SnT 2021
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

CTBTO
PREPARATORY COMMISSION

Devices to reduce the emission of radioactive noble gases into the environment

Eduardo Carlos Carranza

P2.4-405

POSTER

FISION RADIOISOTOPES PRODUCTION PLANT
ATOMIC ENERGY NATIONAL COMISION OF
ARGENTINA

SnT 2021
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE
Poster No.: P2.4-405

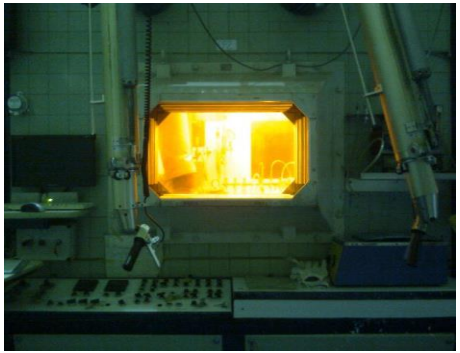
Devices to reduce the emission of radioactive noble gases into the environment

Eduardo Carlos Carranza

CTBTO PREPARATORY COMMISSION

Abstract

The Fission Radioisotope Production Plant of Argentina, located at the Ezeiza Atomic Center, produces 99Mo since 1985 irradiating targets with High Enrichment Uranium. In 2002 the targets have been changed by Low Enrichment Uranium. Facilities that produce radioisotopes by fission increase the background of noble gases in the environment, especially radioactive xenon. This background could interfere with the CTBTO assessments of nuclear explosions. The work will show the production method for 99Mo and 131I that is carried out in Argentina, the emission levels and production during the last years. The current measurement system will also be described. Finally, different mechanisms for the reduction of noble gas emissions and a comparative study of the advantages and disadvantages of each of them will be presented.



Promotional text: The objective of the poster is to show which are the different alternatives for reducing noble gas emissions to the environment due to the production of radioisotopes by fission

Devices to reduce the emission of radioactive noble gases into the environment

Eduardo Carlos Carranza

PRODUCTION

^{99}Mo RADIOCHEMICAL PROCESS FEATURES

Dissolution of LEU Aluminide targets.
Filtration
Ion Exchange Purification.

DISSOLUTION OF LEU ALUMINIDE TARGETS

Alkaline digestion.
Solution: ^{99}Mo, ^{131}I, ^{137}Cs and other F.P.
soluble in alkaline medium.
Precipitate: UO_2 and insoluble F.P. (actinides, etc.).

FILTRATION

Sintered stainless steel plate. Non-fissioned Uranium remains in the precipitate.

MOLYBDENUM PURIFICATION

Molybdenum solution is loaded and stripped in four different columns of ion exchangers for purification and conditioning. Finally, the ^{99}Mo is delivered for quality control and dispatch.

Hydrogen is produced by Al during targets dissolution.

Chemical reaction:

Al+NaOH+H2O → NaAlO2+3/2H2

The targets of aluminum- uranium irradiated in the RA3 Reactor are dissolved in sodium hydroxide.

This process generate hydrogen , mixed with nobles gases.

Different ways of handling the hydrogen :

1- Decaying noble gases with hydrogen.

2- Converter the hydrogen in water

3- Separate the hydrogen of noble gases.

LEU ALUMINIDE TARGETS

Average weekly production of the last 5 years: 1350 Ci (end of process)

Devices to reduce the emission of radioactive noble gases into the environment

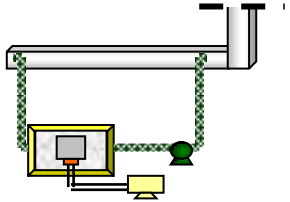
Eduardo Carlos Carranza

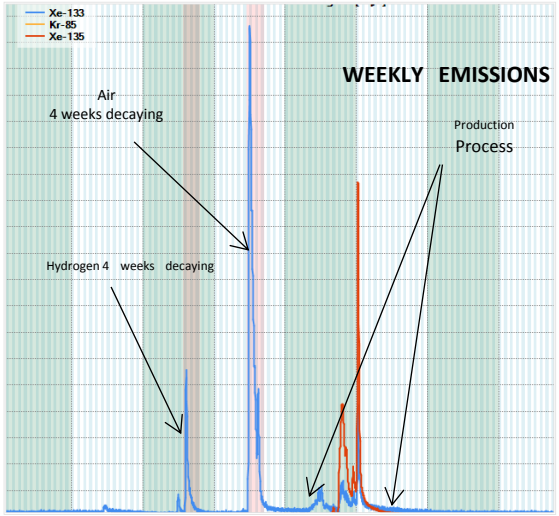
EMISSIONS

The emissions has two way : Air and Hydrogen

Gases Continuous Monitoring System

The pump extract 50 liters/minute of gases after the filters of ventilation cells system.
Pass through the stainless vessel and return to the system two meter water down.
The stainless steel vessel is located inside five centimeters lead shielding.
The detector is a NaI(Tl) 2”x2”,
is in contact with the vessel.
The software Genie 2000 shows the continuous spectrum of gases emission in a Personal Computer
The measurements are every 90 seconds





Average annual emission of the last 5 years

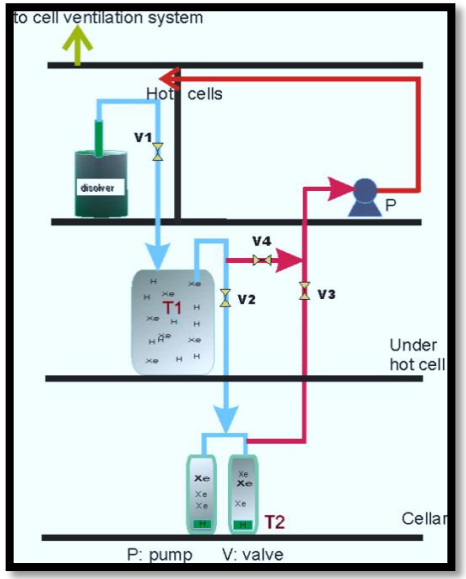
$^{133}Xe = 8.1\ 10^4$ GBq

$^{135}Xe = 3.5\ 10^4$ GBq

Devices to reduce the emission of radioactive noble gases into the environment

Eduardo Carlos Carranza

DEVICES



HYDROGEN CAPTURING DEVICES

The characteristic of hydrogen capturing device is their ability to absorb hydrogen reversibly.
When these materials are in contact with hydrogen at a given pressure and temperature a reaction of phase change is produced.
A new compound is formed.

$$M + X/2\ H_2 \leftrightarrow MH_x$$

M = hydride forming materials
X = number of atoms of H
MHx = formed hydride
It is a reaction with heat exchange:
Exothermic when the hydride is formed.
Endothermic when releases hydrogen.

POROUS DEVICES

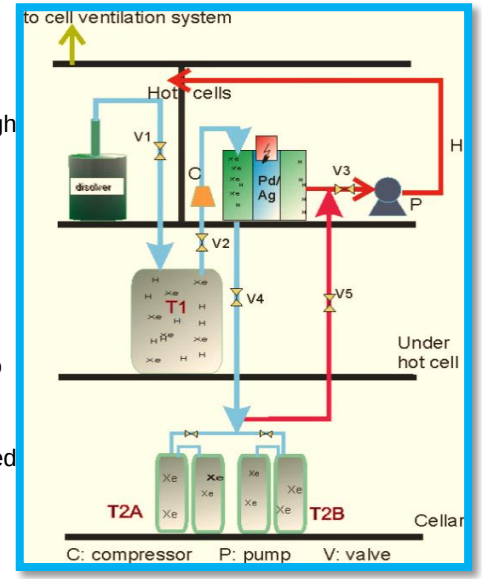
The operating conditions need high temperatures to increase the permeability of the hydrogen.

The hydrogen permeates through the membrane and the impurities (noble gases, nitrogen, etc.) are returned to the tank or are sent to another.

Requires a differential pressure to both sides of the membrane.

After each cycle of hydrogen separation, noble gases are moved to T2 for decay.

In T2 Xe decay 10 weeks

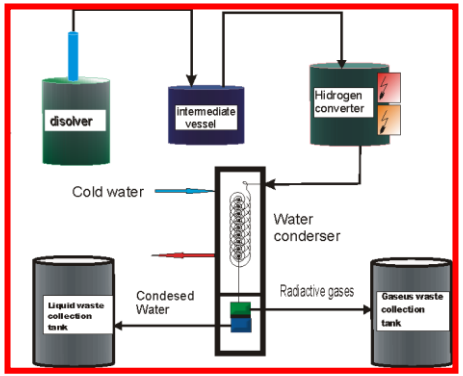


Devices to reduce the emission of radioactive noble gases into the environment

Eduardo Carlos Carranza

DEVICES

Hydrogen Converter



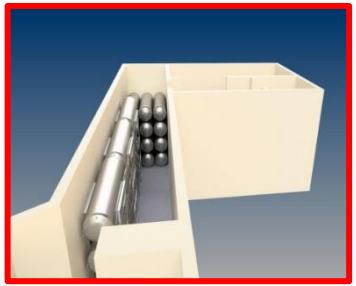
CONVERT HYDROGEN TO WATER

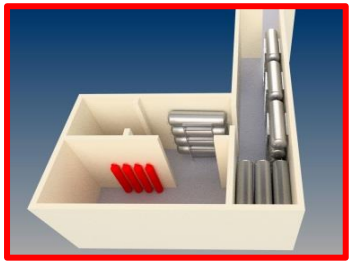
COPPER OXIDE REGENERATION STAGE:
NORMAL OPERATING TEMPERATURE: 450 °C (1022 ºF)
NORMAL OPERATING PRESSURE: 101 KPA
REGENERATION TIME SCHEDULE
1 hours at 300 °C (572 ºF)
1 hours at 400 °C (752 ºF)
34 hours at 500 °C (932 ºF)
Need shielding, space and pipes to connect services.

Manufactured and installed by Invap Argentina in Radioisotopes Production plants of Ansto (Australia) and Insha (Egypt).

GAS INLET COMPOSITION: H2 (246 l) , N2 (2,4 l.) and fission gases (2 ml)
OUTLET COMPOSITION: H2 (24 l), N2 (2,4 l), H2O (0,2 l) and fission gases (2 ml).

Evacuated tanks provide a large volume of storage. More storage represents more decay time and less emission of noble gases to the environment.
The evacuated tanks are used for air and hydrogen, but on different lines.
They need vacuum pumps, very little maintenance and large space.



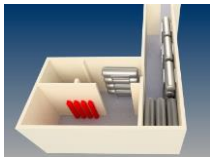


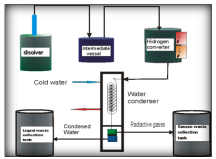
Evacuated Tanks

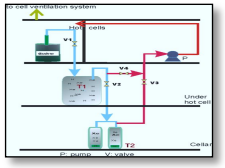
Devices to reduce the emission of radioactive noble gases into the environment

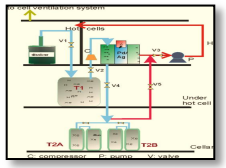
Eduardo Carlos Carranza

DEVICE	ADVANTAGES	DISADVANTAGES
EVCUATED TANKS	SIMPLE. FEW DEVICES (ONLY VACUUM PUMP). TESTED. AIR AND H -LITTLE MAINTENCE	LARGE VOLUME OF TANKS NEED A LONG PLACE LARGE BIOLOGIC SHIELDING
HYDROGEN CONVERTER	LOW VOLUME OF TANKS. -TESTED	REQUIRED EQUIPMENT FOR HEATING AND COOLING.TIME TO REGENERATE.TEMPERATURE OF WORK : 500 ° C (932 ° F)
HYDROGEN CAPTURING DEVICES	LOW VOLUME OF TANKS	IN DEVELOPMENT REQUIRES HEATING
POROUS DEVICES	LOWEST VOLUME OF TANKS	IN DEVELOPMENT. REQUIRES A COMPRESSOR AND HEATING



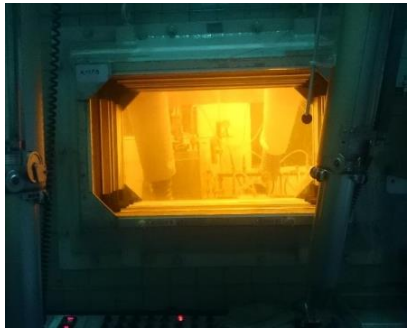






Conclusión

All devices take into account the handling of Hydrogen. Evacuate Tanks and Hydrogen Converter have already been tested in the Plant with good performance.
It should be considered that the Hydrogen Converter requires more equipment and maintenance and the Evacuate Tanks more space. The Porous Device and Hydrogen Capturing Devices are under development, but the prototypes tested in the Plant showed a very good performance.
Evacuate Tanks are appropriate for Air handling (it is the only proven alternative at he Plant). There are Zeolite beds for the reduction of noble gases in Air, but they have not been tested at the Plant.



Devices to reduce the emission of radioactive noble gases into the environment

Eduardo Carlos Carranza

EZEIZA ATOMIC CENTER
Argentina