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Application of gamma rays to determine the optimal location of wells excavated for petroleum exploration using Monte Carlo method

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Extended Abstract

Summary

Gamma ray interactions with materials is a non-destructive method, which can be used for obtaining useful information such as the densities of the materials. In this work, the Monte Carlo Neutron – Photon (MCNP) code was used to simulate a block composed of sedimentary rocks with four holes (wells) so that each hole contained a detector. Then, by placing a Cs^{137} source in one of the holes and adding various percentages of water and oil to the sedimentary constituents of the block, the contrast value for the output and scattered gamma rays was obtained by the response function of the detector inside each of the wells. The response function of the detector in front of the source is greater than that of the other detectors. The obtained contrast in the block containing sedimentary rocks with forty percent of oil in the first to fourth holes is -219.10, -354.85, -174.75 and -197.30, respectively, and the contrast for the case of water in the first to fourth holes is -198.31, -330.87, -167.73 and -185026, respectively. Given the fact that by digging several holes either for the scattered or crossed gamma, one can obtain a better location for the detector position. It is also clear from the calculated values that the contrast obtained from the second hole (that is in front of the source) is greater than the rest of the contrasts. However, due to the quantity D, the first hole is superior to the rest, because it can be distinguished from minerals by the percentage of materials in the soil.

Introduction

In the field of nuclear physics, the use of gamma rays is an important and practical method. This method is used in various industries such as oil and gas production, mining and quarrying, environmental monitoring and so on. The technology of using gamma rays is based on the interaction of these beams with materials. In this regard, the three main phenomena are the interaction of gamma rays with photoelectric materials, Compton scattering, and pair-production phenomena.

In this research, different simulations have been carried out on soil and sedimentary rocks, and some information such as the depth of penetration of gamma rays in different energies was achieved. Using this information, many aspects for the discovery of various underground resources can be recognized, including exploration of oil and gas reservoirs.

Methodology and Approaches

The Monte Carlo method is a class of computational algorithms that rely on random iterative sampling to calculate their results. To use this code, a structured input file must be provided including problem information such as geometry, material type, source, output type, and so on. The code solves the problem using input file information and the cross-section library, and generates the results in an output file. In this study for the simulations using the Monte Carlo method, a cuboid block is considered to be a two-meter side, with its constituent material being a type of sedimentary rock, oil, water, and a combination of the rock and water or oil. Each of the simulated holes in this work has a depth of 180 cm and a radius of 7.62 cm. A two-inch NaI (Tl) detector is inserted into each of the holes.

Results and Conclusions

According to the results, the amount of C is increased by increasing the percentage of the oil or water with soil in all the holes. In addition, in situations where a small amount of oil or water is mixed with the soil, the amount of contrast obtained for both oil and water is approximately equal, and we use a quantity D to separate these two materials. As it is clear from the calculated values, the contrast obtained from the second hole (that is in front of the source) is higher than the rest of the contrasts. However, the quantity D shows that in the first hole, oil and water can be separated from each other in all mixed percentages except the percentages between 55 and 65 of these two materials. Thus, the best well is the first hole, which is directly in front of the source.