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Prediction of dry ice mass for firefighting robot actuation (Conference Paper)

Ajala, M.T.[ab], Khan, M.R.[a], Shafie, A.A.[a], Salami, M.J.E.[a], Mohamad Nor, M.I.[c]

[a]Department of Mechatronics Engineering, International Islamic University, Kuala Lumpur, Malaysia
[b]Department of Industrial Maintenance Engineering, Yaba College of Technology, PMB 2011, Lagos State, Yaba, Nigeria
[c]Department of Chemical Engineering, University of Malaya, Kuala Lumpur, Malaysia

Abstract

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The limitation in the performance of electric actuated firefighting robots in high-temperature fire environment has led to research on the alternative propulsion system for the mobility of firefighting robots in such environment. Capitalizing on the limitations of these electric actuators we suggested a gas-actuated propulsion system in our earlier study. The propulsion system is made up of a pneumatic motor as the actuator (for the robot) and carbon dioxide gas (self-generated from dry ice) as the power source. To satisfy the consumption requirement (9cfm) of the motor for efficient actuation of the robot in the fire environment, the volume of carbon dioxide gas, as well as the corresponding mass of the dry ice that will produce the required volume for powering and actuation of the robot, must be determined. This article, therefore, presents the computational analysis to predict the volumetric requirement and the dry ice mass sufficient to power a carbon dioxide gas propelled autonomous firefighting robot in a high-temperature environment. The governing equation of the sublimation of dry ice to carbon dioxide is established. An operating time of 2105.53s and operating pressure ranges from 137.9kPa to 482.65kPa were achieved following the consumption rate of the motor. Thus, 8.85m^3 is computed as the volume requirement of the CAFFR while the corresponding dry ice mass for the CAFFR actuation ranges from 21.67kg to 75.83kg depending on the operating pressure. © Published under licence by IOP Publishing Ltd.

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