International Atomic Energy Agency

INDAG

International Nuclear Desalination Advisory Group

INDAG NEWSLETTER

N° 1 - September 2001

A WORD FROM THE DEPUTY DIRECTOR GENERAL

The International Nuclear Desalination Advisory Group, INDAG, was created following the 1996 General Conference Resolution (GC(40)/RES/14) requesting the IAEA to take the appropriate measures to assist Member States in the process of preparatory actions for nuclear desalination demonstration projects. This resolution was reiterated in the following IAEA General Conferences and INDAG is now in its second term, ending in 2004.

From its very beginning, INDAG has actively contributed to the promotion and stimulation of nuclear desalination activities in IAEA Member States. Its achievements are numerous but they are perhaps relatively less well known to people outside IAEA and related organisations.

I, therefore, heartily congratulate INDAG for taking the initiative of publishing this Newsletter and bringing to you not only a report of their activities but also in succinctly presenting the latest innovations and advances taking place in Member States in the field of nuclear desalination.

V. M. Mourogov
Deputy Director General
Department of Nuclear Energy, IAEA

TO OUR READERS

This is the first issue of the Newsletter, prepared by INDAG members with support from the IAEA, in particular from the Nuclear Power Technology Development Section (NPTDS), Division of Nuclear Power, Department of Nuclear Energy, which also provides the Scientific Secretariat of INDAG.

Our main purpose in issuing this Newsletter is to bring to you directly all up to date information regarding INDAG, the activities stimulated through its actions and recommendations and the impact that such activities had, or are having, in IAEA Member States (MS).

Each issue of the Newsletter will be accompanied by a short article from one of the INDAG members (all members will take turns), indicating the advances made in the promotion and/or the implementation of nuclear desalination in his/her country.

This issue thus includes the first of these articles by P. Tewari and B. Misra, from India, who explain the motivation and the various steps that have led to the realisation of the nuclear desalination system using the Kalpakkam nuclear reactor. The project is expected to be operational in 2003.

We intend to publish the Newsletter each year, just before the General Conference (GC) of the IAEA.

You may thus well imagine the intense pressure we had in bringing out this first issue just few days before the 2001 GC, since the decision to publish the newsletter was taken quite recently during the INDAG Meeting.

Hastily putting together this first issue was very hard work indeed, but, nonetheless, great fun. We hope that you will have as much fun reading it as we had in handcrafting this issue.

S. Nisan (Chairman, INDAG*)

*Members of the Editorial Committee are:
S. B. Abdel Hamid (Egypt),
J.R. Humphries (Canada),
T. Konishi (IAEA),
S. Nisan (France),
P.K. Tewari (India)

WHAT IS INDAG?

INDAG was created with a view to :

- Provide advice and guidance on IAEA activities in nuclear desalination and review their progress.
- Identify important topics for status reports, Co-ordinated Research Projects (CRP), technical meetings and topical conferences in the field of nuclear desalination.
- Provide a forum for the exchange of information on the progress in national and international nuclear desalination programmes.
- Provide advice on preparatory action by Member States for implementing nuclear desalination demonstration projects.

The first meeting of INDAG was held in September 1997 and since then the group has met regularly every year.

Current members of INDAG are :

Members of INDAG, Term II (2001-2004)

Argentina
Mr. N. Masriera

Canada
Mr. J.R. Humphries

China
Mr. Z.X. Wu

Egypt
Mr. S.B. Abdel Hamid

France
Mr. S. Nisan (Chairman)

India
Mr. P.K. Tewari

Israel
Mr. A. Barak

Japan
Mr. A. Minato

Korea, Republic of
Mr. S.H. Kim

Libyan Arab Jamahiriya
Mr. S.M. Ghurbal

Morocco
Mr. D. Benhima

Russian Federation
Mr. Y.D. Baranaev

Saudi Arabia
Mr. A.S. Al-Kheliewi

Tunisia
Mr. H. Ben Kraiem

United States of America
Mr. J. Binder

Concomitant with its terms of reference, the group has :

- Presented and discussed the status of nuclear desalination programmes among its members.
- Provided various recommendations for IAEA on supporting activities.
- Reviewed the activities implemented by the IAEA, using standard IAEA tools e.g. Advisory Group Meetings (AGMs), Co-ordinated Research Programme (CRPs), TECDOCS and other technical publications, etc.

What has been achieved ?

INDAG, through its meetings, has provided common methodology, computer tools and activities which have encouraged other MS to engage in nuclear desalination activities in a more coherent manner.

Similarly, under INDAG's recommendations and suggestions, IAEA has already implemented important activities for the promotion of the cause for nuclear desalination in the world :

- Launching of the CRP on **"Optimisation of the coupling of nuclear reactors and desalination systems" (1998 - 2003).**

• Compilation of a Technical Report Series (TRS) on "**Introduction of Nuclear Desalination: A Guidebook".**

• Activities related to the **economical competitiveness of nuclear desalination**:

  – Validation and improvement of the IAEA Cogeneration Desalination Economic Evaluation assessment code and its upgrading to a user-friendly interface in the form of the Desalination Economic Evaluation Programme (the DEEP code).

  – Preparatory work for a new CRP on "Economic Research on, and Assessment of, Selected Nuclear Desalination Projects and Case Studies".

• Establishment of a **database for non-electrical heat applications** of nuclear energy.

• Publication of Technical Documents on selected topics of high interests, such as, **Safety Requirements of Integrated Nuclear Desalination Systems, Economics, Guidance for Preparing User Requirements Documents**.

• Co-operation with other **international organisations or projects**.

IMPACT OF INDAG ACTIVITIES

A major impact of Agency's above activities has been to serve as an international forum for technical exchanges between interested supplier and user Member States (MS) and that these exchanges have gradually led to bi-lateral or multi-lateral collaborations between several MS:

■ Collaboration between Republic of Korea and Indonesia.

■ Use of IAEA publications for the initial preparation of the EURODESAL project, currently being carried out by a consortium of 7 partners, including nuclear industrial companies from Europe and Canada and EU R&D organisations.

■ The collaboration between Canada and Russia on the barge mounted nuclear desalination concept.

■ The initiation of a Franco-Tunisian collaboration on feasibility studies of nuclear desalination for a site in Tunisia.

NEW ACTIVITIES FOR 2004-2005

INDAG identified the following potential new activities for 2004 - 2005:

• Evaluation of utilisation potential of nuclear waste heat for desalination.

• Development of computer programs for coupling optimisation.

• Development of DEEP-3, incorporating new modeling of coupling configurations and its validation.

• Promotion of the training of personnel in all aspects of nuclear desalination. In this context, the Indian offer of accepting trainees on its Kalpakkam nuclear desalination plant, beginning 2003, is a welcome initiative.

• Addressing regulatory aspects, specific to nuclear desalination systems.

In addition, some activities are likely to be continued from 2002 - 2003 including:

• CRP on "Economic Research on, and Assessment of, Selected Nuclear Desalination Projects and Case Studies".

• Maintenance of the extended PRIS data tables for heat application systems.

• Collection and updating of technical information on non-electric applications of nuclear energy.

In order to further enhance the chances for an accelerated deployment of nuclear Desalination, INDAG members further proposed that the Agency should:

- Promote experimental studies designed to confirm or validate theoretical results.
- Favour site specific studies.
- Promote R&D on the utilisation of waste heat from nuclear reactors to more efficiently couple these reactors to desalination systems.

Most developing countries still feel the necessity of having additional tools for their own project evaluations. INDAG recommended that the Agency:

- Provide new software tools and upgrade existing ones, permitting the accurate technical and economical assessments of relevant projects.
- Launch the CRP on detailed site specific economic studies.

INDAG members also recommended that the most expeditious means of introducing nuclear desalination would be to install desalination facilities at existing nuclear plants, where possible and where a need for water exists. INDAG recommended that IAEA:

- Explore the possibility of stimulating such a project, with MS having existing nuclear installations in locations where water is needed.
- Explore the possibility of cooperating in such a project as a means for obtaining and disseminating information to interested MS regarding the practical, detailed aspects of project implementation.

NEXT MEETING

The next INDAG meeting will be held at VIC from 10 to 12 June, 2002.

HOW TO CONTACT US ?

Please feel free to browse the IAEA Nuclear Desalination website at (http://www.iaea.org/nucleardesalination)
or, contact Mr T. KONISHI, phone : 0043 1 2600 22822
e-mail: T.konishi@iaea.org

Nuclear Desalination Demonstration Project (NDDP) in India

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The Bhabha Atomic Research Centre (BARC) has been engaged in research and development of desalination since 1970s with a view to augment water resources in areas of scarcity. As a result, multi-stage flash (MSF) and reverse osmosis (RO) technologies were developed indigenously.

Introduction

In order to gainfully employ the years of experience and expertise in various aspects of desalination activity, BARC (India) has undertaken installation of a hybrid nuclear desalination plant coupled to 170 MW(e) PHWR station at Kalpakkam, Chennai in the Southeast coast of India. The integrated system, called the Nuclear Desalination Demonstration Project (NDDP), will thus meet the dual needs of process water for nuclear power plant and drinking water for the neighbouring people.

Objectives

NDDP aims for demonstrating the safe and economic production of good quality water by nuclear desalination of seawater. It comprises a 4500 m^3/d Multistage Flash (MSF) and a 1800 m^3/d Reverse Osmosis (RO) plant. MSF section uses low pressure steam from Madras Atomic Power Station (MAPS), Kalpakkam.

The objectives of the NDDP (Kalpakkam) are as follows:

1. To establish the indigenous capability for the design, manufacture, installation and operation of nuclear desalination plants.

2. To generate necessary design inputs and optimum process parameters for large scale nuclear desalination plant.

3. To serve as a demonstration project to IAEA welcoming participation from interested member states.

The hybrid plant is envisaged to have a number of advantages:

1. A part of high purity desalted water produced from MSF plant will be used for the makeup demineralised water requirement (after necessary polishing) for the power station.

2. Blending of the product water from RO and MSF plants would provide requisite quality drinking water.

3. The RO plant will continue to be operated to provide the water for drinking purposes during the shutdown of the power station.

Hybrid MSF-RO Nuclear Desalination Demonstration Plant

The 6300 m^3/d hybrid MSF-RO nuclear desalination installation is located in between the existing 170 MW(e) PHWR station and proposed 500 MW(e) FBR at Kalpakkam.

MSF Plant

The MSF plant uses cheaper material of construction, deploying carefully controlled seawater chemistry. A wide flash temperature range leads to more than 30 stages, offering GORs of 9-10. The long tube design reduces the pumping power.

The MSF plant uses significant quantity of low pressure (LP) steam for seawater desalination. In order to avoid any chance of ingress of radioactivity (tritium) to MSF process and product water, it has been decided to incorporate an isolation heat exchanger between MAPS steam supply and the brine heater of MSF. The LP steam is tapped from the manholes in the cold reheat lines after HP turbine exhaust from both the nuclear reactors (MAPS I and II).

The moisture content is removed through a moisture separator. The steam is sent to intermediate isolation heat exchanger to produce process steam for brine heater of the MSF plant. The pressure and temperature of steam generated from isolation heat exchanger determines the terminal temperature difference. It has been decided to generate steam at 0.270 MPa (130.48 °C saturation temperature) in isolation heat exchanger so that the steam is available at the inlet to brine heater at about 0.249 MPa.

Furthermore, it is desirable to keep the steam temperature in brine below 130 °C to avoid scaling on the tube side.

The work on steam system is progressing well. The steam pipeline layout from MAPS to NDDP has been finalised. The condensate from the isolation heat exchanger is returned back to the deaerator section of the power station.

Adequate provisions for monitoring and control have been

incorporated for isolation of the steam supply in case of shutdown of the power station or desalination plant.

The tender document for the steam and condensate system has been released. The offers have been received from the bidders. The technical and commercial evaluation for undertaking the job has been completed.

RO Plant

The RO plant employs spiral wound membrane modules. It requires relatively lower operational pressure which is due to the use of elevated feed sea water temperature.

The pretreatment for the RO plant is presently conventional using chlorination, clariflocculation, sand filtration, acid dosing, antiscalant dosing, dechlorination and cartridge filtration.

The RO plant is fitted with energy recovery hydraulic turbocharger. It is planned to blend the return stream of cooling seawater from the reject stages of MSF with the seawater to bring down the temperature to 36-38 °C for RO feed.

General Characteristics of NDDP

NDDP requires around 2000 m^3/hr seawater. Different alternatives for seawater intake were considered and evaluated. The possibility of an exclusive intake for supply of raw seawater was investigated in detail.

The bathymetric and morphological surveys were carried out. The geology of seabed was identified. The tests were carried out for the soil bearing capacity, erosion and depositional characteristics of the seabed. The raw water samples were collected to carry out detail analysis.

From the bathymetry and seabed soil characteristics it is observed that the seabed primarily consists of silty sand. Morphological changes along the beach are very high with respect to seasonal changes. After studies, it has been decided to use process cooling water from MAPS outfall seal pit as a source of seawater supply for NDDP. The outfall seawater temperature varies from 26 – 32 °C which is about 4 °C higher than ambient temperature due to heat being rejected from the process cooling water system.

The cooling water discharge has no debris since the intake water passes through the trash rack and travelling water screens. It is reported to have less biofouling potential.

The tender for the seawater intake and reject disposal system has been released. The offers were received from the interested parties.

The technical evaluation has been completed.

Status

Considerable progress has been achieved in the implementation of the project. Indents for all the major equipment and materials for NDDP have been released and are in various stages of procurement and fabrication at works. Fabrication of process tanks has already been completed and installed at NDDP site.

Fabrication of multistage steam jet ejector with pre-, inter- and after-condenser has also been completed and delivered at site.

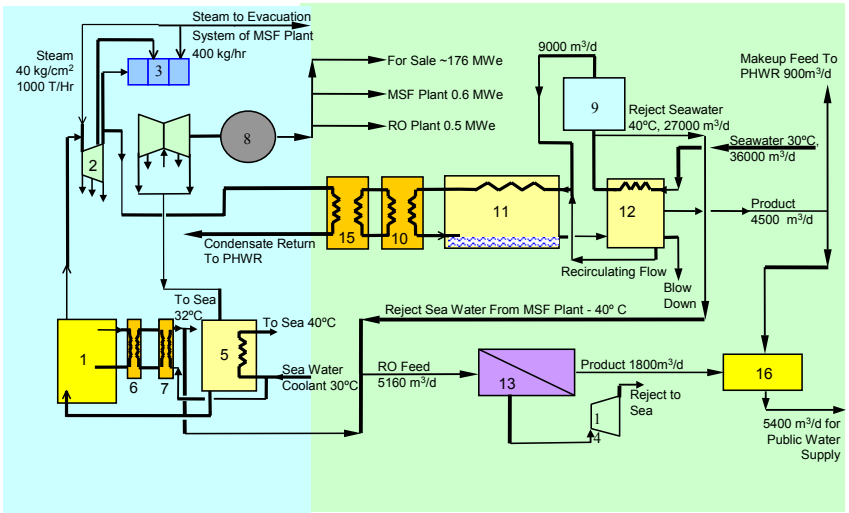
The fabrication of MSF modules and de-aerator has started at supplier's works. The civil foundation work for the MSF module has been taken up. Civil works at site is in full swing and nearing completion.

The construction work of workshop, electrical substation, administrative and stores building has been completed. RO building is also ready.

Installation of the RO pretreatment system has started at the site. The offers received for RO modules have been evaluated and purchase order has been released to the party. Electrical systems such as transformer, HT cables, LT panel and MCC are in advanced stage of procurement and supply.

Useful design data is expected from the plant on the coupling of SMR based on PHWR with a hybrid desalination plant.

Trial runs and commissioning are envisaged later in 2002. On completion of the commissioning test, the NDDP will be open to international participation by interested Member States under the IAEA umbrella in order to share the relevant information of operation and maintenance of a nuclear desalination plant.



1. PHWR 170 MWe
2. HP Turbine
3. Moisture Separator / Reheater
4. LP Turbine
5. Power Plant Condenser
6. Moderator - DM Water Cooling Loop
7. DM Water - Sea Water Cooling Loop
8. Generator
9. MSF Plant Chemical Pretreatment Section
10. MSF Plant Brine Heater
11. MSF Plant Heat Recovery Section
12. MSF Plant Heat Reject Section
13. RO Plant
14. RO Plant Energy Recovery Turbine
15. Intermediate Heat Exchanger
16. Product Storage Tank

6,300 m^3/d MSF- RO DESALINATION PLANT COUPLED TO 170 MWe PHWR