



PINSTECH Newsletter

SPECIAL ISSUE

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Patron

Dr. Jamshed Hussain Zaidi

Editors

Dr. Riffat Mahmood Qureshi
Dr. Javed Iqbal Akhter
Waqar Ahmad Butt

Address

Scientific Information Division
PINSTECH, P.O. Nilore, Isb.
Ph. 9248801-7, Fax, 9248808
E-mail: newsletter@pinstech.org.pk

EDITORS CORNER

Another landmark in the history of PINSTECH has been achieved by a dedicated team of scientists and engineers of the Isotope Production Division whose efforts have led to the successful commissioning of fission ^{99}Mo production facility. This unique facility is the first of its kind in Pakistan. Presently, fourteen nuclear medical centres of PAEC as well as many reputed hospitals in the country will benefit from this facility saving a huge amount of foreign exchange that was being spent on the import of ^{99}Mo . More significantly, PINSTECH will be able to generate foreign exchange through export of fission ^{99}Mo as well as $^{99}\text{Mo} \rightarrow ^{99\text{m}}\text{Tc}$ generator systems to the regional end-users. This special issue of PINSTECH Newsletter is dedicated to this laurel of the Institute.

COMMISSIONING OF FISSION ^{99}Mo PRODUCTION FACILITY

During the month of July 2010, PINSTECH has achieved another milestone by commissioning a technical facility for indigenous production of fission ^{99}Mo at the Isotope Production Division of the Institute. The fission ^{99}Mo thus produced shall be used in the production of $^{99}\text{Mo} \rightarrow ^{99\text{m}}\text{Tc}$ generators to meet the requirements of national nuclear medical centres and hospitals. The prominent position of $^{99\text{m}}\text{Tc}$ in nuclear medicine practice has been due to its near ideal nuclear properties (140 keV gamma for imaging and no β particle emission), the ready availability in the form of convenient $^{99}\text{Mo} \rightarrow ^{99\text{m}}\text{Tc}$ generator systems and the rapid progress made in recent years in the development of $^{99\text{m}}\text{Tc}$ radiopharmaceuticals for application in oncology, cardiology and other fields. $^{99\text{m}}\text{Tc}$ is the short-lived (half-life=6h) daughter product of the parent

molybdenum-99 (half-life = 66 h), which is produced by the nuclear fission of ^{235}U .

PINSTECH has been importing fission ^{99}Mo from South Africa for the last seven years for weekly production and dispatch of Pakgen $^{99}\text{Mo} \rightarrow ^{99\text{m}}\text{Tc}$ generators to 38 nuclear medical centers and hospitals in Pakistan.

To overcome the problems associated with import of fission ^{99}Mo such as hard currency, increasing price of ^{99}Mo , import policies, delay and changes in supply schedules, etc., the indigenous production of fission ^{99}Mo in the country was planned. In March 2004, the Planning Commission of Pakistan approved a three years project worth Rs. 212 million for installation of fission ^{99}Mo production facility (MPF) for medical use. Accordingly, for the supply of equipment and transfer of technology, Pakistan Atomic Energy Commission (PAEC) signed a contract worth Euro 2.62 million in January 2005 with M/s Wälischmiller, Dresden, Germany. As per agreement, supply & installation of equipments as well as radioactive commissioning of ^{99}Mo facility were the responsibility of Wälischmiller, while renovation of laboratory, fabrication of target plates, target transport container and ^{99}Mo product container were to be done by PINSTECH scientists and engineers. The development of chemical process for separation of ^{99}Mo from fission products and its implementation was the joint responsibility of Wälischmiller and PINSTECH.

Installation work for MPF started in June 2006 and was completed in March 2007. The inactive functionality testing of equipments and tools was performed by PINSTECH prior to radioactive commissioning of the MPF. Radiochemical separation procedure for isolation of fission ^{99}Mo from neutron irradiated U/Al alloy target was initiated

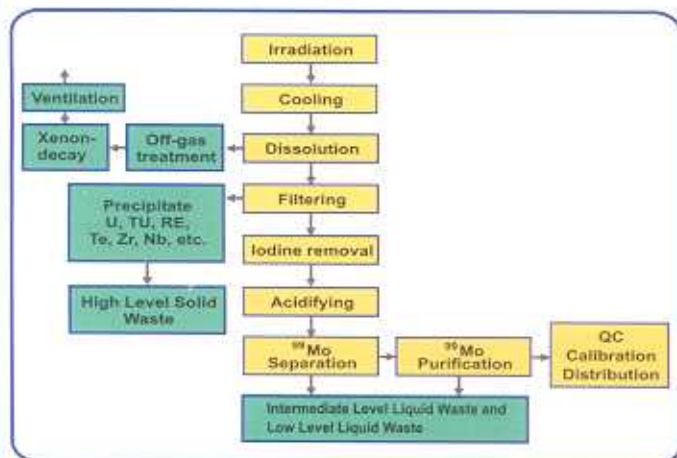


Hot cells with master slave manipulators and control panels of fission ^{99}Mo facility



Researcher behind Commissioning of fission ⁹⁹Mo facility

in the supervision of German experts which was finally accomplished by PINSTECH researchers in July 2007. During cold commissioning, the in-cell equipment was checked thoroughly and deficiencies were communicated to the supplier. Finally installation work was completed in June 2009 and complete cold run as well as tracer experiments with ¹³¹I and ⁹⁹Mo were performed. In December 2009, mCi level radioactive commissioning was performed. Natural U/Al target plates were irradiated for short periods in the core of Pakistan Research Reactor-1 (PARR-1) and ⁹⁹Mo was separated from uranium, actinides and other fission products. The final ⁹⁹Mo product was of high purity and met all necessary specifications for medical applications.



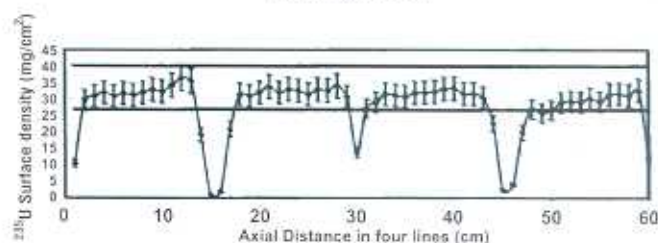
Main steps in the production of fission ⁹⁹Mo

Licensing issue of ⁹⁹Mo Production Facility with Pakistan Nuclear Regulatory Authority (PNRA) started in March 2006. PNRA allowed irradiation of Highly Enriched Uranium (HEU) target plates in PARR-1 in July 2010. Prior to irradiation in the reactor, ⁹⁹Mo target plates were qualified using standard destructive and non-destructive tests such as ultrasonic, gamma radiography and Eddy current tests. A qualified HEU target plate was irradiated for 12 hours in the core of PARR-1 on July 16, 2010 and radiochemical separation was performed on July 19, 2010 with fission ⁹⁹Mo yield of 10 Ci. The radiochemical purity and radionuclidic purity was checked, which was in

accordance with prescribed specifications of fission ⁹⁹Mo for medical applications.



⁹⁹Mo target plate



Maximum surface density of ²³⁵U = 36.28 mg/cm²
Average surface density of ²³⁵U = 31.32 mg/cm²
Reference Value of surface density of ²³⁵U = 33.33 mg/cm²

Gamma scan of ⁹⁹Mo target plate

The main working areas of the ⁹⁹Mo production facility hosts 3 hot cells. There are lock rooms through which the activated targets, the final-product, solid and liquid wastes are dispensed.

The commissioned ⁹⁹Mo Production Facility is capable of producing more than 100 Ci reference day activity of ⁹⁹Mo under specified conditions. Irradiation of 3 HEU target plates for 12 hours in the core of PARR-1 will produce more than 30 Ci of ⁹⁹Mo sufficient to meet the country requirement. Indigenous production of ⁹⁹Mo required for country will save Rs. 40 million annually. By irradiating 3 HEU target plates for 48 hours in PARR-1, extra 40 Ci may be available for export purposes. Rs. 45 million may be generated by export of ⁹⁹Mo to different countries, such as Bangladesh, Iran, Saudi Arabia and Philippines.

End-users of Pakgen ⁹⁹Mo → ^{99m}Tc generators in Pakistan

PAEC Medical Centers	Public Sector Hospitals	Private Sector Hospitals
<ul style="list-style-type: none"> NORI, Islamabad IRNUM, Peshawar INMOL, Lahore CENUM, Lahore MINAR, Multan PINUM, Faisalabad BINO, Bahawalpur LINAR, Larkana KIRAN, Karachi AEMC, Karachi AEMC, Jamshoro CENAR, Quetta INDR, Abbotabad GINUM, Gujranwala 	<ul style="list-style-type: none"> PIMS, Islamabad Federal Govt. Services Hospital, Islamabad NESCOM Hospital, Islamabad AFIP, Rawalpindi AFIC, Rawalpindi Lady Reading Hospital, Peshawar CMH, Lahore SIUT, Karachi Punjab Institute of Cardiology, Lahore 	<ul style="list-style-type: none"> Shifa International Hospital, Islamabad Mukhtar Asia Trust, Rawalpindi Shaukat Khanum Memorial Hospital, Lahore Ittefaq Hospital, Lahore Doctors Hospital, Lahore Shaikh Zaid Hospital, Lahore TABSA Hearts International Hospital, Karachi Nuclear Medical Centre, High Way, Karachi Agha Khan Hospital, Karachi Liqaat National Hospital, Karachi KIND, Karachi NICVD, Karachi Dr. Ziauddin Hospital, Karachi PIONEER, Peshawar FIG, Faisalabad
Total 14 Centres	Total 09 Centres	Total 15 Centres