Material Selection of a Tri-adjustable Automated Heavy-Duty Handling System Designed on Industry 4.0 Principles

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Abstract

Materials Handling (MH) is one of the most essential aspects within manufacturing processes and/or industries. MH equipment are mechanical equipment used for the movement, storage, control and protection of materials, goods, and products throughout the process of manufacturing, distribution, consumption, and disposal. Transportation equipment used in manufacturing industries varies from pallet jack to forklift trucks and/or cranes. The size and type of a Material Handling System (MHS) and/or equipment influences the effectivity of the internal logistics within manufacturing industries. Therefore, it is very essential to choose a correct MHS for a correct manufacturing process which requires material handling to complete its operation. Incorrect usage or selection of an MHS for an operational process may lead to down time, damage to facility, increase in operating costs and/or pose Occupational Health and Safety (OHS) risks to workers. Over the years, many South African industries have been using Forklift trucks to move bigger loads from one point to another till today. The use of large forklift trucks within indoor manufacturing processes poses OHS risks to workers as its Internal Combustion Engine (ICE) produces fumes (Carbon Monoxide, CO) when in operation and exhaust fumes, (CO), are harmful to human's health. On this basis, a new system design is recommended to eliminate the use of MHS that relies on ICE power source to prevent OHS risks in indoor manufacturing industries. In this project, Autodesk Inventor Professional software was used for design development of technical drawings and simulation as well as validation of the new system's structure. Vehicle Dynamics' principles and equations are used to determine the overall Rolling Resistance, Tractive Effort of the new system, wheel torque, and the power required to drive the system under 20 – ton load capacity. The new system design has been developed to operate using a Hydraulic Power pack source, where it consists of four hydraulic wheel hubs for driving the system, four hydraulic cylinders for lifting & lowering, and a double rod end hydraulic cylinder for steering. Electro-Hydraulic circuit systems were developed and proposed using electronics and fluid mechanics phenomena. Again, principles, laws and equations of Strength of Materials has been carried out for validation of the material selection of the new design system's structure as well as verifying buckling, deflection & bending stresses, and moments.

Keywords: Material Handling System, Internal Combustion Engine, Occupational Health & Safety, Manufacturing, Hydraulics, Finite Element Methods.

Biographies

Shaun Zamawelase Mafokwane is a PhD candidate at the University of Johannesburg, Department of Mechanical and Industrial Engineering. Shaun is currently employed by Tetra Pak SA Pty Ltd and works as an Electro-

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Dr Daramy Vandi Von Kallon is a Sierra Leonean holder of a PhD degree obtained from the University of Cape Town (UCT) in 2013. He holds a year-long experience as a Postdoctoral researcher at UCT. At the start of 2014 Dr Kallon was formally employed by the Centre for Minerals Research (CMR) at UCT as a Scientific Officer. In May 2014 Dr Kallon transferred to the University of Johannesburg as a full-time Lecturer and later a Senior Lecturer in the Department of Mechanical and Industrial Engineering Technology (DMIET). Dr Kallon has more than twelve (12) years of experience in research and six (6) years of teaching at University level, with industry-based collaborations. He is widely published, has supervised from master's to Postdoctoral and has graduated seven (7) Masters Candidates. Dr. Kallon's primary research areas are Acoustics Technologies, Mathematical Analysis and Optimization, Vibration Analysis, Water Research and Engineering Education.