

ISSUE NO. 288 | JANUARY 2008

बीएआरसी
न्यूज़लैटर

BARC
NEWSLETTER



IN THIS ISSUE

**APPLICATION OF AN ELECTROCHEMICAL FILTER FOR IRON
TURBIDITY REMOVAL FROM THE ACTIVE PROCESS WATER SYSTEM**

**DIGITAL RECORDING SYSTEM FOR THERMOLUMINESCENCE
SET-UP FOR PHOTOSYNTHESIS STUDIES**

In the next issue

CPA Nd: glass laser system for intense laser matter interaction research

The Chirped Pulse Amplification (CPA) technique, has become the technique of choice for producing high peak power, ultra-short pulse duration pulses in the femtosecond range. Using this technique a regenerative amplifier and stretcher for a CPA system, has been designed and demonstrated for the first time in BARC. A brief description of the femtosecond range oscillator, the stretcher/compressor system, the regenerative amplifier system and the trigger synchronization systems are covered in this article.

Potential and prospects of ultrafiltration

Membrane processes are selective separation processes, wherein the bulk phases are physically separated by a third phase, the membrane; there are various types of membrane processes. Ultrafiltration; a pressure-driven membrane process has been described in the present article. The membrane configuration, concentration polarization / fouling and control of membrane fouling and potential applications of ultrafiltration have also been discussed in this article.

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URL:<http://www.barc.gov.in>

डॉ. श्रीकुमार बॅनर्जी

निदेशक, भा.प.अ. केंद्र, का नव वर्ष संदेश



प्रिय साथियों,

मेरे लिए यह अत्यंत प्रसन्नता का अवसर है कि मैं आप सभी तथा आपके परिवारजनों को नववर्ष की शुभकामनाएं देता हूँ।

भाभा परमाणु अनुसंधान केंद्र विश्व के सबसे बड़े अनुसंधान एवं विकास केंद्रों में से एक है जहाँ हम एक ही छत के नीचे विविध गतिविधियों को सम्मिलित करते हुए नाभिकीय विज्ञान एवं प्रौद्योगिकी में उत्कृष्टता का अनुसरण करते हैं।

पिछला वर्ष नाभिकीय विज्ञान एवं प्रौद्योगिकी तथा विद्युत उत्पादन, कृषि खाद्य परिरक्षण, स्वास्थ्य देखभाल, उद्योग एवं राष्ट्रीय सुरक्षा में विकासशील प्रयासों में एक और सफल वर्ष रहा है। पिछले वर्ष के दौरान विकसित विभिन्न प्रणालियों एवं प्रौद्योगिकियों में से कुछ प्रमुख उदाहरणों का उल्लेख मैं करना चाहूँगा।

अनुसंधान रिएक्टर

तीनो रिएक्टर अप्सरा, सायरस और ध्रुवा अपने उच्च उपलब्धता गुणांक के साथ संतोषजनक रूप से कार्यरत रहे।

वर्तमान में अप्सरा रिएक्टर को 2 MW रिएक्टर में उन्नयित करने संबंधी व्यवहार्यता अध्ययन चल रहे हैं। भूकंपीय घटना से बचाव के लिए अप्सरा रिएक्टर भवन हेतु प्रति फिटिंग मानकों के एक भाग के रूप इलेस्टो प्लास्टिक डम्पर्स सहित अप्सरा रिएक्टर भवन प्रारूप के शेक टेबल परीक्षण सफलतापूर्वक किये गये और प्रतिक्रियास्वरूप इसमें उल्लेखनीय कमी देखी गई।

सायरस रिएक्टर सामान्यतः 20 MW(th) पर 90.2% की उपलब्धता गुणांक सहित प्रचालित किया जाता था। फिर भी, रिएक्टर की शक्ति को आवश्यकतानुसार उच्चतर स्तरों तक बढ़ाया गया था।

अनुसंधान रिएक्टर ध्रुवा, रेडियोआइसोटोप उत्पादन हेतु मुख्य सुविधा के रूप में कार्यरत रहा और न्यूट्रॉन किरणपुंज अनुसंधान हेतु राष्ट्रीय सुविधा के रूप में सेवारत रहा। रिएक्टर को 60 MW(th) पर 82.7% की उपलब्धता गुणांक सहित चलाया गया जिसके दौरान करीब 650 नमूनों को किरणित किया गया। पिछले वर्षों की तरह ही, वैज्ञानिक अनुसंधान हेतु UGC-DAE संकाय के तत्वावधान में देश के विभिन्न शैक्षणिक संस्थानों से बड़ी संख्या में आये अनुसंधान छात्रों ने रिएक्टर का प्रयोग करते हुए अपनी अनुसंधान गतिविधियों को जारी रखा।

एएचडब्ल्यूआर एवं आगामी पीएचडब्ल्यूआर रिएक्टरों के भौतिकी प्रयोगों हेतु नवीन क्रांतिक सुविधाओं की विभिन्न प्रणालियों का सफलतापूर्वक कमीशनन कर लिया गया। सुविधा में 25 विखंडन चेंबर पर आधारित फ्लक्स मैपिंग सिस्टम की स्थापना कर ली गई है। सुविधा को शीघ्र ही प्रचालनरत करने हेतु प्रयास तेजी पर हैं।

एएचडब्ल्यूआर कार्यक्रम

ईआरबी की पूर्व-लाइसेंसिंग अभिकल्पन संरक्षा समिति द्वारा एएचडब्ल्यूआर की समीक्षा करीब-करीब पूरी कर ली गई है और यह निष्कर्ष निकाला गया है कि कोई ऐसा सम्भावित मुद्दा नहीं है जिसके कारण एएचडब्ल्यूआर की लाइसेंसिंग में बाधा आये।

इसी बीच विभिन्न प्रारंभिक लोडिंगों का विस्तार से विश्लेषण किया गया ताकि क्रोड पुनःसक्रियता एवं शटडाउन आवश्यकताओं सहित समाकृति अनुकूलन तक पहुँचा जा सके ।

एएचडब्ल्यूआर की क्रांतिक पॉवर निर्धारित करने हेतु प्रयोगों को 3 MW क्वथन जल में निष्पादित किया गया था जिससे यह निश्चित हुआ कि डिजाइन में विचार किए गये ताप मार्जिन परम्परागत हैं ।

निष्क्रिय संरोधन पृथक्करण प्रणाली के निष्पादन को जाँचने के लिए एक परीक्षण सुविधा की स्थापना कर ली गई है ।

एनपीसीआईएल के साथ एक समझौता ज्ञापन हस्ताक्षरित किया गया है ताकि ताप जलीय परीक्षण करने के लिए समग्र जाँच सुविधाओं का स्थापन किया जा सके तथा अनुसंधान एवं विकास केन्द्र, तारापुर में ईंधनन मशीनों से संबंधित अध्ययन किये जा सकें ।

एचटीआर कार्यक्रम

दूसरे शटडाउन हेतु बेरिलियम ऑक्साइड परावर्तक तथा प्रारंभिक शटडाउन के लिए टंगस्टेन छड़ों की अक्षीय गति पर आधारित संहत उच्च तापमान रिएक्टर के लिए एक वैकल्पिक शटडाउन प्रणाली का प्रस्ताव है ।

सीएचटीआर के युग्मित न्यूट्रॉनिक एवं ताप हाइड्रालिक विश्लेषण हेतु समय आश्रित विसरण सिद्धान्त पर आधारित एक 3-D त्रिकोण ज्यामिति कोड का विकास कर लिया गया है और इसका विधिमान्यकरण प्रगति पर है ।

प्रस्तावित सीएचटीआर में शीतलक के रूप में द्रव धातु (सीसा बिस्मिथगलन क्रांतिक) के सामान्य परिसरण तथ्य का अध्ययन करने के लिए एक लूप की स्थापना पूर्ण होने वाली है ।

पीएचडब्ल्यूआर कार्यक्रम

पीएचडब्ल्यूआर के ईंधन चैनलों हेतु अक्षीय विसर्पण (UMAC) के तीव्र एवं अधिक विशुद्ध पराश्रव्य मापन हेतु एनपीसीआईएल के साथ समझौता ज्ञापन हस्ताक्षरित किया गया ।

एक द्रवचलित सुदूरहस्तन द्वारा प्रचालित त्रिपदीय माइक्रोमीटर का विकास किया गया और इसे दाब नलिका के आन्तरिक व्यास के स्वस्थाने मापन हेतु RAPS-2 में लगाया गया ।

एनटीपीसी के साथ एक समझौता ज्ञापन के तहत, एक ऑन लाइन, गैर-अन्तर्वेधी कंपन मॉनीटरन प्रणाली, जैसी कि TAPS-3 में स्थापित की गई थी, का स्थापन यू.पी. में औरइया संयंत्र की गैस टर्बाइन इकाई में कर लिया गया है । यह देश में अपने प्रकार की अकेली प्रणाली है जहाँ टर्बाइन ब्लेड्स एवं शाफ्ट की स्थिति का मॉनीटरन किया जाता है ।

प्राकृतिक परिसरण अस्थिरता के दमन हेतु तथा परिसरण दर को बढ़ाने हेतु नैनो-तरल (नैनो-कण तरल में पानी की तरह फैल जाते हैं) का उपयोग भा.प.अ. केंद्र में सफलतापूर्वक निर्दिशित किया गया है ।

एक अति उच्च दाब एवं तापमान वाली टैस्ट लूप की स्थापना की गई है और उसका प्राकृतिक परिसरण स्थिरता आचरण के अध्ययन तथा सुपर क्रांतिक जल एवं कार्बन-डाई-ऑक्साइड के ताप जलीय संबंध हेतु हाइड्रोटेस्ट किया गया है ।

पीएफबीआर

आईजीकार/भाविनी को पीएफबीआर के लिए आनत ईंधन मशीन (आईएफटीएम) उपलब्ध कराने एवं एईआरबी से संरक्षा क्लियरेंस दिलाने में सहयोग दिया गया ।

भापअ केंद्र ने एफबीटीआर के प्रचालन के लिये मिश्रित कार्बाइड एवं मॉक्स ईंधनों की आपूर्ति जारी रखी तथा वर्ष 2007 के दौरान रिकार्ड आपूर्ति की। मिश्रित कार्बाइड ईंधन के 6 ईंधन उप-समुच्चयों के लिए पिनों की आपूर्ति की गई जिसमें वे भी शामिल हैं जिन्हें मिश्रित कार्बाइड पुनर्संसाधन से प्राप्त Pu द्वारा बनाया गया, इस तरह एफबीटीआर हेतु ईंधन चक्र को पूर्ण किया गया। नवीन FBTR ईंधन संविरचन लाइन अब Pu कमीशनन हेतु तैयार है और आगे भी उत्पादन क्षमता में पर्याप्त संवर्धन होगा।

भा.प.अ. केन्द्र द्वारा संविरचित पीएफबीआर ईंधन अभिकल्पन के प्रयोगात्मक मॉक्स ईंधन को एफबीटीआर क्रोड के केन्द्र में किरणित किया जा रहा है और इसका बर्नअप 80,000 MWD/T तक पहुँच चुका है जोकि पीएफबीआर ईंधन के बर्नअप लक्ष्य का 80% है। पीएफबीआर ईंधन एवं अक्षीय ब्लैंकेट के विनिर्माण का निदर्शन पहले दो उप-समुच्चयों हेतु सफलतापूर्वक किया जा चुका है और प्रेषण के लिए तैयार है।

स्वास्थ्य, पर्यावरण एवं संरक्षा अध्ययन

चैनल हीट-अप सुविधा में मॉडरेटर कूलिंग के साथ व उसके बिना प्रेशर थ्यूब बैलूनिंग युक्त विभिन्न दुर्घटना परिदृश्य हेतु प्रयोगात्मक अध्ययन किये गये। इन अध्ययनों के द्वारा दुर्घटना विश्लेषण में गृहीत सेजिंग एवं बैलूनिंग के लाभों को वास्तव में पहली बार महसूस किया गया।

बहुत से ताप हाइड्रालिक विश्लेषणों द्वारा निर्मित डाटाबेसों के आधार पर, LOCA से जुड़े 32 ब्रेक सिनरियों हेतु आपातकालीन क्रोड शीतलन प्रणाली के साथ और उसके बिना तंत्रिका नेटवर्क विश्लेषण किये गये। इन परिणामों को ऑपरेटर की सहायता के लिए लक्षण आधारित नैदानिक प्रणाली में समाविष्ट किया गया है।

दादरी संयंत्र में जहाँ क्रीप एवं फटिंग डैमेज के ऑनलाइन मॉनीटरन हेतु वीएआरसी संरचनात्मक मूल्यांकन प्रणाली BOSSES का प्रयोग किया जाता है, 27,000 घंटे से अधिक के क्षतिग्रस्त डाटा को प्राप्त किया गया है। BOSSES द्वारा पहचान की गई क्षति का सत्यापन सुपरहीटर बाह्य हैडर के विभिन्न बिन्दुओं से रिप्लीकेस के सूक्ष्मसंरचनात्मक परीक्षण द्वारा संतोषजनक रूप से किया गया।

यूरेनियम एवं इसके क्षयजातों के प्रवसन के मन्दन में यूरेनियम टेलिंगस पॉन्ड में बेन्टोनाइट लाइनिंग की सामर्थ्य के मूल्यांकन संबंधी अध्ययनों से यह स्पष्ट हुआ है कि टेलिंगस पॉन्ड के नीचे चरम सांद्रता बिना बेन्टोनाइट लाइनर की तुलना में लगभग 1.5 गुना कम होती है।

प्रगत हल्के हैलीकैप्टरों में स्थायी रूप से लगाने हेतु एक वायु उपयुक्त एरियल गामा स्पेक्ट्रोमीटर सिस्टम का विकास कर लिया गया है और अब इसे तैनात किया जा रहा है। इसका प्रयोग रक्षा संस्थानों द्वारा आपातकालीन तैयारी व प्रशिक्षण हेतु किया जायेगा।

एक चलती-फिरती विकिरणकीय संघात आकलन प्रयोगशाला की स्थापना ट्राम्बे में की गई है ताकि विकरणकीय आपातकाल के दौरान पब्लिक क्षेत्रों में संघात मूल्यांकन किया जा सके। मद प्रयोगशाला ऐसे मूल्यांकन हेतु आवश्यक अनिवार्य इनपुट उपलब्ध कराने के लिए GPS एवं मौसमविज्ञान संबंधी प्रणाली से सुसज्जित है।

दो NPP क्षेत्रों जैसे नरोरा एवं कैगा के आस-पास आश्रमस्थानों, अस्पतालों, निष्क्रमण मार्गों इत्यादि की उपलब्धता पर विभिन्न स्तरों वाली डाटायुक्त भौगोलिक सूचना प्रणाली (जीआईएस) की स्थापना कर ली गई है।

नरोरा GIS डाटा बेस को साइट पर कमीशन किये गये इन्डियन रियल-टाइम ऑनलाइन डिजीजन सपोर्ट सिस्टम (IRODOS) के साथ जोड़ा गया है।

NAPS के इर्दगिर्द 26 IERMON प्रणालियों को दो रिंगों में रिंग मॉनीटर के रूप में स्थापित किया गया ताकि IRODOS संसाधन प्रणाली को विकिरण डाटा उपलब्ध करवाया जा सके ।

GSM आधारित डाटा कम्युनिकेशन सहित सौर ऊर्जा वाले पर्यावरणीय विकिरण मॉनीटरो के उपयोग द्वारा 52 IERMON स्टेशनों को पूरे देश में स्थापित किया गया । आधुनिकतम प्रौद्योगिकी वाली इन प्रणालियों का विकास एवं विनिर्माण, भापअ केंद्र में किया गया है ।

ईंधन पुनर्संसाधन एवं अपशिष्ट प्रबंधन गतिविधियाँ

अनुसंधान रिक्टरों से प्राप्त भुक्तशेष ईंधन को संसाधित करने के लिए ट्राम्बे में प्लूटोनियम संयंत्र सक्षमता पूर्वक प्रचालनरत है । NAPS-1 एवं कैगा को पुनःईंधन की आपूर्ति के लिए आवश्यक निःशेष यूरेनियम (DU) की आपूर्ति प्लूटोनियम संयंत्र द्वारा प्राथमिकता के आधार पर की गई ।

प्रिफ्री, तारापुर बहुत ही संरक्षा पूर्वक प्रचालनरत है तथा इसके द्वारा रिकार्ड उत्पादन किया गया है और प्रगत काचीकरण सुविधा तारापुर में 102 काचीकरण ऑपरेशन पूर्ण कर लिए गये हैं परिणामस्वरूप उच्च स्तरीय अपशिष्ट के 222 m³ का काचीकरण हुआ है ।

28 सितम्बर, 2007 को काचीकृत अपशिष्ट उत्पादों के 200 वें कनस्तर का उत्पादन कर WIP, ट्राम्बे ने विशिष्ट उपलब्धि प्राप्त की ।

तारापुर में SSSF के भंडारण वाल्ट के एक सेक्शन के कमीशनन सहित, AVS तारापुर से कुल 47 औवरपैक तथा WIP, ट्राम्बे से 9 औवरपैकों को सुरक्षा पूर्वक स्थापित किया गया ।

मल्टीपल ब्लेड समुच्चयन संकल्पना पर आधारित एक अभिनव भुक्तशेष ईंधन चॉपर का विकास किया गया ताकि एक स्ट्रोक में ही PHWR ईंधन गुच्छों की गैंग चॉपिंग की जा सके । यह नवीन, पूर्णतयः स्वचालित सुदूरहस्तन द्वारा प्रचालित मशीन मेसर्स एचएमटी लिमिटेड द्वारा निर्मित की गई है तथा तारापुर संयंत्र हेतु सुपुर्दगी हेतु तैयार है ।

भापअ केंद्र द्वारा भाभाट्रॉन एवं अन्य टेलीथेरेपी मशीनों हेतु कोबाल्ट-60 स्रोत के परिवहन हेतु एक 15 किलो संचयी क्षमता वाले कन्टेनर का विकास किया गया ।

पदार्थ अनुसंधान

नवम्बर, 2007 को तुमल्लपल्ली, आंध्रप्रदेश में प्रथम यूरेनियम माइन एवं मिल हेतु शिलान्यास किया गया । नींव समारोह के मुख्य अतिथि आंध्रप्रदेश के मुख्यमंत्री डॉ. वाई.एस. राजशेखर रेड्डी थे । इस केन्द्र के वैज्ञानिकों द्वारा एएमडी, यूसीआईएल एवं एनपीसीआईएल के सहयोग से एक पूर्णतयाः नवीन क्षारीय निक्षालन वाले संसाधन को प्रस्तावित संयंत्र में लगाया जायेगा ।

भापअ केंद्र द्वारा फॉस्फोरिक अम्ल से यूरेनियम की पुनःप्राप्ति हेतु प्रस्तावित पाइलट सुविधा में नाभिकीय ग्रेड के अमोनियम ड्राईयूरेनेट के उत्पादन के लिये भारी पानी बोर्ड के कर्मचारियों को प्रशिक्षण सहित विश्लेषणात्मक सहायता प्रदान की गयी ।

एलसीए कार्यक्रम हेतु भापअ केंद्र द्वारा शेष मेमेरी पदार्थ वाले अनेक हीट श्रिकेबल स्लीव्स (2500) की आपूर्ति की गयी एवं वर्तमान में इन स्लीव्स की सहायता से सात हवाई जहाज उड़ रहे हैं । इस वर्ष के दौरान एचएएल में उत्पादन सुविधा स्थापित

करने के लिये एडीए एवं एचएएल के साथ भापअ केंद्र का एक समझौता ज्ञापन हस्ताक्षरित किया गया है। यह सुविधा विश्व भर में मौजूद कुछ सुविधाओं में से एक है जिसमें इस प्रकार के पदार्थों का उत्पादन किया जाता है।

जर्कोनियम मिश्रधातु के संक्षारण एवं हाइड्रोजन अपटेक आचरण पर प्रस्तावित 750 Mw दाबित भारी पानी रिएक्टरों में अपनाये जाने वाले आंशिक क्वथन के प्रभाव पर अध्ययन से पता चला है कि घुलित ऑक्सीजन के प्रति जहां जर्कोलॉय असंवेदनशील रहते हैं वहीं Zr-Nb के ऑक्सीकरण दर पर प्रतिकूल प्रभाव पड़ता है।

भापअ केंद्र द्वारा आईपीआर, अहमदाबाद स्थित संलयन रिएक्टर के लिये आवश्यक अतिचालन चुंबकों हेतु अनेक अभिविन्यास के केबल -इन-कॉन्ड्यूट-कंडक्टर (CICC) का विकास एवं संविरचन कार्य प्रारंभ किया गया है। 48 मल्टी-फिलामेंटरी Nb-Ti SC तारों एवं 288 OFHC तांबे के तारों युक्त 10KA CICC (20mm x 20mm क्रॉस सेक्शन x 6m L) का संविरचन कर आईपीआर को आपूर्ति की गयी। कॉन्ड्यूट में परिशून्य गुणांक ~ 30% है जो द्रव हीलियम के प्रवाह हेतु आवश्यक है।

हाइड्रोजन भंडारण प्रौद्योगिकी विकास के अध्ययन के अंतर्गत, Mg/Pd तनु फिल्मों में हाइड्रोजन उद्ग्रहण, MgH₂ के रससमीकरणमिक्तिक अनुपातों के निकट पाया गया। विहाइड्रोजनीकरण एवं हाइड्रोजनीकरण चक्रों का उन्हीं फिल्म समूह पर अध्ययन जारी है। सामान्य कोशिकाओं की तुलना में कैसर युक्त कोशिकाओं द्वारा स्वर्ण नैनो-कणों का उद्ग्रहण अधिक पाया गया। अब नैनो-कणों को उचित बायो अणुओं से लेपित करने के लिये विशेष उपचार पद्धति अपनाई जायेगी जिससे केवल कैसर कोशिका ही स्वर्ण नैनो-कणों का उद्ग्रहण कर सकें। इससे नैनो चिकित्सा में नये विकास का मार्ग खुलेगा।

सेरेमिक मधुकोष संरचनाओं (ARCI द्वारा उपलब्ध कराई गयी) पर ऐलुमिना के मीसो एवं नैनो-पोरस फिल्मों का प्रयोग करके पेय जल से घुलित फ्लोराइड को हटाने हेतु एक किट का विकास किया गया। ऐलुमिना के प्रत्येक किलो पर 15mg क्षमता तक फ्लोराइड हटाया जा सका।

निम्न ऊर्जा उच्च तीव्रता प्रोटान त्वरक (LEHIPA)

निम्न ऊर्जा उच्च तीव्रता प्रोटान त्वरक (LEHIPA) में अनुप्रयोग हेतु तीन इलेक्ट्रोड अभिविन्यास का प्रयोग करते हुये एक 50 kV, 30 ma इलेक्ट्रॉन साइक्लोट्रॉन अनुनाद (ECR) आधारित माइक्रोवेव आयन स्रोत का कमीशनन किया गया।

35 kV निष्कर्षण वोल्टता पर 800 W, 245 GHz माइक्रोवेव शक्ति का प्रयोग करते हुए उत्पन्न ECR हाइड्रोजन प्लाज्मा से 17 ma की अधिकतम प्रोटान करेंट प्राप्त की गई।

निम्न ऊर्जा किरणपुंज वहन लाइनों हेतु भापअ केंद्र में अभिकल्पित चार सोलेनाइडों को RRCAT में संविरचित किया गया। ड्रिफ्ट ट्यूब लिनाक (DTL) का यांत्रिक एवं तापीय डिजाइन को ज्यमितीय सहायता एवं ब्योरों सहित पूरा किया गया।

LEHIPA फैसिलिटी के बेसमेंट स्थल में लिनाक एवं बीम डंप रूम हेतु शील्डिंग वाल्स सहित सिविल कार्य पूरा किया गया।

रासायनिकी

क्वान्टम रासायनिक परिकल्पनों के माध्यम से, यह निर्दिष्ट किया गया है कि फुलरीन अणुओं के क्षार धातु परमाणुओं से सम्मिलन पर

उनकी हाइड्रोजन अधिशोषण क्षमता बढ़ती है। यह देखा गया है कि प्रस्तावित अभिनव नैनो पदार्थ Na_8C_{60} , 48 हाइड्रोजन अणुओं का अवशोषण करता है जिसके फलस्वरूप अधिशोषण क्षमता 9wt% तक बढ़ जाती है।

पीकोसेकंड लिनाक के फोटोकैथोड गन हेतु प्रयोग में लायी जाने वाली फेम्टोसेकंड टेरा-वाट लेसर प्रणाली का सफलतापूर्वक कमीशनन किया गया। लेसर सिस्टम एक Ti: सैफायर आसिलेटर-800 nm पर 36 fs पल्स में 35 mJ रीजनरेटिव एम्प्लिफायर देने वाले पर आधारित है।

प्रतिदीप्ति में महत्वपूर्ण उन्नति का निदर्शन उपयुक्त सुप्रामालिकुलर होस्ट-गेस्ट रासायनिकी द्वारा किया गया एवं ऐसी उन्नति को बायोसेन्सर/प्रोटीन सेन्सर अनुप्रयोगों हेतु लाभकारी रूप से प्रयोग में लाया जा सकता है।

चयनित जीवाणु से *E.Coli* क्लोनिंग एवं धातु संवाहक जीनों के ओवर एक्सप्रेशन द्वारा धातु आयन के वहन में वृद्धि करते हुए जीवाणु की धातु निष्कासन क्षमता बढ़ाई गई। इस तकनीक के प्रयोग द्वारा अनुकारित विसंदूषण भुक्तशेष घोल से ^{60}Co के निष्कासन में प्रयोग करने पर एक घंटे में दो चक्रों द्वारा 75% से अधिक उपलब्धि देखी गई।

स्वगृहे विकसित 33 युग्म युक्त कैथोड एवं एनोड ग्रेफाइट फेल्ट्स की परिवर्ती व्यूह वाले विद्युत रसायनिक फिल्टर (ECF) का कैगा यूनिट 1 की सक्रिय प्रक्रम जल प्रणाली में अन्तर्वर्ती शीतलन परिपथ में लोहे के गदलेपन को दूर करने में सफलतापूर्वक प्रयोग किया गया।

51 एलिमेंटों तक के एक साथ स्पेक्ट्रोरासायनिक विश्लेषण हेतु एक परमाणु उत्सर्जन स्पेक्ट्रममापी का विकास किया गया। B, Cd, Mn एवं Ni हेतु प्राप्त निम्नतम डिक्टेसन सीमा 0.05 ppm. है।

लेसर एवं प्लाज्मा प्रौद्योगिकी

एक सुदूर प्रचालित संकीर्ण बैंडविड्थ सिंगल लांगिट्यूडिनल मोड ट्यूनेबल पल्स लेसर प्रोटोटाइप का लगभग 560 nm पर 375 MHz बैंडविड्थ के साथ निदर्शन किया गया। यह देखा गया कि लेसर, 75 GHz से भी ऊपर बिना मोड हॉप के ट्यूनिंग मिरर पर 20 माइक्रान ट्रैवल के साथ पीजोएक्ट्रिक का प्रयोग करते हुए स्कैन कर सकता है।

भापअ केंद्र में पहले विकसित EXAFS बीमलाइन को आरआरकैट, इंदौर स्थित इंडस-2 सिंक्रोट्रान स्रोत के बीम पोर्ट नं. 8 पर अग्रभाग के साथ जोड़ा गया। स्वगृहे विकसित एक LAB View आधारित साफ्टवेयर के माध्यम से प्रयोक्ता, ट्रांजे से बीमलाइन के साथ सुदूर रूप से कार्य कर सकेंगे।

मैट्रिक्स समर्थित लेसर डिस्पार्शन / आयनाइजेशन टाइम ऑफ फ्लाइट मास स्पेक्ट्रोमीटर (MALDI - TOFMS) का विकास किया गया ताकि 1 pmole (पिको-मोल) स्तर पर 1 KDa (किलो डालटन) से 100 KDa तक की मास रेंज में जैव अणुओं के इन्टैक्ट आयनस् का उत्पादन तथा उनके आण्विक भार का संसूचक / अनुमान लगाया जा सके। मानक प्रोटीनों के प्रयोग द्वारा स्पेक्ट्रोमीटर का विस्तृत कार्य निष्पादन मूल्यांकन किया गया। स्टेन्लेस स्टील एवं सिलिकॉन सबस्ट्रेटों पर थिंट्रियम आक्साइड थिन फिल्मों के निक्षेपण हेतु एक माइक्रोवेव इलेक्ट्रान साइक्लोट्रान रिसोर्नेन्स प्लास्मा उन्नयित रासायनिक वाष्प निक्षेपण प्रक्रिया का विकास स्वदेशी संश्लेषित धातु कार्बनिक प्रिकर्सर के प्रयोग करते हुए किया गया।

निर्लवणीकरण प्रौद्योगिकी

देश के विभिन्न भागों में कुल 17 पार्टियों को ऑनलाइन घरेलू जल शुद्धिकारक की प्रौद्योगिकी का हस्तांतरण किया गया। अनुमानों के अनुसार हमारे लाइसेन्सी द्वारा देश के विविध भागों में लगभग 100,000 यूनिटों की बिक्री की गई। एटमिक एनर्जी वर्कर्स एण्ड स्टाफ यूनियन द्वारा इन जल शुद्धिकारकों को पञ्च कर्मचारी के परिवारों को रियायती दर पर उपलब्ध कराया गया।

कूलिंग टावर से जुड़ी मल्टी-इफेक्ट डिसेलीनेशन वेपर कंप्रेशन एवं लो टेंपरेचर इवापरेशन पर आधारित अति शुद्ध (> 10 मेगा ओहम-सेमी) जल उत्पादन करने वाली नेक्स्ट जनरेशन समुद्रीजल निर्लवणीकरण प्रौद्योगिकियां विकसित की गईं और ट्रांजे में इनका कमीशनन किया गया।

डॉ. अल बरेदी, महा निदेशक, अंतरराष्ट्रीय परमाणु ऊर्जा अभिकरण, दिनांक 9 अक्टूबर 2007 को भापअ केंद्र में पधारे एवं भापअ केंद्र द्वारा विकसित प्रचालनरत निर्लवणीकरण संयंत्रों एवं जल शुद्धिकरण प्रणाली पर प्रदर्शनी भी देखी।

नाभिकीय कृषि

कृषि के क्षेत्र में महत्वपूर्ण प्रगति की गई है। 8 नई ट्रांजे की फसल किस्में - मूंग की 2 एवं मूंगफली, सोयाबीन, सरसों, सूरजमुखी, चवली एवं अरहर की प्रत्येक की 1 किस्म का उन्मोचन किया गया और उन्हें कृषि मंत्रालय द्वारा देश के विभिन्न कृषि-मौसम क्षेत्रों में वाणिज्यिक कृषि हेतु अधिसूचित किया गया। इसके साथ ही अब तक उन्मोचन तथा वाणिज्यिक कृषि के लिए अधिसूचित ट्रांजे फसल किस्मों की कुल संख्या 35 हो गई है। ट्रांजे मूंगफली किस्मों के 600 किंवल से भी अधिक प्रजनक बीजों का उत्पादन कर विभिन्न बीज एजेन्सियों और किसानों को आपूर्ति की गई।

जैविकीय विज्ञान

जीवाणु में पहली बार एक डीएनए डैमेज एवं रिपेयर संबंधी अभिनव संकेत लक्षण की खोज की गयी। आनुवांशिक रूप से तैयार किए गए *E. Coli* जीवाणु क्षारीय फास्फेटेस (pho-N) जीन को दर्शाने वाली के द्वारा सक्षम रूप से कैड्मियम का अवक्षेपण किया जा सका अर्थात् उसके शुष्क भार से 20 गुना अधिक कैड्मियम फास्फेट के रूप में।

खाद्य प्रौद्योगिकी प्रभाग में पूर्व में पृथक् एक नवीन N-एल्कैलेटेड प्रोडिजियोसिन एनलॉग कैन्सर कोशिकाओं के प्रति साइटोटॉक्सिक पाया गया एवं यह कोशिका के स्वरूप अनुसार एपाप्टोसिस या नेक्रोसिस द्वारा कोशिका को नष्ट होने में प्रेरित करता है।

जैव प्रौद्योगिकी

8 निसर्गऋण बायोगैस संयंत्र जैव अपचयी अपशिष्ट के संसाधन हेतु जनवरी 2007 से कार्यरत हो चुके हैं तथा अब प्रचालनरत संयंत्रों की संख्या 19 हो गई है।

विकिरण चिकित्सा

विकिरण चिकित्सा केंद्र द्वारा अनेक रोगियों का उपचार जारी रहा। कैलेंडर वर्ष 2007 के दौरान 8000 से भी अधिक नैदानिक जांच किये गये। पहली बार यह देखा गया है कि रेडियो आयोडीन, नान थाइराइड ट्यूमरों के लिये चिकित्सीय विकल्प है। इसका निदर्शन एक रेडियो आयोडीन सांद्रित लंग ट्यूमर में किया गया, जिससे यह देखा गया कि रेडियो आयोडीन थेरेपी के पश्चात ट्यूमर का आकार छोटा हो गया। 18 FDG पोजिट्रान एमिशन टोमोग्राफी (PET) से आण्विक इमेजिंग से पता चला है कि रेडियो आयोडीन थेरेपी के पश्चात एक यूथाइराइड की स्थिति बनाये रखने के लिये एक संस्टेन्ड थाइराइडिटिस जैसी स्थिति की आवश्यकता है।

पोजिट्रान एमिशन जैसे फंक्शनल मेडैलिटीज द्वारा उपलब्ध कराई गई MRI एवं परिमाणात्मक आपचयी सूचना जैसी संरचनात्मक इमेजिंग तकनीकों से विभाजित वाल्युमैट्रिक डाटा के साथ जोड़कर लाल मज्जा की ग्लोबल उपापचयी गतिविधि के सही मापन के लिये एक नई संकल्पना तैयार की गयी है। संक्रमण, शोध, फाइब्रोमैटोसिस एवं अन्य विकृतियों जैसे सुसाध्य रोगनिदान में पीईटी की क्षमता को परखा गया।

अस्पताल सूचना प्रणाली

अध्यक्ष, पऊआ द्वारा अणुशक्तिनगर में आयोजित एक समारोह में आयुर्विज्ञान प्रभाग हेतु एक अधुनातन अस्पताल सूचना प्रणाली का उद्घाटन किया गया। इस समारोह में अमृत विश्व विद्यापीठ के उप कुलपति एवं अमृता आयुर्विज्ञान संस्था, कोइंबतूर से उनके साथी भी उपस्थित थे। HIS एक व्यापक साफ्टवेयर है जो चिकित्सीय क्षेत्र के सभी क्षेत्रों में प्रवेश सुगम्य बनाता है तथा आज की बदलती हुई स्वास्थ्य रक्षण की स्थिति में उचित समाधान प्रदान करते हुए तेजी से आगे बढ़ने के लिए आवश्यक है। HIS द्वारा रोगी के चिकित्सीय विवरण के साथ-साथ पैथलाजी, एक्सरे एवं कार्डियोवैस्कुलर रिपोर्ट, रोगी द्वारा प्राप्त कोई शल्य चिकित्सा का विवरण आदि सिर्फ माउस क्लिक करने पर ही उपलब्ध हो जाते हैं जिससे डाक्टरों द्वारा किसी भी मामले पर निर्णय लेना अति सरल हो जाता है।

प्रौद्योगिकी हस्तांतरण

भापअ केंद्र द्वारा बैक वाशेबल माड्यूल के लिए विकसित की गई प्रौद्योगिकी संबंधी जानकारी हस्तांतरण के लिए रिलीज की गई है। इसके अंतर्गत 6 गुना कम मात्रा तक बैक्टीरिया एवं 4 गुना कम मात्रा तक वायरस युक्त जल का उत्पादन किया जा सकता है। पार्टिकल एरोडायनामिक साइज सेपरेटर प्रौद्योगिकी का भी हस्तांतरण किया गया।

ग्यारहवी योजना कार्यक्रम

जैसे कि आप सभी जानते हैं, ग्यारहवी योजना कार्यक्रम के अंतर्गत भापअ केंद्र द्वारा प्रस्तावित लगभग सभी परियोजनाओं को योजना आयोग द्वारा सैद्धांतिक रूप से अनुमोदित किया जा चुका है एवं कुछ परियोजनाओं के लिए वित्तीय मंजूरी भी जारी हो चुकी है। आप सभी से मैं अपील करता हूँ कि परियोजना संबंधी गतिविधियों एवं प्रगति की आवधिक रिपोर्टिंग हेतु हमारे परिणय प्रोग्राम का उपयोग करें। यह सुनिश्चित करना हमारा प्रयास होगा कि हमारे प्रत्येक वैज्ञानिक एवं तकनीकी सहकर्मियों की गतिविधि परिणय प्लैटफॉर्म के माध्यम से देख पाएं।

निष्कर्ष

अंततः मैं, इस बात पर बल देना चाहूँगा कि भविष्य में हमारे सामने कई चुनौतियाँ हैं। मुझे विश्वास है कि भापअ केंद्र में हम अपने सभी वैज्ञानिकों, इंजीनियरों, तकनीशियनों तथा प्रशासकों के एकजुट प्रयासों से भापअ केंद्र की परंपरा के अनुरूप भावी चुनौतियों का सामना करने में सफल होंगे।

मैं भापअ केंद्र की सुरक्षा एवं सीआईएसएफ के कर्मिकों की भी हमारे संस्थान में प्रभावी सुरक्षा बंदोबस्त बनाये रखने एवं वैयक्तिक सुरक्षा उपलब्ध कराने तथा शांतिपूर्ण वातावरण बनाये रखने में उनके सराहनीय योगदान की प्रशंसा करता हूँ। मैं भापअ केंद्र अग्निशमन सेवा कर्मियों की भी हार्दिक सराहना करता हूँ जो हमारे संगठन की विभिन्न स्थापनाओं पर सतत निगरानी रखने के कार्य में लगे हुए हैं। मैं अपने वाहन चालकों की भी सराहना करता हूँ जो हमें कार्यालय में समयबद्धता बनाए रखने में सहायता दे रहे हैं। इस स्थान का आकर्षक परिवेश हमारे भूदृश्य एवं स्वच्छता अनुरक्षण अनुभाग के कर्मिकों के सराहनीय प्रयासों का चित्रण करता है।

आइए, हम यह दृढ़ संकल्प करें कि अपनी जनता के कल्याण के लिए हम नाभिकीय विज्ञान एवं प्रौद्योगिकी के अग्रणी क्षेत्रों में उत्कृष्टता को बनाए रखने हेतु पूर्ण समर्पण की भावना से कार्य करेंगे।

NEW YEAR MESSAGE FROM DR. SRIKUMAR BANERJEE DIRECTOR, BARC

Dear colleagues,

It is indeed a matter of great pleasure for me, to extend my greetings and best wishes for the New Year to each and every one of you and your family.

BARC is one of the world's largest R&D centres, where we pursue excellence in Nuclear Science and Technology, covering a very wide spectrum of activities under a common umbrella.

Last year has been yet another successful year in our developmental efforts in Nuclear Science and Technology and its applications in power generation, agriculture, food preservation, health care, industry and national security. Among the various systems and technologies developed during the last year, I would make a mention of only a few as illustrative examples.

Research Reactors

The three Research reactors, Apsara, Cirus and Dhruva continued their operation satisfactorily with high availability factors.

The feasibility studies on upgrading the Apsara reactor to a 2 MW reactor are presently in progress. As part of retro-fitting measures for Apsara reactor building against seismic events, shake table tests of the APSARA reactor building model, with elasto-plastic dampers have been successfully carried out and significant reduction in its response was observed.

Cirus reactor was generally operated at 20 MW (th) with the availability factor of 90.2 %. However, reactor power was raised to higher levels as and when required.

Research reactor Dhruva continued to be the major facility for radioisotope production and served as a national facility for neutron beam research. The reactor was operated at 60 MW(th) with the availability factor of 82.7 % during which about 650 samples were irradiated. As in the previous years, a large number of research scholars from various academic institutions in the country continued their research activities using the reactor under the aegis of the UGC-DAE Consortium for Scientific Research.

Various systems of the new Critical Facility for Reactor Physics experiments of AHWR and future PHWRs were commissioned successfully. The flux mapping system based on the 25 fission chambers has been installed in the facility. Attempts are in full swing, for making the facility operational very soon.

AHWR Programme

The review of AHWR design by the Pre-licensing Design Safety Committee of AERB has been almost completed and it was concluded that there was no potential issue that could preclude the licensing of AHWR.

Meanwhile, various initial core loadings were analyzed in detail, to arrive at a configuration consistent with core reactivity and shutdown requirement.

Experiments were performed in 3 MW Boiling Water Loop to assess the critical power of AHWR which confirmed, that the thermal margin considered in the design is conservative.

A test facility to check the performance of passive containment isolation system has also been installed.

An MoU has been signed with NPCIL for setting up integral test facilities for conducting the thermal hydraulic tests and fuelling machine related studies at the R&D Centre, Tarapur.

HTR Programme

An alternative shutdown system is proposed, for the Compact High Temperature Reactor (CHTR), based on the axial movement of beryllium oxide reflector blocks for secondary shutdown and tungsten rods for primary shutdown.

For the coupled neutronic and thermal hydraulic analysis of CHTR, a 3-D Triangular-Z geometry code, based on time-dependent diffusion theory has been developed and its validation is in progress.

The setting up of a loop, to study the natural circulation phenomenon of liquid metal (Lead-Bismuth Eutectic) as coolant, in the proposed CHTR is in an advanced stage of completion.

PHWR Programme

An MoU has been signed with NPCIL, for supply of faster and more accurate Ultrasonic Measurement of Axial Creep (UMAC), for the fuel channels of PHWRs.

A hydraulic, remotely-operable three-leg micrometer has been developed and deployed at RAPS-2 for *insitu* measurement of internal diameter of the pressure tube.

Under an MoU with NTPC, an online, non-intrusive vibration monitoring system, similar to that installed in TAPS-3, has been installed on a Gas turbine unit of Auriya plant in UP. This is the only system of its kind in the country, to monitor the health of the turbine blades and the shaft.

Use of Nano-fluids (nano-particles dispersed in fluid such as water) to suppress natural circulation instability and to enhance circulation rate has been successfully demonstrated in BARC.

A very high pressure and temperature test loop has been installed and hydro-tested to study natural circulation stability behaviour and thermo-hydraulic relationships of supercritical water and carbon-dioxide.

PFBR

Support was provided to IGCAR/BHAVINI for getting design and safety clearance from AERB, for Inclined Fuel Transfer Machine (IFTM) for PFBR.

BARC continued to supply mixed carbide and MOX fuels for operation of FBTR with record supply made during the year 2007. Pins for six fuel sub-assemblies of mixed carbide fuel including those made by Pu recovered from mixed carbide reprocessing have been supplied, thus marking the closing of the fuel cycle for FBTR. New FBTR fuel fabrication line is now ready for Pu commissioning and will further augment production capacity considerably.

Experimental MOX fuel of PFBR fuel design fabricated by BARC is undergoing irradiation in the centre of FBTR core and has reached a burn up of 80,000 MWD/T which is 80% of the design target burn up of PFBR fuel. Manufacture of PFBR fuel and axial blanket has been demonstrated successfully with fuel pins for the first two sub-assemblies which are ready for despatch.

Health, Environment and Safety Studies

Experimental studies for severe accident phenomena comprising of pressure tube ballooning with and without moderator cooling, were carried out in Channel Heat-up Facility. The benefits of sagging and ballooning, assumed in the accident analyses were in fact, realized for the first time through these studies.

Based on a database created by numerous thermal-hydraulic analyses, a neural network analysis has been carried out, for 32 break scenarios leading to LOCA with and without Emergency Core Cooling System. These results have been incorporated in the symptom-based diagnostic system for operator assistance.

More than 27000 hrs of damage data has been acquired in Dadri Plant where the BARC structural evaluation system BOSES, has been in use for the online monitoring of creep and fatigue damage. The extent of damage predicted by BOSES was satisfactorily verified by microstructural examination of replicas from different points of the superheater outlet header.

The studies on assessing efficacy of bentonite lining in the uranium tailings pond in retarding the migration of uranium and its daughter products has revealed, that the peak concentration below the tailings pond, is lower by a factor of about 1.5 than that without the bentonite liner.

An air-worthy Aerial Gamma Spectrometry System for permanent deployment in Advanced Light Helicopters has been developed and is now in the process of deployment. This will be used by defence establishments for

emergency preparedness and for training.

A Mobile Radiological Impact Assessment Laboratory has been established at Trombay, for impact assessment during a radiological emergency in the public domain. This laboratory is equipped with GPS and meteorological system to provide essential inputs needed for such assessment.

A Geographic Information System (GIS) with various layers populated with data on availability of shelters, hospitals, evacuation routes etc. around two NPP sites, viz. Narora and Kaiga has been established. The Narora GIS data base has been integrated with the Indian Real-time Online Decision Support System (IRODOS) commissioned at the site.

Twenty six IERMON systems were installed as ring monitors in two rings around NAPS for providing radiation data to the IRODOS processing system.

Fifty two IERMON stations were installed across the country, using solar powered environmental radiation monitors with GSM-based data communication. These systems using latest technology are developed and manufactured at BARC.

Fuel Reprocessing and Waste Management Activities

The Plutonium Plant at Trombay has been operating efficiently to process spent fuel from research reactors. The Depleted Uranium (DU) required for refueling NAPS-1 and Kaiga was supplied by the Plutonium Plant on priority basis.

PREFRE, Tarapur was operated with excellent safety record and achieved a record production and the Advanced Vitrification Facility at Tarapur, has completed 102 vitrification operations resulting in the vitrification of 222 m³ of high level waste.

At WIP, Trombay, a milestone was achieved through the production of 200th canister of vitrified waste product on September 28, 2007.

With the one section of storage vault of SSSF at Tarapur commissioned, a total of 47 overpacks from AVS, Tarapur and 9 overpacks from WIP, Trombay have been placed safely.

A state-of-the-art spent fuel chopper has been developed, based on a multiple blade assembly concept for gang chopping of a PHWR fuel bundle in one stroke. This innovative, fully automatic remote-operated machine, has been manufactured by M/s HMT Ltd. and is ready for delivery to Tarapur plant.

BARC has developed a 15 kilo curie capacity container for transporting Cobalt-60 source for Bhabhatron and other teletherapy machines.

Materials Research

The Foundation stone for the first uranium mine and mill was laid down in November, 2007 at Tumallapalle in Andhra Pradesh. The Chief Minister of Andhra Pradesh, Dr. Y.S. Rajashekara Raddy was the Chief Guest at the foundation laying ceremony. An entirely new process involving alkaline leaching, developed by the scientists of this centre, with support from AMD, UCIL and NPCIL will be deployed in the proposed plant.

BARC provided analytical support with manpower training to the Heavy Water Board for production of nuclear grade Ammonium Di-Uranate in the proposed pilot facility for recovery of uranium from phosphoric acid.

A large number of heat shrinkable sleeves (2500) of shape memory material, have been supplied by BARC for the LCA programme and seven aircrafts are currently flying with the sleeves supplied by BARC. During this year, BARC has entered into an MoU with ADA and HAL, to set up a production facility at HAL, which will be one of the few in the world, to produce materials of this type.

Studies on the effect of partial boiling, to be adopted in the proposed 750 MW PHWRs, on corrosion and hydrogen uptake behaviour of zirconium alloys revealed, that while zircalloys remain insensitive to the dissolved oxygen content, the oxidation rates of Zr-Nb alloy gets adversely affected.

BARC has initiated development and fabrication of Cable-in-Conduit-Conductor (CICC) of various configurations for superconducting magnets, required for fusion reactor at IPR, Ahmedabad. 10 KA CICC (20 mm x 20 mm cross section x 6 m L) containing 48 multi-filamentary Nb-Ti SC wires and 288 OFHC copper wires has been fabricated and supplied to IPR. Void fraction in the conduit is ~ 30% which is required for liquid helium flow.

As part of studies on hydrogen storage technology development, uptake of hydrogen in Mg/Pd thin films was noted to be near to stoichiometric ratios of MgH_2 . The studies on dehydrogenation and hydrogenation cycles on the same set of films are in progress.

The uptake of gold nano-particles by cancerous cells has been found to be significantly higher than that in normal cells. It is now planned to devise special treatment methods to coat the nano-particles with suitable bio-molecules so that only cancer cells take up the gold nano-particles. This should pave the way for newer developments in nano-medicine.

Meso and nanoporous films of alumina on ceramic honey-comb structures (provided by ARCI) have been used, to develop a kit for the removal of dissolved fluoride in drinking water. Removal capacity of upto 15 mg of fluoride per kg of alumina has been achieved.

Low Energy High Intensity Proton Accelerator (LEHIPA)

A 50 kV, 30 ma Electron Cyclotron Resonance (ECR) based microwave ion source using three electrode configuration for application in the Low Energy High Intensity Proton Accelerator (LEHIPA) has been commissioned.

A maximum proton current of 17 ma has been extracted from the ECR hydrogen plasma produced using 800 W, 2.45 GHz microwave power at an extraction voltage of 35 kV.

Another milestone has been reached in terms of fabrication of a full length prototype of 400 keV Radio Frequency Quadrupole with necessary vane modulations. The final RFQs for 400 kV and 3 MV accelerating potentials, using OFHC copper, are under fabrication at KELTEC, Thiruvananthapuram.

For the Low Energy Beam Transport lines, four solenoids designed at BARC were fabricated at RRCAT. Mechanical and thermal design of Drift Tube Linac (DTL) with geometry of supports and details of drift tubes have been completed.

Civil work in the basement area of the LEHIPA facility is complete, with shielding walls for linac and beam dump room.

Chemistry

Through quantum chemical calculations, it has been demonstrated that, decorating fullerene molecules with alkali metal atoms, remarkably enhances their hydrogen adsorption capacity. The proposed novel nanomaterial, Na_8C_{60} , is shown to absorb 48 hydrogen molecules leading to an adsorption capacity as high as 9 wt %.

A femtosecond tera-watt laser system to be used for photocathode gun of the picosecond LINAC has been successfully commissioned. The laser system is based on a Ti: sapphire oscillator - regenerative amplifier, delivering typically 35 mJ in 36 fs pulse at 800 nm.

Remarkable enhancement in fluorescence has been demonstrated by suitable supramolecular host-guest chemistry and such enhancement could profitably be employed in biosensor / protein sensor applications.

Metal removal capability of bacteria was enhanced by increasing metal ion transport into the cells by the cloning and over-expression of metal transporter genes from selected bacteria into *E. coli*. Removal of ^{60}Co from simulated decontamination spent solution, using this technique, was noted to have been achieved in excess of 75% in one hour through two cycles.

An Electro Chemical Filter (ECF) containing 33 pairs of alternating array of cathode and anode graphite felts, developed in-house, was successfully used for removal of iron turbidity, in the intermediate cooling circuit of Active Process Water System of Kaiga Unit 1.

An Atomic Emission Spectrometer for the simultaneous spectrochemical analysis of upto 51 elements was developed. The lowest detection limit achieved for B, Cd, Mg, Mn and Ni was 0.05 ppm.

Laser and Plasma Technology

A remotely-operated narrow bandwidth, single longitudinal mode tunable Pulsed Dye Laser prototype, was demonstrated with a 375 MHz bandwidth, at around 560 nm. The laser was shown to scan over 75 GHz without mode hop using a piezoactuator with 20 micron travel on the tuning mirror.

The EXAFS beamline developed earlier in BARC was integrated with the front end at the beam port no. 8 of INDUS-2 Synchrotron source at RRCAT, Indore. A LABView based software developed in-house would enable the users to work with the beamline remotely from Trombay.

Matrix Assisted Laser Desorption/Ionization Time Of Flight Mass Spectrometer (MALDI-TOFMS) has been developed, to generate intact ions of biomolecules and their detection / estimation of molecular weights in the mass range 1 kDa (kilo Dalton) to 100 kDa, at 1 pmole (pico-mole) level. A detailed performance evaluation of the spectrometer has been carried out using standard proteins.

A microwave Electron Cyclotron Resonance plasma enhanced Chemical Vapour Deposition process, for deposition of yttrium oxide thin films on stainless steel and silicon substrates has been developed, using indigenously synthesized metal organic precursors.

Desalination technology

The technology of On-line Domestic Water Purifier has been transferred to a total of 17 parties in different parts of the country. As per estimates, about 100,000 units have been sold out in different parts of the country by our licensees. These water purifiers were made available to the families of the DAE employees at concessional rates through Atomic Energy Workers' & Staff Union.

Next generation seawater desalination technologies, producing ultra-pure (> 10 mega ohm-cm) water based on Multi-Effect Distillation Vapor Compression and Low Temperature Evaporation integrated with Cooling Tower, have been developed and commissioned at Trombay.

Dr. El-Baradei, Director General, International Atomic Energy Agency visited BARC on 9th October 2007 and witnessed the operating desalination plants and exhibits on water purification systems, developed by BARC.

Nuclear Agriculture

Significant progress has been made in the field of agriculture. Eight new Trombay crop varieties – two in mung and one each in groundnut, soybean, mustard, sunflower, cowpea and pigeonpea were released and gazette notified in 2007 by the Ministry of Agriculture, for commercial cultivation in various agro-climatic zones of the country. With this, the Trombay crop varieties released and notified for commercial cultivation so far has reached 35. More than 600 quintals of breeder seed of Trombay groundnut varieties was produced and supplied to different seed agencies and farmers.

Biological Sciences

A DNA damage and repair-related novel signaling phenomenon, was discovered in bacteria, for the first time. Genetically engineered *E.coli* bacteria expressing the alkaline phosphatase (pho-N)

gene, could efficiently precipitate cadmium i.e., 20 times its dry weight as cadmium phosphate. A novel N-alkylated prodigiosin analogue isolated earlier in the Food Technology Division, was shown to be cytotoxic to cancer cells and induced cell death by apoptosis or necrosis depending on the cell type.

Biotechnology

Eight Nisargruna Biogas Plants for processing of biodegradable waste have become functional since January 2007 bringing the tally of operating plants to 19.

Radiation Medicine

The Radiation Medicine Centre continues to serve a large number of patients. Over 8000 diagnostic investigations were carried out during the calendar year 2007. For the first time, it was shown that radioiodine could be a therapeutic option, in non-thyroidal tumours. This was demonstrated in a radioiodine concentrating lung tumour, which showed, reduction in size following radioiodine therapy. Molecular imaging with ¹⁸F FDG Positron Emission Tomography (PET) showed that a sustained thyroiditis like picture is necessary for a maintained euthyroid state following radioiodine therapy.

A new concept was introduced for accurate measurement of global metabolic activity of red marrow by combining segmented volumetric data from structural imaging techniques such as MRI and quantitative metabolic information, provided by functional modalities such as positron emission. The potential of PET was also explored in benign pathologies like infection, inflammation, fibromatosis and other disorders.

Hospital Information System

A state-of-the-art Hospital Information System (HIS) for the Medical Division was inaugurated by Chairman, AEC at a function held at Anushakti Nagar, in which the Vice Chancellor of Amrita Vishwa Vidya Peetham and his colleagues from Amrita Institute of Medical Sciences, Coimbatore were also present. HIS is a comprehensive software solution that allows a holistic approach within and across clinical segments, delivering solutions with an innovation and synergy necessary to help move forward in today's changing health care environment. HIS will provide the medical history of the patient including pathology, X-ray and cardiovascular reports, any history of surgical treatment received by the patient etc., all at the click of a mouse, which will definitely ease the doctor's job in decision making processes.

Technology Transfer

The technology developed by BARC, for back-washable spiral wound module for delivering sterile water with six orders of magnitude reduction of bacteria and four orders of magnitude reduction of virus, has been released for know-how transfer. The technology for a Particle Aerodynamic Size Separator was also transferred.

XI Plan programme

As you all may be aware, almost all the projects proposed by BARC under the XI Plan programme have been in principle, approved by the Planning Commission and the financial sanctions have already been issued for some of the projects. It would be my earnest appeal to all of you, to utilize our PARINAY program for periodically reporting project-related activities and progress. It would be our endeavor to ensure that the activity of each and every one of our scientific and technical colleagues is visible through the PARINAY platform.

Conclusion

In conclusion, I would like to emphasize that we have plenty of challenges for the future. With the synergistic effort of all of us in BARC - the scientists, engineers, technicians and administrators, I am sure, we will be able to rise to the occasion to meet the future challenges in a manner, consistent with the tradition of BARC.

I appreciate the exemplary work rendered by BARC security and the CISF personnel for effectively maintaining security measures and for their commendable task in providing physical protection and in maintaining a peaceful environment in our establishment. I would also like to appreciate the BARC Fire Service personnel for maintaining a constant vigil on the various establishments within our organization and our drivers for helping us to maintain office timings. The contribution made by the personnel in our Landscape & Cosmetic Maintenance Section is aptly demonstrated by the beautiful ambience of this Centre.

Let us firmly resolve and rededicate ourselves to continue our pursuit of excellence, in the frontier areas of Nuclear Science and Technology, for the betterment of life of our people.

APPLICATION OF AN ELECTROCHEMICAL FILTER FOR IRON TURBIDITY REMOVAL FROM THE ACTIVE PROCESS WATER SYSTEM OF THE KAIGA GENERATING STATION UNIT # 1

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Introduction

The Active Process Water System (APWS) at Kaiga Generating Station (KGS) units-1&2 (Schematic-A) experiences iron turbidity of different levels, during various operational periods of the system. The entry of iron corrosion products from the backup fire water system, seems to be the cause for the observed turbidity levels in APWS. On the one hand, APWS cools the shell-tube type moderator heat exchanger and on the other hand it transfers this heat to the Active Process Cooling Water System (APCWS) through plate-type heat exchanger(s). The water in APCWS in turn gets cooled by the Induced Draft Cooling Tower (Schematic-A). The continued operation of turbidity-ridden APWS, can result in fouling of the plate-type HXs through deposition of iron corrosion products. Such a fouling of the heat exchanger, reduces the desired cooling efficiency of APWS, to maintain the temperature of moderator water within the specified limits, which in turn will have safety repercussions.

Turbidity in a large cooling water system, due to suspended micron or submicron size particles and at

low particulate concentration, poses a problem for its removal by normal micron / sub-micron filtration or by ion exchange process. Surface modified ion exchangers resins i.e., Precipitated Ion-Exchange (PIE) resins can be used for this purpose, but this requires a back-up normal ion-exchange column, to remove the soluble metal ions, resulting from the limited solubility of the precipitate from the PIE resin, which otherwise can enter the main system as impurities [1]. When the turbidity levels are low, this washing-out effect impacts on the throughput, realizable by these precipitated ion-exchangers. Thus the use of PIE resins has limitations if one encounters large system volumes of dilute turbidity to be cleaned up. Commercial Zeta-potential filters on the other hand, employ a special cartridge (housed in an outer shell), which has a thin coating of a material on a base matrix, with a zeta-potential opposite to the zeta potential of the suspended particles. They are very suitable for treating very dilute turbidities { < 5 Nephelometric Turbidity Units (NTU)} but in medium range (5-10 NTU) and high ranges (> 10 NTU) can give rise to problems of cartridge change, which requires new filter procurement as these filters can be used only once.

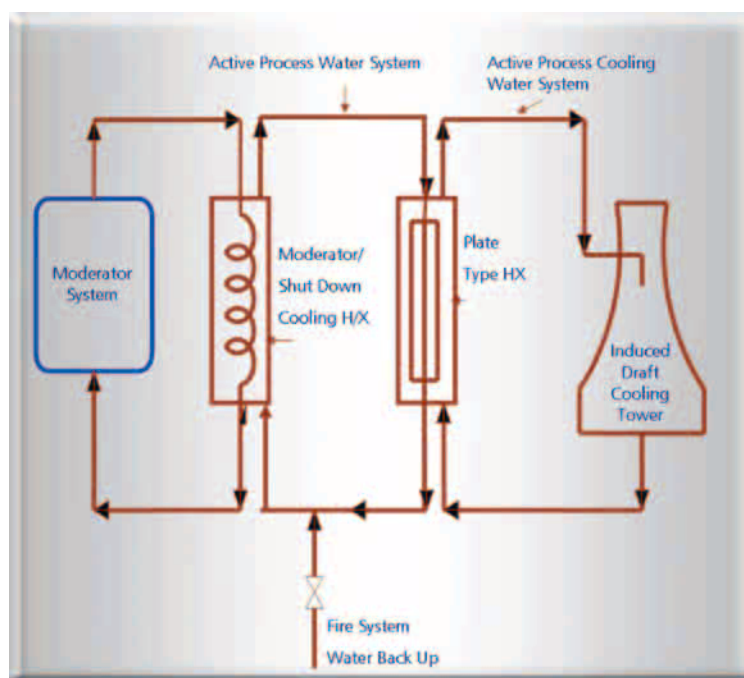
Electro-deposition of suspended particles from a turbid solution on graphite felts is another method for this type of dilute turbidity removal from water [3]. The higher surface area (typically 10-12 m²/g) with a concomitant improved contact with flowing solution, high fluid permeability with free flow of the solution without back pressure to higher flows and chemical, electrochemical inertness, their regenerability and reuse makes the graphite felt electrochemical filter more suitable for dilute turbidity removal. Alumina turbidity was removed from heavy water circulation in a nuclear reactor by electrosorption on fibrous carbon electrode [4]. Use of a prototype graphite felt electrode assembly for the removal of radioactive indium turbidity from the moderator heavy water of Unit-1 of Rajasthan Atomic Power Station was earlier reported from our laboratory [5]. Such a prototype filter has also been demonstrated from the same laboratory for the microbial bacteria removal [6] from RAPS -2 moderator heat exchanger cooling water. The particle size of turbidity observed in the APWS of KGS solution showed two distributions between 1.0 – 3.5 μm and 0.2-0.5 μm with negative charge at system pH of 9.5 [7]. Out of total iron in the solution 90 % was insoluble hydrated ferric hydroxide/oxyhydroxide. A quantitative turbidity removal was observed using prototype filter with batch sample runs [7]. A larger size filter was in-house designed, fabricated and connected to the surge tank of APWS of the KGS unit #1 for turbidity removal.

Experimental

Turbidity characterization

The brown coloured fluid collected from electrochemical filter used for turbidity removal from Active Process Water System (APWS) of Kaiga

Generation Station (KGS) unit-1 was characterized. The fluid was dried at 60 °C for 4-5 h to get a fine powder. Fig.1 shows the Mossbauer and Raman spectrum of the powder. The Mossbauer spectrum showed a doublet with an isomer shift value of 0.32 mm/s, which is characteristic of $\gamma\text{-FeOOH}$ species. The quadrupole shift value of -0.74 mm/s shows the asymmetrical electrical field, around the iron nucleus in FeOOH. In Raman spectra the peaks at 269.5 cm^{-1} and 353.5 cm^{-1} are due to FeOOH, thus supporting the conclusion arrived at, from Mossbauer data. The peaks at 1375 cm^{-1} and 1625 cm^{-1} could be due to fine graphite possibly contributed by the carbon felt. Both Mossbauer and Raman data point to the presence of gamma form of allotropic modification of FeOOH. Fig. 2 shows XPS spectrum of turbidity powder. The dominant peak at 711.1 eV shows presence of Fe^{3+} . The XPS depth analysis shows presence of OH/H₂O on the surface. This indicated presence of FeOOH in the sample. The weight loss step observed (Fig. 3) in DT/TGA analysis of the sample, also matched the conversion of FeOOH to Fe₂O₃. A 2 L sample of APWS



Schematic A: Active Process Water System (APWS) at KGS

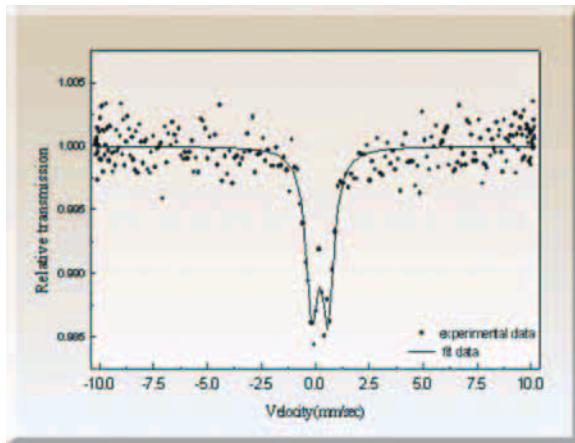


Fig.1a: Mossbauer spectrum of the turbidity powder

Sample	Isomer shift (mm/sec)	Quadrupole shift (mm/sec)	FWHM (mm/sec)
	0.32	-0.74	0.66

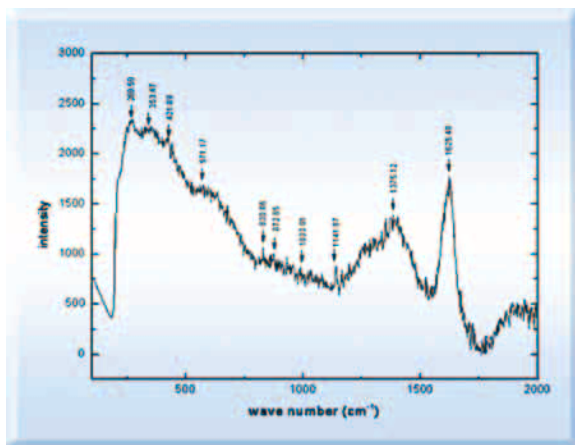


Fig.1b: Raman spectra of turbidity powder recorded with 514 nm laser

was filtered through 0.45 mm filter paper and the crud content obtained was weighed and analyzed for iron. From this analysis, about

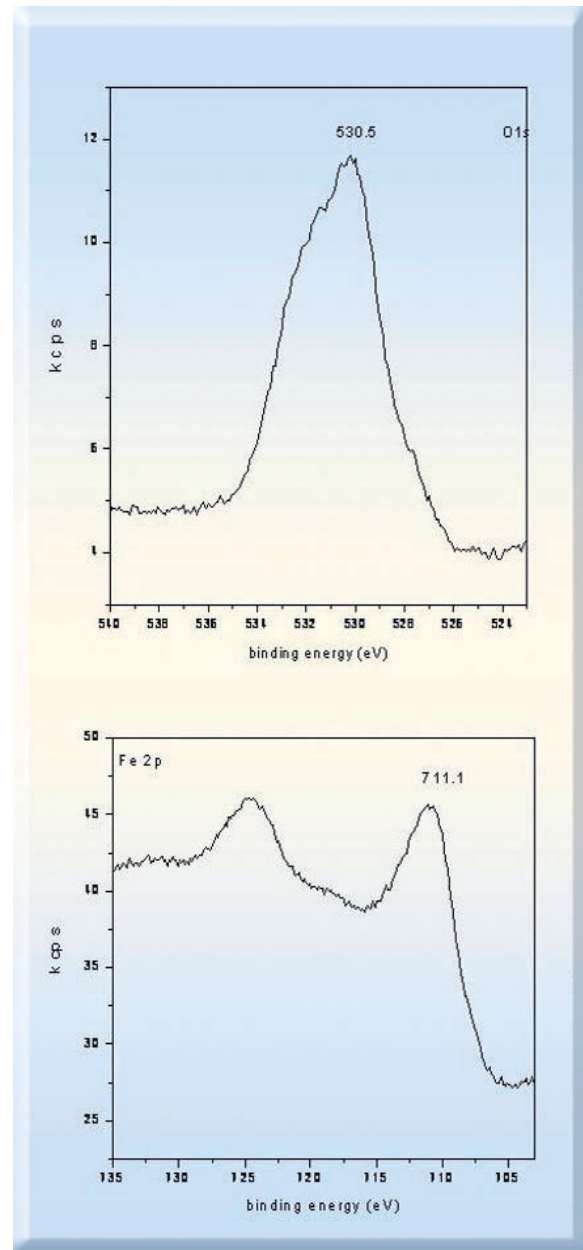


Fig. 2. XPS spectrum of KGS #1, APWS turbidity powder

83% weight of the crud could be attributed to the FeOOH species. Thus the characterization study confirms the presence of γ -FeOOH as major species causing turbidity in APWS water.

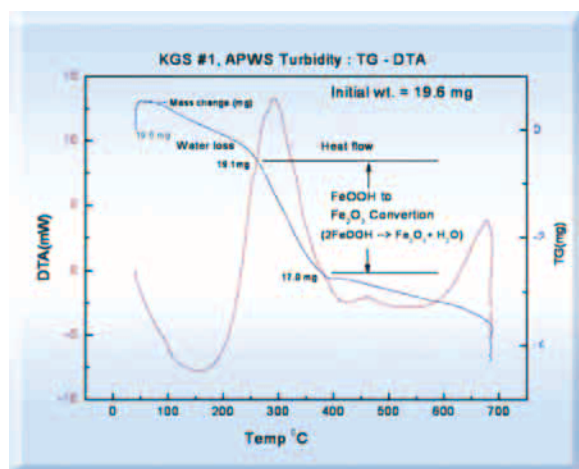


Fig. 3: DT- TGA of KGS #1, APWS showing FeOOH to Fe₂O₃ conversion step

Electrochemical filter (ECF) fabrication

A cross-sectional view of the fabricated ECF is shown in Fig. 4. The outer cylinder (integrated with flanges), central pipe leading the inlet turbid solution and the inlet / outlet connections of the filter are made of stainless steel. 33 pairs of circular graphite felt anode and cathode of about 6mm thickness –150 mm diameter, supported on perforated polymethylmethacrylate (Perspex) plates, were assembled inside the cylinder (clearance between SS shell and the felt housing made of Perspex is $13 \pm 6 \mu\text{m}$). Alternately, a set of 33 discs of graphite felt was contacting the outer SS cylinder, at periphery of the cylinder and was isolated from the central SS pipe using spacers, and another set of 33 discs was contacting central SS pipe of the filter and was isolated from outer periphery of the cylinder, using box-type cathode support perspex plates. Thus the electrodes could be used as alternate anodes and cathodes while applying potential. Both inlet and outlet of the filter were connected from top of the filter. The central stainless steel pipe served as inlet to the filter, with water flowing down through the pipe and rising above from the bottom, through a bottom end spacer, then

through the perforated perspex plates holding the cathode/anode graphite felts before exiting. The inlet flange portion of the central SS pipe and the flange part of the main SS shell were used as contact points for imposing the electromotive force. The central SS pipe was Teflon coated from inside, to avoid streaming currents due to flow. Graphite felts were activated by heating them in an oven at 450°C for 2 h in an air oven prior to packing them in the ECF.

ECF Test Run

ECF, for test run, was connected to the 48-m³ capacity surge tank of the APWS (system volume 800 M³) of KGS #1 in a re-circulating mode (Figs.5,6 and Photograph 1). Outlet of the filter was connected to a flow meter, then to the suction side of a 0.5 Hp centrifugal pump and was again discharged back in the same surge tank. Except for a few flow variation tests, for most of the time the filter was run at 10 lpm flow. Potential to filter was applied using home made 200 V, 10 A DC power supply. 52.5 M³ of water was circulated through the filter. Fig. 6 shows the variation of filter outlet turbidity as a function of various parameters. Except for the turbidity values, the other parameters remained same for the solution at the inlet and outlet of the filter (Table 1).

Turbidity Measurements

Turbidity measurements of ECF inlet (APWS) and outlet samples were carried out, using Systronics digital Nephlo-Turbidity Meter -132. A 400 NTU turbidity standard was prepared, by mixing 5 ml of 1 % hydrazine sulphate [(NH₂)₂. H₂SO₄] with 5 ml of 10% hexamethyltetramine [(CH₂)₆N₄], allowing it to stand for 24 h at 300 K and diluting it to 100 mL full volume. Using this stock turbid solution, calibration standards in the range of 2-10 NTU were prepared, using DM Water. The Nephlo –Turbidity meter was calibrated each time before measurements.

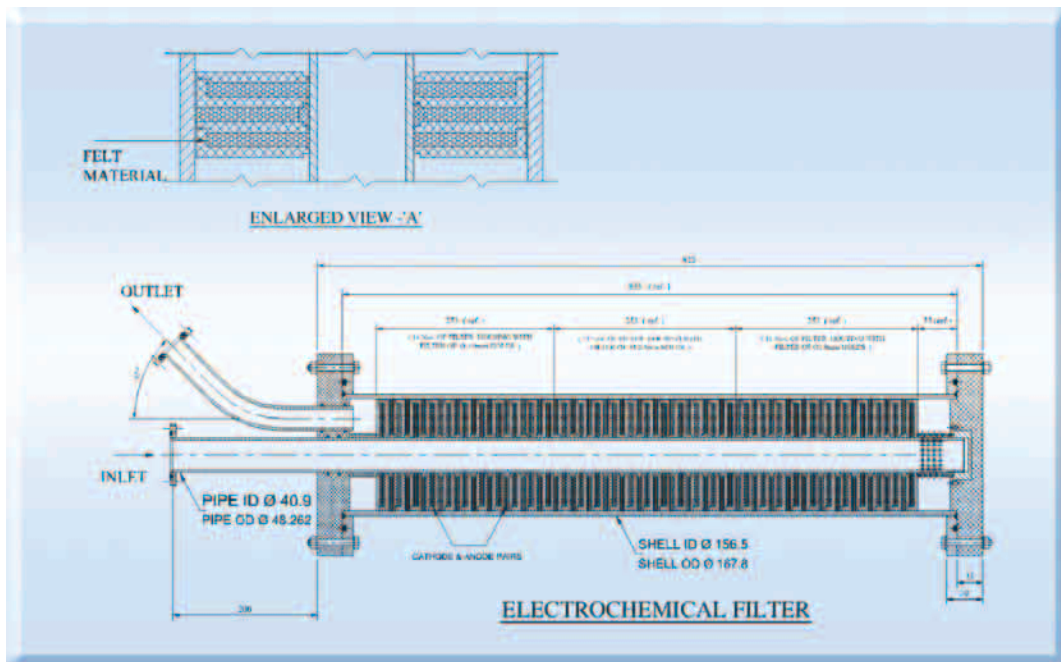
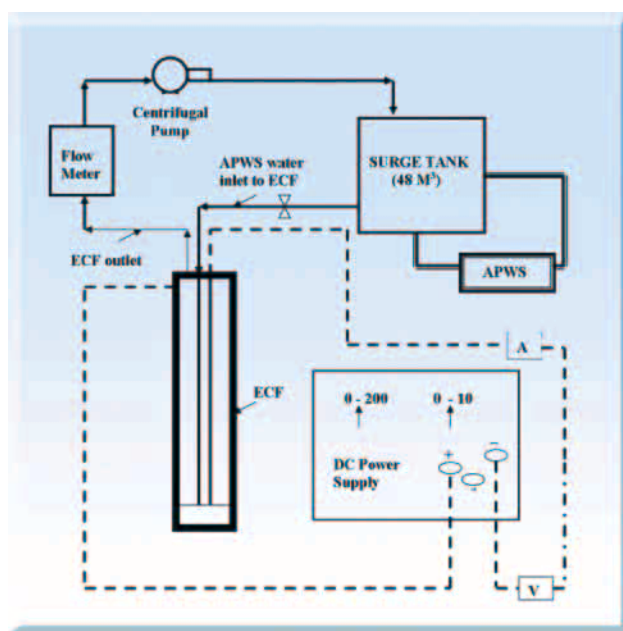


Fig. 4: Landscape view of the internals of the electrochemical filter



legend:
 APWS water flow;
 Electrical connection
 APWS Main system

Fig. 5 : Experimental setup involving ECF for turbidity removal from Active Process Water System

Results and Discussion

PZC of iron turbidity particles and ECF carbon felt

Most of the hydrous / hydrated or hydrous oxides of iron containing Fe in the Fe_3^+ or in $[Fe^{2+} + Fe^{3+}]$ state have pzc in the range of 6.0 to 8.5: F_3O_4 : 6.5, $\alpha-Fe_2O_3$: 6.7, $\gamma-Fe_2O_3$: 6.7, $\alpha-FeOOH$: 6.7, $\gamma-FeOOH$: 7.4, $Fe(OH)_3$ (amorph): 8.5 [8]. At pH value of 8.5-9 of APWS these corrosion products will have a negative surface charge as governed by the equation:

$$\zeta = k (pzc - pH) \dots (1)$$

where ' ζ ' is the zeta potential of the suspended particle, 'pzc' is its point of zero charge and pH is the solution acidity in pH units. The zeta potential of graphite felt particles suspended in distilled water was found to be -25 mV at neutral pH. Even at a pH of 1.5 the graphite



Photograph 1: ECF hookup to APWS surge tank and the power supply

Table 1: Chemical parameters of the typical water samples of APWS system at the ECF inlet and outlet

Parameter	Filter inlet	Filter outlet	Filter inlet	Filter outlet
pH	8.9	8.7	8.8	8.5
Sp. Cond.(mS/cm)	17.4	16.2	16.1	15.6
TDS (ppm)	10.35	9.2	-	-
Turbidity (NTU)	6.7	2.1	4.7	0.6
N ₂ H ₄ (ppm)	4.5	3.9	3.7	2.8
SiO ₂ (ppm)	0.65	0.65	-	-
Na ⁺ (ppm)	1.43	1.43	1.15	1.1
K ⁺ (ppm)			<0.01	<0.01
P. alkalinity as CaCO ₃ ppm	-	-	3.75	2.8
M. alkalinity as CaCO ₃ ppm	-	-	17.0	13.0

felt particles were found to carry a negative surface charge. Hence by the natural zeta potential effect the hydrated / hydrous oxides of Fe³⁺ will be electrostatically repelled from the fibrous graphite felts. However, in the present study, these graphite felts are made anodic / cathodic with the help of an applied potential, thus overcoming its natural zeta potential effect.

Effect of various operational parameters on turbidity removal

Figs. 6.1 and 6.2 show the turbidity values at the outlet of ECF as a function of inlet solution turbidity, applied potential/current and flow rate through the filter.

1. Influence of Applied potential and Flow rate on Outlet Turbidity

Fig. 6.3 shows the effect of applied potential and flow rate on the filter outlet turbidity. During the very initial stages of the run (Figs.6.3 a-e) showing the expanded initial stage during 0-1 m³ throughput), under low applied potentials (6.3 Volts) open-circuit condition itself, the filter was found to remove turbidity with 52% efficiency (a reduction from 6.35 NTU at inlet to 3.3 NTU at filter outlet) with the flow rate remaining low at 2 lpm. This behaviour could be attributed predominantly to the gravity induced settling of the larger sized (~1 – 3.5 μm) particles. On increasing the potential to 15-20V, it is observed that the outlet turbidity decreased steadily from 3.8 NTU to 2.2 NTU from an inlet turbidity value of 6.3 NTU thereby showing a turbidity removal efficiency [removal efficiency = {outlet turbidity / inlet turbidity} x100] of 65%. This has occurred in spite of the increase in flow rate from 2 lpm to 9 lpm, which can reduce the contact time of the turbid solution with the filter material.

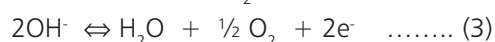
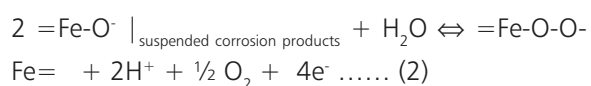
Figs.6.3a-e show the applied potential, outlet turbidity and flow rate variation during 9.7-12 m³ throughput. With the flow remaining constant, when the potential was increased to 25 V, the outlet turbidity rose to 2.2 NTU from 1.7 NTU with the inlet turbidity remaining

at 6.3-6.7 NTU (66% efficiency). But when the potential was brought back to about 17 V, the outlet turbidity became 1.8 NTU yielding 70-74% removal efficiency. During the throughput from 10.6 to 11.6 m³ when the potential was off, still the turbidity removal occurred with 74% efficiency with the inlet turbidity remaining at 6.2 NTU. The already loaded (with iron oxyhydroxide) carbon felts acting as an efficient remover of turbidity is shown by such an observation. After 11.6 m³ when the potential was switched on and about 18-20 V was applied, the outlet turbidity decreased to 1.5 NTU taking the removal efficiency to 76%.

The negatively-charged turbidity causing iron oxyhydroxide particles, get effectively attracted to the anodic surface, on experiencing the electrical force (reactions 2&3) which complements the gravitational settling force, while the cathodic surface has only retained the gravity settled particles. When the potential is around 20 V, the gas evolution at the anodic (reactions 2&3) and cathodic sites (reaction 5) has not disturbed the settled particles of iron oxyhydroxide.

The electrochemical action of the graphite felts under the applied potential condition can be represented as:

At the anode / solution interface:



At the cathode / solution interface:

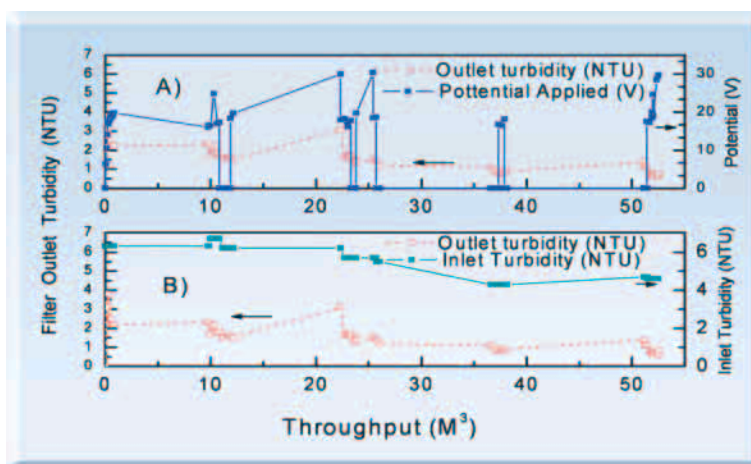
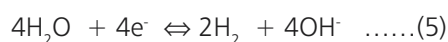
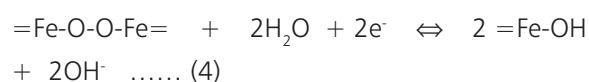


Fig. 6.1: ECF outlet turbidity as a function of applied potential and inlet turbidity

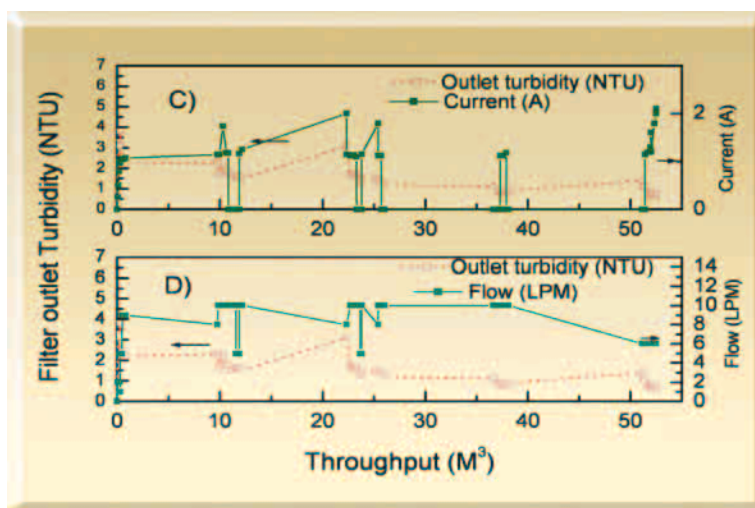


Fig. 6.2: ECF outlet turbidity as a function of observed current and flow rate

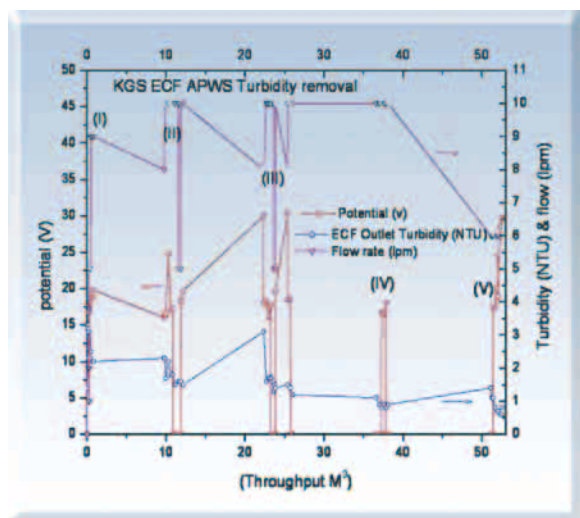


Fig. 6.3: Regions of interest (a to e) marked in the outlet turbidity variation with potential and inlet turbidity

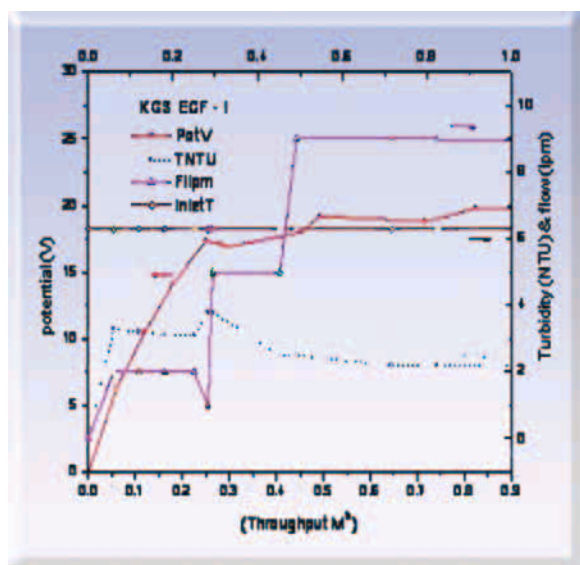


Fig. 6.3a: Region I

After realizing a throughput of 22 m³ when the potential was increased to 30 V the outlet turbidity became 3.1 NTU for an inlet turbidity of 6.2 NTU (50 % removal efficiency) with flow rate continuing to remain at earlier values of 10 lpm (Fig.6.3c). This behaviour could be explained by release of gravity settled iron oxyhydroxide particles from the cathodic

surface through a combined effect of change in pH near the vicinity of the cathode (reactions 4&5) with a consequent pH dependent charge variation of colloidal particles and the H₂ gas evolution at its surface exerting a force opposite in direction to the gravity induced settling forces [9]. The oxygen evolution at the anodic surface does not seem to disturb the oxide due to the good amount of oxyhydroxide that could have settled due to the electrical (attracting) force operating at the surface of the anode. When the potential was reduced to about 17-18 V the outlet turbidity came back to a value of 1.7 NTU with the inlet turbidity being at 5.7 NTU (removal efficiency 70%). The 75% removal efficiency continued between 23-26 m³ throughput also with the potential held at about 18 V and flow rate remained at 10 lpm. Between 26 and 37 m³ throughput even when the applied potential was zero still 78% turbidity removal could be achieved which could be attributed to the reasons already mentioned.

Between 36 and 38 m³ (Fig. 6.3d) with the flow reduced to 6 lpm and potential held at about 18 V the outlet turbidity became 0.8 NTU against an inlet turbidity of 4.3 NTU (81 % removal efficiency). Between 38 and 51 m³ (Fig.6.1) with the potential at zero and inlet turbidity rising to 4.7 NTU, the outlet turbidity rose to 1.1 NTU (77% efficiency). Beyond 51 m³ throughput and upto the near end of run when 52 m³ throughput was realized, application of increasing potentials from 17 to 29.6 V (Fig.6.3e) has helped in decreasing the outlet turbidity to 0.6 NTU with the inlet remaining at 4.6 NTU and flow rate at 6 lpm during this period. Thus an efficiency of ~87% could be realized. When the potential was increased beyond 29.6 V after 53 m³ of throughput, there was a slight increase in outlet turbidity (value rose from 0.6 to 0.8 NTU).

Applied Current

Observed outlet turbidity as a function of current is shown in Fig. 6.2. Since the conductivity of the medium was significant, higher currents could be observed at

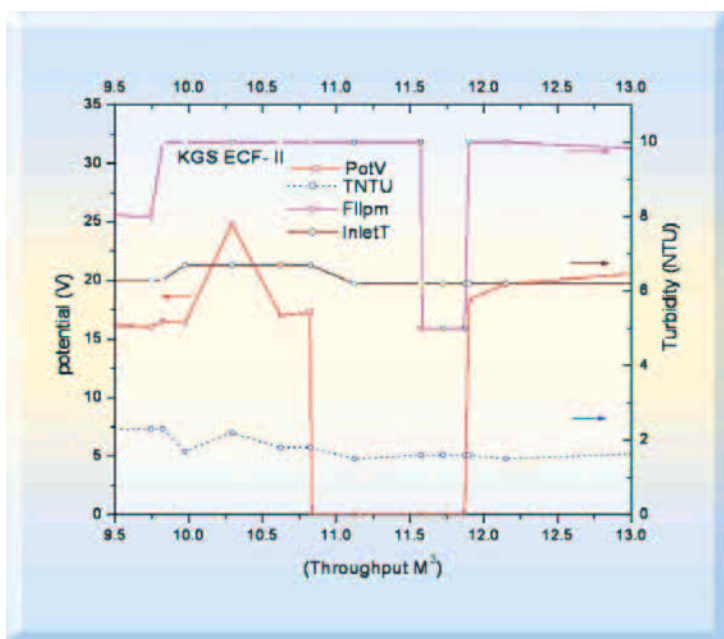


Fig. 6.3b : Region II

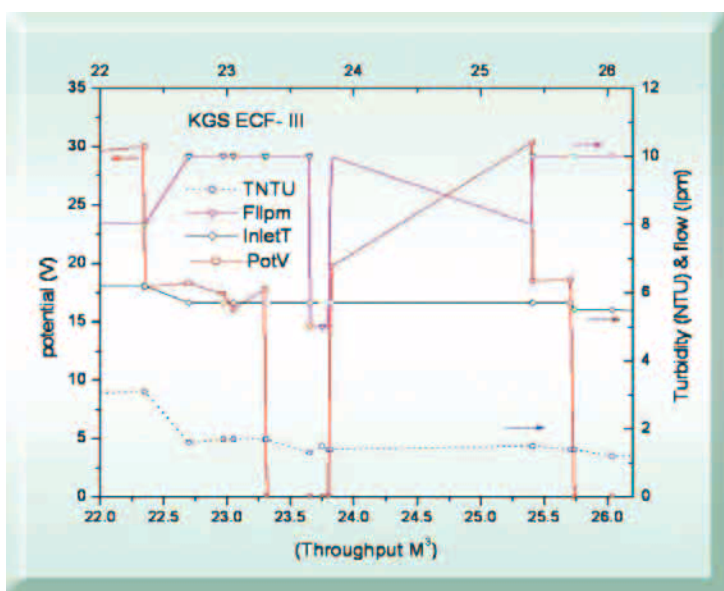


Fig. 6.3c: Region III

lower applied potentials. As current is proportional to applied potential the trend was similar to that observed with the applied potential.

Inlet Turbidity

Fig. 6.2 shows outlet turbidity as a function of inlet turbidity of the filter. Increase in the inlet turbidity was found to result in increase in outlet turbidity. A removal of efficiency of 65-70% in the initial stages and about 87% in the later stages was observed.

Assessment

The operation of electrochemical filter has revealed the possible occurrence of three phenomena simultaneously: a) the settling of negatively charged oxide particles on the anode surface, b) the release of gravity settled particles causing turbidity possibly from the cathode surface and c) the effect of O_2 and H_2 evolution on the settled oxide particles from the electrode (anodic and cathodic) surfaces. When the turbidity values are high, application of potentials of the magnitude of 20 V appears optimum for turbidity removal (75% removal). Once sufficient accumulation occurs on the fibrous felts, this efficiency is observed even when there is no applied potential. But once low levels of inlet turbidity are reached (< 5 NTU) then outlet turbidity could be suppressed further

(≤ 1 NTU) by increasing the potential beyond 20 V i.e., 25 to 30 V. Hence for each application of turbidity removal, an optimization of parameters like potential and flow vis-à-vis inlet turbidity requires to be carried out.

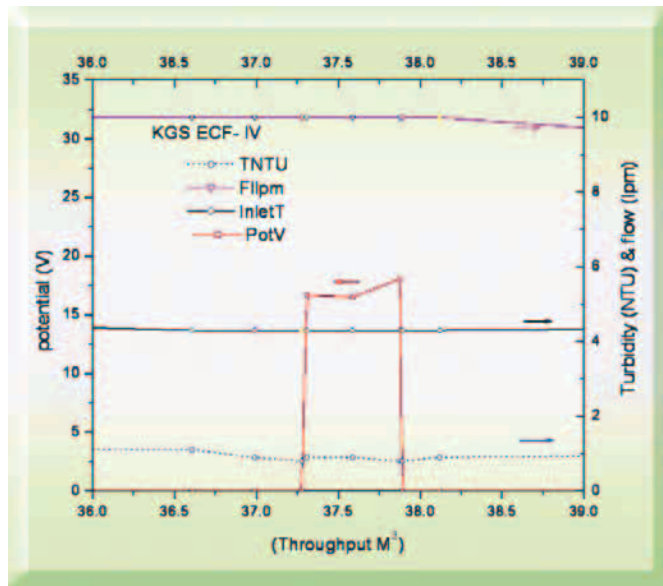


Fig. 6.3d : Region IV

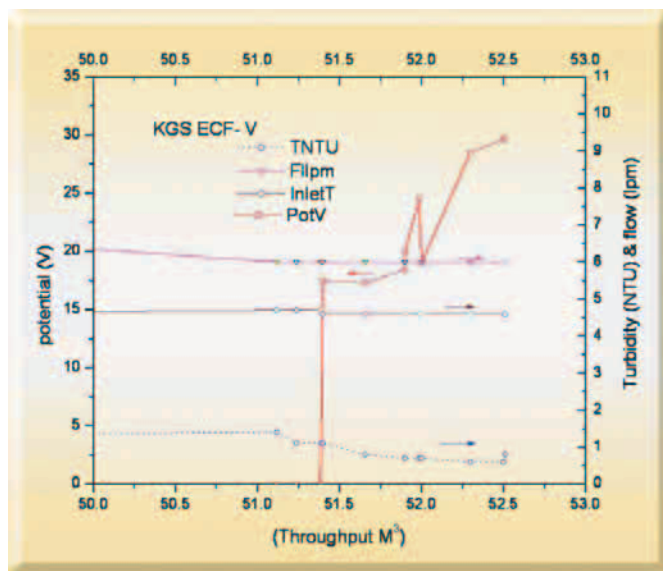


Fig. 6.3e : Region V

After flowing 40 m³ of APCW through the ECF, with the existing 0.5 hp pump, flow could not be maintained at 10 lpm and it decreased slowly to 6 lpm. This may be due to the clogging of the filter and hence the run

was terminated. At this point, the outlet ECF turbidity was 0.6 NTU indicating that the filter still has capacity to remove turbidity and it has not reached saturation. Towards the end of the run, the applied potential was 29 V, current was 1.4 A and the filter showed an efficiency of 87 %. As far as a submicron sized and low concentration turbidity removal is concerned, such an efficiency exhibited by the ECF, indicates its satisfactory performance. At the termination of the experiment, a throughput of > 2.08x10⁵ NTU-liters could be realized and still the filter was working at about 85% efficiency. At the end of the experiment, the internals of ECF were removed for observation. Only about 30% of the felts from the bottom of the filter were found to be used up and the rest appeared new and unused. Hence the throughput of this filter is expected to be much more than 2x10⁵ NTU-liters.

The electrochemical filter has the advantages of treating dilute or concentrated turbidity. Further, irrespective of the sign and magnitude of charge on the turbidity, the filter can work due to the applied potential nature. It does not leach out any significant amount of soluble/ insoluble materials, which will find its way into the coolant system. It uses a material that is regenerable, hence reusable and does not add to waste disposal problem.

Conclusions

1. The major component of the turbidity was characterized as γ -FeOOH.
2. Test of the pilot plant scale electrochemical filter employing fibrous graphite felt electrodes with APWS of KGS #1 has shown, that the fine turbidity from the system could be removed effectively.

3. Applied potential, flow rate and the effect of open-circuit conditions were evaluated for the turbidity removal. When the initial turbidity levels are of the order of 6-7 NTU, an applied potential of 20V and a flow rate of 10 lpm was found to be optimum. But when the initial turbidity levels are low (< 5NTU) the application of 30 V was found to be helpful. The ECF showed an average efficiency of 75%.
4. Turbidity removal by ECF involves no addition / hookup of any chemical or chemically loaded ion-exchanger in the system and the method is independent of zeta-potential of the particles unlike commercial zeta-potential filters.
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DIGITAL RECORDING SYSTEM FOR THERMOLUMINESCENCE SET-UP FOR PHOTOSYNTHESIS STUDIES

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and

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Digital logging systems provide a flexible method of acquiring the process data, performing simple data manipulations, reduction (if required) and subsequent recording of values on suitable storage media. The construction of a user-friendly data acquisition system coupled with the availability of signal conditioning modules for different types of sensors, enables the configuration of a data logger, suitable for the requirements of specific applications. Recently, a digital logging system has been designed and developed to acquire data from thermoluminescence set-up. This eliminates the need to record data on the strip chart recorder. Microcontroller based data converter, acquires thermocouple input and thermoluminescence signal in analog form and converts it to its digital equivalent, before transmitting it serially to the personal computer.

The thermoluminescence pattern from photosynthetic membranes, has been under investigation for the past several decades, in the Bio-Medical Group of Bhabha Atomic Research Centre. In 1971 Dr. V.G. Tatake had designed and built a special instrument using a variable temperature cryostat for the measurement of thermoluminescence (TL) (Tatake et al 1971). This TL

set up provided accurate information on the temperature of the glow peaks because the thermocouple was located very close to the sample. Coupled with a suitable photomultiplier tube this unit among the best of its kind.

In photosynthesis, light energy is absorbed by chlorophyll containing pigment-protein complexes in chloroplasts, resulting in charge separation. If excitation of pigment-protein complexes is done under carefully controlled conditions, pre-illuminated frozen oxygenic photosynthetic membranes emit light at distinct temperatures, when warmed from low temperatures in the dark. This phenomenon is called Thermoluminescence (TL). In oxygenic photosynthetic membranes, different charge pairs are involved in generating the glow peaks appearing at different temperatures.

In BARC, TL is used mainly in dosimetry, however with the right type of photomultiplier tubes, it can also be used to study the photosynthetic membranes. Thermoluminescence is a simple technique which can monitor *in vivo* changes in redox characteristics of donor and acceptor states. The upgraded TL set up

was used to obtain glow curves from a variety of samples. The digital set-up has improved the quantitative analysis of TL data.

TL set up has been upgraded with the in-house designed and developed microcontroller based data recording system. This has improved the functioning of the thermoluminescence and allowed the use of modern implements of the data processing techniques on the signal received.

A block diagram of the digital recording system is given in Fig. 1. Eight inputs are acquired and connected to the signal conditioning circuit. Outputs from various channels are then sent to the data acquisition and control card (BIOSLC). This is a microcontroller based

card, which reads eight analog signals from the signal-conditioning card. The rate of sampling is half a second. Data is collected and transmitted on asynchronous serial lines to be acquired in PC. Micro programme for data acquisition card is written in the assembly language code. Data is sent at the baud rate of 9600. Alternatively, the output data can be monitored on the Digital Panel Meter. Flow diagram of the programme is given in Fig. 2.

The Signal conditioning subsystem is a circuit that accepts eight analog inputs. This circuit mainly serves as the isolation signal conditioning circuit for input signals.

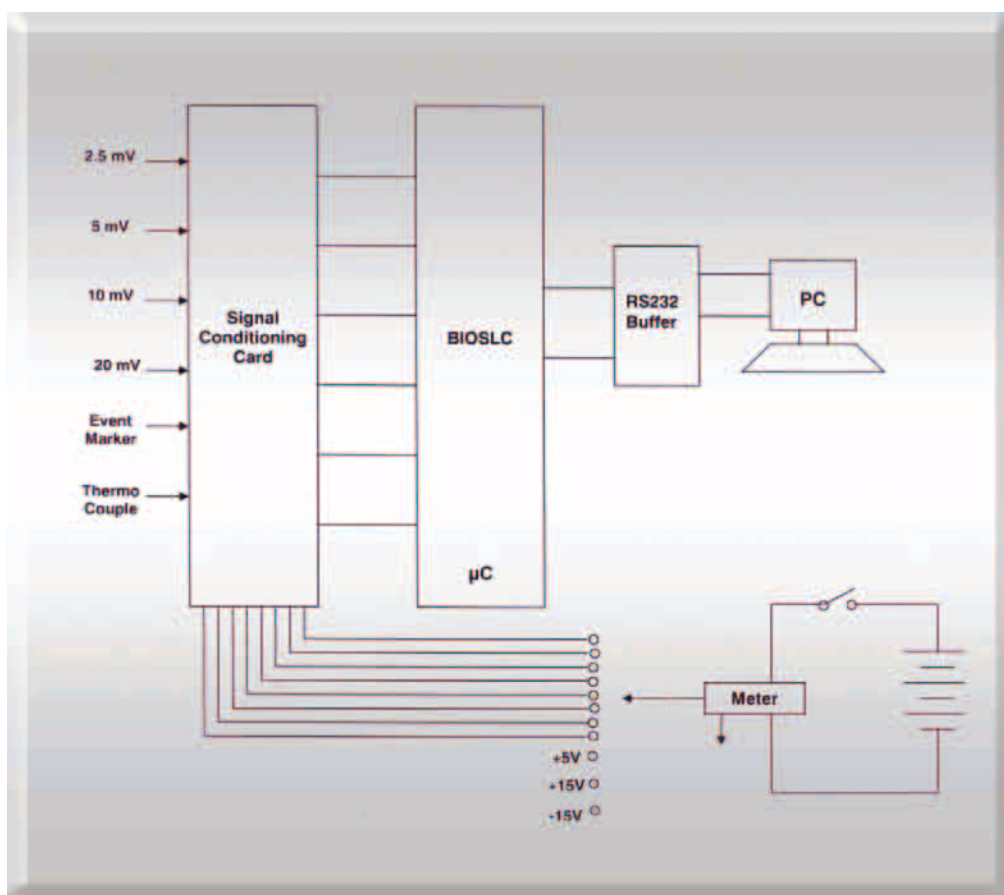


Fig. 1: Block diagram of the digital recording system

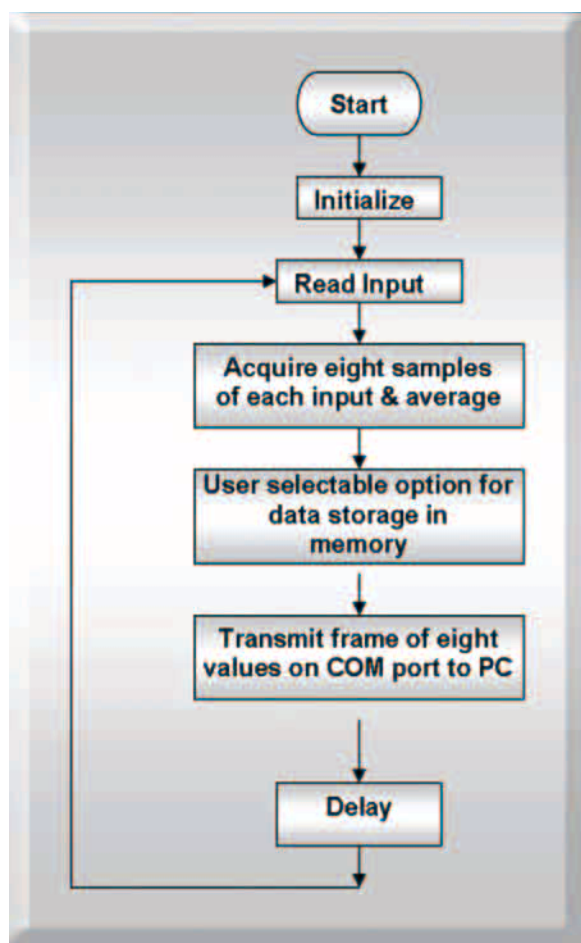


Fig. 2: Flow diagram of assembly language programme in BIOSLC

There are eight identical channels. Analog input is fed to a single channel, which consists of a floating operational amplifier for signal pre-conditioning. The output of operational amplifier is fed to isolation amplifier. The output of isolation amplifier is fed to dual operational amplifier. The span and zero can be adjusted by potentiometers available on the signal conditioning circuit. Clock generator IC generates the carrier clock for isolation amplifier. Linear voltage regulators generate the reference voltages respectively. The isolation amplifiers and clock drives are "import substituted" components (Das et al 2005).

Software using Visual Basic programme was used for receiving data in the PC. Data is received and is stored

as an XLS file. Digital recording system (Fig. 3a) was assembled and integrated with the thermoluminescence set-up as shown in Fig. 3b. The upgraded TL set up was used for measurement of glow peaks of a variety of samples.

Results

Thermoluminescence glow curves of groundnut leaf

Leaf disc of groundnut were relaxed in dark, prior to illumination with a light intensity of 210 W m^{-2} for



Fig. 3a: Digital recording system



Fig.3b: Digital recording system interfacing thermoluminescence set-up

4 minutes in a planchet. The sample was quickly cooled by dipping in liquid nitrogen. Sample was placed on the stage of cryostat maintained at 77 K and heated at a predetermined rate by temperature controller. Fig. 4 shows the glow peaks obtained from leaves of groundnut with and without treatment with DCMU (3-(3, 4-dichlorophenyl) 1,1-dimethyl urea), a herbicide which is known to disrupt electron transport

in photosynthetic membranes. The intensity of Q peak increases and B peak decreases as expected after treatment with DCMU.

Thermoluminescence glow curves of *Chlorella*

The cells of unicellular non-motile algae *Chlorella* were relaxed in dark and subsequently exposed to white light. Fig. 5 shows glow peaks obtained from *Chlorella*. Cells not exposed to light did not give any glow peaks whereas Q and B peaks were seen in samples kept in light.

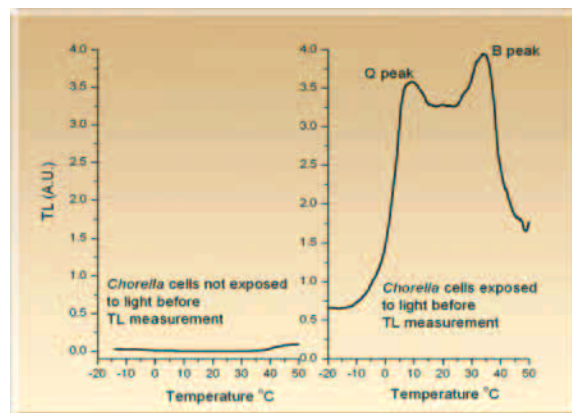


Fig. 5: Thermoluminescence glow curves of *Chlorella* cells: Thermoluminescence is expressed in arbitrary units TL (A.U.)

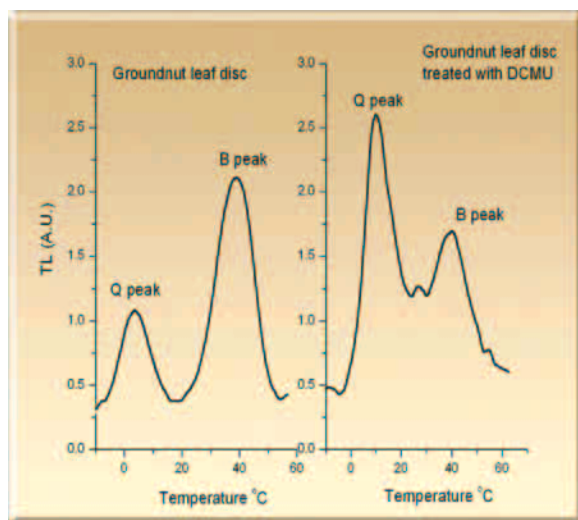


Fig. 4: Thermoluminescence glow curves of Groundnut leaves. Thermoluminescence is expressed in arbitrary units TL (A.U.)

Thermoluminescence glow curves of cyanobacteria

The cells of unicellular cyanobacteria *Anacystis nidulans* were relaxed in dark and subsequently exposed to white light. The photosynthetic membranes in cyanobacteria are different from membranes in higher plants. Fig. 6 shows the glow peaks of *Anacystis nidulans*. The intensity of B peak decreased when cyanobacteria were treated with DCMU.

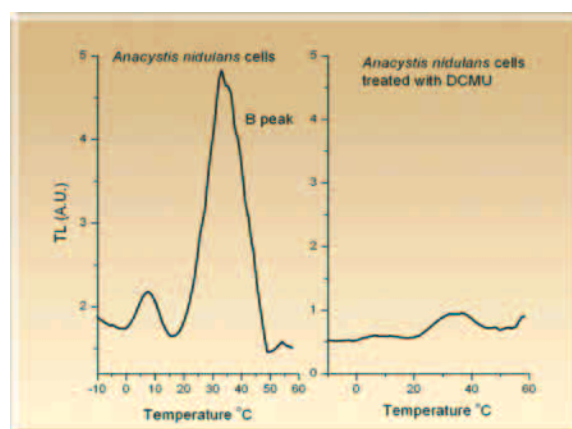


Fig. 6: Thermoluminescence glow curves of *Anacystis nidulans* : Thermoluminescence is expressed in arbitrary units (TL (A.U.))

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64TH BRNS-IANCAS NATIONAL WORKSHOP: A REPORT

The Indian Association of Nuclear Chemists and Allied Scientists (IANCAS) organized the 64th BRNS-IANCAS National Workshop on Radiochemistry and Applications of Radioisotopes at the Department of Chemistry, Rastrasant Tukadoji Maharaj Nagpur (RTMN) University, Nagpur during 2nd to 10th July, 2007. Forty-eight persons from different disciplines such as Chemistry, Zoology etc. with affiliations to IIT Roorki, NEERI, CISF and various colleges and Departments of Nagpur University, M.S. University (Baroda) and Sant Gadgebaba Amaravati University participated in the workshop.

Dr. V. C. Sahni, Director, RRCAT and Director, Physics Group, BARC in his inaugural address, briefly mentioned the challenges in the nuclear field and stated that the activities of IANCAS by way of

conducting such workshops and dissemination of information through bulletins and web-site, would help in enhancing the professional competence and provide impetus to increasing use of nuclear energy and radioisotopes, for the welfare of mankind. In a function presided over by Dr. S. N. Pathan, Vice-Chancellor, RTMN University, Dr. V. K. Manchanda, Head, Radiochemistry Division, BARC and President, IANCAS provided detailed information about activities of IANCAS and said that in the emerging world scenario, nuclear energy and related activities are going to play an important role and will require personnel with specialization in Nuclear Chemistry and Radiochemistry. Dr. H. D. Juneja, Head, Department of Chemistry, RTMNU delivered the welcome address. Dr. S. V. Godbole, Coordinator of Workshop, emphasized the importance of the workshop and



Inauguration (L-R): Dr. V.C. Sahni, Director, RRCAT & Director, Physics Group, BARC inaugurating the workshop, Dr. D.V. Parwate, Dr. H.D. Juneja, Head, Chemistry Dept., Dr. S.N. Pathan, Vice Chancellor, RTM Nagpur univ., and Dr. V.K. Manchanda, President, IANCAS, BARC

briefed the participants about its theme and scope. Dr. D. V. Parwate, Host Coordinator of the Workshop proposed a vote of thanks.

In a span of 8 days, 16 lectures were delivered and 6 experiments were conducted. The lectures were highly interactive and led to useful discussions between the participants and the team of resource persons. In the laboratory, the participants got hands-on experience in dealing with radioisotopes and radiation Instruments. Dr. Aparna Banerji, the practical coordinator gave details about the experiments and the procedure to be followed in safe handling of radioactivity in the university laboratories.

Special lectures were delivered by Dr. Manchanda, Mr. S.G. Markandeya, Dr. S.P. Kale, Prof. A.N. Garg, Mr. B.K. Sen and Mr M.K. Roy from AMD.

Mr. B. K. Sen, Head, Product Development Section, BARC, delivered the valedictory address and donated a set of G.M. Counter & NaI (TI) detector along with standard radioisotope sources, to the host institute on behalf of IANCAS. The participants in the workshop were awarded certificates. Dr. Parashar, Pro-Vice Chancellor, RTMNU was the Chief Guest.

Three workshops were organized at local school and colleges and more than 600 students benefited through this hands-on experience. Lectures on Introduction to Radioactivity, Nuclear power and safety aspects of handling radioactivity were delivered along with demonstration of experiments on radioactivity counting to the students at schools and college. Dr. S.V. Godbole, Dr. Sarbjeet Singh, Dr. Aparna Banerji, Mr. T. V. Vittal Rao, Mr. Rahul Tripathi, Mr. A. Sarkar from BARC and Dr. Yojana Singh, BRIT served as resource persons during this workshop.

NEW PUBLICATION

SMART STRUCTURES

Blurring the Distinction between
the Living and the Nonliving

Vinod K. Wadhawan,

Bhabha Atomic Research Centre,
Mumbai, India

'A unique book, well written and of a wide interest. The idea of smart materials is very much of the moment.' A. M. Glazer, University of Oxford.

A structure is an assembly that serves an engineering function. A smart structure is one that serves this function smartly, i.e. by responding adaptively in a pre-designed useful and efficient manner to changing environmental conditions. Adaptive behaviour of one or more materials constituting a smart structure requires nonlinear response. This book describes the three main types of nonlinear-response materials: ferroic materials, soft materials and nanostructured materials. Information processing by biological and artificial smart structures is also discussed. A smart structure typically has sensors, actuators, and a control system. Progress in all these aspects of smart structures has leaned heavily on mimicking Nature and the all-important notion in this context has been that of evolution. Artificial Darwinian and Lamarckian evolution holds the key to the development of truly smart structures. Modestly intelligent robots are already on the horizon. Projections about the low cost availability of adequate computing power and memory size indicate, that the future really belongs to smart structures. This book covers in a compact format the entire gamut of concepts relevant to smart structures. It should be of interest to a wide range of students and professionals in Science and Engineering.

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



A. Mitra

डॉ. ए. मित्रा, खगोल भौतिकी विज्ञान प्रभाग द्वारा लिखित तथा “सोर्सस ऑफ स्टेलर एनर्जी आइन्स्टाइन एडिंगटन टाइमस्केल ऑफ ग्रैविटेशनल कॉन्ट्रैक्शन एण्ड इटरनली कोलैप्सिंग ऑब्जेक्ट्स”, शीर्षक वाले अनुसंधान पत्र को वर्ष 2006 के लिये मैक्स प्लॉन्क सोसाइटी ऑफ जर्मनी के हाइलाइट पेपर के रूप में चुना गया है। यह लेख जो “न्यू एस्ट्रोनमी” के दिनांक 1 नवंबर, 2006 के अंक में प्रकाशित हुआ था, में यह स्पष्ट किया गया था कि नाभिकीय ईंधन पूरी तरह समाप्त होने के पश्चात भी अति विशाल तारे संकुचन के कारण स्वतः नये दाब एवं ऊष्मा उत्पन्न करते हैं। इसके फलस्वरूप ब्लैक होल का निर्माण करने के बजाय वे वास्तविक रूप में “इटरनली कोलैप्सिंग ऑब्जेक्ट” नामक विकिरण दाब प्रेरित अर्धस्थैतिक अभिविन्यास का रूप लेते हैं। लेख में रिपोर्ट किया गया कार्य डॉ. ए. मित्रा द्वारा मैक्स प्लॉन्क इन्स्टिट्यूट ऑफ कर्नफिजिक, हीडलबर्ग में मार्च - अगस्त 2006 के दौरान विजिटिंग वैज्ञानिक के रूप में रहते समय किया गया था।

The research paper entitled, “Sources of stellar energy Einstein – Eddington timescale of gravitational contraction and eternally collapsing objects”, authored by Dr. A. Mitra of Astrophysical Sciences Division has been selected as a Highlight Paper of the Max Planck Society of Germany for the year 2006. The paper which appeared in the Nov.1, 2006 issue of “New Astronomy” explains that even after exhausting nuclear fuel, massive stars self generate new pressure and heat due to contraction. As a result rather than forming black holes they actually end up as radiation pressure supported quasistatic configuration called “Eternally Collapsing Object”. The work reported in the paper was carried out by Dr. A. Mitra at the Max Planck

Institute of Kernphysik, Heidelberg during March-August 2006 when he was a Visiting Scientist at the Institute.



Shweta Roy



Rajni Pande



S.V.L.S. Rao



P. Singh

श्वेता रॉय, रजनी पांडे, एस.वी.एल.एस. राव, एवं पी. सिंग द्वारा लिखित च्छलेक्ट्रोमेगनेटिक डिज़ाइन ऑफ डीटीएल केविटी फॉर एलईएचआइपीए छ नामक शोध-पत्र को सितंबर 19-21, 2007 के दौरान भाभा परमाणु अनुसंधान केंद्र, अणुशक्तिनगर, मुंबई में आयोजित डीईई - बीआरएनएस -पीएसआइ सिम्पोज़ियम ऑन आयन बीम टेक्नॉलोजी एन्ड एप्लिकेशनस (एसआइबीटीए-2007) की परिचर्चा में सर्वश्रेष्ठ पुरस्कार प्रदान किया गया।

A paper entitled “Electromagnetic Design of DTL Cavity for LEHIPA”, authored by Shweta Roy, Rajni Pande, S.V.L.S. Rao and P. Singh was awarded the best poster paper prize during the DAE-BRNS-PSI Symposium on Ion Beam Technology and Applications (SIBTA-2007) held at BARC, Mumbai during September 19-21, 2007.

श्रीमती श्वेता रॉय भाभा परमाणु अनुसंधान केंद्र के नाभिकीय भौतिकी प्रभाग में वर्ष 2003 से काम कर रहीं हैं। ये भाभा परमाणु अनुसंधान केंद्र के प्रशिक्षण विद्यालय के 46वें बैच

से हैं इन्होंने देहली, आइआइटी से भौतिक विज्ञान में एमएससी प्राप्त की। श्रीमती श्वेता रॉय भाभा परमाणु अनुसंधान केंद्र में एडीएस प्रोग्राम हेतु उच्च प्रबल प्रोटॉन गतिवर्धक के भौतिक विज्ञान के अध्ययन में व्यस्त हैं।

Ms. Shweta Roy is working in the Nuclear Physics Division, BARC since 2003. She is from the 46th batch of BARC Training School. She did her M.Sc. in Physics from IIT, Delhi. Ms. Shweta Roy is involved in Physics Studies of the High Intensity Proton Accelerator being developed at BARC for ADS Programme.

श्रीमती रजनी पांडे एवं आरआरसीएटी प्रशिक्षण विद्यालय के द्वितीय बैच से हैं। श्रीमती रजनी पांडे वर्ष 2002 से भाभा परमाणु अनुसंधान केंद्र के नाभिकीय भौतिकी प्रभाग में कार्यरत हैं। इन्होंने लखनऊ विश्वविद्यालय से भौतिक विज्ञान में एमएससी की डिग्री प्राप्त की। एडीएस प्रोग्राम हेतु उच्च प्रबल प्रोटॉन गतिवर्धक के विकास में इनकी रुचि है।

Ms. Rajni Pande is from the second batch of RRCAT Training School and is working in the Nuclear Physics Division since 2002. She did her M.Sc. in Physics from Lucknow University. Her interest is in development of a High Intensity Proton Accelerator for the ADS Programme.

श्री एस.वी.एल.एस राव ने वर्ष 2000 में हैदराबाद विश्वविद्यालय से भौतिक विज्ञान में एमएससी प्राप्त की तथा भाभा परमाणु अनुसंधान केंद्र के ओरियंटेशन प्रोग्राम के एक वर्ष पश्चात् 2001 में नाभिकीय भौतिकी प्रभाग की सदस्यता ली। श्री राव इस समय एडीएस प्रोग्राम हेतु उच्च प्रबल प्रोटॉन गतिवर्धक के विकास में व्यस्त हैं।

Mr. S.V.L.S. Rao did his M.Sc. in Physics from University of Hyderabad in 2000 and joined the Nuclear Physics Division in 2001 after one year of Orientation programme at BARC. Mr. Rao is presently involved in development of High Current Accelerator of ADS.

डॉ. पीतांबर सिंह, भाभा परमाणु अनुसंधान केंद्र प्रशिक्षण विद्यालय के 19^{वें} बैच के स्नातक, ने वर्ष 1976 में भाभा परमाणु अनुसंधान केंद्र के नाभिकीय भौतिकी प्रभाग में सदस्यता ली। इन्होंने मुंबई विश्वविद्यालय से वर्ष 1983 में भौतिक विज्ञान में पीएचडी डिग्री प्राप्त की। आपने मेक्स प्लैंक स्नातक की हेसियत से एमपीआइ, हाइदेलबर्ग, जर्मनी में एक वर्ष व्यतीत किया। भारत में पहला 2 एमवी टैंडम गतिवर्धक की रूपरेखा एवं निर्माण में सम्मिलित होने के अतिरिक्त इन्होंने हैवी रिकॉयलंड आयन का पता लगाने हेतु भाभा परमाणु अनुसंधान केंद्र में 6 एमवी टैंडम गतिवर्धक (फोटिया) सुविधाएं पश्चाघात पृथक्कारी पुंज स्थापित करके एक विशिष्ट योगदान दिया। देश में गतिवर्धक प्रौद्योगिकी के स्थायी विकास हेतु उत्कृष्ट योगदान के लिए इन्हें वर्ष 2000 का डीईएस टेक्निकल एक्सिलेंस अवार्ड प्रदान किया गया। आप “नैशनल अकादमी ऑफ साइन्सिस, इन्डिया” के आजीवन सदस्य हैं। डॉ. सिंह डीईएस के एडीएस प्रोग्राम हेतु उच्च प्रबल प्रोटॉन गतिवर्धक के विकास में व्यस्त हैं। 250 से भी अधिक प्रकाशन इनके श्रेय में हैं।

Dr. Pitamber Singh, a graduate of the 19th batch of BARC Training School, joined the Nuclear Physics Division, BARC in 1976. He received his Ph.D. degree in Physics from Mumbai University in 1983. He spent about a year at MPI, Heidelberg, Germany as Max Planck Fellow. In addition to participating in design and building the first 2 MV Tandem Accelerator in India and a recoil Mass Separator for detection of heavy recoiled ions, he has made an outstanding contribution in setting up the 6 MV Folded Tandem Ion Accelerator (FOTIA) facility at BARC. He was conferred DAE's Technical Excellence Award for the year 2000 for his excellent contributions towards indigenous development of accelerator technology in the country. He is a life member of "The National Academy of Sciences, India". Dr. Singh is working on the development of High Intensity Proton Accelerators for the ADS programme of DAE. He has more than 250 publications to his credit.



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Editorial Management : Ms. S.C. Deokattey,

Computer Graphics & Layout : B. S. Chavan, SIRD, BARC

BARC Newsletter is also available at

URL: <http://www.barc.gov.in> (for private circulation only)