Benefits Of Dynamic Load On Four Wheel Vehicles As Renewable Energy Sources Substituting For Oil Fuel (OF)

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Benefits Of Dynamic Load On Four Wheel Vehicles As Renewable Energy Sources Substituting For Oil Fuel (OF)

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***Abstract*-- The goal of this research is to resolve the crisis of energy through efforts to reduce the use of fossil oil fuel (OF). The specific target to be achieved is to convert the vertical dynamic load four wheeled vehicles into renewable energy that can be used as energy reserves. The target can be achieved by substitution methods that replace the use of fuel energy with repetitive dynamic load of vehicles passing on the road. The method used in this study is sucking and injecting the air outside into the storage tank using vertical dynamic load of four-wheeled vehicles. Vertical dynamic load is obtained through a mechanism of flexible portal mounted transversely on the road surface. The mechanism of injection is done by a pneumatic cylinder piston which is actuated up and down by the portal crushed by the wheels (tires) of vehicles. The compressed air storage process is supported by the installation of some non return valve and the reducer connection on both inlet storage tank. Variations weight of the vehicle : light, medium and heavy that cross the road surface simultaneously pump the air outside into the storage tank. The amount of injection pressure of a pneumatic cylinder comes from the dynamic load vehicles at about 0.3 bar to 0.5 bar. This renewable energy can replace the use of fuel or electricity to produce compressed air.**

***Index Term*-- dynamic loads, vehicle, renewable energy, pneumatic cylinder, tank.**

1. INTRODUCTION

A number of four-wheeled vehicles particularly passing on the road surface at any time produce a number of unused dynamic load. Associated with the diminishing of mineral energy reserves derived from fossils in the ground, it is necessary an option solution to overcome the crisis. An innovative study on how to convert/change or absorb energy of vertical dynamic load of vehicle into renewable energy that can be stored without using oil fuel (OF) is an alternative solution that can be considered. The objectives to be achieved from this research is replacing the use of oil fuel (OF) with Vertical Dynamic Load of Vehicle (BDVK) as renewable energy generation in the form of compressed air, storing and preparing the free energy process to people who pursue business areas such as maintaining vehicles independently, as well as reducing the investment cost of compressor procurement. Renewable energy is obtained through technology of air compression into the storage tank by means of pneumatic cylinder through wheels foothold of the vehicle. The process of retrieval and storage of this pressurized air is done by injecting compressed air of pneumatic cylinder piston movement that comes from repeated dynamic loads of the vehicle. The amount of compressed air stored is in accordance with the number of vehicles crossing the road without the cost of processing. With the working principle of the coupling moment, then the injection force can be moved into the connecting rod of pneumatic cylinder piston and subsequently presses the compressed air into the storage tank.

2. STUDY OF LITERATURE AND DEVELOPING HYPOTHESIS

Vehicle dynamic load effects is refers to a fundamental problem-solving that are axle load fluctuations due to varied loads, variations in the speed and the road conditions (pavement conditions)[1]. Dynamic load variations on the axle impact on spring suspension system that burdens the tires of vehicles. The change of styles is as a result of changes in the horizontal direction, vertical and rotary movement of the wheels/tires of vehicles. On the surface of the concrete road, speed and tire pressure is constant at 40 mph and 70 psi with a axle static load of 18.050 lb.

Lateral forces that occur on the turned road is expressed to a function of the slip angle α whose radius can be fluctuated[2]. The amount of compressed air volume that goes into the tank is extremely determined by cylinders dimensions that are used and the ability of injection force that drives the piston back and forth. The magnitude of the injection force of the piston can be changeable and be highly dependent on the size of the dynamic weight of vehicles passing over flexible steel pedals. Ratio between atmospheric air volume, V_0, and compressed air volume, V_1, is 7 : 1[3]. An increase in pressure goes into the storage tank can be measured by using a manometer installed on the outlet pneumatic cylinder. The amount of air pressure generated by a pneumatic cylinder is obtained from the

pressure P_1 (bar) in the compression chamber, A_1, and the pressure P_2 (bar) in the compression chamber, A_2.

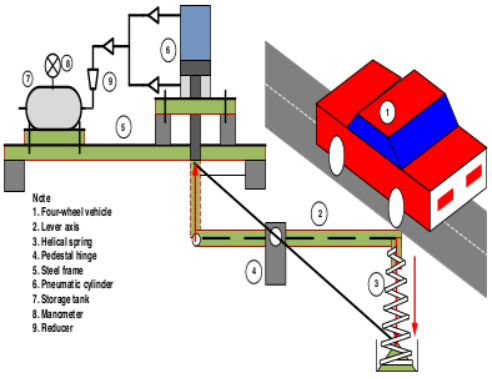
Dynamic load action of vehicles passing over the flexible portal will exert an action force against the spiral spring, the weight of the piston, connecting rod and friction between piston seal and the cylinder wall. In this section action-reaction Newton's law works, and needs to be taken into account to obtain a real effective vertical dynamic load.

Study of vehicle weights passing on the street is done by taking into account secondary data such as idle weight, and weight with passenger or good loads.

Action force of vertically dynamic load, F_{Dkv}, before doing the coupling torque on central pedestal of hinge, initially will receive a reaction force from the spring of F_p(N) as shown in Figure 1.2. As a result of the emergence resistance of spring reaction force, then it will reduce the work of vertically dynamic load of the vehicle towards frictional force, F_f (N), movement of the piston and connecting rod of pneumatic cylinders will back and forth or up and down. To improve the working dynamic load of the vehicle, then the lever rod arm, L_2 is made longer than the arms L_1, ($L_2 > L_1$). The driving force of tire experiencing braking is given by the following equation :

$$F_t = \mu(\lambda)\ N_v \qquad (2.1)$$

Tire normal force (the reaction force of the ground on the tire), N_v, is dependent on vehicle parameters such as vehicle weight, center of gravity and dynamic suspension system of the vehicle. For dry conditions on the asphalt and concrete, adhesion coefficient μ (λ) = 0.1 and 0.9.



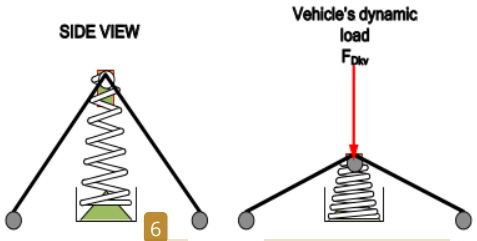


Fig. 2.1. Action of the vertically dynamic load of vehicles.

The working principle of coupling torque occurs in the mechanism of the working process of vertically dynamic load on the pedestal hinge equipped by pin as load holder [4, 5]. Base point of tipping force caused by the dynamic load of the vehicle is as far L_2, while the repulsive force (compression) on the pneumatic cylinder has working point as far as L_1. The magnitude of ratio between L_1 and L_2 on the equation (2.2) also influences on the coupling torque that will work on the pneumatic cylinder piston [1, 6].

$$\frac{L_1}{L_2} = 0.5 \qquad (2.2)$$

Equilibrium of coupling torque generated by vertically dynamic style of vehicle, FD_{vk} - FD'_{vk} and the normal force F_f - F_p fulfills the principles of force and moment equilibrium.

Force and moment equilibrium equations are involving weight of piston and connecting rod, F_w, the friction force, F_f, spring force, F_p, and vertically dynamic force of vehicle, FD_{vk}, and arms L_1 and L_2 .[6]

$$\sum F_V = 0 \quad \text{and} \quad \sum M_V = 0$$

$$FD_{vk} - \mu(F_w + F_f) - F_p = 0 \qquad (2.3)$$

$$(FD_{vk} - F_p)\, L_2 - \mu\,(F_w + F_f)\, L_1 = 0 \qquad (2.4)$$

If the coefficients of friction between the piston and the cylinder wall, μ = 0.1 with noting equation (2.2), then the equation (2.4) turns into :

$$\{(FD_{vk} - F_p) - 0.05(F_w + F_f)\}\ L_2 = 0, \text{ or}$$

$$FD_{vk} = F_p + 0.05\,(F_w + F_f) \qquad (2.5)$$

If P_1 and P_2 respectively the injected air pressure on the piston step forward and piston step backward, then the effective pressure, P_{ef} ,produced is (P_1 - P_2), which is formulated [7, 8]as follows :

$$P_{ef} = \frac{4F_{Dvk}}{\pi D^2} - \frac{4F_{Dvk}}{\pi(D^2-d^2)} \qquad (2.6)$$

The dimensions of piston and connecting rod of pneumatic cylinders used is determined due to standard manufacturing, while the dynamic vertical force of the vehicle, FD_{vk}, refers to the vehicles' weights or masses passing through the injection port [3]. The main properties of air are compressible, so that outside air pressure of one atmosphere, P_o, with volume V_o can be compressed into a volume V_1 and the pressure P_1. The amount of compression from V_o becomes V_1 is shrunk to seven times, or $\frac{V_o}{V_1} = 7$ [9]. The study of the relationship between the piston diameter, D, and air channel diameter, d_1, has been preliminary carried out in the form of equation (2.7) [10].

$$d_i = 0.065713\ D \qquad (2.7)$$

The dimensions of air Channel to be used is adapted to the dimensions of the selected pneumatic cylinder piston.
The process of air storing in storage tanks is done by using the downsizing system of the cross section (reducer) in the air duct by controlling the airflow based on Figure 2.2.

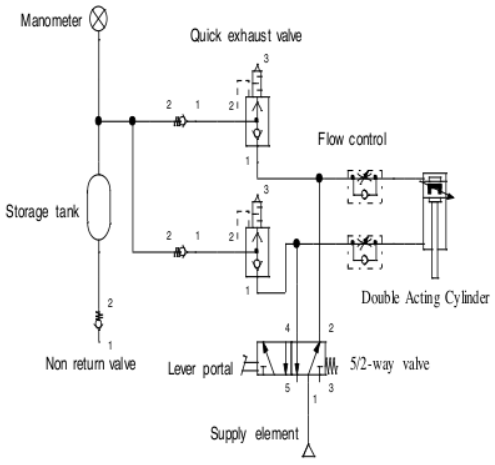


Fig. 2.2 Circuit of air injection process to the pressurized tank.

3. RESEARCH METHODS

Stages of research that began with the literature and preliminary data is important to be a new inspiration source, examining the studied and the unstudied matters, as well as thinking the system development that is more innovatively and efficiently.
Preliminary data that is closely related to the plan that will be examined such as dimensions, weight and type of vehicles as the data baseline of the research. Other data sourced from journals reference or results of previous studies is also very helpful to support the implementation of further research.

The description of the stages of research activities to be conducted integratedly from start to finish is entirely shown in Figure 3.1 The design of drawing and circuit of pneumatic control system can be saved as a document hereinafter to serve as a reference to assemble the components and simulate the system movement that has been designed. The next step is testing the systems work and data collection. In this stage testing is done by rolling the wheel or tire of the vehicles on the pedals portal, then push the piston of pneumatic cylinder up and down.

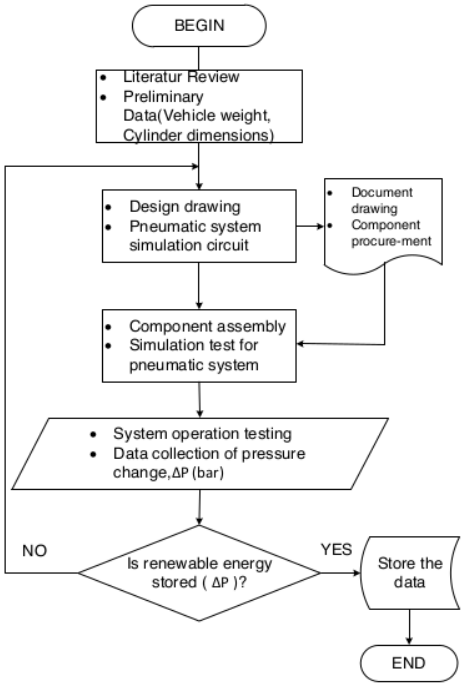


Fig. 3.1 Research flow chart.

In such situations the air is compressed and injected into the pressurized storage tanks.
The amount of compressed air stored in the tank can be obtained by installing a manometer or measuring devices that detect the increase in pressure (ΔP, bar) that is injected and stored in the tank.

The activity of this research is conducted entirely in the campus of State Polytechnic of Ujung Pandang supported by facilities and infrastructures are as follows :
CNC laboratory, to perform machining such as production of shaft lever components, connections, mounting hinges,

pins and so on. Pneumatic/Hydraulic and Electro pneumatic, PLC, and Mechatronics laboratories to make the control circuit design and movement simulation using Fluid Simulation software. Welding Workshop, for conducting the connection of rod components into a single mechanic framework of system. Multimedia Laboratory, to conduct drawing design of system prototype completed with document of necessary components images.
Mechanic Workshop, to do the plate working and plate rolling of the compressed air storage tanks.

4. RESULTS AND DISCUSSION

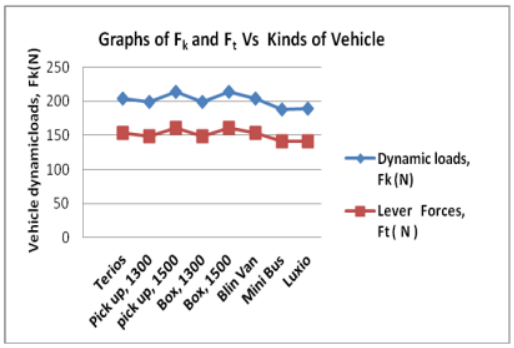
Based on data from the vehicle's weight contained in Table 4.1 using equation (2.5) and (2.6), then the amount of vehicles' dynamic load, FD_{vk} (N) and the lever force, F_t (N) which produces incremental pressure P_1 and P_2 entering the storage tank is in the range between 0.24 (bar) to 0.27 (bar) for piston forward movement and between 0.42 (bar) to 0.48 (bar) for piston backward movement.

Vehicle dynamic loads and maximum leverage force according to the graph in Figure 4.1, are obtained at 214.78 N and 160.55 N respectively.

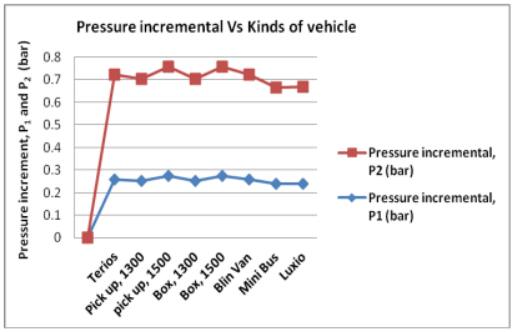
Table 4.1
Relationship between dynamic load and lever force on a pneumatic cylinder

Total weight of vehicle	Dynamic Loads	Lever force	Injection Pressure on Pneumatic Cylinder (N/m^2)	
m, (kg)	FDvk (N)	Ft (N)	P1	P2
2000	203.87	152.91	25971.4	46171.2
1950	198.78	149.08	25322.1	45016.9
2100	214.07	160.55	27270.0	48479.8
1950	198.78	149.08	25322.1	45016.9
2100	214.07	160.55	27270.0	48479.8
2000	203.87	152.91	25971.4	46171.2
1840	187.56	140.67	23893.7	42477.5
1850	188.58	141.44	24023.6	42708.4

The experimental results obtained show that the tank filling mechanism which uses the dynamic load of four-wheeled vehicles is very helpful for maintenance purposes of the vehicle wheels. The maintenance could be refilling pressurized air into the vehicle tire whose pressure decreases periodicly due to load repetition, overload, or passing on bumpy road surfaces. As the energy of pressurized air is obtained from a number of vehicles passing on the road, then the implementation of this research is also for maintenance purposes to vehicle tires experiencing the emergency of wind shortages.



(a)



(b)

Fig. 4.1 (a) Graphs of dynamic loads, lever force and kinds of vehicles. (b) Graphs of increment of pressure and kinds of vehicle.

5. CONCLUSION

Based on the results that have been obtained through the testing of vehicle dynamic load and analysis toward results of designs created, it can be concluded as follows :

1. The amount of the increase in air pressure that is obtained through the injection process of the pneumatic cylinder ranges from 0.3 to 0.5 bar. The greater the dynamic load of the vehicles the higher the increase of incoming air pressure into the compressed air storage tanks. The increase of vehicle volume passing through the road will add up the pressurized air into the storage tank.
2. Renewable energy that is derived from the injection mechanism of the pneumatic system refers more to the no use of electricity, fuel oil (BBM) and procurement costs of compressor to produce pressurized air. The excess of energy in the storage tank that comes from repetition of vehicle loads can be neutralized by the quick exhaust valve which is installed on the system.

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