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Studies of a Pyroelectric Crystal to Develop a Tabletop
Monoenergetic Neutron Source via Nuclear Fusion

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Studies of a Pyroelectric Crystal to Develop a Tabletop Monoenergetic Neutron Source via Nuclear Fusion

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Abstract

The development of a monoenergetic neutron source from an existing commercial pyroelectric X-ray generator using pyroelectric fusion is described. The commercial device originally uses a pyroelectric crystal to create an electric field that accelerates electrons towards a copper target to produce X-rays. The device is suitably modified to increase its electric field and is configured to be operated in a deuterium gas filled chamber so that deuterium ions are accelerated toward a deuterated target with sufficient energy to produce neutrons via a nuclear fusion reaction. This method provides a relatively inexpensive and safe monoenergetic neutron source for use as a laboratory tool and demonstrates nuclear fusion on the tabletop using only a 9-V, low current power source.
I. INTRODUCTION

Pyroelectricity\(^1\) is the ability of certain materials to generate an electrical field perpendicular to their surface when they are heated or cooled. The positions of atoms within a pyroelectric crystal structure are modified in response to a change in temperature leading to a net polarization. Although the polarization disappears after the dielectric relaxation time, the temperature gradient gives rise to a temporary electric potential and therefore a large electric field at the surface of the crystal. A crystal is typically heated and cooled in alternating cycles, with the polarity of the subsequent electric field flipping each time. “Pyrofusion” was first described in Ref. 3 where a pyroelectric crystal was used to achieve nuclear fusion. In this original experiment, a copper disk was mounted on the crystal and a tungsten needle was attached to the disk to increase the electric field at the needle tip to a magnitude of gigavolts per meter. The crystal was placed in a chamber filled with deuterium gas. During operation, deuterium atoms were ionized around the tungsten tip and accelerated toward a deuterated target to produce approximately 800 fusion reactions every second via the process: \( ^1_2 H^+ + ^1_2 H \rightarrow ^3_2 He \ (820 \text{ keV}) + ^1_0 n \ (2.45 \text{ MeV}) \).

Guided by this work, the modification of a commercial pyroelectric COOL-X X-ray generator\(^4\) to achieve pyrofusion is described. In this device, a pyroelectric crystal is mounted in a hermetically sealed TO-8 package that is partially evacuated to 40 – 160 mTorr. The generator thermally cycles the crystal using a Peltier junction inside the TO-8 package every 1 – 2 minutes. The electric field ionizes atoms and the resulting electrons are accelerated toward a thin copper target that generates X-rays that escape the package through a thin Be window. Modification of the device is advantageous because the generator already contains the necessary circuitry, heater, and pyroelectric crystal to properly regulate heating and cooling cycles of the crystal without overheating. It is all powered by a low-current 9-V AC/DC converter, and hence is ideal for undergraduate research.

II. COOL-X CONTROLLER SYSTEM

As described in Ref. 2, the controller is enclosed inside a metallic case. The function of the controller is to supply power to the X-ray generator, monitor its temperature, and automatically change the heating and cooling phases of the cycle. Both a 9 V AC adapter
and a 9 V battery are included. The battery will provide approximately 6 hours of operation. An electronic block diagram and picture of device shown below in Fig. 1

![Block Diagram and Image of COOL-X Device](image)

**FIG. 1:** Block diagram of COOL-X circuitry and photograph of the COOL-X device.

### III. EXPERIMENT

#### A. X-ray Detector and X-ray Source

The properties of the COOL-X generator were first determined and compared to the manufacturer’s specifications. A 7.5-cm long × 8.6-cm diameter NaI (TI) scintillating crystal coupled to a photomultiplier tube (PMT) (Harshaw Type 12A12) read out by an Ortec 926 multi-channel analyzer (MCA) was used to measure the X-ray energy spectrum. The MCA was calibrated using a $^{55}$Fe radioactive source that produces X-rays at 5.19 and 5.90 keV. The spectrum was collected as a histogram with particle detections on the $y$-axis and relative pulse height as bin numbers on the $x$-axis. The source was placed 10 cm from the
The PMT/scintillator and its spectrum was collected in the MCA for 60 seconds. The peak position of the resulting $^{55}$Fe photopeaks, as shown below in Fig. 2, corresponded to two particular bins in the histogram. The energies at these bins were entered into the program that controls the MCA and the energies of the remaining bins were automatically calculated in the internal calibration procedure.

![Iron 55 Gamma Detections](image)

**FIG. 2**: Gamma production for the duration of one minute from a $^{55}$Fe radioactive source. Gammas detected using a NaI scintillating crystal, PMT, and MCA.

If the program which controls the MCA was unable to automatically calibrate itself, the energy calibration could be calculated manually. To do this, the two maxima are plotted with bin number on the $x$-axis and the energy corresponding to those photopeaks on the $y$-axis as shown above. The slope-intercept form could then be used with these known values to determine the energy at any bin as shown below in Fig. 3. The linearity of the calibration was checked with other sources.

Following the energy calibration, the cut-off energy of the X-ray spectra of the COOL-X generator was observed to be roughly 30 keV, as shown below in Fig. 4, in agreement with the manufacturer’s specifications. This upper bound on the energy is a result of the limited electric field produced by the pyroelectric crystal.

The PMT/scintillator combination used in this setup did not have sufficient resolution to observe photopeaks that should be present in the COOL-X spectrum. They should be
FIG. 3: Calibration curve for the MCA using a $^{55}$Fe gamma source. Linear equation for specific curve: 

$$\text{Energy (keV)} = 0.0031 \times (\text{Energy (keV)} / \text{bin}) \times \text{bin} - 1.693 \times (\text{Energy (keV)})$$

FIG. 4: Energy spectrum from COOL-X with end-point energy 30 keV. Spectrum collected using NaI scintillator with PMT.

visible because the COOL-X generates X-rays by colliding electrons with a copper target. To detect these X-ray peaks which are characteristic of copper, a cryogenic, Ortec GLP series intrinsic Ge X-ray detector was used. This detector resolved two peaks at energies of 8.0493 and 8.8996 keV, matching known characteristic copper X-ray lines, as shown below in Fig. 5.
FIG. 5: Energy spectrum of COOL-X with photopeaks at 8.0493 and 8.8996 keV. Spectrum collected using high resolution cryogenic X-ray detector.

With the characterization complete, the process of modifying the COOL-X device began. Although the TO-8 package can be opened manually, Amptek generously provided an additional device, already opened, which contained the bare pyroelectric crystal without the copper target or Be window. This package easily detaches and reattaches to the heater and electronic circuitry using a unique electronic pin configuration and a small screw. Before attempting to convert the device into a neutron generator, it was checked that the opened device operated as expected. The entire generator was mounted inside a custom cylindrical aluminum vacuum chamber of radius 28.9 cm and length 35.2 cm, mated to a positive displacement vacuum pump. The chamber was instrumented with a thermocouple gauge and several electrical feedthrough ports for operating the device in the vacuum. The previously used cryogenic X-ray detector could not be used because it was housed inside of container several times larger than the vacuum chamber. To remedy this, an Amptek XR-100CR solid state X-ray detector was used that has dimensions matching those of the COOL-X. It was readout by the same MCA system above and was mounted inside the vacuum chamber to measure the X-ray energy spectrum, as shown below in Fig. 6.
FIG. 6: Schematic for final version of the vacuum chamber, including components for neutron production, which are not present for X-ray production.

As shown in Fig. 7 the opened device was first operated in a vacuum between 40 and 160 mTorr with a grounded copper mesh target replacing the copper target in the TO-8 package. This attempt was unsuccessful for two reasons. First, the target was a mesh instead of a sheet which resulted in many electrons simply passing through gaps, rather than striking copper target material. Secondly, the mesh material was considerably thicker than the original copper device target foil, resulting in significant absorption of produced X-rays. A second attempt used a grounded, gold-plated, Mylar foil, 20-µm thick, target. The target was placed between the COOL-X generator and the X-ray detector at a distance of approximately 3 cm from each.

Data from the full heating to cooling cycles showed a 1.73 keV peak, a new 2.16 keV gold characteristic photopeak during the heating cycle, in addition to the original 8.05 and 8.90 keV copper characteristic-photopeaks, as shown below in Fig. 8. The copper peaks are due to a very thin layer of copper that covers the surface of the pyroelectric crystal. A property of the pyroelectric crystal is that the direction of the electric field is reversed between heating and cooling cycles. During the cooling cycle, the direction of the pyroelectric field is such that electrons from ionized air are accelerated back towards the crystal striking the copper and generating detectable X-rays, characteristic of copper. The pyroelectric crystal in each COOL-X device is mounted with arbitrary polarity so that the direction of the electric field during heating and cooling cycles is arbitrary for each device. Each device is also unique in
FIG. 7: X-ray production shown with opened device operating in cylindrical aluminum chamber at a pressure of 20 mTorr. The upper graphic shows both opened and original COOL-X devices.

how long it takes to heat and cool. When operated in a partial vacuum, the device cools down slowly because the lack of air decreases the effectiveness of convection cooling. This prolongs the time length of the cooling cycle while decreasing the length of the heating cycle. This turned out to be beneficial because the rate of X-rays during the cooling cycle is greater than during the heating cycle. The device was characterized as a function of pressure and was found to produce the greatest number of candidate events at 25 mTorr, as shown below in Fig. 9.

In addition to the behavior of the COOL-X changing in vacuum, the X-ray detector was also affected. When used at pressures below 50 mTorr, the XR-100CR solid state detector stopped functioning after roughly 10-15 minutes. If the detector was turned off for several minutes and turned back on, it would begin to function again, but only briefly. To remedy this, the chamber had to be brought back up to normal pressure and then reevacuated. Although the X-ray detector is not cryogenic, it does use a Peltier junction for cooling. When in vacuum, the device is unable to release its heat efficiently through convection with air particles. It overheats, loses efficiency, and then ceases operation. The X-ray detector was still able to be used, but only for short periods of time.

With the functionality of the opened COOL-X device confirmed, a sharp tungsten tip was
FIG. 8: X-ray production shown with opened device operating in cylindrical aluminum chamber with gold-plated Mylar foil target.

FIG. 9: X-ray production characterized as a function of pressure shown with opened device operating in cylindrical vacuum chamber with gold target. Both heating and cooling cycles are shown separately.

added to the face of the crystal to increase the magnitude of the electric field and therefore the energy of the accelerated electrons. Sharp tungsten tips were produced in the laboratory using a simple technique called etching, as described in Ref. 6. A tungsten wire was placed with its tip in a pool of KOH solution facing straight down. In the bottom of the pool, the
other end of the same tungsten wire was embedded in a block of graphite. Using a power source, a current of 0.2 to 0.3 A was created between the two ends of the tungsten wire. During this time, the KOH solution causes the tungsten in the plane of the surface of the solution to dissolve. It continues to dissolve quickest at the plane of the solution while the rate decreases as a function of distance from the plane. After roughly 30 seconds, the mass of tungsten wire hanging just below the plane becomes too massive for the ever decreasing radius of tungsten in the plane, and it falls to the bottom of the solution leaving behind a sharp tungsten tip hanging just above the surface of the solution. The endpoint of this process can also be observed with a DMM or oscilloscope when the voltage suddenly drops to 0 V.

The radius of curvature for the tips were on the order of 100 nm. The tungsten tip was swaged perpendicularly to a 0.09 cm thick circular aluminum disc with a diameter matching the crystal face dimensions and avoiding the introduction of any other sharp points that would concentrate the electric field. To facilitate the swapping of tungsten tips, the disc and tip were mounted to the crystal face using a piece of Teflon tape impaled by the tungsten tip and then secured to the TO-8 case behind the pyroelectric crystal, as shown in Figure 10.

![FIG. 10: Tungsten tip shown swaged to the circular aluminum disc, which is held onto the pyroelectric crystal with a strip of non-conducting Teflon tape [color online].](image)

With the tungsten tip in place, data was taken to measure potentially higher energy electrons during the heating and cooling cycles. As shown in Fig. 11, the endpoint of the X-ray energy spectrum with no tip was approximately 30 keV, while the energy spectrum
with the tungsten tip extended to as high as 80 keV. This verifies that the presence of the tungsten tip does indeed increase the electric field, as expected.

![X-ray energy spectrum of gold foil with and without the tungsten tip for both heating and cooling cycles. The higher maximum X-ray energy with the tip verifies the increased electric field and increased energy of accelerated electrons.](image)

FIG. 11: X-ray energy spectrum of gold foil with and without the tungsten tip for both heating and cooling cycles. The higher maximum X-ray energy with the tip verifies the increased electric field and increased energy of accelerated electrons.

While cooling, the expected copper peaks were observed; however, several additional high energy X-ray peaks were observed. These are thought to be from heavy nuclei, possibly from the alloys which make up the aluminum vacuum chamber. During the heating cycle, one peak was observed at 10.11 keV which is believed to be gold. The Au peak observed at 2.16 keV, before the tip was added, is no longer present because the background count in the lower channels became much higher than the signal. The presence of Cu during the cooling cycle and Au during the heating cycle shows that electrons are being accelerated toward the Au target during the heating cycle. We can therefore expect that the positively charged deuterium ions in the next step are expected to be accelerated toward the target during the cooling cycle.
B. Neutron Detector

With verification that the tungsten tip produces a higher energy electric field, and that ions are being accelerated toward the target during the cooling cycle, the conversion to a neutron source began. The gold foil was replaced with a deuterated target with dimensions 2 inches × 3 inches and 497 ± 5 mg/cm² deuterium. A PMI-30 $^3\text{He}$ neutron detector, 2.5-cm diameter × 12-cm long with interface box was added alongside the X-ray detector as shown in Fig. 12. The detector works via the process: $^3\text{He} + _0^1n \rightarrow ^3\text{H} + _1^1p$. When a neutron enters the detector, it reacts with $^3\text{He}$ to produce a proton and a triton. The proton is accelerated toward the negatively charged wire running through the central axis of the cylindrical detector and causes a cascade of particles that are measured as a signal pulse when they reach the wire. The detector was surrounded by a custom cylindrical polyethylene moderator with a 2.5-cm inside diameter, 5.1-cm outside diameter, and 14 cm in length that thermalized the incident neutrons, reducing their energy from the expected 2.45 MeV to energies of the order of keV. This was a necessary step because the efficiency of the $^3\text{He}$ neutron detector is prohibitively low for high energy neutrons in the MeV range. To increase the acceptance for neutron detection, the pyroelectric generator and the neutron detector were placed at distances 0.64 cm and 0.79 cm from the deuterium target, respectively, as shown in Fig. 13.

To verify the operation of the neutron detector, it was first tested using an intense Pu-Be neutron source. The source was surrounded by moderating plastic in a cylindrical lead chamber with four cylindrical ports. When resting on top of the lead chamber for 2 minutes, the neutron detector showed a fairly large signal of 90 neutrons/second and a larger signal of 137 neutrons/second when positioned directly in front of an open port. These neutron rates were observed without moderating the neutron detector. With the moderator in place, the rates became 75 neutrons/second and 92 neutrons/second for the top and in front of a port, respectively. This drop in the rate of neutrons occurred because the Pu-Be neutron source is already constructed to thermalize neutrons. When the detector’s moderator is added, some neutrons become absorbed in the plastic before reaching the detector. The neutron signal at the two positions with and without moderator are shown below in Fig. 14. The background rate of the $^3\text{He}$ neutron detector is a negligible 0.4 counts/minute, due to cosmic rays, and the moderator/detector combination is insensitive to external alpha particles. This test also allowed for the identification of the electronic signal corresponding to a true neutron.
FIG. 12: Deuterium ions are created at the tungsten tip and are attracted to the grounded copper mesh behind the deuterated target. When they collide with the target, nuclear fusion occurs, thereby creating neutrons and $^3$He. The neutrons are thermalized in the moderator and are detected in the $^3$He neutron detector [color online].

FIG. 13: Photograph of pyroelectric generator with tungsten tip, deuterated target and neutron detector.

To further test the functionality of the neutron detector, a humorous experiment was conducted. The ceramic tiles in the old bathrooms of Swain West are glazed with Uranium-oxide, a weak source of alpha and beta particles, which can easily be detected using a Geiger counter. When alpha particles collide with Beryllium, a reaction occurs where neutrons are
FIG. 14: Two neutron detector signals observed over a period of 2 minutes. Each trial observes signals from a Pu-Be source housed in a lead chamber with moderating plastic. One trial avoids the lead chamber via an opened port while the other rests on top of the lead chamber. Neither trial makes use of the neutron detector’s plastic moderator.

emitted, which is also how the Pu-Be neutron source works. The neutron detector was placed inside the moderating plastic cylinder which was wrapped in a thin layer of Cu-Be. This equipment along with the MCA and computer were all placed on a cart and taken into the bathroom outside the student machine shop. Using a Geiger counter, the most radioactive tile was found. The neutron detector with moderator and surrounding Cu-Be were placed directly against the wall and 30 cm from the wall while accumulating data for two minutes. The distribution collected is shown in Fig. 15.

The rate of neutrons from the bathroom setup trials were 5860 neutrons/second, a factor of 50 higher than the Pu-Be sealed source, and 5760 neutrons/second when placed directly against the wall and only 88 neutrons/second when distanced 30 cm. This considerably higher rate of neutrons, compared to the Pu-Be source, may be the result of the distance between source and detector. For the Pu-Be source, the detector was located roughly 1 meter from the source of the neutrons with a thick leader chamber in between. In the bathroom U-Be source, the neutrons are being created at the surface of the moderating plastic cylinder, which is only 0.025 meters from the detector. The decrease in distance
FIG. 15: Two neutron detector signals observed over a period of 2 minutes. Each trial observes signals from a U-Be source under identical physical conditions but on different days.

of 2 orders of magnitude may account for the difference in neutron rates. The higher rate may also be caused by gamma rays. When a gamma from the event which generated the neutron, or from the Uranium-oxide, interacts with the detector wall, additional charged particles may be created which are detected as neutron signals in the detector.

An effort was made to check whether this high neutron rate was reasonable. Using the Geiger counter, a rate of 100 detections/second was measured for the tile used. This rate is lower than the neutron rate; however, the alphas must pass through approximately 50 µm of beryllium before being detected. Using TRIM Ref. 8, a Monte Carlo simulation package, it was determined that at energies of 5.48 and 8.00 MeV, alpha particles would only travel 28.34 and 50.8 µm in beryllium, respectively. This, however, does not provide sufficient information to determine what fraction of alphas from the Uranium-oxide would be able to penetrate the beryllium window. Therefore, the possibility that the glaze is emitting alphas in excess of 5000 per second cannot be ruled out.
C. Nuclear Fusion

With a reliable method to detect neutrons, the neutron detector was mounted in the vacuum chamber and deuterium gas was admitted. The efficiency of neutron generation was first tested as a function of the deuterium gas pressure inside the vacuum chamber. The pressure was measured using an air-calibrated vacuum gauge. The corresponding pressure of deuterium was determined using the correction supplied by Ref. 11. According to this reference, the observed partial pressure on the gauge should simply be multiplied by 0.8 to obtain the deuterium gas pressure, which holds for pressures below 1 Torr. Before each trial, the chamber was evacuated for roughly 20 minutes to bring the pressure to its minimum of 8 mTorr and to prevent out-gassing from increasing the pressure. Sufficient deuterium gas was then bled into the chamber to bring it up to the desired pressure. Data runs, each approximately 5 hours long, were taken in steps covering the range from 20 – 800 mTorr. The maximum count rate was measured between 20 and 32 mTorr, the lowest attainable pressure for the setup. Such a pressure is a trade-off between having sufficient deuterium atoms to ionize versus the shielding of the ions incident on the target, and would be expected to be a function of the crystal-to-target distance.

The background count rate measured by the neutron detector with the chamber filled with deuterium gas at 20 – 32 mTorr and the pyroelectric generator off was 24 ± 2 counts/hour, consistent with a small level of noise and cosmic rays. When the chamber is filled with air at the same equivalent pressure and the pyroelectric generator is operating, the count rate was measured to be 85 ± 4 counts/hour. This higher background rate was determined to be primarily from electronic noise emitted by the generator or gammas interacting in the material surrounding the neutron detector. When the pyroelectric generator is operated in 20 – 32 mTorr of deuterium gas, a rate of 297 ± 8 counts/hour is measured by the neutron detector. The reproducible excess of 212 ± 9 counts/hour is attributed to neutron candidates and evidence that nuclear fusion was indeed achieved, as shown in Fig. 16. The signal is likely due to neutrons and not gammas, otherwise the signal with air in the chamber would be as large as with deuterium gas in the chamber. The neutron signal differs from the Pu-Be and Ur-Be sources because of impedance mismatching. When running the neutron detector in vacuum, the method used to run the high voltage signal through the chamber caused the impedance mismatch.
FIG. 16: Three neutron detector signals are observed over a period of 5 hours. The three trials observe signal with the generator on and off with deuterium in the chamber and with the generator on with air in the chamber.

IV. CONCLUSION

A pyroelectric neutron generator was developed from an existing, commercial X-ray generator. The device operated by accelerating deuterium ions into a deuterated target with sufficient energy to produce a nuclear fusion reaction. The rate of neutrons was relatively low at $212 \pm 9$ neutrons/hour in comparison to a rate of 800 neutrons/second in the original demonstration of pyrofusion in Ref. 3. It may be possible to dramatically increase the flux by adding an array of higher quality tungsten tips or carbon nanotubes instead of using a single self-made tip. Despite the relatively low rate of neutrons, the described experiment is an ideal project for an undergraduate physics laboratory, demonstrates pyrofusion, and provides a monoenergetic neutron source that can be used in a variety of follow-up projects.
V. FUTURE IDEAS

A final verification that neutrons are being generated is to fill the chamber with gaseous $H_2$. It is possible that the neutron signal is being caused by the ionization of deuterium gas around the neutron detector. Using $H_2$ cannot generate neutrons and can be used as a control because it has identical ionization properties to deuterium gas. If the neutron signal is real, using gaseous $H_2$ will result in a spectrum similar to air.

While it is exciting that nuclear fusion can be achieved with a small and semi-portable device, the rate of neutrons is low. To remedy this, it is proposed that carbon nanotubes be installed in place of the single tungsten tip. A patterned nanotube$^9$ array would have several hundred sufficient electric field sources to produce neutrons with an electric field value per tube of approximately 2500 V/nm. Although individual tubes have smaller volumes with sufficient electric fields, the combination of many nanotubes would encompass a greater volume than the single tip that should allow for a greater rate of neutrons.

Once this larger rate has been demonstrated, a device similar to the COOL-X could be constructed to produce neutrons. It would work nearly identically to the COOL-X and the control circuitry would remain the same. It would have an array of carbon nanotubes on the surface of the crystal, a deuterated target, a copper mesh behind the target to attract the ionized deuterium, and would be filled with deuterium gas at a low pressure. Since the device would be emitting neutrons instead of X-rays, the expensive and delicate beryllium window would be removed and instead would be a continuation of the aluminum chassis. In contrast to X-rays, neutrons easily penetrate the aluminum casing, so the special beryllium window is not necessary.

The main concern of this neutron generator is that the pressure of gas in the TO-8 canister would decrease over time. When the COOL-X generates X-rays, the air pressure inside remains constant because none of the nuclei are escaping. With the neutron generator, each fusion reaction would create a Helium-3 nucleon and the emitted neutron would escape. Over time, the number of available nuclei would decrease, causing a drop in the rate of neutrons. This decrease in deuterium nuclei, however, appears to be insignificant. Assume a pressure of 20 mTorr or $2.67 \times 10^{-3}$ kPa with the volume of the canister at 1700 mm$^3$ or 0.0017 L. The number of molecules in the canister is calculated using $PV = nRT$ where $T$ is 298.15 K and $R = 8.314 \text{ J}/(\text{K} \times \text{mol})$. Solving for $n$, the resulting number of molecules in
the chamber is $1.1 \times 10^{15}$ deuterium nuclei. Assuming the device ran for 5 hours per week for 40 weeks, the number of deuterium nuclei consumed after 1 year would only be 72 million. This drop is insignificant compared to the number of nuclei initially in the chamber.

This result demonstrates that the device would continue to run at an optimal neutron rate for a long time. The device design can remain as simple as the COOL-X with no additional port needed for refueling the deuterium gas. Such a device could potentially be fabricated at a price comparable to the COOL-X and would provide a safe, easily portable, 9-V powered neutron source.

**VI. ACKNOWLEDGEMENTS**

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4 Amptek Inc., 14 De Angelo Drive, Bedford, MA. 01730 USA.

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Aware Electronics Corp., P.O. Box 4299, Wilmington DE 19807 USA.


Knoll, Glen, Radiation Detection and Measurement, p. 521, Fig. 14.1: Cross section versus neutron energy for some reactions of interest in neutron detection.

Gas Correction Curves for PG105 Gauges, All PG105 convection-enhanced Pirani gauges are factory-calibrated and temperature-compensated for nitrogen (air). However the response of the gauge to other gases is very well characterized and, with the proper calibration data, it is possible to obtain accurate pressure measurements for other gases as well: http://www.thinksrs.com/downloads/PDFs/ApplicationNotes/IG1pggasapp.pdf.