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Pneumatic Vehicle, Research and Design

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Abstract

This paper describes the research, design and construction of a viable experimental pneumatic driven vehicle. The main goal is to find ways to drive efficient by using alternative energy, not necessary cheaper, but more environmental friendly in increasing polluted metropolis. This is done by taking the emission source from the vehicle's tail pipe to the central electrical generating plant. Emission control measures at a central generating plant may be more effective and less costly than treating the emissions of widely dispersed vehicles. Where low emissions sources are available like: aeolian, water, solar, and nitrogen byproducts; net production of pollutants can be reduced. The background results used in this study are obtained by designing, building and testing five experimental configurations of compressed-air/gas vehicles. This study presents the latest one of these five vehicles.

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Keywords: Pneumatic vehicle; alternative energy; gas consumption optimization; gas expansion of cold gases; compressed-air/gas vehicles.

1. Introduction

Renewable energy: wind, solar, geothermal, hydroelectric, and biomass provides substantial benefits for our climate, our health, and our economy. Each source of renewable energy has unique benefits and cost associated with these energy technologies. [1]

Compared with natural gas, which emits between 0.6 and 2 pounds of carbon dioxide equivalent per kilowatt-hour (CO_2E/kWh), and coal, which emits between 1.4 and 3.6 pounds of CO_2E/kWh, wind emits only 0.02 to 0.04 pounds of CO_2E/kWh, solar 0.07 to 0.2, geothermal 0.1 to 0.2, and hydroelectric between 0.1 and 0.5.

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Renewable electricity generation from biomass can have a wide range of global warming emissions depending on the resource and how it is harvested. Sustainably sourced biomass has a low emissions footprint, while unsustainable sources of biomass can generate significant global warming emissions. [2]

Today, renewable energy provides only a fraction of its potential electricity output in the US and worldwide. But numerous studies have repeatedly shown that renewable energy can be rapidly deployed to provide a significant share of future electricity needs, even after accounting for potential constraints. More than 500 factories in the United States only, manufacture parts for wind turbines, and the amount of domestically manufactured equipment used in wind turbines has grown dramatically in recent years: from 35 percent in 2006 to 70 percent in 2011. [3]

A more practical tendency is to use compressed air energy is the "Adiabatic Compressed Air Energy Storage (AA-CAES) system" that assesses its operation capabilities within power markets [4].

Compressed air can be an energy source for many applications, Compressed air systems account for 10 percent of total industrial electricity consumption and are found in 70 percent of all manufacturing facilities, according to the U.S. Department of Energy [5].

The compressed gas consumption problem is mainly discussed in large factories for powering industrial equipment, providing motion, cooling, pressurization, and other functions for such as air-powered hand tools, actuators, and sophisticated pneumatic robotics. [6] The optimization of electrical consumption for the compressed gasses is done by using performance compressors, [7] efficient equipment, low installation loss, etc. When these methods are exhausted, there are other ways to further improve de consumption by using cold [8], cheep, and common atmospheric extracted neutral gasses from excess electrical energy [9]. This method also uses the expansion property of cold gases for beater storage and other functionalities due to this low temperature.

This paper presents the pneumatic design, simulation and test study of an actual Programmable Logic Controller driven system by putting the industrial problem in a more interesting one person pneumatic prototype vehicle. The goal is to obtain the lowest gas consumption with the imposed dynamic performances for a short distance urban vehicle. The questions raised are in two fields of application. First is the industrial mentioned problem with its economical and performance benefits context and second the socially, economically, and environmental context of an urban low distance pneumatic vehicle viability. [10]

These concept idea starts from the possibility of using excess produced electrical power to compress Nitrogen and the advantage of large quantity storage as liquefied cold gas. [11] Other benefit is the relishing of these gasses in polluted conglomerate metropolis for beater air quality and transporting the pollution outside these areas by producing the compressed energy off city grid limits. Already important actions are taken by producing energy from water such as PEM electrolysis as a commercially viable hydrogen production solution. [12]

2. Method used

The project methodology is to: parameter calculus, pneumatic design, electric design, mechanical design, stress analyzing, dynamic simulation, construction, testing and optimizing. The designed vehicle is presented in Fig. 1.

The requirements and specifications of the prototype vehicle concern to find the best method to transform the pneumatic pressure energy into mechanical torque and [13] velocity at imposed demands such as:

- Minimum sped at longest distance: min 10Km/h;
- Average speed 30 km/h;
- Maximum speed 60 km/h;
- Power source: standard 10 to 25 liter tank of liquefied Nitrogen gas at 180 bar;10 liter bottle with 200 bar compressed Nitrogen gas;
- Minimum 3 Km/ recharge;
- Operational secondary pressure: 0.3 to 10 bar;
- Engine type: Expansion dual action mono cylinder;
- Command: programmable logic controller (PLC) and manual;
- Type of frame: 3 wheels, one person vehicle;
- Turn radius: max 4m
- Primary transmission: double action chain and sprocket with one way bearings system;