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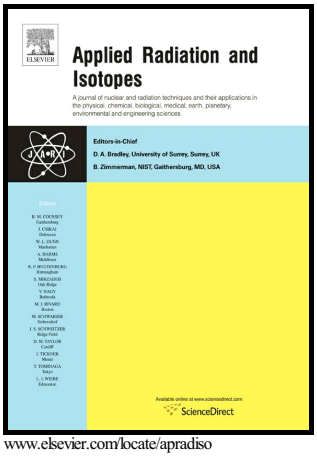

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Pouyan Jahangiri, D. Mark Martinez, Cornelia Hoehr

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Pressure rise in medical cyclotron liquid targets: Transient analysis

Pouyan Jahangiri[a,b,*], D. Mark Martinez[b], Cornelia Hoehr[a]

[a] *TRIUMF, 4004 Wesbrook Mall, Vancouver, Canada, V6T 2A3*
[b] *University of British Columbia, 2360 East Mall, Vancouver, Canada, V6T 1Z3*

Abstract

Transient behavior of proton-beam bombarded liquid-targets are studied at various initial conditions at the TR13 cyclotron at TRIUMF. Depending on the initial condition, experiments show a range of different responses from steady-state to self-sustained oscillations. To address this, a system of equations based on the conservation of mass and energy is proposed. Coupling between the beam and fluid-density and chemical reactions driven by the beam (radiolysis) are identified as the main reasons to describe this behavior. Excellent qualitative agreements are achieved.

Keywords: *Liquid target*, *Beam-fluid interaction*, *Radiolysis*, *Medical cyclotron*, *PET isotopes*.

1. Introduction

Application of isotopes in medicine and health science is quite critical. Each year over forty million people around the world benefit from the nuclear medicine imaging techniques (NEA (2017)). Medical radioisotopes, such as ^{18}F, ^{11}C and ^{99m}Tc, are used in non-invasive imaging techniques such as Positron Emission Tomography (PET) and Single Photon Emission Computed Tomography (SPECT) to help identify, categorize and track common conditions such as heart disease and cancer. With nearly a thousand cyclotrons installed and operating around the globe (Schaffer (2015)), including a growing number of higher power machines (>20 MeV, >300 μA), demands

* Corresponding author.
Email address: pouyanj@mail.ubc.ca (Pouyan Jahangiri)