MODELING AND ASSESSMENT OF RADIOACTIVE IODINE DISPERSION INSIDE EGYPTIAN RADIOISOTOPE PRODUCTION FACILITY

Hesham Elkhatib[1], Abdelfatah Abdelmaksoud[1], Mosa Othman[1], Mohamed Abdelaziz[2], And Hamdy Kotb[3]

[1]*Nuclear Reactors Department-Nuclear research center- Atomic Energy Authority-Cairo-Egypt*
[2]*Department of nuclear safety research and radiological emergency-NCRRT- Atomic Energy Authority-Cairo-Egypt*
[3]*Department of mechanical engineering-Faculty of engineering-Monoufiya University*

Abstract

Air quality is very important topic in radioisotope production facility. It is mandatory for some operators to be available behind hot cell to practice some activities concerning maintenance and operation. One of these tasks is redundant transferring Radioiodine from cell to QC lab and vice versa for measurements. Contamw3.2 is a simulation model from NIST (National Institute of Standards and Technology) is used to predict I^{131} concentration in air in hot cell and area of operator behind the cell in emergency case. Emergency is described by dropping small amount of I^{131} on cell floor. The model predicts the elapsed time for exhaust system to remove contaminants to dedicated filter and protect operator from inhalation. An emergency statue is also studied in case of opening I^{131} cell door hole (20 cm) by operators to pick the sample for quality control tests. Pressure interference occurs in this situation permitting some Iodine traces in the area under consideration.

1. Introduction

Sandra Stefanović [1] presented methodology used for determination of airflow and contaminant related phenomena and aimed to model and investigates possible indoor contaminant behavior as a result of implementation of building energy efficiency measures and GHG emission mitigation scenarios. As a reference example representation, modeling and simulation performance of one typical Belgrade dwelling has been performed. It incorporates developing of dwelling idealization, schematic representation, defining its components, performing simulation and at the end review of results. Ismail Abdul Rahman [2] presents simulation works carried out regarding to the airflow movement and particle dispersion in mechanically ventilated laboratory space at Faculty of Civil and Environmental Engineering of Universiti Tun Hussein in Malaysia. The measurement of air velocity was measured while the particle dispersion was also measured at random points. Comsol Multiphysics software simulation results are validated with the measured value and found that the percentage differences are within 6 – 10 % which is accepted by many researchers.

2. Methodology

CONTAM [3] is a powerful tool that models airflow and contaminant dispersal in buildings. This tool implements mathematical relationships to model airflow and contaminant related phenomenon and therefore incorporates assumptions that simplify the model. The basis for contaminant dispersal analysis is the application of conservation of mass for all species in a control volume (c.v.). A c.v. is a volume of air which may correspond to a single room, a portion of a room, or several well-coupled rooms (a CONTAM zone) or the ductwork. CONTAM uses mathematical relationships referred to as source/sink elements or models to implement sources and sinks when performing contaminant simulations. In this studies Contaminant Source/Sink Elements have been modeled by: Constant Coefficient Model (ETS, PM2.5, radon) Airflow elements describe the mathematical relationship between the flow through an airflow path and the pressure drop across the path.

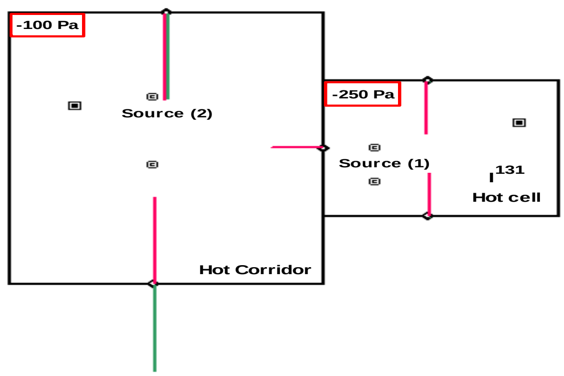

Figure 1. Schematic of hot cell air exhaust

3. Results and Discussion

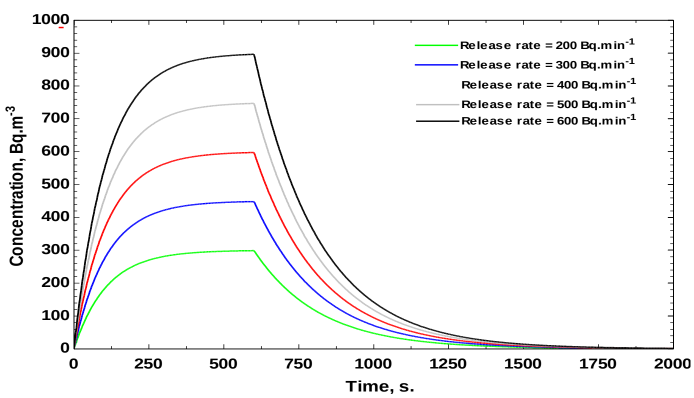

Figure 2. Air concentration in Iodine hot cell with different source release

Different exhaust air is studied in Fig. 3 to predict contaminants removal times. The extraction system is affected by filters efficiency which reduces air extraction. Simulation is conducted by assuming and reducing air extraction to 0, 50, 75%. Full extraction means 100% while 0% represents no extraction and stopping extraction system.

The half extraction 50% removes contaminants through 1800 sec., while stopping the extraction keeps activity and contaminant in its maximum level depends on time of source emission and decontamination process. Behind the hot cells are hot corridor which is the area of transportation of radioactive isotopes from the production cells to quality control Laboratories and packaging process to clients. It is very important to predict contaminant concentration and keep it to lower limits in this area for operator safety. Fig. 3 predicts contaminant concentration in this area at different extraction configuration. Extraction of 1200 $m^3.hr^{-1}$ is the design extracted air that keeps corridor depression at -100 Pa., and this value is above cell value for safety as hot cells have more contaminants than corridor.

Operators open cell door to sample I131 for quality control measurements and this door let the cell depression to be reduced permitting the free contaminants to be extracted to hot corridor. In this case of radioactive material emits 60 Bq.min^{-1}.

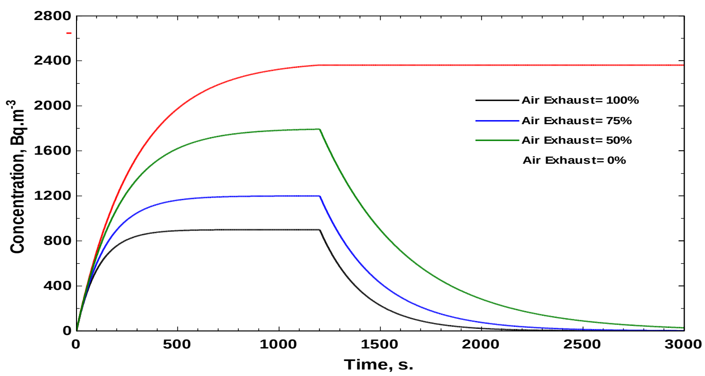

Figure 3. Air concentration in Iodine hot cell with different ventilated air.

Fig. 4 illustrates capability of extraction system to remove contaminants in suitable time. Using 100% extraction, the contaminants is removed within 1000 sec. and increases consequently with minimizing air extraction until reaches to more than one hour in case of 25% extraction. Operators should monitor and maintain filters to avoid lack of extraction air and maintain level of contaminants within safe limits to avoid inhalation.

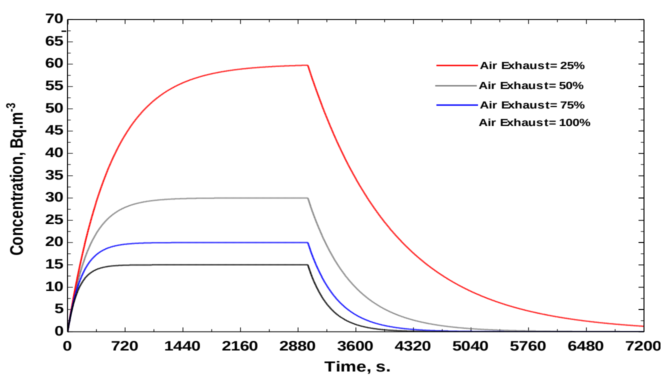

Figure 4. Air concentration behind hot cell with different air exhaust.

As the area exposed to same source and different air exhaust the contaminant concentration increases with reduced exhaust air. 14, 19, 30 and 60 concentrations are realized with respectively100, 75, 50 and 25% exhaust air. Also the necessary time for removing contaminant is increased and takes much time until more than one hour in case of 25%.

Conclusion

Simulation model is formulated using Contam3.2 to predict radioiodine 131 contaminant in two areas during normal and emergency situations. One is hot cell which produce isotope and second is corridor back the cell to handle iodine radioisotope. Concentration of contaminant is predicted inside hot cell at different I131source and different exhaust air from the cell. More source activity results in more emission rate and concentration in air, but keeping exhaust fan flow rate 100% leads to remove this contaminant rapidly to dedicated filters. Also the corridor exhaust system removes these contaminants in case of cell door opening to collect I131 from cell for lab measurements. The extraction system of the cell and corridor cleans any spilled radioactive material from area to dedicated filters in certain time in case of normal and emergency situations but operators behind the cell should wear masks if it is mandatory to do tasks in emergency condition.

References

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