plasma is initiated by a microwave discharge in the presence of a magnetic field created through a pair of solenoids. The microwave power is generated by a 2.45 GHz, 2 kW, cw Magnetron and is fed to the source via a plumbing line. To prevent the electrodes from getting overheated, the portion of the aperture close to the beam is made from molybdenum. A 30 cm long HV column, having three successive insulating rings of Alumina, brazed at the ends with the metallic flanges, are used to hold the high voltages.

Table 1 : Design parameters of the ECR source

Beam Energy (keV)	50
Proton Current (mA)	50
Discharge Power (W)	600 - 1000
Frequency (GHz)	2.45
Axial Magnetic Field (G)	875 - 1000
Duty Factor (%)	100 (dc)
Proton Fraction (%)	> 80 %
Beam Emittance (π mm-mrad)	< 0.2 (rms, normalized)

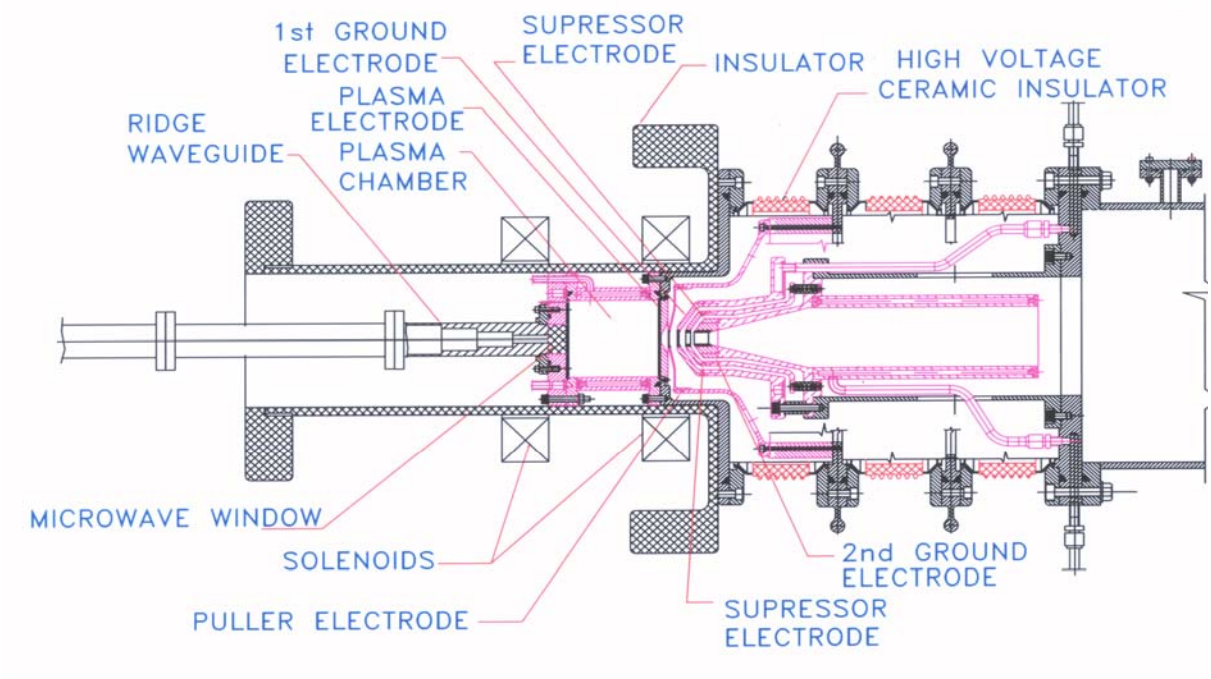

Fig. 5 Schematic of the 50 keV, 50 mA ECR Proton Ion Source

The design of the electrodes has been optimised with the help of a multi-particle code "PBGUNS" [14]. In order to generate low emittance proton beam, five-electrode extractor geometry, as used in the duoplasmatron source, has been adopted. The puller electrode is found to be highly effective in controlling the transmission of the downstream beam as is evident from Figure 6. The beam trajectory for 50 mA current simulated through PBGUN is depicted in Figure 7.

The ion source rms normalised emittance has been theoretically estimated to be ~ 0.1 π mm-mrad. This corresponds to an ion temperature of kT_i = 1.5 eV. Lower the plasma ion temperature, lower is the emittance and better the beam quality. Variation of ion source emittance with plasma ion temperature is shown in Figure 8. This value becomes minimum at a puller voltage of 40 kV as is depicted in Figure 9.

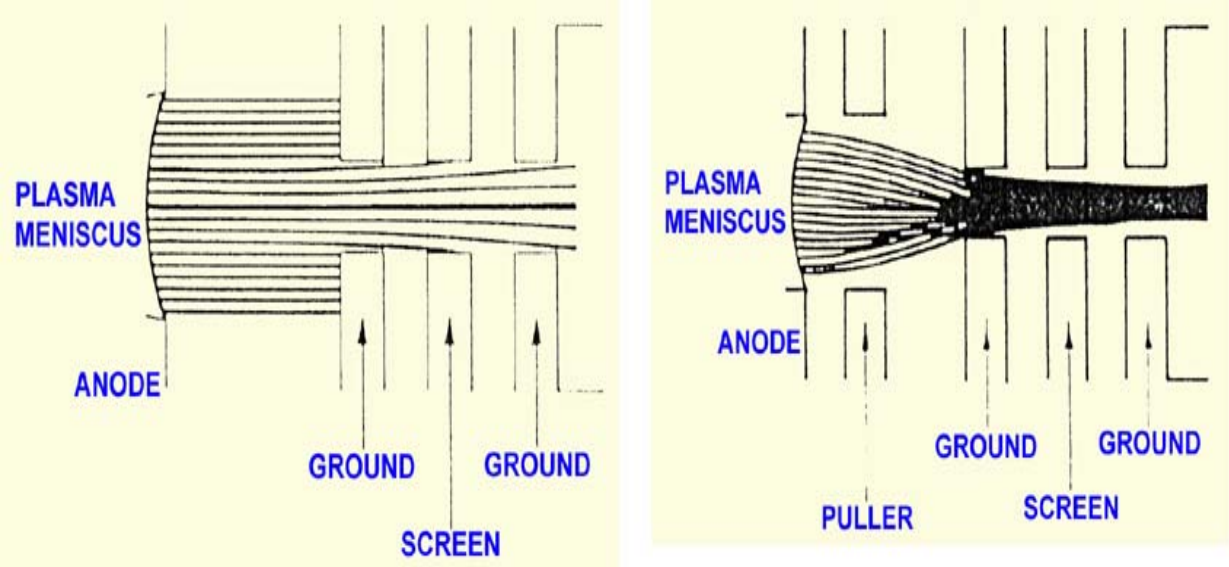

Fig. 6 Transmission of the beam through the Pentode Extraction Geometry

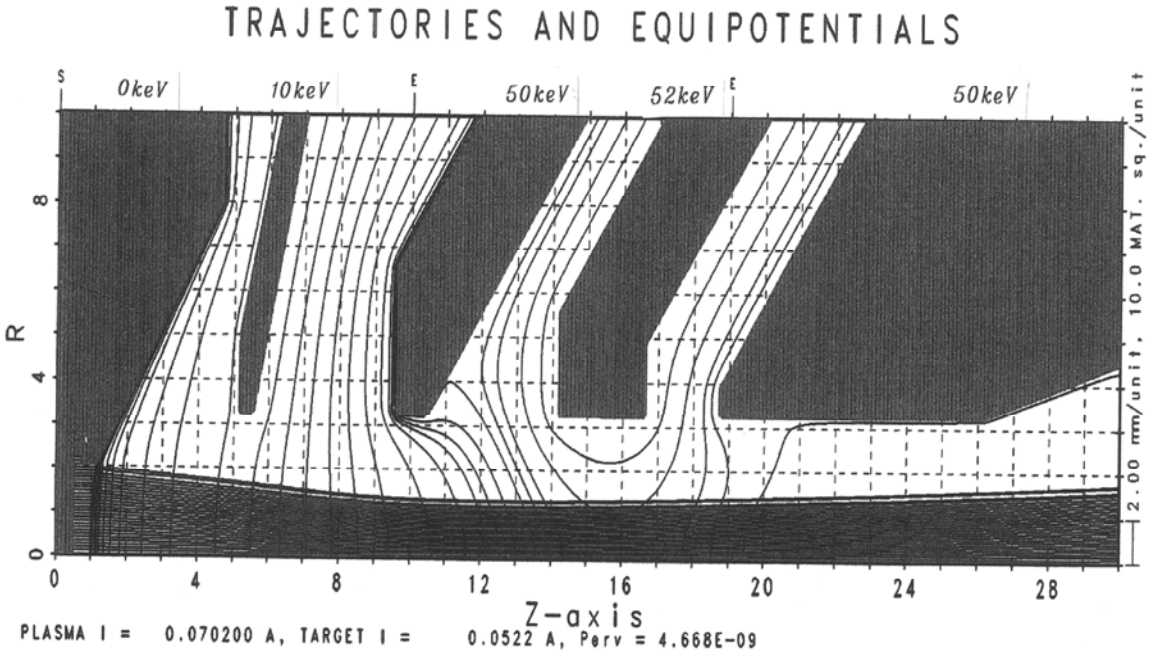

Fig. 7 Simulation of 50 keV, 50 mA beam through the Extractor Geometry

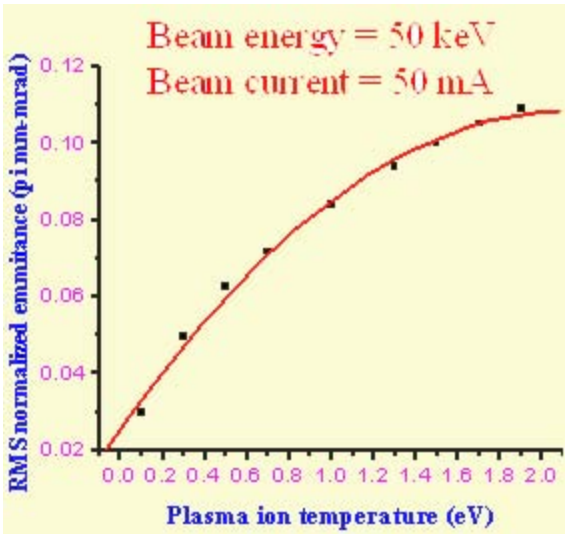

Fig. 8 Ion Source Emittance vs Plasma Ion Temperature

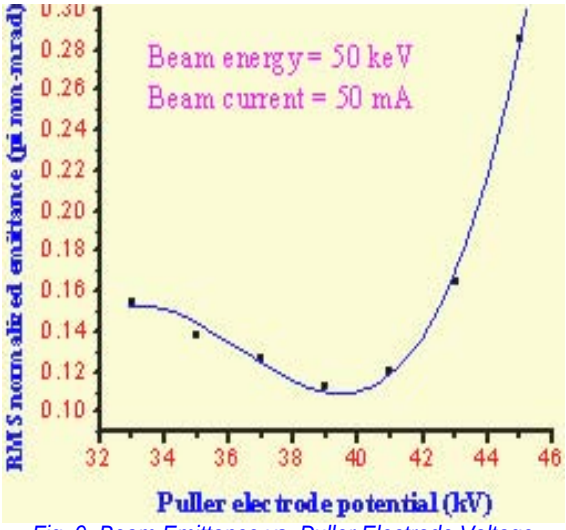

Fig. 9 Beam Emittance vs Puller Electrode Voltage

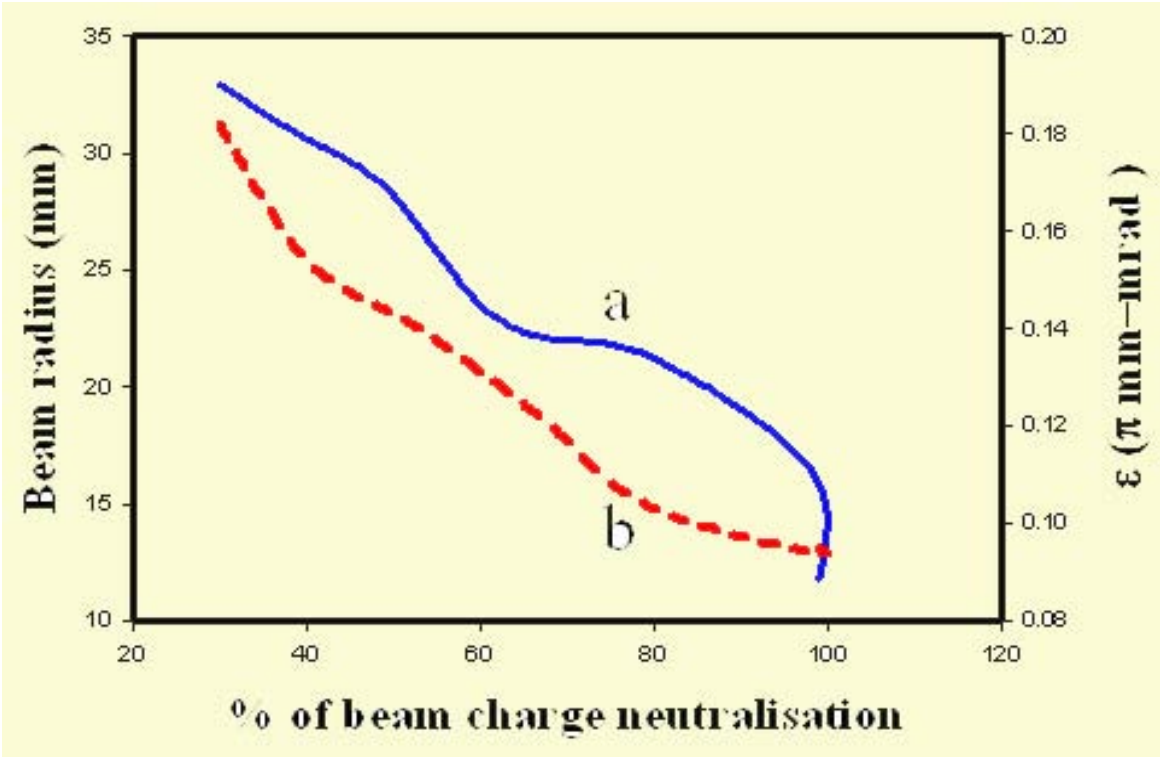

Fig. 10 Beam radius and beam emittance as a function of beam charge neutralisation

The beam charge neutralisation is an important aspect of space charge dominated beams. It can reduce the emittance and hence improve beam quality considerably. This feat can be accomplished by providing extra electrons through the deterioration of vacuum in the beam line of the source. The beam characteristics at a distance of 40 cm downstream is shown in Figure 10. The reduction in the beam radius and normalised emittance, ε, with increase in neutralisation, clearly indicates that the beam is highly space charge dominated. With more and more neutralisation, both the beam radius and the emittance values can be brought down to a minimum. In our case, this minima is attained when the beam is more or less fully neutralised which happens at a level of about 98%.

The 2.45 GHz Microwave generator used for this purpose is magnetron based. It can deliver cw power up to 2.0 kW. The power can be continuously varied from 300 Watts to 2.0 kW. An RF plumbing line consisting of a circulator, dual directional coupler and a four-stub auto-

tuner is used to feed the source. The circulator is used to protect the magnetron from the reflected power, the directional coupler to measure the power and the auto tuner for matching the impedance to that of the load. The generator has been tested up to a power level of 1.8 kW. In Figure 11 is shown the complete set up of this microwave generator. Its performance characteristic is shown in Figure 12. The operation of the microwave generator is controlled through a micro-controller [15]. The system shown in Figure 13 is presently going through a phase of debugging.

Fig. 11: Microwave Generator and the Plumbing Line

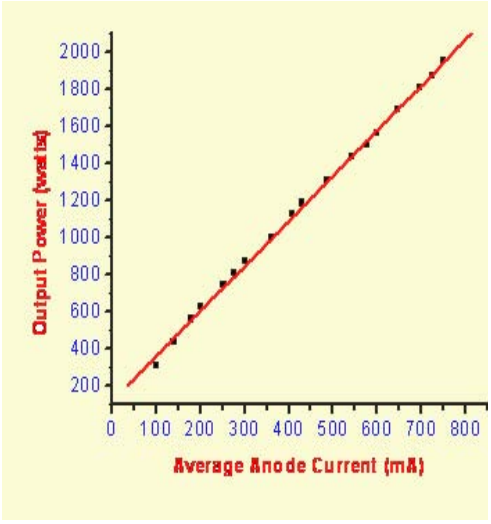

Fig. 12 : Performance of the Magnetron

Fig. 13 : Computer control of Microwave Power Generator

Table 2 : Design parameters of solenoid magnets

ID of the solenoid	20 cm
OD of the solenoid	36 cm
Length of the solenoid	5 cm
Field on axis	1 kG
Copper conductor (hollow)	10mm x 10 mm
Voltage drop	4.83 volts
Total power dissipation	3.3 kW
Water flow per circuit	5 litres / min

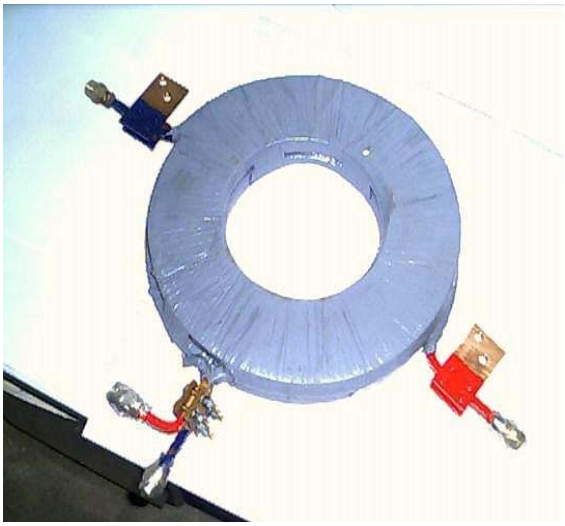

Fig. 14: Double Pancake Solenoid

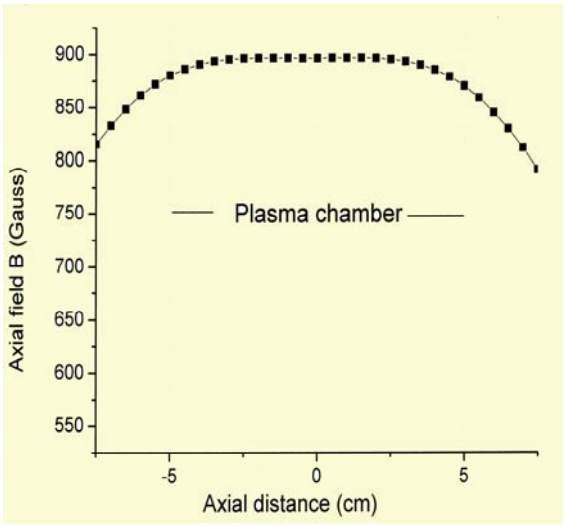

Fig. 15: Magnetic field profile for the ECR discharge

Fig. 16 : A view of the Plasma Chamber

The axial magnetic field of 875 G, needed for generating the ECR discharge, is provided by water cooled solenoids. The discharge will be generated at two places. One will be near the microwave window and the other close to the extraction hole.

The design parameters of the solenoid are shown in Table II. These solenoids have been fabricated from a hollow square copper conductor and are in the form of a double pancake. Both the solenoids are independently powered. A view of one of the solenoid is shown in Figure 14. The profile of the magnetic field is given in Figure 15.

The plasma chamber for the source has a quartz window on the front side. A 1600 litre/sec turbo pump will be used to evacuate the source. The flow of hydrogen gas will be monitored through a mass flow controller. The plasma chamber has been made and tested up to a vacuum of 10^{-6} Torr. A view of the chamber is depicted in Figure 16.

The ion beam current will be monitored by a DCCT and a Faraday cup. Video diagnostics will be used for knowing the beam profile, the slit & wire scanner for getting the emittance, the four grid energy analyser for neutralisation and Wien filter for the mass analysis. The source is expected to be operational by 2007.

Conclusions

High current ion beam source technology is foreseen to be playing a crucial role in almost all the sectors. They form the backbone of Accelerator Driven subcritical Systems (ADS), Spallation Neutron Sources, Accelerator based Fusion programmes as well as many other applications, requiring high current ion beams. Internationally, proton beams of about 100 mA have been already realised. Although APPD, BARC, has established a good base in this technology, but it has still a long way to go.

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MACHINE DYNAMICS DIVISION DEVELOPS MSF DESALINATION PLANT SIMULATOR (MSFSIM)

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A majority of large scale desalination plants all over the world employ multi-stage flash (MSF) distillation process. An MSF plants is being set up at Kalpakkam to effectively utilize the low grade steam from the power plants as the source of energy. A steady state mathematical model has been developed to analyze the process fundamentals of MSF process. This is required to have a better functional understanding of various parameters in the process responsible for the product water cost (e.g., performance ratio, heat transfer coefficient, specific flow rate of re-circulated brine). It should be noted that MSF processes are energy intensive and hence it is essential to carry out thermal analysis of the process which leads to reduction of energy consumption and consequently lower water production cost. In the present work, steady state performance analysis has been done for an MSF desalination plant. There are several parameters that affect the performance of the MSF plant. They are divided into two categories i.e. external parameters such as heating steam quality, seawater condition and controlled parameters such as Top Brine Temperature (TBT) and brine re-circulation flow rate. Applying the above model a computer code MSFSIM was developed to predict the operating envelope of an MSF plant by taking into account the constraints due to TBT and blow down salinity and to simulate the Multistage Flash Desalination Plant at Kalpakkam (NDDP). This code can be used for both steady state and transient analysis of the plant. The aim of the work is prediction of plant performance under different operating conditions, optimization of plant output and design of control system. A graphic user interface is developed to enhance the usability of the code MSFSIM. The original code runs in background and interacts with the user through a user-friendly front end. Hence MSFSIM can be handled by even plant operators and also can be used for training purpose. Therefore this is extremely useful software for any MSF desalination plant operation. MSFSIM can be used for both steady state and start up analysis.

Steady State simulation

Multistage flash desalination plant comprises three main modules viz. brine heater, heat recovery and heat reject stages which function as

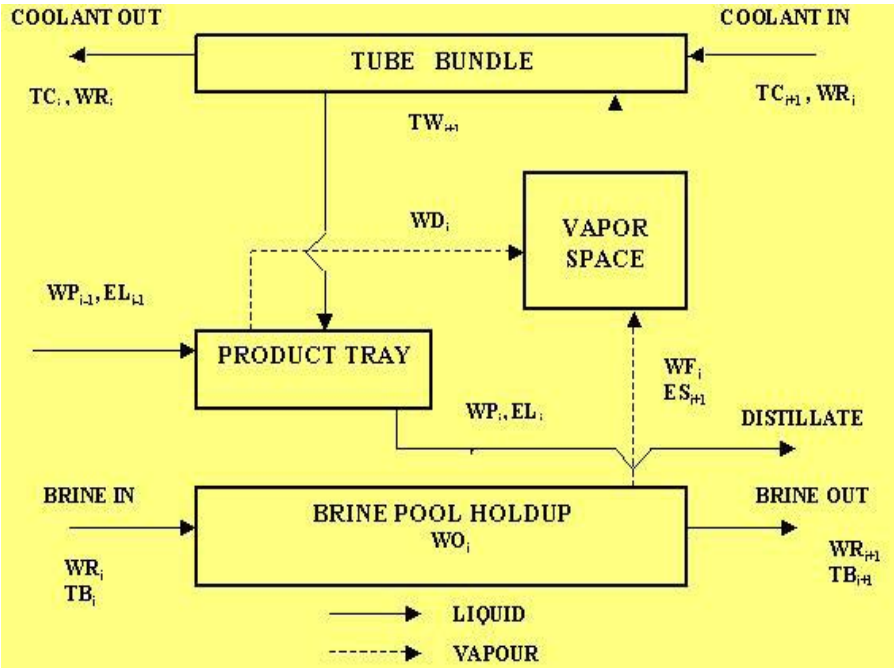

Fig. 1 Schematic of the evaporator

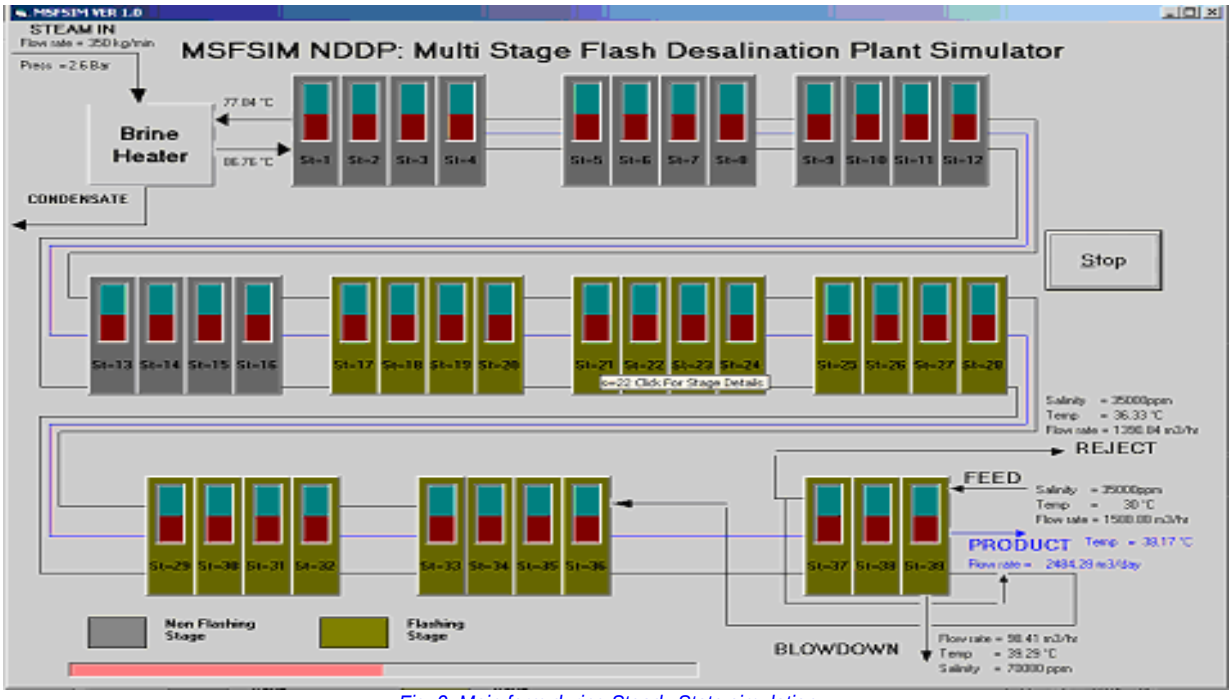

Fig. 2 Main form during Steady State simulation

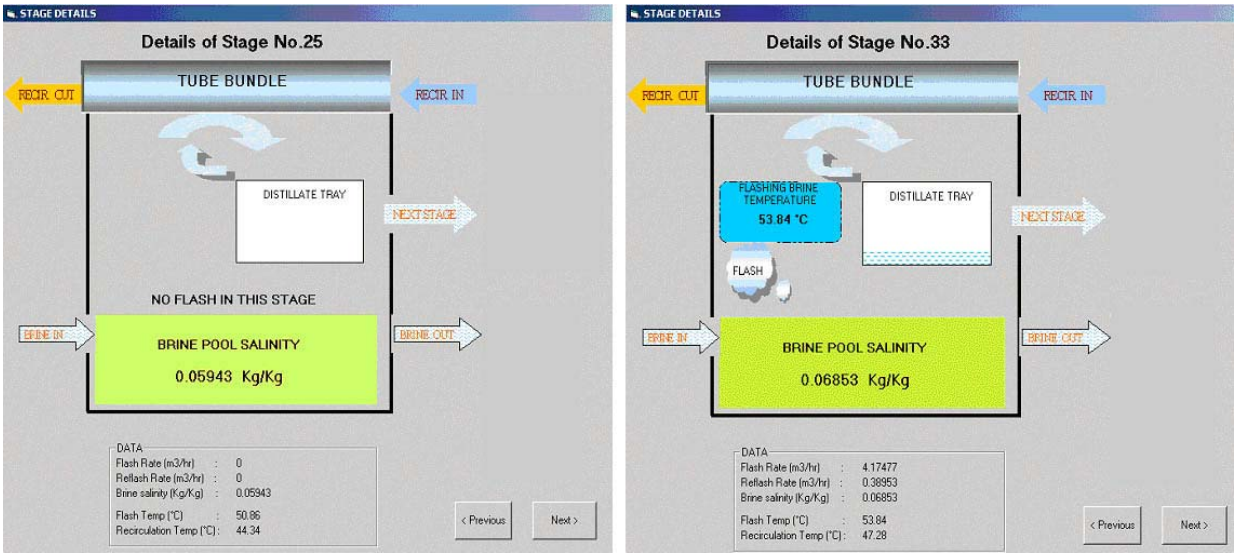

Fig. 3 Details of a Non- flashing stage and a Flashing stage

evaporator. Figure 1 shows a schematic of an evaporator. Main form of the simulator MSFSIM shown in figure 2 shows details (flow rate, pressure, temperature, salinity etc.) of different streams like heating steam, sea water feed, reject, blow down and product, dynamically as the program runs. Also the brine heater inlet and outlet temperature is dynamically displayed on this form. Colour of a stage changes automatically once the brine starts flashing. Figure 3 shows flashing and non-flashing stages. A message showing “No flash in this stage” indicates presently there is no brine flashing in this stage. This can also be seen that the distillate tray is completely empty. The values of brine flashing rate from brine pool, brine re-flashing rate from distillate tray, brine salinity, flashing brine temperature and re-circulating brine temperature are summarized at the bottom of the form. One can also see the details of the previous and next stage by clicking the corresponding button at the right bottom corner of the form.

Once the progress bar at the main form stops, indicating end of the program, the final result form shown in figure 4 becomes visible.

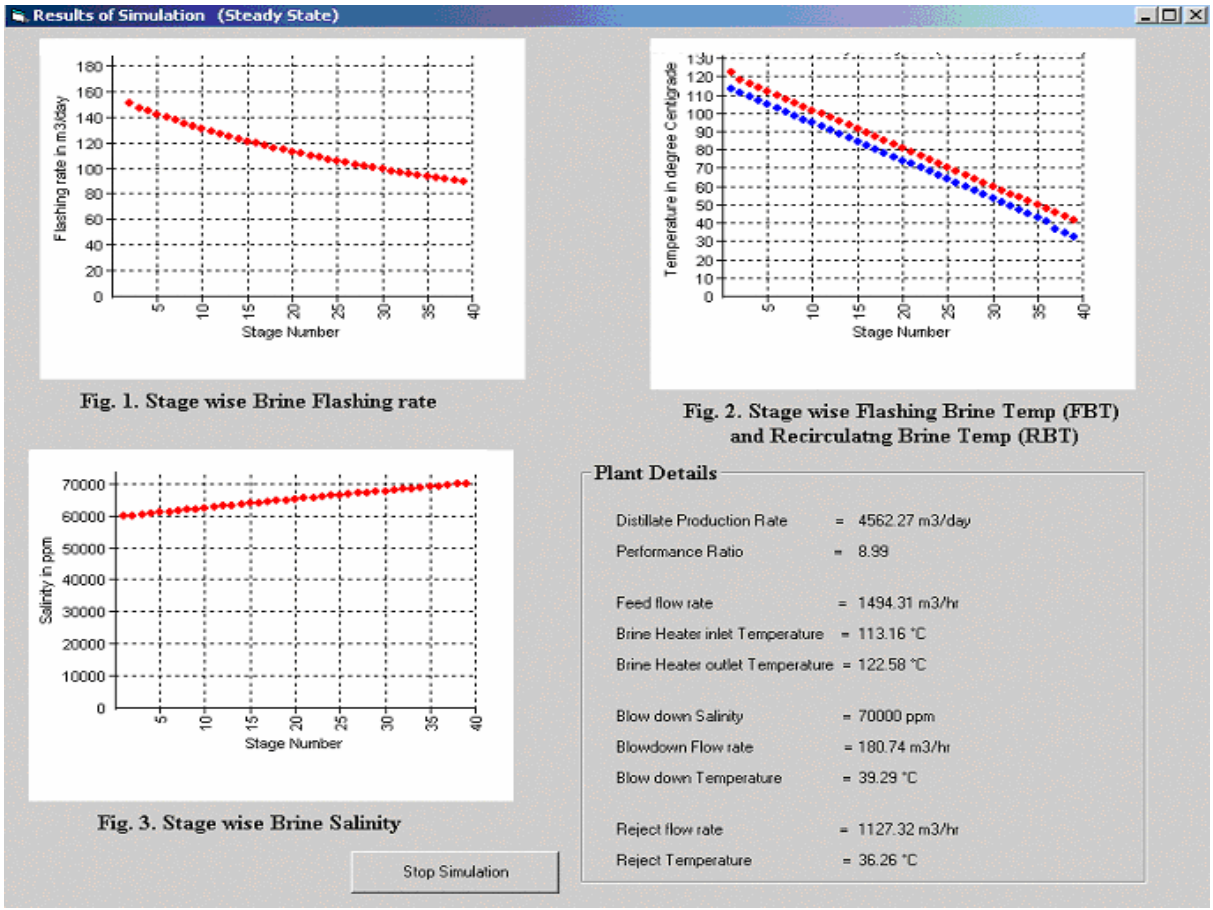

Fig. 4 Final Steady State simulation result form

Start up simulation

Startup simulation requires the brine recirculation pattern with time. Figure 5 shows the input form for startup simulation.

After fixing these inputs the user has to press “start simulation” button to start the transient simulation of the MSF desalination plant. Once the code is activated at the background two result forms are shown on the screen simultaneously for dynamically plotting the data from the code output. These two forms are shown in figure 6 and 7 respectively.

To stop the code the user need to press stop simulation button in the first simulation result form.

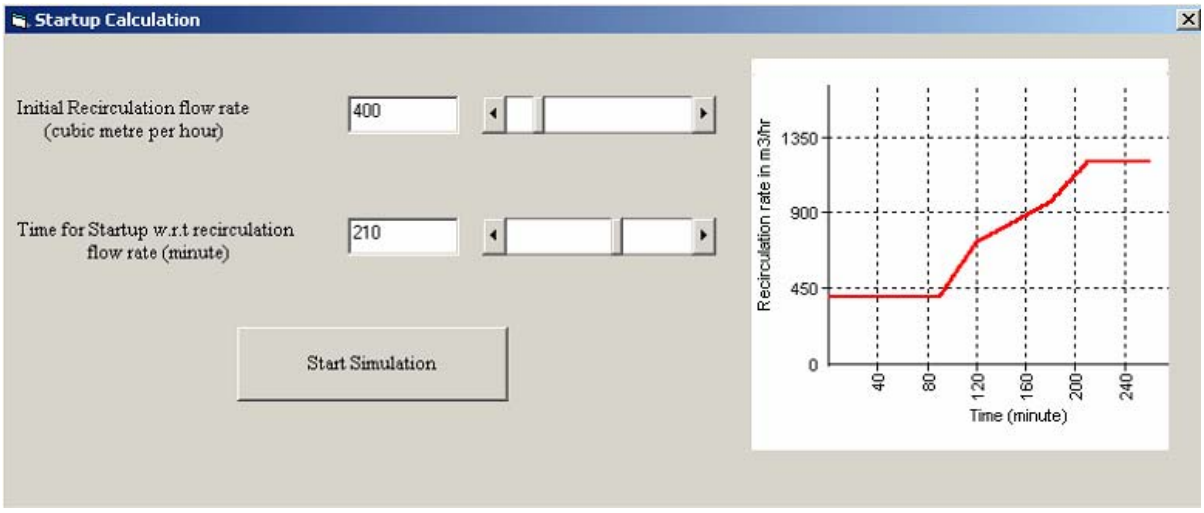

Fig. 5 Form for startup simulation

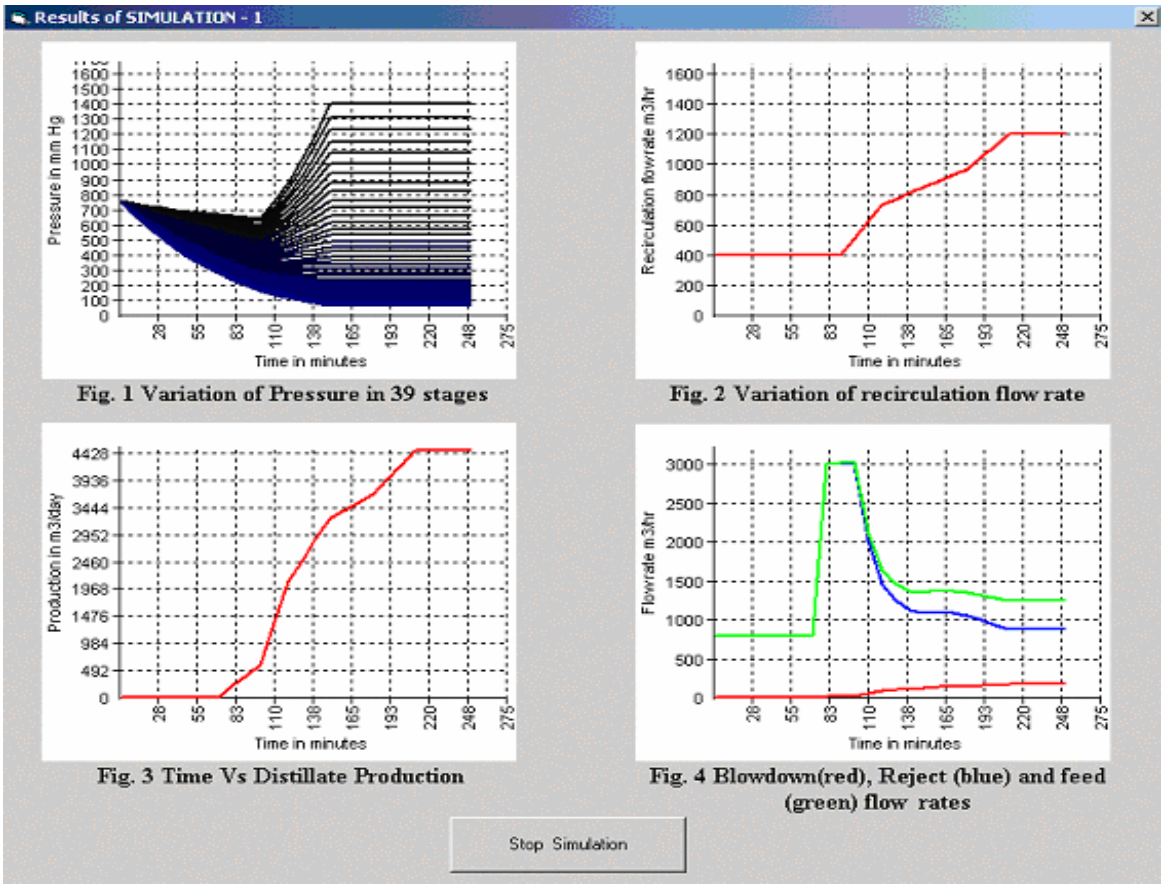

Fig. 1 Variation of Pressure in 39 stages

Fig. 2 Variation of recirculation flow rate

Fig. 3 Time Vs Distillate Production

Fig. 4 Blowdown(red), Reject (blue) and feed (green) flow rates

Fig. 6 First result form of start-up simulation

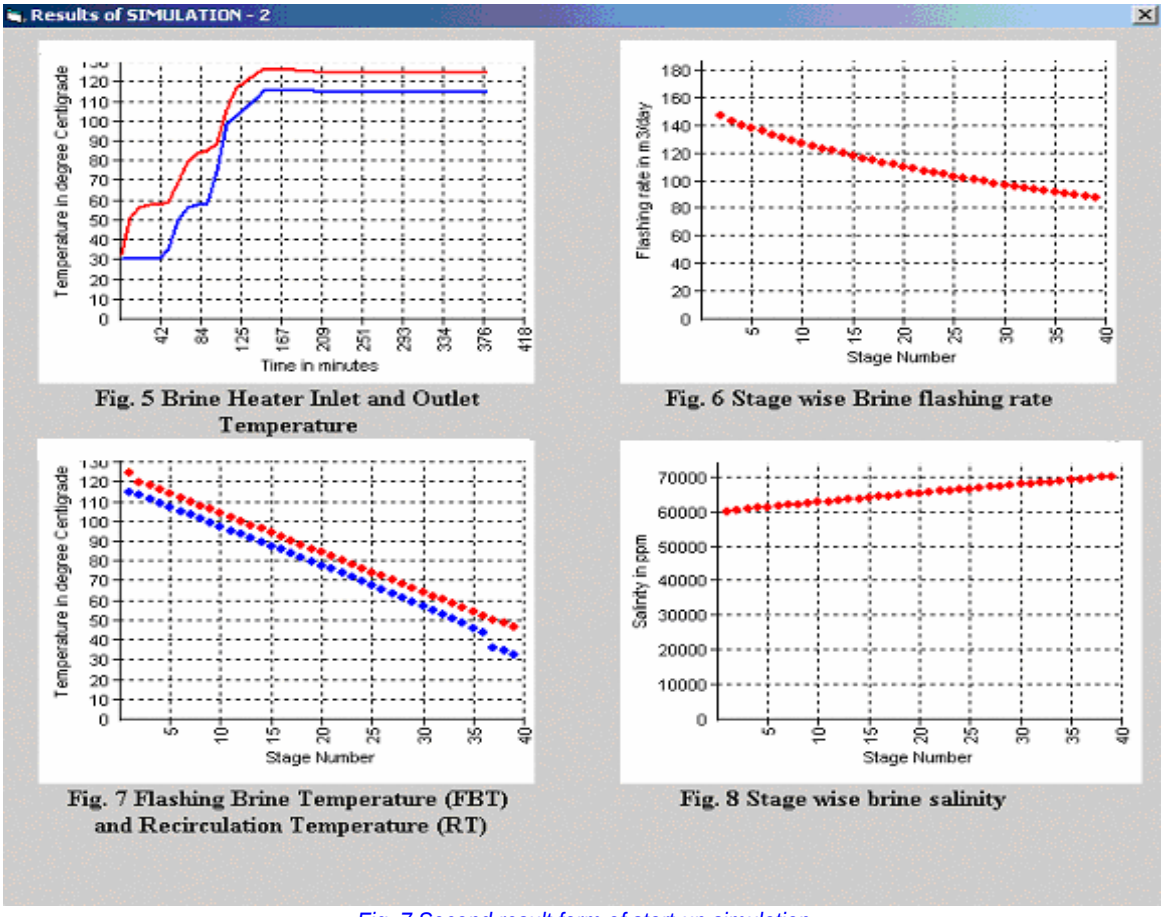

Fig. 5 Brine Heater Inlet and Outlet Temperature

Fig. 6 Stage wise Brine flashing rate

Fig. 7 Flashing Brine Temperature (FBT) and Recirculation Temperature (RT)

Fig. 8 Stage wise brine salinity

Fig. 7 Second result form of start-up simulation

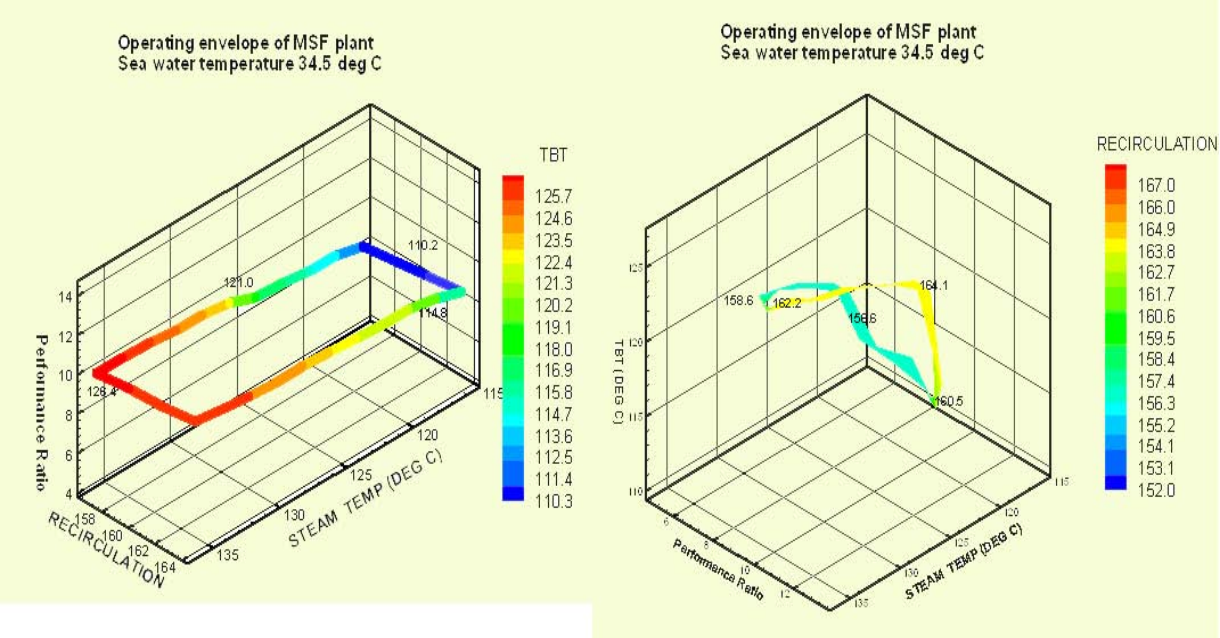

Fig. 8. Operating envelope of the MSF Plant generated by the simulator MSFSIM

Operating Envelope of Pilot MSF Plant

Steady state simulation is normally used to generate operating envelopes to describe the possible operating conditions of the MSF distillation plant. An envelope of possible operating conditions of the 425 m³/day capacity pilot desalination plant at Trombay. is shown in figure 8. It illustrates the operation as performance ratio vs. heating steam temperature and brine re-circulation flow rate. The Top brine temperature (TBT) values becomes governing in order to select the operating condition. The plant envelope lies between the lowermost bound of TBT (such that the stages should flash) and upper most bound (limited by scale formation due to sulphate deposition).

Conclusion

MSFSIM has helped in carrying out studies for start-up and steady state simulation and optimization of 4500 m³/day NDDP, Kalpakkam. Thus, MSFSIM can be used to validate design, optimize, simulate and predict transients of a multistage flash desalination plant. MSFSIM with graphic user interface enhances the usability of the code. MSFSIM can also train plant operators and generate input data for the expert system.

CDM DEVELOPS TOOLING FOR REVERSE COUNTER BORING OPERATIONS IN RESTRICTED SPACE

Counter boring on inner 'X' face of flanges of both end flanged components (with small gap between flanges) like Bearing Housing for CRDM (Fig.1) is not possible using conventional

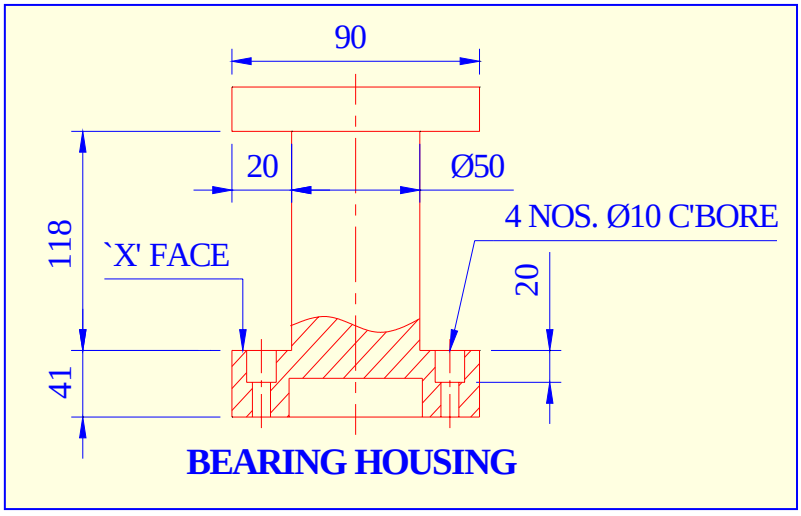

Fig.1: Schematic drawing of Bearing Housing

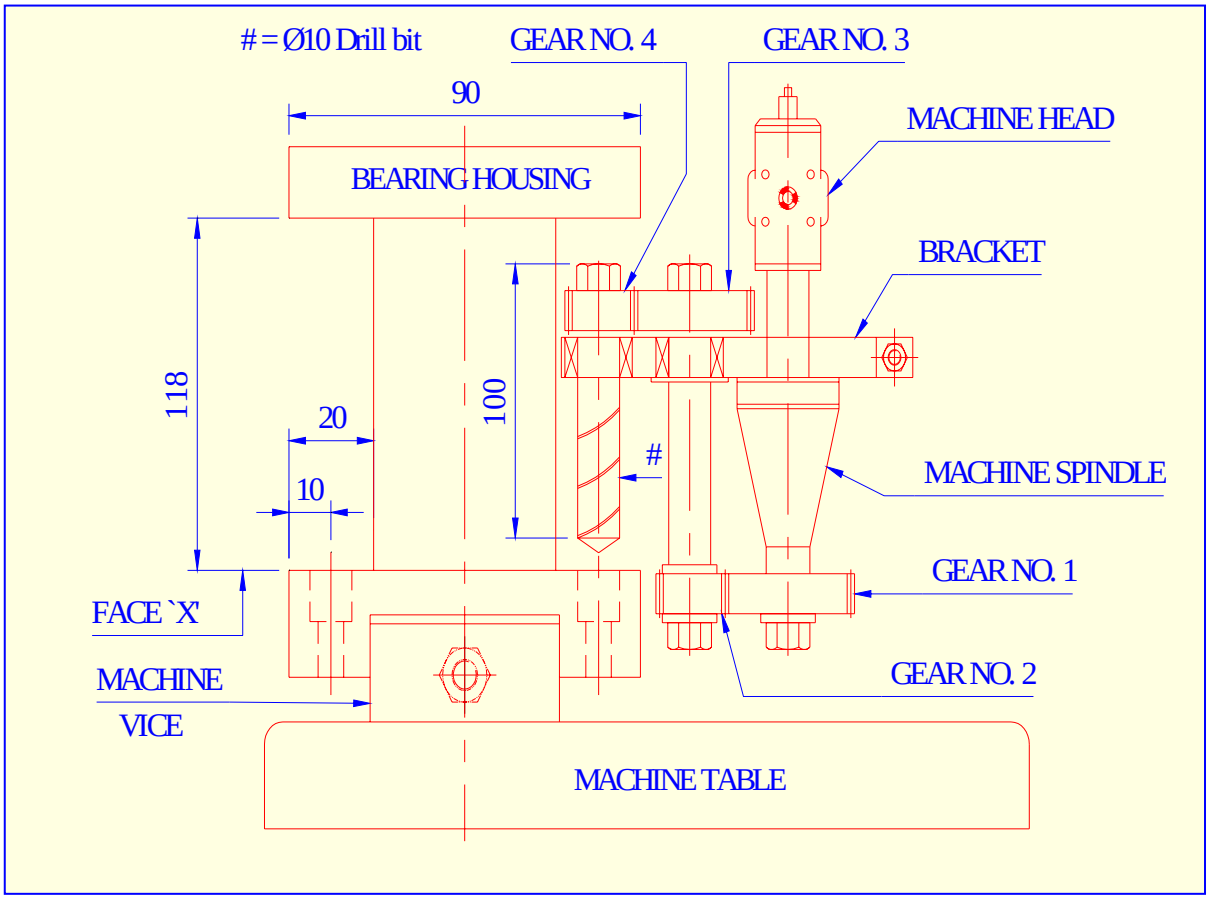

Fig.2 Schematic diagram of Counter Boring Attachment

Fig.3 Inner face Counter Boring Attachment in use

drilling/milling machine. Tooling for such an operation is not readily available in indigenous market. Centre for Design & Manufacture has developed an attachment for counter boring on the inner face of such components. This attachment does away with the difficulty in counter boring on the innerface due to hindrance and space limitation, caused by 20 mm dimension.

Fig.2 shows details of counter boring attachment along with flanged component. Counter bore of 10 mm diameter upto 20 mm depth is to be made on face `X'.

The gap between the flanges of the component is only 118 mm.

As seen from Fig.2, direct drilling is not possible on face `X' due to obstruction of the top flange and body of the housing.

Performing this operation requires special toolings. Keeping in mind the above mentioned constraints, an attachment is designed in such a way that the axis of spindle and axis of drill bit are offset from each other and drill bit is rotated by connecting it to machine spindle through a gear train.

The gear train and drill bit are supported on a bracket, which is attached to machine. Gears are designed to achieve the required cutting speed. To take thrust load generated during drilling operation, a mechanism with pre-loading arrangement is used. This attachment is compact, flexible and can accommodate drills of various sizes.

With the attachment developed as mentioned above, several jobs were counter bored and delivered to user.

NATIONAL FIRE SERVICE WEEK

Every year 14th April is observed as National Fire Service Day. On this day, in the year 1944, the fire service personnel displayed exemplary courage and devotion to duty as they fought the huge fire that had erupted following an explosion on a ship S.S. Fort Sticken berthed at the docks of Mumbai Port Trust. Many fire fighters lost their lives, leaving behind their names etched in the minds of Mumbaites forever. Even after this accident, while fighting fire, so many fire fighters have lost their lives. On 14th April of every year, due respect and homage is paid to those brave fighters.

Several programmes were organised by Fire Service Section, BARC, during the Fire Service Week during April 14-20, 2005 to create fire safety awareness among the employees in BARC, Trombay, and the residents at Anushaktinagar.

Mr A.K. Tandle, Chief Fire Officer, BARC, offering pin flag to Dr S. Banerjee, Director, BARC

On behalf of BARC, Mr A.K. Tandle, Chief Fire Officer placed wreaths on April 14, 2005 at the memorials erected on the grounds of Mumbai Port Trust and at the headquarters of Mumbai Fire Brigade, Byculla. He attended the inaugural ceremony of Fire Service Week at Raj Bhavan where His Excellency, Mr S.M. Krishna, Governor of Maharashtra, inaugurated the fire services personnel welfare fund raising campaign.

Dr S. Banerjee, Director, BARC, was offered pin flag on April 15, 2005 to start the fund raising campaign in BARC. Dr Banerjee emphasised the need for fire safety awareness in organisations like BARC. Mr D.S. Shukla, Director, Chemical Engineering & Technology Group, BARC, and Mr P.B. Kulkarni, Director, ESG & Chairman CFSRC, were also offered pin flags.

Two crews from BARC Fire Service Section participated in Tactical Medley Drill Competition on April 16, 2005 organised by Government of Maharashtra at Civil Defence Headquarters. Eighteen teams belonging to various organisations like Mumbai Fire Brigade, BPCL, Mumbai Port Trust, State Fire Training Center etc. participated in the competition. Team 'B' from this section was awarded the fourth prize in the competition.

Fire Fighting & Rescue demonstration in a high rise building was held at Udayagiri

Demonstration of use of first-aid fire and fighting equipment at WIP, BARC

High elevation rescue by using triple extension ladder at Udayagiri building, Anushaktinagar

Building, Anushaktinagar, on April 17, 2005. Fire safety posters and banners were displayed at the location and also cards on "Using LPG safely" & "Fire safety in high rise building" were distributed to residents who were present to witness the programme. Around 300 residents of Anushaktinagar witnessed the programme.

Mr N.K. Bansal, Associate Director, NRG, BARC, inaugurated the "Fire safety equipment exhibition" at WIP. Mr S.K. Ghosh, Head, Chemical Engineering Division, BARC, was present as a special guest. Fire fighting and rescue demonstrations were held after inauguration. Staff members from WIP and nearby facilities witnessed the programme. Information Card on "Electrical safety, house keeping & fire safety" were distributed to

members who came to witness the programme.

Mr Bansal emphasised the need for fire prevention measures and zero fire incident target for WIP. He also appreciated the fire safety measures adopted by Fire Services Section.

A Hose Drill competition was organised by Mutual Aid Response Group of the Trombay-Chembur Industries at Tata Power, Trombay, in which 13 teams, from HPCL, Tata Power, RCF, BPCL, and Mumbai Port Trust, took part. Two teams from BARC, Team A and Team B, also participated in the competition. Our team secured second position.

Mr D.S. Shukla, Director, Chemical Engg. & Tech. Group, BARC, inaugurating the Emergency Rescue Tender

On April 19, 2005, a film on "Preventing Accident in the Home" was screened through cable network at Anushaktinagar to increase the fire safety awareness among the residents of Ansuhaktingar. A Quiz contest was organised by Mutual Aid Response Group of Trombay-Chembur Industries at Tata Power, Trombay. 12 teams from various industries, viz. Mumbai Port Trust, BPCL, Tata Power, RCF and HPCL, took part in the quiz. Team from BARC secured 3rd position.

During Fire Service Week, Mr D.S. Shukla, Director, Chemical Engg. & Tech. Group, BARC, inaugurated the new Emergency Rescue Tender which is having cable winch of 5 tons capacity, built in 5 kVA capacity alternator, imported pneumatically operated telescope mast and other accessories required for rescue operation. While inaugurating the Emergency Rescue Tender, Mr Shukla emphasised the need for Fire Emergency preparedness and appreciated the steps taken by the Fire Services Section.

Voluntary donations were also collected this year. A sum of Rs. 11,038/- was collected from the staff members in BARC. School No.4 in Anushaktinagar also collected Rs.1,305/- as donation.

The Fire Service Week culminated with a ceremonial parade at Cross Maidan, Dhobi Talao, Mumbai, on April 20, 2005 in which BARC's Fire service personnel contigent participated along with Emergency Rescue Tender & Equipments.

TRAINING PROGRAMME ON "NAA AND OTHER MODERN ANALYTICAL TECHNIQUES IN FORENSIC SCIENCE"

A three day training programme on "NAA and other modern analytical techniques in Forensic Science" was organised jointly by the Neutron Activation Analysis (NAA) Unit of Central Forensic Science (CFSL), Hyderabad, Analytical Chemistry Division (ACD), BARC, and Fuel Chemistry Division, Indira Gandhi Centre for Atomic Research (IGCAR) at IGCAR, Kalpakkam, during March 16-18, 2005.The objective of the course was to expose mainly the forensic scientists to recent advances in the use and interpretation of data based on NAA and

Dr M. Sudersanan, Head, Analytical Chemistry Division, BARC, receiving bouquet. Dr N. Chattopadhyay, Deputy Director & Course Director, NAA unit of CFSL, Hyderabad at ACD (seated) and Dr A.K. Basu, Assistant Director, NAA Unit of CFSL, Hyderabad at ACD (standing) look on

other modern analytical techniques for elemental analysis of evidentiary materials, which has proved to be of immense value in forensic investigations.

At the Inaugural function, Mr K.C. Srinivas, Head, CFD, IGCAR, Kalpakkam, formally welcomed the participants who had come from different places to attend the course.

Dr N. Chattopadhyay, Deputy Director, NAA Unit of CFSL, Hyderabad (at ACD, BARC) who is the Course Director, talked about the workshop and introduced to the gathering the course contents focussing the necessary objective to conduct such type of course.

Dr M. Sudersanan, Head, ACD, BARC, gave introductory address by elaborating on scientific and technological advances made with facilities existing in BARC as well as IGCAR for possible forensic science research. He stated the importance of this unique joint programme between DAB and MHA employing nuclear as well as non-nuclear analytical techniques.

Dr (Ms) R. Krishnamurthy, Director, Forensic Science Laboratory, Mumbai, in her Introductory remarks, highlighted the scenario with respect to forensic context and advised the participants to take the best advantage of the opportunity of exposure to the scientists of IGCAR & BARC which are the premier research centres in the country.

Dr C.N. Bhattacharyya, Director, CFSL, Hyderabad, inaugurated the Training Programme by stating the objective and utility of the course. Delivering the Inaugural Address, he stressed upon the need for an analytical mind and strength in observations to come as simple means of logical conclusions. He also stated the importance of nuclear technology in helping to solve criminal cases. He also appreciated the sustained team effort and competence of the scientists to take up challenges and opportunities. Compiled lecture notes in the form of books were released by Dr M. Sudersanan after the inaugural address. These were prepared to enhance information contents and for the benefit of the participants.

Dr A. K. Basu, Assistant Director, NAA Unit of CFSL, Hyderabad (at ACD, BARC) proposed the vote of thanks. He was also the curtain raiser of the inaugural function.

Dr M. S. Rao, Director-cum-Chief Forensic Scientist, DFS, MHA, New Delhi, through a message, conveyed that a good response to this training programme is an indication that the interest in this specialised branch of analytical chemistry is sustaining and quite challenging problems are being pursued. He conveyed his good wishes for the success of the course.

The programme consisted of a series of lectures on different aspects of NAA techniques. Lectures on Analytical Spectroscopy, NDT techniques, SEM-EDAX and role of other modern analytical techniques in forensic science were also

Participants and some of the faculty members of the training programme on "NAA & other modern analytical techniques in forensic science" organised at IGCAR, Kalpakkam

covered. In addition, a special lecture on the bomb blast cases in Mumbai was also arranged.

Practical demonstration in measurement of characteristic radioactivities (utilising Kamini reactor facilities of IGCAR, Kalpakkam) of a few typical elements of forensic interest for Neutron Activation Analysis were shown. Associated gamma-ray spectrometry were also explained for the benefit of the participants.

Faculty members were drawn from among CFSL scientists stationed at BARC, State FSL, Mumbai, ACD & APSARA of BARC, and IGCAR, Kalpakkam.

The three day training course was meant to create awareness among the scientists of various state and central forensic science laboratories to take advantage of the Nuclear Analytical Technique, specially in those circumstances where other normal analytical techniques do not yield satisfactory information to reach to a conclusion. A total of 19 participants from different FSL(s), CFSL(s) and GEQD(s) attended the course. Objective type exercise for technical feed back in the form of 4 possible options to arrive at the most appropriate answers were conducted for the participants.

On March 18, 2005, in an informal valediction, Dr. A. K. Basu, Assistant Director (NAA) summed up the programme. Some of the participants expressed their views on usefulness of the course. Mr C.R. Venkata Subramani, FCD, IGCAR, who was the local convener also made his remarks. Dr N. Chattopadhyay, Course Director, expressed his observations. Dr P.R. Vasudeva Rao, Director, Chemistry Group, IGCAR, in his valedictory address, mentioned that the impact of interactive deliberations will be fruitful from both sides, i.e., end users as well as providers of facilities. He wished all the participants success in their respective endeavours. He then presented the certificates and mementos to the participants. Dr A. B. R Tripathi, JSO, NAA Unit, extended the vote of thanks.

Overall the programme was thought provoking and the lively discussions during and the after presentations were highly appreciated by the participants.

WORKSHOP ON ORGANOMETALLIC CHEMISTRY

A three-day workshop on Organometallic Chemistry was organised by the Chemistry Group, BARC, during April 18-20, 2005 at Niyamak Bhavan (AERB), Anushaktinagar. The workshop, sponsored by the Department of Science & Technology (DST), New Delhi, was planned to promote research activity in emerging areas and to sustain ongoing activities in the broad area of organometallic chemistry.

Dr S. Banerjee, Director, BARC, delivering the inaugural address

The workshop was inaugurated by Dr S. Banerjee, Director, BARC, on April 18, 2005 in the AERB auditorium. He also released the proceedings of the workshop. Dr V. K. Jain, Convener of the workshop, welcomed the delegates and invitees. Dr T. Mukherjee, Chairman, Organising Committee, delivered the presidential address. Dr T. Ramasami, Director, CLRI, Chennai, gave an overview of inorganic chemistry research. Dr R. Brakaspathy, Member Secretary, PAC (Project Advisory Committee) from DST, introduced the gathering with various scientific programs of DST. Dr (Ms) Dimple Dutta, Secretary, Organising Committee, proposed a vote of thanks. Prof. S. S. Krishnamurthy from I.I.Sc, Bangalore, delivered a key note address with an emphasis on an interplay of organophosphorus chemistry and organometallic chemistry.

Eminent scientists actively working in various sub-disciplines of organometallic chemistry were requested to deliver lectures covering the theme areas of the workshop. In all, there were 18 lectures on different topics like organometallics in organic synthesis, bio-organometallic chemistry, organometallics in materials science, analytical aspects of organometallic compounds, etc. High standards of this workshop were reflected form

Seen on the dais from left to right are : Dr T. Mukherjee, Chairman, Organising Committee of the wokshop, Dr S. Banerjee, Director, BARC, Dr T. Ramasami, Director, CLRI, Chennai, Dr R. Brakaspathy, Member Secretary, DST and Dr V.K. Jain, Convener of the workshop

the quality of lectures delivered by the faculty. A half-day visit to BARC was arranged on April 19, 2005 for conducting some experiments. There were 35 participants in this workshop.

Valedictory function was held at the end of IXth scientific session on April 20, 2005. The function was chaired by Dr T. Mukherjee, Associate Director, Chemistry Group, BARC. The interactive workshop had a lively feedback from the participants. The peers and the participants regarded the workshop as highly successful. It was also suggested that such workshops should be organised at regular intervals. Participation certificate was given to all the participants.

WORKSHOP ON IMPACT OF NUCLEAR SCIENCE & TECHNOLOGY – OPPORTUNITIES AND PERSPECTIVES

The year 2005 has been declared as the International year of Physics (IYP-2005) by the United Nations General Assembly to commemorate the centenary of the three famous papers of Einstein on Relativity, Photoelectric effect, Brownian motion, all published in 1905. In order to celebrate the IYP-2005, a seminar on "Impact of Nuclear Science and Technology – Opportunities and Perspectives" was jointly organized by BARC and Andhra University at Visakhapatnam during 11-12, April 2005. The workshop was inaugurated by Dr R. Chidambaram, Principal Scientific Adviser to Govt. of India. During his inaugural address, he highlighted the importance of "Attracting young people to careers in science". Dr A. Kakodkar, Chairman, AEC in his special address emphasised the role for synergy between

The dignitaries seated on the dais from right to left are : Dr S. Banerjee, Director, BARC, Dr R. Chidambaram, Principal Scientific Adviser to Govt. of India, Dr Anil Kakodkar, Chairman, Atomic Energy Commission, Prof. Veerraju of Andhra University, Prof. S. Lakshminarayana, Andhra University and on the mike is Dr S. Kailas, Associate Director, Physics Group and Head, Nuclear Physics Division, BARC

national laboratories and teaching institutions. He also announced the setting up of a new DAE R&D Centre at Visakhapatnam. Prof. Veerraju of Andhra University presided over the inaugural function.

The technical session started with a keynote address by Dr. S. Banerjee, Director, BARC. He brought out the impact of Nuclear Science and Technology in the areas of energy, healthcare, industry, food and agriculture. According to him the new centre at Visakhapatnam will have a focus on Energy, Environment and Education. In the session on Nuclear Physics research, Dr B. C. Sinha, VECC/SINP gave a talk entitled "Degrees of freedom : A changing scenario from very low energy to very high energy". Dr. S. Kailas, BARC covered the topic of "Nuclear Radiation Detection Techniques". Under the accelerator programme, Dr V.C. Sahni, BARC/CAT spoke on "A perspective of some national and international accelerator related activities" and Prof. V.N. Bhoraskar, University of Pune addressed the topic of "Applications of Accelerators". Mr R.K. Sinha, BARC gave a talk on "Thermal Reactor Based Indian Nuclear Power Programme" and Shri G. Vaidyanathan, IGCAR spoke on "Fast Breeder Program – An Inevitable Option For India's Energy Security". Both these talks covered the various aspects of reactor technology. On the theme of nuclear science applications, the following talks were held : Dr V. Venugopal, BARC on "Radioisotopes in healthcare and industry". Dr K. B. Sainis, BARC on "Radiation Technologies for Agriculture and Food", Prof. S. Lakshminarayana, Andhra University on "Neutron Activation Analysis for Environment", Prof. S. Bhuloka Reddy, Andhra University on "Trace Element Analysis in the Tissues of Some Cancer Afflicted Human Organs by PIXE Technique". There was also a session devoted to societal benefits covering "Water Desalination" by Dr P.K. Tewari, BARC and "Biodegradable waste disposal : Nisargruna Approach" by Dr. S. P. Kale, BARC. The workshop ended with a panel discussion on "Synergy between DAE & Universities – Opportunities". The panelists were Prof. P. Rama Rao, BRNS, Prof. K. Siddappa, Bangalore University, Dr S. Banerjee, BARC, Prof. P. Veerraju, Andhra University. A number of suggestions were made including one of parking some activity of a national lab in an university environment . Prior to the workshop, Dr S.K. Malhotra, DAE gave a lecture covering different aspects of the DAE programmes broadly addressing the myths and realities of Atomic Energy.

The two day workshop was well attended by students and faculty members of Andhra University. They were all very excited about the prospects of having a DAE R&D centre at Visakhapatnam.

FORTHCOMING SYMPOSIA

(A) SEMINAR ON ADVANCES IN METALLOGRAPHY AND MICROSTRUCTURE (MICROSTRUCTURE-2005)

Optical microscopy and other microscopy techniques are important tools in the study of the interrelationship between the structural characteristics and the physical and mechanical properties of metals, alloys and nonmetallic materials such as ceramics, polymers or composites. Microstructural characterisation is essential for tailoring of microstructure or microstructural engineering in developing newer alloys and material, improving properties of a given material and optimising processing parameters.

Metallography is invaluable in today's industrial workplace to maintain close control over production processes, in basic materials research, in development of new materials and in failure analysis. The advanced microscopy

techniques such as SEM, TEM, STM and AFM are used to characterise finer microstructure with much higher spatial resolution. Spectroscopy techniques in EPMA, SEM, TEM and EPMA are utilised for fully qualitative and quantitative compositional analysis of the constituent phases of microstructure from micron to nanometre scale.

A two-day seminar on "Advances in Metallography and Microstructure (Microstructure-2005)" will be held at the Training School Hostel, Anushaktinagar, Mumbai, during December 1-2, 2005. This seminar will act as a forum for engineers, heat treators, quality control personnel working in engineering industry, researchers, metallurgists and academicians working in the scientific laboratory and academic institutions who are interested in the area of microstructural characterisation using metallography techniques and microscopy techniques. Experts in the different fields covered in this seminar will deliver invited talk. It will be an excellent opportunity for the researchers, academicians and students to present and observe the latest research, results, and ideas in these areas. This seminar will aim to strengthen relations between industry, research laboratories, and universities.

Scope

The different aspects of metallography and microstructure will be covered in this conference. The topics include :

- Practices, principles and interpretation of microstructure in metallography
- Stereology, image processing and quantitative metallography
- Advance microscopy techniques: SEM, TEM, STM, AFM
- Microstructure-property relationship
- Microstructural studies of
  - carbon steels, stainless steel and other ferrous alloys and their correlation to heat treatment and mechanical properties
  - non-ferrous alloys
  - ceramics and composites
  - failure analysis using microscopy techniques

Metallography Competition

Micrographs obtained using optical microscope, SEM, TEM, AFM and any other advance techniques can be submitted for the metallography competition. Interested persons may send their entries to Convener.

For further details, contact :

Dr. D. Srivastava, Convener,
Microstructure-2005, Materials Science Division,
Bhabha Atomic Research Centre, Mumbai 400085
Phone: 022-25595404, 022-25592242
Fax: 022-25505151, 022-25505304
Email: microstructure2005@yahoo.co.in

(B) FIFTH DAE-BRNS NATIONAL LASER SYMPOSIUM (NLS-5)

The Fifth DAE-BRNS National Laser Symposium sponsored by the Board of Research in Nuclear Sciences, Department of Atomic Energy, will be held at Vellore Institute of Technology, Vellore, during December 7 - 10, 2005. The symposium will include plenary talks on recent developments in physics, technology and applications of lasers, invited and contributed presentations by leading experts and young researchers and Ph.D. thesis presentations in the related research areas. The organising committee of the symposium invites all research scientists, engineers and research students who are engaged in basic or applied research & applications in the broad area of lasers and related fields to participate in the deliberations of the symposium.

Topics of interest covered are :

1. Physics and Technology of Lasers
2. Lasers in Nuclear Science & Technology
3. Laser Materials, Devices and Components
4. Quantum Optics
5. Ultrafast Lasers and Applications
6. Nonlinear Optics
7. Lasers in Material Science

8. Tunable Lasers & Applications
9. Laser Plasma Interaction
10. Lasers in Industry & Defence
11. Lasers in Spectroscopy
12. Lasers in Chemistry, Biology & Medicine
13. Laser-based Instrumentation

The Indian Laser Association (ILA) will organise a couple of short tutorial courses on December 6, 2005, preceding the symposium. Details of this will be announced separately by ILA. ILA also awards prizes for the best thesis and poster presentations.

For further details, contact :

Mr S.V. Nakhe, Secretary NLS-5, Laser Systems Engineering Division, Centre for Advanced Technology, Indore-452013.
Email : nls2005@cat.ernet.in

(C) SYMPOSIUM ON NUCLEAR PHYSICS

DAE-BRNS 50th symposium on Nuclear Physics will be held at BARC, Mumbai, during December 12-16, 2005. The topics for the symposium will include :

a. Nuclear structure
b. Low and medium energy nuclear reactions
c. Physics with radioactive ion beams
d. Intermediate energy nuclear physics
e. Relativistic nuclear collisions and QGP
f. Nuclear matter and nuclear astrophysics
g. Instrumentation and accelerators for nuclear physics

In addition to Invited Talks, there will be sessions on contributory posters and thesis presentations. Last date for submission of one-page abstract on the above topics by e-mail only to sympnp@barc.ernet.in

For further details, contact :

Dr Suresh Kumar, Convener
Tel : (91)-22-25593712
E-mail : sureshk@barc.ernet.in

Or

Dr L.M. Pant, Symposium Secretary
Te; : (91)-22-25593616
Email : sympnp@barc.ernet.in

(C) NATIONAL SYMPOSIUM ON "RADIATION PHYSICS" (NSRP-16)

In order to provide a common forum for radiation physicists working in multi-disciplinary areas, Indian Society for Radiation Physics (ISRP), in collaboration with Universities and colleges, has been organizing biennial National Symposia on Radiation Physics (NSRP) in different parts of the country. These symposia highlight the current trends and future prospects in radiation physics research. The sixteenth in the series, NSRP-16 is to be held at Indira Gandhi Centre or Atomic Research Kalpakkam, and Meenakshi College for Women, Chennai during January 18-20, 2006.

Boltzmann transport equation was originally intended for explaining macroscopic reversible dynamics. Linearised version of the equation found application in nuclear reactor engineering for assessing radiation transport in bulk materials. The solution of this equation provides detailed knowledge about the spatial and temporal distributions of radiation in reactor core and shielding materials. All design and safety parameters of practical interest such as criticality parameters, heat production, reaction rates, neutron and photon flux profiles are derived therefrom. Diffusion approximation to transport equation has been found quiet adequate for predicting the parameters of a nuclear reactor core. However, for shields where the neutron flux deeper in the shield is highly anisotropic, we need transport methods.

The linear Boltzmann transport equation is solved in closed form only for the simplest of configurations. Hence, numerical methods are resorted to for almost all practical applications. Many standardised computer codes have been developed and validated against benchmark experiments. The numerical methods in vogue include discrete ordinates, integral equation

approach. Monte Carlo methods, etc. NRSP-16 will lay special emphasis on issues of radiation transport viz., experimental, numerical and analytical.

The symposium will feature invited talks by eminent scientists in the different disciplines of Radiation Physics. Contributed papers representing original work will be included in oral/poster presentation. The focal theme of NSRP-16 is "Radiation Transport – Experiments, Computations and Theory"

Topics to be covered in the symposium include :

- Radiation Transport
- Reactor Physics
- Accelerator based Radiation Physics
- Radiation Detection and Measurements
- Radioactivity transport in Natural Environment

For further details, contact :

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Website : www.isrp-ind.org

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

● श्री आर.के. पुरी, रिमोट हैंडलिंग एन्ड रोबोटिक्स प्रभाग, को डेवलोप्मेंट ऑफ बीएआरसी चैनल इन्स्पेक्शन सिस्टम (बारसिस) फॉर इन-सर्विस इन्स्पेक्शन ऑफ कूलन्ट चेनल्स् ऑफ प्रशराइज्ड हैवी वाटर रियक्टरस्, डेवलोप्मेंट ऑफ अन्डरवाटर रेडियेशन रेज़िस्टन्ट सीसीटीवी कैमरा सिस्टम फॉर विजुअल एक्ज़ामिनेशन ऑफ इन्नर सरफेस ऑफ केलेन्ड्रिया एन्ड कूलन्ट ट्यूब्स्, सैग मेजरिंग सिस्टम फॉर मेजरिंग सैग प्रोफाइल ऑफ कूलन्ट चैनलस् तथा डेवलोप्मेंट ऑफ सिस्टमस् फॉर एनडीटी एप्लिकेशन में उत्कृष्ट योगदान के लिए इन्डियन सोसाइटी फॉर नॉन-डेस्ट्रक्टिव टेस्टिंग (आइ एस एन टी), मुंबई शाखा के द्वारा रिसर्च एन्ड डेवलोप्मेंट अचीवमेंट अवार्ड 2004 प्रदान किया गया।

Mr R.K. Puri of Division of Remote Handling & Robotics, BARC, was presented Research & Development Achievement Award 2004 by Indian Society for Non-destructive Testing (ISNT), Mumbai Chapter, for his outstanding contribution in the development of BARC Channel Inspection System (BARCIS) for in-service inspection of coolant channels of pressurised heavy water reactors, development of underwater radiation resistant CCTV camera system for visual examination of inner surface of calandria & coolant tubes, sag measuring system for measuring sag profile of coolan t channels and development of systems for NDT application.

● श्री एन. गोपीनाथ, ईंधन रसायनिकी प्रभाग, भाभा परमाणु अनुसंधान केंद्र को सोसाइटी फॉर एडवान्समेन्ट आफ इलेक्ट्रोकेमिकल साइन्स एन्ड टेक्नोलोजी (एसएईएसटी), सीईसीआरई केम्पस, कराइकुडी, के द्वारा आयोजित व मदुराई थियागरजर इंजीनियरिंग कालेज के 12वें नेशनल कन्वेन्शन आफ इलेक्ट्रोकेमिस्टस् (एनएसई-12) में प्रस्तुत, जयश्री वी. कामत, एन.गोपीनाथ एवं एस.के. अग्रवाल द्वारा लिखित " डिफरेंशियल पल्स अनोडिक स्ट्रिपिंग वोल्टामीट्रिक स्टडीज़ इन एक्उस सोल्यूशन ऑफ सोडियम कार्बोनेट फॉर दि डिटरमिनेशन ऑफ ट्रेस अमाउन्ट ऑफ केडमियम प्रज़न्ट इन UO_2 फ्युअल " नामक शोध-पत्र के लिए टेक्निकल सत्र में बेस्ट पेपर अवार्ड प्रथम श्रेणी का पुरस्कार प्राप्त हुआ।

श्री एन. गोपीनाथ ने वर्ष 1973 में श्री वेन्कटेश्वर विश्वविद्यालय, तिरुपति से रसायनिकी (भौतिक रसायनिकी) में एम.एस.सी की डिग्री प्राप्त की। इन्होंने वर्ष 1977 में भाभा परमाणु अनुसंधान केंद्र के रेडियोकेमिस्ट्री

प्रभाग में सदस्यता लेकर विभिन्न नाभिकीय ईंधन चक्रों में विभिन्न इलेक्ट्रो एनेलिटिकल टेक्नीक्स के विकास तथा उपयोग, जैसे पोटेन्श्योमीट्री, एम्पेरोमीट्री, काउलोमीट्री, वोल्टामीट्री आदि में सक्रिय रूप से कार्यभार संभाला। वे इन्डियन सोसाइटी फॉर इलेक्ट्रोएनालिटिकल केमिस्ट्री (आइएसईएसी) के सचिव भी हैं।

Mr N. Gopinath, Fuel Chemistry Division, BARC, received the Best Paper award in Technical Session 1 (First prize) for his paper, “Differential pulse anodic stripping voltammetric studies in aqueous solution of sodium carbonate for the determination of trace amounts of cadmium present in UO_2 fuel”, authored by Jayshree V. Kamat, N. Gopinath and S.K. Aggarwal,presented at the Twelfth National Convention of Electrochemists (NSE-12) held at Thiagarajar College of Engineering, Madurai, during February 18-19, 2005, organised under the auspices of Society for Advancement of Electrochemical Science and Tehnology (SAEST), CECRI campus, Karaikudi, India.

Mr N. Gopinath obtained his M.Sc. degree in Chemistry (Physical Chemistry) from Sri Venkateshwara University, Tirupati, in 1973. He joined Radiochemistry Division, BARC, in 1977. Since then, he has been actively involved in developing and employing various Elecroanalytical Techniques, like Potentiometry, Amperometry, Coulometry, Voltammetry, etc. for different applications in the nuclear fuel cycle. He is the Secretary of the Indian Society for Elecroanalytical Chemistry (ISEAC).

● कुमारी डी. अलमेल्यू, ईंधन रसायनिकी प्रभाग, भाभा परमाणु अनुसंधान केंद्र , को अक्तूबर 7-12, 2004 के दौरान शिमला में आयोजित मास स्पैक्ट्रोमीटरी की 11वीं आइएसएमएएस कार्यशाला में प्रस्तुत, एस.के. अग्रवाल एवं डी.अलमेल्यू द्वारा लिखित " ए नोवल एप्रोच फॉर दि डिटरमिनेशन ऑफ ^{238}Pu बाई थरमल आयनाइज़ेशन मास स्पेक्ट्रोमीटरी (टी आइ एम एस)" नामक शोध-पत्र के लिए इनोवेटिव रिसर्च (आई आर) प्रज़न्टेशनस् सत्र में बेस्ट पेपर अवार्ड प्रदान किया गया। कुमारी डी. अलमेल्यू ने अन्नामलाई विश्वविद्यालय, चिदांबरम, तमिलनाडु से एमएससी की डिग्री प्राप्त की। भाभा परमाणु अनुसंधान केंद्र के प्रशिक्षण केंद्र के 38वें बैच से स्नातकता प्राप्त करके इन्होंने वर्ष 1995 में ईंधन रसायनिकी प्रभाग के मास स्पैट्रोमीटरी सेक्शन में सदस्यता ली। तब से ये "टाइम ऑफ फ्लाइट मास स्पैक्ट्रोमीटर के स्थानीय विकास में सक्रिय रूप से व्यस्त हैं। थरमल आयोनाइज़ेशन, मास स्पैक्टरोमीटरी एवं अल्फा स्पैक्ट्रोमीटरी भी इनकी रुचि के क्षेत्र में शामिल हैं।

Ms D. Alamelu, Fuel Chemistry Division, BARC, was given the Best Paper award in Innovative Research Presentations (IR) Session for her paper “A novel approach for the determination of ^{238}Pu by Thermal Ionisation Mass Spectrometry (TIMS)”, authored by S.K.Aggarwal and D. Alamelu, presented at the Eleventh ISMAS Workshop on Mass Spectrometry held at Shimla, during October 7-12, 2004.

Ms D. Almelu obtained her M.Sc. degree in Physics from Annamalai University, Chidambaram, Tamilnadu. After graduating from 38th batch of Training School, BARC, she joined Mass Spectrometry Section of the Fuel Chemistry Division in 1995. Since then, she has been actively involved in indigenous development of Time of Flight Mass Spectrometer. Her other areas of interest include thermal ionization mass spectrometry and alpha spectrometry.

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