Automobile Fuel Saver

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Abstract

Conserving energy is vital for survival of life on earth. The proposed device reduces pollution by saving fuel.

Already efforts are made to conserve the energy being lost in braking by regenerative braking. The regenerative braking has limitation regarding percentage of recovery due to motor/generator design. Also its efficiency is low because of energy conversions like

Mechanical → Electrical → Chemical

Mechanical ← Electrical ←

To make the energy recovery system more efficient and effective it is proposed to store the kinetic energy in the same form and utilize through 'Automobile Fuel Saver'.

Automobile Fuel Saver directs the kinetic energy of vehicle to flywheel while braking and stores it. While releasing the brake, it facilitates the transfer of energy from flywheel to vehicle. This way, it is estimated to save 2% of energy being lost in braking of vehicle. It is estimated that 7% of energy is lost in braking and accelerating the vehicle. 2% of mechanical energy saving will result in 10% saving in fuel consumption assuming 20% thermal efficiency of engine.

With 10% fuel saving, it is estimated that global savings will be of the order of 54 Crores per day

Keywords

Fuel, Kinetic energy, Mechanical energy, Braking, Automobile, Fuel-saver

I. Introduction

Automobile fuel saver consists of 13 main parts as indicated in the diagram. Pusher (1) freely slide axially with the force from lever (12) andapply pressure on rotating Pressure plate (2) which is mounted on vehicle axle. Clutch plate (3) is splined on to vehicle axle with free axial movement. Friction plate cum internal gear (4) is mounted on vehicle axle and freely rotating. Internal gear (4) is meshed with pinion -1 (5). Pinion-1 (5) is integral with internal gear -2 (6) and mounted on pin (7) which is fixed on housing and vehicle axle with bearings on either side.Internal gear – 2 (6) meshes with pinion – 2 (8) which is integral with flywheel (9).

Whenever force applied on pressure plate (2) by pusher (1) theMechanical energy is transferred to and fro between vehicle and flywheel. If the clutch plate is rotating at a speed higher than friction plate (4)Mechanical energy is transferred from the vehicle to flywheel.This happens while braking.In case the friction plate speed is higher than clutch plate speed kinetic energy is transferred from the flywheel to vehicle. This occurs when the brake pedal is moved back.

Thus the energy can be transferred from vehicle to flywheel while braking and flywheel to vehicle when the brake pedal is released for accelerating the vehicle. Suppose the vehicle is moving at 60kmph and the AFS clutch plate (3) is rotating at 400rpm (Assumed vehicle wheel diameter 0.8m) since it is splined to vehicle axle.

To slow down the vehicle the lever – 1 (10) is pulled in the direction shown in the diagram by the movement of brake pedal. This anti-clock wise rotation of lever – 1(10) will cause the lever – 2 (12) to apply required force on pressure plate (2) through pusher (1). Then, kinetic energy is transferred from vehicle to flywheel. When the lever – 1(10) completes the anti-clock wise rotation pressure on the pressure plate is released. Vehicle and flywheel are disconnected. Hence the speed of vehicle can be brought down by further movement of brake pedal through braking system.When the brake pedal is released the backward movement of the pedal is used to rotate the lever – 1(10) clockwise and this rotation causes the clutch engaged and transfer the energy from flywheel to vehicle since friction plate speed is more than clutch plate speed .

II. Illustration

Suppose a vehicle of 10,000kg weight is moving at a speed'S'kmph and vehicle wheel diameter is 0.8m.

Kinetic energy of vehicle (E_v) $=1/2 * 10{,}000\ (s* 1000/3600)^2 = 385.8\ S^2$ Nm.

When the vehicle at a speed S kmph the speed of vehicle wheel is given by

/1000 = 0.15 N

N= 6.635 * S rpm, $E_v = 385.8\ (0.15\ N)^2 = 8.76\ N^2$

AFS clutch plate speed = vehicle wheel speed.

Using the above formulae values of kinetic energy of vehicle and vehicle wheel speed at different vehicle speedsare calculated and given in table 1.

When the vehicle is at 60kmph, if the AFS clutch plate is engaged by pressing the brake pedal, transfer of energy takes place from vehicle to flywheel. Calculation details are given below.

III. Data Considered

Weight of flywheel 40kg each and 2 flywheels

Mean radius = 0.3m

Friction plate speed = n rpm

Energy of flywheel (E_f) $= ½*Iw^2$

$= 0.5 * 80* (0.3)^2 * (2 * 25 * n/60)^2$

$=24.7\ n^2$

AFS clutch is engaged when the vehicle is moving at 60kmph.

At vehicle speed 50kmph the amount of energy transferred from vehicle to flywheel = $E_{v60} - E_{v50}$ = 13, 88,880 – 9, 64,500 = 4, 24,380 NM

Assuming no friction loss the speed of flywheels in terms of friction wheel speed is given by

$(24.7n_1^2 - 0) = 4,\ 24{,}380$

n= 131rpm

Similarly the flywheel speeds in terms of friction plate speeds are calculated at different speeds of vehicle and given in Table 1.

At vehicle speed 31 kmph friction plate attains speed of 202rpm almost equal to friction clutch plate speed. At this stage with the further progression of brake pedal, AFS clutch is disengaged and vehicle is brought to rest by conventional brake.

Then, the energy values are given in Table 2.

Now with the backward movement of brake pedal AFS clutch is engaged again and transfer of energy from flywheel to vehicle takes place as indicated below

Suppose the fly speed in terms of friction plate speed is reduced from 202 to 174.

With this energy transfer vehicle speed is given by the equation.
$24.7 * (202^2 – 174^2) = 8.768 N^2$
N = 172.2
Corresponding vehicle speed N/6.635
= 172.2/6.635
= 25.95kmph
Flywheel energy= $24.7 * 174^2 = 747817.2$
At 25.96 kmph, energy values are indicated in Table 3

Energy transferred = 2, 60,042 Nm
Further release of brake pedal will make the AFS clutch disengaged and the vehicle is free to get accelerated with engine power leaving the flywheel rotating at 4350rpm. This completes one cycle.
Vehicle speeds, vehicle energy values, vehicle wheel speeds, friction plate speeds and flywheel speeds are calculated as detailed above and given in table 4 for two cycles.

A. Percentage of Energy Recovery

Percentage of recovery = (Loss without AFS – Loss with AFS) / Loss without AFS

1. Cycle 1:

Loss = Initial energy – Final Energy
= 13,88,880 – (2,60,042 + 7,47,817)
= 3,81,021
Reduction in loss = 13,88,880 – 3,81,021
= 10,07,859
% Recovery = (loss reduction / loss without AFS) * 100
= (10,07,859 / 13,88,880) * 100
= 72%

Calculated as above for the cycle 2, recovery is 65%.
Average recovery = 68.5%
Assuming the efficiencies of clutch, gear train-1, gear train-2 are 0.85, 0.9 and 0.9 respectively.
Charging efficiency = 0.685 * 0.85*0.9 * 0.9 = 0.472
Efficiency of recovery system = 0.9 * 0.9 * 0.85 = 0.689
Overall recovery = 0.47 * 0.689 = 0.324
Percentage of energy saving = percentage of energy consumed in braking and acceleration * overall efficiency of AFS system = 7 * 0.324 = 2.265% = ~2%
This value is for highway drive. For city drive it will be much more.

2. Saving Estimation

World consumption of petroleum fuels = 9x 10^7 barrels / day [1] out of this 45% is towards road transport [1]. Two percent saving in mechanical energy will save 10% fuel assuming 20% thermal efficiency.

Reduction in fuel consumption = $0.1 * 9 * 10^7 = 9 * 10^6$ barrels
Monetary saving = $9 * 10^6 * \$ 100 = \$9 * 10^8$ = Rs 54 Crores

3. Reduction in Co_2 Emission

CO_2 emission in 2012 = 6,526*106 tons [7]
Transport sector contribution = 28% = $0.28 * 6526 * 10^6 = 1827 * 10^6$ tons
Reduction with Automobile Saver = 10% = $0.1 * 1826 * 10^6 = 182.6 * 10^6$ tons

4. Economics of Proposal

Estimated cost for 2 units of ‘Automobile Fuel Saver’ = Rs 60,000

Assuming a 10 ton truck gives 5 kilometers per liter fuel cost per kilometer = 70/5 = 14Rs per kilometer. Saving at 10% reduction in fuel consumption = Rs 1.4 per kilometer. Cost of AFS can be recovered by a travel of 60,000/1.4 = 50,000 kilometers. By 1lakh kilometers travel profit = 50,000 * 1.4 = Rs 70,000 after cost recovery.

For this device patent filed on 23/12/2013 vide application number 6003/CHR/2013

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Table 1: Energy Values at Various Vehicle Speeds

Vehicle Speed kmph	Kinetic Energy of Vehicle Nm	Vehicle wheel speed RPM	Friction plate speed RPM	Flywheel speed RPM	Energy of flywheel Nm
60	13,88,880	398.10	0	0	0
50	9,64,500	337.75	131	3175	4,24,380
40	6,17,280	265.40	176	4400	7,71,600
31	3,70,754	205.6	202	5050	10,07,859

Table 2

Vehicle Speed kmph	Kinetic Energy of Vehicle Nm	Vehicle wheel speed RPM	Friction plate speed RPM	Flywheel speed RPM	Energy of flywheel Nm
0	0	0	202	5050	10,07,859

Table 3

Vehicle Speed kmph	Kinetic Energy of Vehicle Nm	Vehicle wheel speed RPM	Friction plate speed RPM	Flywheel speed RPM	Energy of flywheel Nm
25.96	2,60,042	172.2	174	4350	7,47,817

Table 4:

Vehicle speed (kmph)	Vehicle Energy (Nm)	Vehicle wheel speed(RPM)	Friction plate speed (RPM)	Flywheel speed (RPM)	Flywheel energy (Nm)
Cycle 1					
60	13,88,880	398.1	0	0	0
AFS clutch engaged to slowdown the vehicle due to road/traffic condition					
31	3,70,754	205.6	202	5050	10,07,859
AFS clutch disengaged and brake applied to slow down further					
0	0	0	202	5050	10,07,859
Brake released AFS clutch engaged to accelerate vehicle					
26.96	2,60,042	172.2	174	4350	7,47,817
Cycle 2					
AFS clutch disengaged and vehicle is accelerated to 60kmph by engine power					
60	13,88,880	398.1	174	4350	7,47,817
AFS clutch engaged to slow down the vehicle due to road/ traffic condition					
38.28	5.65.160	254	251	6275	15,56,124
AFS clutch disengaged and brake applied to slow down further					
20	1,54,320	132.7	251	6275	15,56,124
Brake released and AFS clutch engaged to accelerate					
33.15	4,23,964	220	228	5700	12,84,004
AFS clutch disengaged and vehicle accelerated to 60kmph					
60	13,88,880	398.1	228	5700	12,84,004