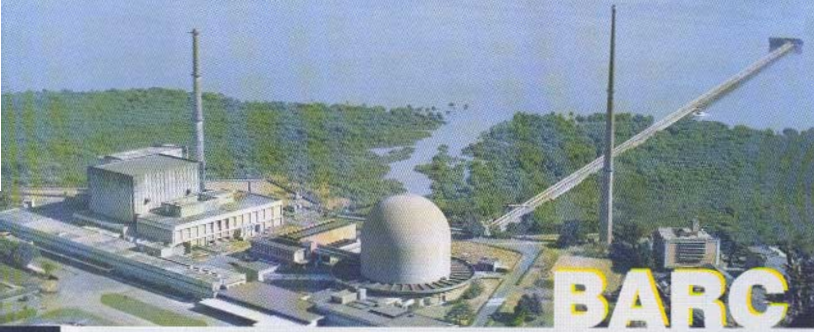

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BULK SHIELDING EXPERIMENTS AT APSARA FOR PROTOTYPE FAST BREEDER REACTOR

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Introduction

In a fast reactor, invessel shielding is provided to reduce the neutron flux from 10^{13} n/cm^2/s at the exit of blanket to 10^5 n/cm^2/s at the Intermediate Heat Exchanger (IHX) location. Hence, invessel shield design involves computation of neutron transport through shield materials, having an attenuation of the order of 10^8. Shield design for these deep penetration problems involving large attenuation is difficult and is associated with large uncertainties. The design calculations are normally carried out using deterministic methods, employing discrete ordinate techniques. 1-dimensional (1-D) and 2-dimensional (2-D) transport codes with multigroup cross section sets are routinely used. To assess the overall accuracy of the codes and nuclear data, mock-up experiments are carried out in shielding facilities, prior to final shield design. In these mockup experiments, the ratios of measured to calculated reaction rates corresponding to the parameters of interest are called the bias factors. These bias factors are used in design of the invessel shielding. This practice is generally followed internationally [1,2].

The invessel shielding has to be designed such that the shield materials are used effectively leading to less thickness of shield. The shield thickness also has direct

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implication on the size of the inner vessel and reactor vessel. Hence, a cost effective shield design calls for optimisation of shields. PFBR shield design is carried out with 1-D and 2-D transport codes ANISN and DORT, with DLC-2(100 group neutrons)/DLC-37 (100 group neutron and 21 group gamma coupled library) cross section data (based on ENDF-B-IV). In line with the international practice, to obtain the bias factors for shield design relevant to PFBR, mock-up experiments have been carried out in Apsara Reactor jointly by IGCAR and BARC [3].

The in-vessel radial shield configurations consist of layers of stainless steel and borated graphite/boron carbide and sodium. This in-vessel shield is provided to reduce the neutron flux at intermediate heat exchanger so that the dose rate due to secondary sodium activity in steam generator building is within acceptable limit. Experiments are being carried out in the shielding corner cavity of Apsara to study the neutron attenuation through shielding materials such as steel, sodium, graphite, borated graphite and boron carbide. Four sets of experiments to study neutron attenuation in radial shields have been completed. Six more experiments will be carried out, two experiments with radial shield materials, one with axial shield and three for radiation streaming through top shield.

Experimental Details

Apsara reactor is a 1 MWt swimming pool light water reactor with a shielding corner facility. It has a unique movable core assembly of enriched Uranium-Aluminium alloy. The neutron flux level of ~10^7 n/cm^2/s in the shielding corner was inadequate for the purpose of carrying out experiments on neutron transport through thick shields. The reason for this low flux is the presence of about 40 cm of water between core and the pool-wall. The neutron flux level was enhanced to 1.03 x 10^{10} n/cm^2/s by displacing most of the water between the core edge and stainless steel (SS) liner of APSARA pool on the shielding corner-side with an air-filled aluminum box.

Dr Anil Kakodkar, Chairman, Atomic Energy Commission, visiting the experimental site

The energy spectrum of neutrons in the shielding corner is essentially a thermal reactor neutron spectrum. Converter assemblies (CA) made of depleted uranium (0.67% U-235) subassemblies were placed in a trolley close to the Al-panel in the shielding corner, such that the emergent neutron spectrum represents PFBR blanket leakage neutron spectrum. A view of the experimental arrangement in shielding corner is shown in Fig.1. Detailed incident neutron spectrum on the emergent face of CA was measured by unfolding the measured reaction rates of a large number of activation detectors. Fig.2 gives a comparison of the measured neutron spectrum on the emergent face of CA with the calculated blanket leakage neutron spectrum of PFBR [4]. This shows that the comparison is very good over the energy range of interest (E >100 eV).

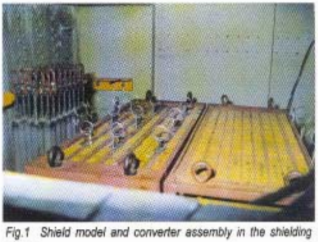

Fig.1 Shield model and converter assembly in the shielding corner

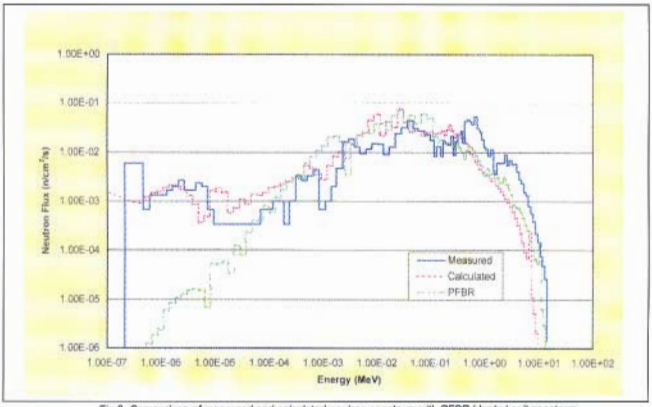

Fig.2 Comparison of measured and calculated neutron spectrum with PFBR blanket exit spectrum

For the experimental campaign, five laminar shield models were fabricated. Two models of 455 mm thickness, are of sodium-carbon steel (CS) with different volume fractions, the third shield model is a borated graphite (3.4 % natural boron)-CS-sodium model, the fourth shield model is a 462 mm thick sodium model and the fifth is a 495 mm thick boron carbide – CS- sodium model. The volume fractions in the model are close to the volume fractions in radial shield configuration of PFBR. Vertical slots are provided at several locations in each of these models for inserting specially fabricated SS foil-holders with activation foil detectors.

These experiments involve a large neutron flux attenuation and measurement of neutron spectrum on the incident face. Hence, large number of activation detectors such as gold, sodium, copper, nickel, indium, iron, titanium and sulfur were used. The detectors used cover the entire energy range from thermal (0.025 eV) to 14 MeV. Gold foils (bare and Cd-covered) are a good measure of thermal and epithermal neutron flux mainly in eV range. As sodium activity is an important parameter in design, it is directly measured with the help of bare and cadmium covered sodium foils. Neptunium and Indium reaction rates (essentially due to neutrons of energy above ≈0.4 MeV and ≈1 MeV respectively) provide data related to radiation damage fluence (dpa). Nickel and sulphur foil reaction rates are used to obtain very hard energy component (> 2.5 MeV) of fast neutron flux. Solid state nuclear track detectors (SSNTD) were used to get fission reaction rates for neptunium, thorium and natural and depleted uranium. Detailed neutron spectrum above 1.0 MeV was also measured on the emergent face of shield models using NE-213 liquid scintillation spectrometer.

Measurements

The experiments were carried out with the shield models installed on the shield model trolley in the shielding corner, as shown in Fig.3. The reactor is operated at C' position, close to the shielding corner. For retrieving foil holders after each irradiation, the reactor core is moved to A position. Sufficient cooling time is allowed before experimenter enters the shielding corner after opening block-1. The foil holder is retrieved from a

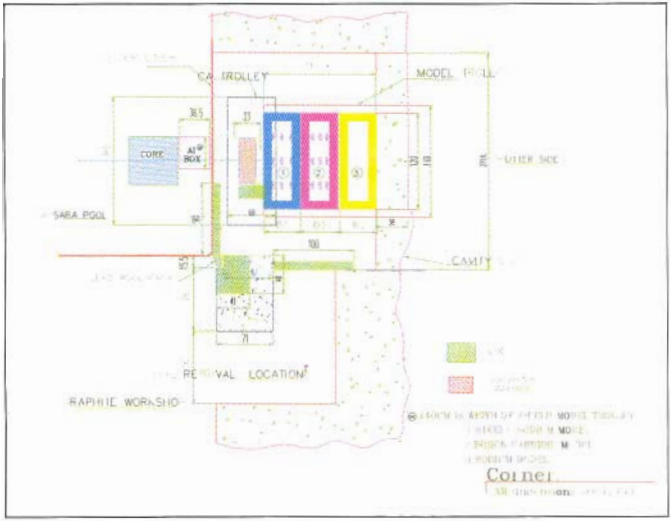

Fig.3 Plan view of Apsara shielding corner

distance with a long telescopic rod by a person standing at the foil retrieval location, as shown in Fig.3. To reduce the dose rate at foil retrieval location, lead shielding is placed inside shielding corner.

Set-1 and Set-2 experiments study neutron transport through in steel-sodium models with different volume fractions of steel and sodium. In Set-1 experiment, shield model arrangement consists of Model-2 followed by Model-4. In Set-2 experiment, shield model arrangement consists of Model-1, Model-4 and Model-2. Set-3 and Set-4 experiments study neutron transport through steel/sodium/borated graphite and steel/sodium/boron carbide models respectively. In Set-3 experiment, shield model arrangement consists of Model-1, Model-3 and Model-4. In Set-4 experiment, shield model arrangement consists of Model-1, Model-5 and Model-4 [4].

The measured attenuation in set-2 experiments for bare, Cd- covered and threshold activation detectors are 0.08, 0.1 and 0.02 respectively. The measured attenuation in set-3 experiments for bare, Cd- covered and threshold activation detectors are 0.004, 0.03 and 0.008 respectively. The measured attenuation in set-4 experiments for bare, Cd-covered and threshold activation detectors are 0.0007, 0.001 and 0.001 respectively. It is to be noted that the various activation foils are sensitive to different parts of the neutron spectrum and hence show different attenuations along the shield model. In the discussions above, only representative values are given.

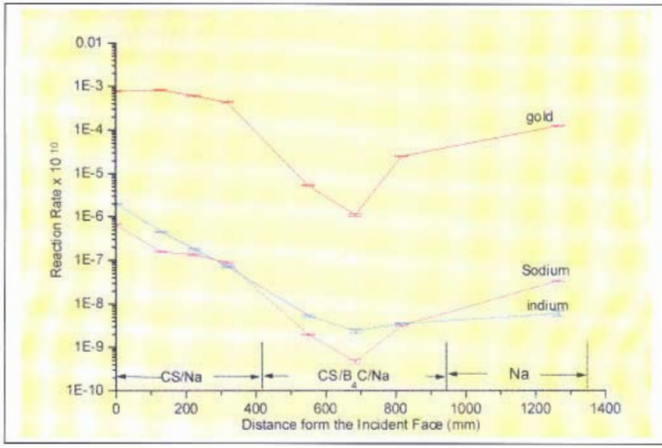

Fig.4 Variation of bare sodium, Cd covered gold and indium foils

Measured reaction rates in model-1 for experiment set-2 were found to be lower than the measured reaction rates in shield model-2 for experiment set-1. This is as expected, because volume fraction of carbon steel was more in shield model-1 than shield model-2. All the reaction rates decrease slowly in sodium/steel model and steeply in borated graphite/sodium model. They also show a slow increase in sodium model, which is due to slowing down effect. There may be a small contribution due to neutrons scattered from the concrete walls of shielding corner. Bare and cadmium covered gold reaction rates are higher than the sodium reaction rates because of higher cross section. Reaction rate for neptunium fission is also higher then other threshold detectors because of low threshold and higher cross section. Reaction rate for sulphur detector is lowest because of the higher threshold and low cross section. Set-4 experiments involve transport through 465 mm thick steel/sodium model, 495 mm thick steel/boroncarbide/sodium model and 465 mm thick sodium model. The measured attenuation of bare sodium, Cd-covered gold and Indium reaction rates in this experiment are shown in Fig.4. The variation of reaction rates in boron carbide model are more pronounced because of higher boron content.

2-D Transport Calculations and Comparison with Measurements

Calculations for the various shield configurations in Set-1 to Set-4 have been carried out using 2D transport code DORT in X-Y geometry with S_8–P_3 approximation. 100 neutron group cross section library DLC-2 has been used in the calculations. The fuel elements of Apsara core are homogenised over each square region. Graphite and BeO reflectors at the peripheral positions of the core are also homogenised over the square. Apsara reactor is surrounded by pool water on all sides. The converter assemblies have been modelled as

homogeneous assemblies. The hexagonal outline has been modelled as close as possible in 2D X-Y representation. The pointwise group flux convergence criterion used is 1.0E-04. This convergence was obtained in all the groups for all the spatial meshpoints, but for a few corner points in the first two groups and thermal group. 100 group activation/fission cross sections for reaction rate calculations have been obtained by collapsing the 620 group cross sections of SAND II library using a flat weighting function.

Reaction rates of bare, Cd-covered and threshold activation detectors have been compared with measured values in the shielding corner, after placing aluminium box. The comparison was found to be within 30%. The calculated neutron spectrum on the emergent face of CA is compared with the measured neutron spectrum in Fig.2. The comparison is very good over the entire energy range. Analysis of reaction rates have been carried out for all four sets of experiments [5]. The ratios of calculated reaction rate (C) to the experimentally measured value (E) have been obtained. It is to be noted that the various activation foils are sensitive to different parts of the neutron spectrum and hence show different C/E along the shield model. Hence a range of values, representative of parameters of interest are given.

In experiment set-2, C/E is found to be between 0.7 to 1.4 in the case of thermal and epithermal activation detectors. In general, it appears that thermal and epithermal flux may be overpredicted by a factor of 1.2 to 1.4 in the calculations of transport through steel/sodium shields. In the case of threshold detectors, C/E lies between 0.5 to 1.2. The reaction rate inside the CS/Na model is underpredicted. Hence, the sodium activity may be overpredicted by a factor of 1.2-1.4. The fast neutron fluence (above 0.1 MeV) and hence dpa may be underpredicted by a factor of 1.5 to 1.8 in the calculations of transport through steel/sodium shields. It is seen that the fission equivalent flux above 2 MeV is well-predicted within 10 to 20% in calculations of transport through steel/sodium shields.

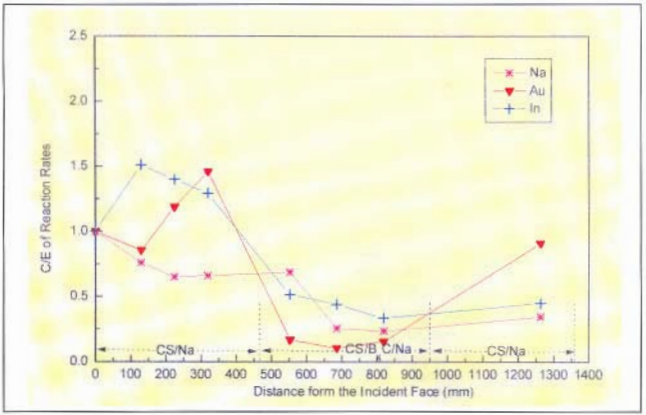

Fig.5 C/E of reaction rates for bare sodium, Cd covered gold and indium foils

In experiment set-3, C/E is found to be between 0.35 to 1.6 in the case of thermal and epithermal activation detectors. In general, thermal and epithermal flux may be underpredicted by a factor of 1.2 to 3.0 in the calculations of transport through steel/borated graphite/sodium shields. In the case of threshold detectors, C/E lies between 0.3 to 1.02. Hence, the sodium activity may be underpredicted by a factor of 1.2-3.0. The fast neutron fluence (above 0.1 MeV) and hence dpa may be underpredicted by a factor of 3.0 in the calculations of transport through steel/borated graphite/sodium shields. It is seen that the fission equivalent flux above 2 MeV is underpredicted by a factor of 2 to 3 in calculations of transport through steel/borated graphite/sodium shields.

In experiment set-4, C/E is found to be between 0.20 to 1.5 in the case of thermal and epithermal activation detectors. In general, thermal and epithermal flux are underpredicted by a factor of 1.2 to 5.0 in the calculations of transport through steel/ boron carbide/ sodium shields. In the case of threshold detectors, C/E lies between 0.3 to 1.0. Hence, the sodium activity may be underpredicted by a factor of 1.2-5.0. The fast neutron fluence (above 0.1 MeV) and hence dpa may be underpredicted by a factor of 1.5 to 3.5 in the calculations of transport through steel/boron carbide/sodium shields. It is seen that the fission equivalent flux above 2 MeV is also underpredicted by a factor of 3 to 5 in calculations of transport through steel/boron carbide/sodium shields. C/E of bare sodium, Cd-covered gold and Indium reaction rates in this experiment are shown in Fig.5.

Conclusions

Fast reactor shielding experiments have been successfully carried out in the Apsara shielding corner. The measured neutron spectrum incident on the emergent face of CA is close to the expected blanket leakage neutron spectrum of PFBR. Thus, we have a shielding facility for fast reactors for the first time in INDIA. In the case of transport through steel-sodium shields, calculations predict the fluxes within a factor of two. In the case of shields with borated graphite and boron carbide, the calculations generally underpredict the neutron fluxes by a factor of 3 to 5. These observations are similar to the trends seen internationally, wherein the bias factors range from 2 to 7. The experiments have been extremely useful in infusing confidence in calculational methods and cross section data available at IGCAR and in obtaining suitable bias factors for PFBR invessel shield design calculations.

In order to reduce the uncertainties to less than a factor of two, it is felt that problem dependent multigroup cross section set with a large number of groups should be generated. More number of groups must be considered in the thermal (< 0.415 eV) region. It is also recommended that there should be a concerted effort to identify and generate suitable activation cross section set for activity calculations. These need to be compatible with the problem dependent cross section sets used in the transport calculations.

Participants

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Operational and Health Physics activities - Mr W.L. Raheja, Mr K. Somakumar, Mr K. Rama Verma of RG, BARC, Mr S.K.Prasad and Mr V.P.Kadam, RHCS, RSSD, BARC and operational staff of ARSARA.

Measurements and Analysis of Experiments - Dr (Ms) R. Indira, Mr D. Sunilkumar, Mr D.K. Mohapatra, Mr V. Sathiyamoorthy and Mr A.K. Jena of RPD, IGCAR, Mr H.K. Dravid, Mr K.K. Rasheed, RPDS, BARC, Mr S. Anilkumar, Mr S.P.Gambhir

and Mr R.V. Kolekar of RSSD, BARC and Mr Brijesh Singh of AERB.

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5) R.Indira, D. Sunilkumar and H.K. Dravid, PFBR Bulk Shielding Experiments at APSARA (set-1 to set-4) - Comparison of Calculations and Measurements, PFBR/01115/DN/1077,1078, 1083,1084/ 2001.

BIOGAS PLANT BASED ON KITCHEN WASTE

S. P. Kale and S. T. Mehetre
Nuclear Agriculture and Biotechnology Division

It is said that nature has suffered more because of man rather than other way round. Wherever there is a human interference, the environment has undergone considerable degradation. Even in Arctic region, we find the bitter fruits of pollution. The realisation has come at a slower pace but it is better late than never. Since nothing new can be created in this world and while existing energy sources are getting depleted at alarmingly rapid rate, we must use every available resource judiciously. There are enough natural agencies, which are too keen to help us in this endeavour. Science has revealed these tools and we must use their potential to achieve the urgent call of nature "CLEAN ENVIRONMENT FOR ALL, INCLUDING NATURE ITSELF".

One such resource is the waste organic matter that is generated in the kitchens and one of the natural agencies which will play an important role in this utilisation is the tiny part of the huge world of tiny microbes. What is so special of these microorganisms? They can thrive in extreme environments where ordinarily no one would even imagine that there would be life. An organism that can happily grow in an extreme environment is an extremophile. The discovery of extremophiles has put a new life into the biotech industry and dreams of stock options in the minds of field biologists. The extreme environments include physical extremes like pressure, temperature and radiation, and geochemical extremes like desiccation, salinity, pH and low redox potentials.

The thermophiles are the extremophiles that can thrive superbly at high temperatures. They have developed such enzyme systems that can help the organisms not only to survive at higher temperatures but also grow and reproduce. They have the ability to use sulphurous waste and convert it into non-toxic products. Since the environment for such microorganisms sustains higher temperatures,

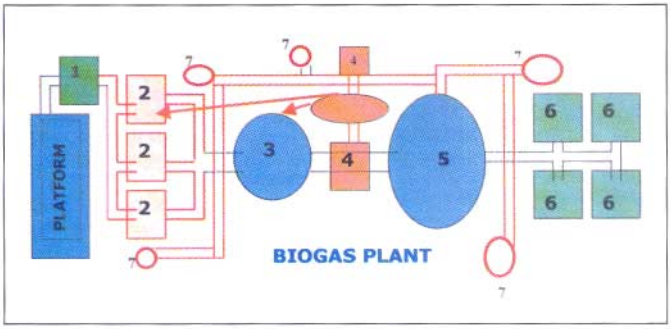
many spoilage and pathogenic organisms cannot survive in such extreme conditions. Therefore, it would be ideal if we can make use of these organisms to degrade the kitchen waste to remove more toxic elements and then subject it to the traditional biogas plant for methane generation. What we need to do is to maintain the high temperature in the predigestor tank. In Mumbai, sunlight is available almost throughout the year except for some days in the months of July-August. This natural source of energy can be effectively used for providing the thermophilic microorganisms their natural environment. This energy is used to heat the water and by controlling the proportion of hot water in the predigestor tank, one can achieve the desired temperature that can be easily sustained for about a day. This would provide favourable surroundings for the potential use of thermophiles to degrade the waste and sustain the culture. Thus, the system is self-sustainable and effective.

Another important aspect in smoother running of a biogas plant based on solid waste is how effectively one can avoid the choking of the plant. This choking may occur due to thick biomass that may be inaccessible to the microorganisms to digest it. The logical solution to such a problem is to convert the solid waste into slurry that would be far more accessible for the microbial action. A high power mixer to convert the solid waste into slurry can achieve this purpose. These two modifications will certainly improve design of the traditional biogas plant.

A biogas plant based on kitchen waste has been installed at Nursery site for environmental friendly disposal of the waste generated in kitchens of various canteens in BARC premises. It is expected that the plant can process all the waste generated in these canteens. This plant works on similar principles of traditional gobar gas plants with the exception of type of feed with the above modifications. However, there are some important points to be stressed to operate this plant with full efficiency. A little introduction to the structure of plant would be appropriate at this juncture to understand the finer points of it.

Biogas plant based on kitchen waste

A: Solar heater; B: Mixer for crushing waste matter; C: Pre-digester tank; D: Main digester



Comparison of BARC model of biogas plant based on kitchen waste with conventional biogas plants

Property	BARC biogas plant	Conventional biogas plant
Typed of waste processed	Kitchen waste, dry leaves, green grass, animal remains, paper etc.	Mainly gobar
Predigester	Included	Not included
Waste feed	After making a slurry in a mixer	Direct
Handling of waste	Needs segregation	Direct
Power consumption	5 HP motor for about 1 hour to run mixer	No power
Use of hot water	Solar heater is used for getting hot water, which is mixed in predigester	No usage of hot water
Type of bacteria	Thermophilic in predigester and Methanogenic bacteria in main tank	Methanogenic
Digestion	Aerobic and anaerobic	Anaerobic
Type of manure	High quality, weedless and odourless manure is obtained which can be used as soil conditioner	Manure is more fibrous and less consistent and may have bad odour
Processing time	About 10-12 days	About 30 days
Gas compositon	Methane 70-75%	Methane 50-55%
Scope	Urban and rural	Rural
Design	Suitable for larger community	Small scale
Advantage	1. Save on transporting of waste 2. Complete digestion of waste is possible 3. More environmental friendly	1. Do but lesser extent 2. Incomplete digestion 3. Do

The biogas plant has following components.

1. A mixer/pulper (5 HP motor) for crushing the solid waste
2. Premix tanks (3)
3. Predigester tank
4. Solar heater for water heating
5. Main digestion tank (35 m^3)
6. Manure pits (4)
7. Gas lamps for utilisation of the biogas generated in the plant

The waste generated in kitchen in the form of vegetable refuse, stale cooked and uncooked food, extracted tea powder, waste milk and milk products can all be processed in this plant. Based on our understanding of thermophilic microorganisms in particular and microbial processes in general, there are two important modifications made in the conventional design of the biogas plant in BARC. We have introduced a 5 HP mixer to process the waste before putting it into predigestor tank. The waste is converted into slurry by mixing water (1:1) in this mixture. Usually, this is the failure point as solid waste is difficult to get digested and can easily clog the system. The other modification is use of thermophilic microbes for faster degradation of the waste. The growth of thermophiles in the predigestor tank is assured by mixing the waste with hot water and maintaining the temperature in the range of 55-60°C. The hot water supply is from a solar heater. Even one-hour sunlight is sufficient per day to meet the needs of hot water.

From the predigestor tank, the slurry enters the main tank where it undergoes mainly anaerobic degradation by a consortium of archaebacteria belonging to *Methanococcus* group. These bacteria are naturally present in the alimentary canal of ruminant animals (cattle). They produce mainly methane from the cellulosic materials in the slurry.

The undigested lignocellulosic and hemicellulosic materials then are passed on to the settling tank. After about a month, high quality manure can be dug out from the settling tanks. There is no odour to the manure at all. The organic contents are high and this can improve the quality of humus in soil, which in turn is responsible for the fertility of the soil.

As the gas is generated in the main tank, the dome is slowly lifted up. It reaches a maximum height of 8 feet holding 35 m^3 of gas. This gas is a mixture of methane (70-75%), carbondioxide (10-15%) and water vapours (5-10%). It is taken through GI pipeline to the lampposts. Drains for condensed water vapour are provided on line. This gas burns with a blue flame and can be used for cooking as well. The gas generated in this plant is used for gas lights fitted around the plant. The potential use of this gas would be for a canteen. The manure generated is of high quality and can be used for our nursery and gamma field.

It must be stressed that the success of this biogas plant depends a great deal on the proper segregation of the kitchen waste. The materials that can pose problems to the efficient running of plant are coconut shells and coir, egg shells, onion peels, bones and plastic pieces. Steel utensils like dishes, spoons, etc. are likely to appear in the waste bags from canteens. While bones, shells and utensils can spoil the mixer physically, the onion peels, coir and plastic can have detrimental effects on microbial consortium in the predigester and main digestion tanks which could be disastrous for the plant. Hence, it is necessary that following precautions may be taken while collecting the kitchen waste. There should be a separate container for coconut shells, coir, egg shells, onion peels and bones. These will not be processed in the biogas plant. There should be separate containers of small volumes (5l. capacity) to collect the wet waste (spoilt or stale cooked food, waste milk products, etc.). The vegetables refuse like peels of various vegetables, rotten potatoes and tomatoes, coriander leaves, etc. may be collected in garbage bags of 5-kilo capacity. It must be noted that such segregation is of utmost importance for the smooth running of the biogas plant.

Thus, the efficient disposal of kitchen waste can be ecofriendly as well as cost effective. While

calculating the cost effectiveness of such waste disposal, one has to consider more than monitory aspects. The dumping of uncooked food in unmanned area may not be very civilized. It can also lead to population growth of nuisance animals. It is undoubtedly unhygienic and can pose threat to the habitat. These factors will add to the value of such plants. Using the natural friends in the form of thermophiles, methanogenic microorganisms and their consortiums, we can certainly handle the kitchen waste and may be other biodegradable waste like paper.

BARC DEVELOPS X-RAY PHOSPHOR

X-ray photographs obtained by using the intensifying screens coated with phosphor made by REDS.

Rare earth based X-ray phosphor has been developed in the country for the first time in the Rare Earth Development Section of BARC. The phosphor has wide applications in the medical field for the production of X-ray intensifying screens, and as an X-ray detector for nuclear applications. The material is relatively inexpensive and can be produced in the country with available raw materials. The intensifier screen produced on a trial basis by a local manufacturer of X-ray accessories has yielded good quality images. The phosphor emission can be used to develop both green and blue sensitive films, which is of added advantage with the phosphor screens to be used in medical radiography. The rare earth based phosphors enable significant exposure dose reduction over the conventional phosphors. Further studies on process optimisation are progressing. The screens of various speeds required for different types of medical radiography can be developed. (The work has been carried by a team consisting of Dr G. Alexander, Ms M. Anitha, Mr P. Ramakrishnan, Mr Ankur Chatterjee and Mr H. Singh of Rare Earths Development Section, Materials Group, BARC. The screen is evaluated by Mr C.R.P. Nair, MPSS, RPAD, BARC.)

ISOMED HONOURED

ISOMED, the first and largest industrial gamma sterilization plant for healthcare products in the country operated under the Board of Radiation & Isotope Technology (BRIT), Department of Atomic Energy, Government of India, was commissioned in the year 1974. ISOMED has completed 28 years of its un-interrupted gamma processing services operation to the healthcare sector by January 1, 2001. ISOMED has obtained ISO-9002 accreditation in July, 2000.

In recognition of the significant role played by their various business associates in their quality endeavours, the Professional Products Division of M/s. Johnson & Johnson Ltd., one of the healthcare products giants in the country, had started holding "Suppliers Recognition Nite", every year. In such an august function arranged by them on August 3, 2001 at Hotel Grand Maratha Sheraton, Sahar,

Dr N. Ramamoorthy, Chief Executive, BRIT, receiving the award on behalf of ISOMED

Mumbai, ISOMED bagged the award for excellence in service. This time, the award was given "in recognition of achieving lead time reduction". Dr N. Ramamoorthy, Chief Executive, BRIT, received the award from Mr Rajesh Dalal, President & Executive Director, Professional Products Division, M/s. Johnson & Johnson. Dr I.J. Singh, Vice President from the host organization, and Mr P. Madhusoodanan, General Manager, Gamma Radiation Processing Services, ISOMED, BRIT, were also present during the award giving ceremony.

The function was also attended by the other management executives and staff of M/s. Johnson & Johnson, as well as a host of other business associates of the host organization. This is the 5th time in succession that ISOMED bagged this prestigious recognition for Excellence in Services. The function had also enlightening talks by eminent management executives from M/s. Johnson & Johnson.

TRAINING COURSE IN 'BASIC RADIATION PROTECTION'

The Radiation Safety Systems Division (RSSD) conducted a three-day training course (September 19-21, 2001) in basic radiation protection for the benefit of staff members working in the Radiological Laboratories, HIRUP, and Advanced Fuel Fabrication Facility, Tarapur. The course was conducted at Radiological Laboratories, BARC.

Dr M.C. Abani, Head, RSSD, BARC, in his opening remarks, said that the course had been specially prepared keeping in view the safety requirements of the Divisions in the Radiological Laboratories. Mr D.S.C. Purushotham, Director, Nuclear Fuels Group, BARC, in his inaugural address, said that such training programmes would enhance the safety awareness among the staff and in turn result in overall safety at our laboratories. Dr V. Venkat Raj, Director, Health, Safety & Environment Group, BARC, said that, as BARC now has its own regulatory function, there is bigger responsibility on the staff to maintain the high standards of safety at BARC.

The faculty and the participants of the training course in "Basic Radiation Protection".

Thirty-seven participants attended the course. Faculty for the course was drawn from the Health, Safety & Environment Group, BARC. The course consisted of 12 lectures covering various subjects such as dose calculation, radiation biology, health physics instruments, dose and contamination control, industrial hygiene & safety, environmental monitoring, radiation emergency handling, radioactive waste disposal, plant-specific H.P. procedures, transportation of radioactive materials, unusual incidents, etc. The course was organized by Mr M.L. Joshi, Head, RHC Section, RSSD, and Dr K.L. Narasimharao, RSSD, with the active help

and co-operation of all the health physics units at RLG. Mr S. Majumdar, Head, RMD, Dr V. Venugopal, Head, FCD, and Dr S.B. Manohar, Head, RChD, gave invited lectures on engineered safety and management overview. Dr M.R.A. Pillai, Head, Radiopharmaceuticals Division, gave the concluding remarks and suggested that such courses should be conducted periodically.

ONE-DAY SEMINAR ON 'BACK END OF NUCLEAR FUEL CYCLE – STATUS & STRATEGIES'

A one-day seminar on "Back End of Nuclear Fuel Cycle – Status & Strategies" was organised by Nuclear Recycle Group, BARC, on July 30, 2001 at BARC, Trombay. Dr Anil Kakodkar, Chairman, AEC & Secretary, DAE, Government of India, inaugurated the seminar, and Mr B. Bhattacharjee, Director, BARC, presided over the function.

Inauguration of the one-day seminar. Seated from left to right are: Mr B. Bhattacharjee, Director, BARC, Mr K. Balu, Director, Nuclear Recycle Group, BARC, Dr Anil Kakodkar, Chairman, Atomic Energy Commission & Secretary to Government of India, and Mr V.P. Kansra, Associate Director, Nuclear Recyle Group, BARC.

In his inaugural address, Dr Kakodkar emphasized the vital role of the back end of the fuel cycle in the successful implementation of the Indian Nuclear Power Programme, wherein plutonium forms the vital link in the three stage programme. Mr Bhattacharjee, in his presidential address, lauded the efforts which have gone into the smooth functioning of all the reprocessing plants in the country and also complimented the successful restart of the vitrification plant for high level waste at WIP, Tarapur. Emphasizing the need to gear up to meet the scheduled nuclear power profile for India, he also stressed for early commissioning of WIPs at Trombay and Kalpakkam.

Mr K. Balu, Director, Nuclear Recycle Group, BARC, discussed fuel cycle strategies and its impact on waste management. He also discussed the development and induction of cross cutting technology that have to be adopted, not only to meet the challenges posed by FBR & AHWR fuel cycle but also to address recycle and recovery of valuable resources from waste leading to positive impact on the environment.

Mr D.S.C. Purushotham, Director, Nuclear Fuels Group, BARC, dealt with advanced fuels and the challenges in their fabrication based on mixed (U-Pu), (Th-Pu), (Th-U233) for different reactor systems, right from thermal reactors to advanced heavy water reactors including fast reactors.

Mr V.P. Kansra, Associate Director, Nuclear Recycle Group, BARC, while giving the status of reprocessing plants all over India, emphasized the need for large size plants which are crucial for the successful implementation of the three stage nuclear power programme. This would entail developmental efforts with respect to processes, technologies, automation and materials to make Indian reprocessing programme meet the enhanced demands of fissile material.

Dr S. Banerjee discussed the selection and development of materials for use at the back end of fuel cycle where they have to withstand very aggressive environment during reprocessing and also ensure long term stability for waste confinement.

Dr V. Venkatraj, Director, Health, Safety & Environment Group, BARC, dealt with the health and safety perspective in reprocessing and waste management plants. While discussing the radiological safety aspect of these plants, he pointed out that the individual and collective doses and activity discharge to the environment have been much below the acceptable limits in all the plants.

The meet concluded with a felicitation ceremony in honour of Mr K. Balu, Director, Nuclear Recycle Group, BARC, on his superannuation. Dr Kakodkar, Mr Bhattacharjee and many others highlighted Mr K. Balu's invaluable contribution to the back end of the fuel cycle and other allied activities of DAE.

IAEA RESEARCH COORDINATION MEETING

BARC hosted a Research Coordination Meeting (RCM) of the IAEA's Coordinated Research Programme (CRP) on "Development of Radioimmunometric Assays & Kits for Non-clinical Applications", during November 5-9, 2001. Mr. B. Bhattacharjee, Director, BARC and Member, Atomic Energy Commission, inaugurated the Meeting on November 5, 2001 in Hotel Parle International, Vile Parle, Mumbai. Nine different countries participated in the Meeting. The participants included two from South America, two from Europe and five from Asia. Dr M.R.A. Pillai, Head, Radiopharmaceuticals Division, BARC & Senior General Manager, Medical & Biological Products Programme (MBPP), BRIT, welcomed the participants and invitees to the inaugural function. Dr J.P. Mittal, Director, Chemistry & Isotope Group, BARC, and Dr N. Ramamoorthy, Associate Director, Isotope Group, BARC & Chief Executive, BRIT, addressed the participants. Dr D.D. Sood, Director, Division of Physical and Chemical Sciences, IAEA, and Dr D.V.S. Narasimhan, Technical Officer, Industrial Applications and Chemistry Section, IAEA, spoke on the Coordinated Research Programme on the non-clinical applications of immunoassays and the role IAEA is playing to bring the benefits of the immunoassay programme for the diagnosis of various diseases in developing countries. Mr B. Bhattacharjee, Director, BARC, while inaugurating the RCM, emphasized the role BARC is playing on the development of medical applications of radioisotopes. He also spoke on the possibilities of using the immunoassay techniques for non-clinical applications such as in veterinary sciences, environmental monitoring and in food technology. Dr (Ms) Grace Samuel, the Principal Investigator of the CRP from India, introduced the participants to the invitees and Dr (Ms) Meera Venkatesh, Head, Radiopharmaceuticals Chemistry Section and General Manager, Quality Control Programme, BRIT, proposed the vote of thanks.

Mr B. Bhattacharjee, Director, BARC, inaugurating the IAEA Research Coordination Meeting on November 5, 2001

The invention of Radioimmunoassay by Rosalyn Yalow and Solomon Berson in the late fifties was a major step in clinical chemistry. This was a successful combination of the use of a biological material (antibody) for the estimation of the antigen against which it is produced. The reaction between the antigen (analyte) and its specific antibody impart high specificity to the immunoassay. The use of the radioisotope in the form of a tracer imparted the sensitivity needed in detection. The immunoassays using alternate labels such as chemiluminescent or fluorescent labels have opened up the possibility of

improving the sensitivity further. The current class of immunoassays hence encompasses all the assays, which use an antibody as a specific molecule, and any one of the markers such as radioactivity, enzyme, chemiluminescent or fluorescent label.

The participants of the Research Coordination Meeting

As a diagnostic tool, immunoassays have found tremendous application in the field of endocrinology. They are being used for several decades for quantitative estimation of nearly all hormones such as thyroid hormones, fertility hormones, etc. Progressively, immunoassays were used for measurement of tumour markers, viral antigens, drugs, steroids, etc. and have made clinical diagnosis far easier than before. The specificity, sensitivity, cost effectiveness and ease of performance of immunoassays have made them indispensable tools in analytical clinical science.

In the past few years, immunoassays have traversed into non-clinical areas such as food industry, environmental study, veterinary science, forensic investigations and pharmocognosy. There is a growing need in many countries to measure or detect a variety of chemicals, which have impact on the environment, the quality and safety of food, and agriculture.

In the food industry, immunoassays are used to estimate a wide variety of substances such as naturally occurring food constituents, flavour constituents, plant growth substances, indicators of spoilage of food, microorganism during food processing and other undesirable components such as micotoxins.

In veterinary science, better cattle breeding management and livestock improvement are possible when their hormonal levels are monitored. Here too, immunoassays are widely used for the estimation of steroid hormones for cattle breeding management and for diagnosis of various diseases that affect cattle.

In environmental science, the potential benefits of immunoassay methods to estimate compounds which were difficult to estimate by gas chromatography were realized and this technique is now being extended to the analysis of soil, water, food and other matrices of environmental significance. Estimation of pesticides, metals and industrial chemicals that are either carcinogenic or toxic are useful in environmental monitoring. With the continued changes in the variety and amounts of pesticides and herbicides used in fields and with the increased concern over the long-term effects of such chemicals, their measurement in various environmental samples become important. In this growing field, immunoassays have made an impact and could find wide applications.

The present CRP will focus on radioimmunoassay of analytes useful for non-clinical applications in veterinary sciences, for food safety and estimation of pesticide residues. In this CRP, the participants will develop radioimmunoassays for three target molecules, namely, viz. aflatoxin B_1, progesterone and atrazine for their measurement in non-clinical samples such as food, milk and environmental matrix, respectively. Scientists from different countries deliberated on the work plan, which they will be executing during the course of the CRP. The Research Coordination Meeting was concluded on November 9, 2001. The participants also visited Bhabha Atomic Research Centre during the Meeting.

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