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Bio-Diesel for Sustainable Development of Belgaum City Transport

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Abstract: ***The study is concerned with the development, encouragement and use of more environment-friendly Bio-Diesel fuels for Belgaum city transport for the sustainable development. These innovative solutions encompass new more environment-friendly transport technologies and also innovative transport concepts with potential for lowering environmental impacts, such as minimizing tail pipe emissions. this study mainly deals with the sustainable development of Belgaum City Transport; by the use of Alternative fuel-Bio-Diesel particularly it focuses on the suggestion to curb the vehicular pollution by the use of Bio-Diesel and sustainable development. In this study the pollution loads have been calculated and compared by considering usage of the Bio-Diesel in place of conventional diesel fuel in buses. The total money which we can save by the use of Bio-Diesel is also calculated and shown here. for the purpose of this study, the Belgaum cities 3 bus depots were considered. The daily total kilometer operated by 3 bus depots of Belgaum city is collected with various other information. These buses run on diesel fuel and are responsible for largest amount of lead emissions and various other pollutants. The pollution loads were calculated on the basis of information collected from the Central Pollution Control Board (CPCB), Environment Protection Agency and previous studies carried out in this regard by various important agencies. The use of Biodiesel shows tremendous reduction in various pollutants. By the use of B20 Bio-diesel we can reduce total unburnt hydrocarbons to 20%, Carbon monoxide to 12%, PM10 and PM25 to 12%, NOx +2 or -2%, SO2 to 20%. By the use of B100 Bio-diesel we can reduce total unburnt hydrocarbons to 67%, Carbon monoxide to 48%, PM10 and PM25 to 47%, NOx +10or -2%, SO2 to 100%.***

Keywords **-Air pollution, Biodiesel, Vehicular Pollution, Central Pollution Control Board.**

I. INTRODUCTION

Belgaum was known as Venugram (Bamboo Village) in ancient days. Belgaum is designated as second capital of Karnataka. It is climatically very pleasant. Generally the summer temperature may not go beyond 40 Degree Celsius and winter temperature may not go below 13 degree Celsius. Belgaum will have equal period of summer, winter and Monsoon season. But because of increase in population, vehicular population and increased infrastructural work the rise in air pollution taken place in the city and surrounding areas which in turn is responsible for climate change. Because of the increased population of vehicles in Belgaum city the pollution levels have increased exorbitantly. Diesel-related pollutants are either already very high or rapidly increasing in Belgaum city. Both particulates and nitrogen dioxides have emerged as pollutants of concern in Indian cities. The contribution of diesel emissions to fine particulate matter, oxides of nitrogen and other carcinogens like polycyclic hydrocarbons cannot be underestimated. The sulphur dioxide (SO2) and nitrogen oxides from diesel vehicles also contribute significantly towards the build-up of secondary particulates and ozone. The particulate emissions from uncontrolled diesel engines are 6-10 times greater than those from petrol engines. Extremely tiny diesel particles go deep into the lungs and are also very toxic. Diesel vehicle however, emit lower carbon monoxide (CO) and hydrocarbons (HCs) compared to petrol vehicles. Controlling urban air pollution is turning out to be an enormous challenge not only because of the rising numbers of total vehicles but also due to the increased toxic risk from the growing numbers of diesel cars. In 1999 CSE had advocated the ban on diesel Vehicles. We need cleaner alternatives to Belgaum city. Serious efforts are needed to create awareness among the consumers to make their vehicles eco–friendly to reduce emissions. In this study we are urging Belgaum city transport to consider Bio-Diesel as an alternative fuel because of its many benefits and are as given below.

II. BENEFITS OF BIO-DIESEL

A. Environmental Benefits

In 2000, bio-diesel became the only alternative fuel in the U.S. to have successfully completed the EPA-required Tier I and Tier II health effect testing under the clean Air Act. These independent test conclusively demonstrated Biodiesel significant reduction of virtually all regulated emissions, and showed bio-diesel does not pose a threat to human health. Bio-diesel contains no sulphur or aromatics, and use of bio-diesel in a conventional diesel engine results in substantial reduction of unburned hydrocarbons, carbon monoxide and particulate matter. A U.S. Department of Energy study showed that the production one use of bio-diesel, compared to petroleum diesel, resulted in a 78.5% reduction in carbon dioxide emissions. Moreover, bio-diesel has a positive energy balance.

B. Energy Security Benefits

With agricultural commodity prices approaching records lows and petroleum prices approaching records highs, it is clear that more can be done to utilize domestic surpluses or vegetable oils while enhancing our energy security. Because bio-diesel can be manufactured using existing industrial production capacity, and used with conventional equipment, it provides substantial opportunity for immediately addressing our energy security issues. If the cost of using foreign oil were imposed on the price of imported fuel, renewable fuels, such as bio-diesel, probably would be the most viable option.

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C. Economic Benefits

Increased utilization of renewable bio fuels results in significance micro economic benefits to both the urban and rural sectors, and the balance of trade. A study completed in 2001 by the U.S. Department of Agriculture found that an average annual increase of the equivalent of 200 million gallons of Soya-based bio-diesel demand would boost total crop cash receipt by $5.2 billion cumulatively by 2010, resulting in an average net farm income increase of $300 million per year. in addition to being to domestically produced, renewable alternative fuel for diesel engines, bio-diesel has positive performance attributes such increased Cetane, high fuel lubricant, and high oxygen content, which may make it a preferred blending stock with future ultra-Clean diesel

D. Quality Benefits

B100 (100 percent bio-diesel) has been designated as an alternative fuel by the U.S. Department of Energy and the U.S. Department of Transportation. Moreover, in December 2001, the American Society of Testing and Material (ASTM) approved a specification (D6751) for bio-diesel fuel. This development was crucial in standardizing fuel quality for bio-diesel in the U.S. market. The National Biodiesel Board, the trade association for the bio-diesel industry, has formed the National Biodiesel Accreditation Commission (NBAC) to audit producers and marketers in order to enforce fuel quality standards in the US. NBAC issue a 'Certified Biodiesel Marketer' seal of approval for bio-diesel marketers that have met all requirements of fuel accreditation audits. This seal of approval will provide added assurance to customers, as well as engine manufacturers, that the bio-diesel marketed by these companies meets the ASTM standards for bio-diesel and that the fuel supplier will stand behind it products.

E. Environmental Protection Act Benefits

Effective November 1998, Congress approved the use of bio-diesel as an Energy policy Act (EP Act) compliance strategy. The legislation allows EP Act-covered fleets (federal, state and public utility fleets) to meet their alternative fuel vehicle purchase requirements simply by buying 450 gallons of pure bio-diesel and burning it in new or existing diesel vehicles in at least a 20% blend with diesel fuel. The Congressional Budget Office and the U.S. Department of Agriculture have confirmed that the bio-diesel option is the least cost alternative fuel option for meeting for Federal government's EP Act compliance requirements. Because it works with existing diesel engines bio-diesel offers an immediate and seamless way to transition existing diesel vehicles into a cleaner burning fleet.

- There is no spilling when filling the tank and no possibility of theft or pilfering.
- Engine noise is low and one will be driving in a more environment-friendly way

III. DIESEL VEHICLE EMISSIONS

Due to low volatility, evaporative emissions are non-significant. Though the concentration of CO and unburnt HC in the diesel exhaust are rather low, they are compensated by high concentration of NOx. There are smoke particles and oxygenated HC, including aldehydes and odour-producing compounds. Fueled vehicles are CO, HC, NOx and Pb while pollutants from diesel-fueled vehicles are particulate matter (including smoke), NO_X, SO_2, PAH. Residence time and turbulence in the combustion chamber, flame temperature and excess O_2 affect CO formation. NO_X includes nitric oxide (NO), nitrous oxide (N2O), nitrogen dioxide (NO_2), dinitrogen trioxide (N_2O_3) and nitrogen pent oxide (N_2O_5). NO and NO_2 collectively represented as NO_X, are the main nitrogen oxides emitted by vehicles. About 90% of these emissions are in the form of NO which is produced in the vehicle engine by combustion of nitrogen at high temperatures. NO_2 is formed by oxidation of NO, and has a reddish brown color and pungent odour. In developing countries, the transport sector accounts for 49% of NO_X emissions and the power sector, 25%; the industrial sector, 11%; the residential and commercial sectors, 10% and other sources 5%. Another important gas emitted is carbon-di-oxide which is a green house gas associated with global warming resulting mainly from increased combustion of fossil fuels including motor vehicle fuels.

IV. MOTIVATION FOR PRESENT STUDY

Belgaum is second capital of Karnataka and famous for pleasant climatically conditions but is highly polluting day by day. Air pollution is particularly alarming because of its harmful effects on human health. Belgaum is mainly suffering from Air Pollution related problems. The fastest growing infrastructure facilities in city, various construction activities and vehicular pollution made the air pollution level very high. The increasing number of vehicles and buses of Belgaum city Transport made situation too worst. Belgaum is the city where commuters are primarily dependent on the road transport system. This has led to an enormous increase in the number of vehicles with the associated problems of traffic-congestion and an alarming increase in air pollution. Therefore, there is an urgent need for vehicles in Belgaum to switch over to various alternative fuels such as Bio-Diesel, CNG, Auto-LPG and LNG, to minimize air pollution in Belgaum city.

The major pollutants emitted by motor vehicles include CO, NOx, sulphur oxides, (SO), HC, lead (Pb) and suspended particulate matter (SPM). These pollutants have damaging effects on both human health and ecology. The human health effects of air pollution vary in the degree of severity, covering a range of minor effects to serious illness, as well as premature death in certain cases. Most of the conventional air pollutants are believed to directly affect the respiratory and cardio-vascular systems. In particular, high levels of SO2 and SPM are associated with increased mortality, morbidity and impaired pulmonary function, Lead prevents hemoglobin synthesis in red blood cells in bone marrow, impairs liver and kidney function and causes neurological damage. Therefore, it is important to reduce pollution from vehicular emissions.

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V. OBJECTIVES OF STUDY

The principal objective of the present research is to carry out a comparison of vehicle pollution for diesel and Bio-Diesel fuelled buses. . The intent is to suggest strategies for minimizing vehicular pollution in Belgaum city. The objectives of the present research are achieved through

- Collection of data related to various alternative fuels, particularly diesel and Bio-Diesel
- Collection of data pertaining to emission factors
- Collection of data pertaining to Belgaum cities total number of buses in all the depots.
- The average running kilometer per day of various buses of Belgaum city transport.
- Buses flying in city and other areas and Comparison of emission level for Diesel fueled and Bio-Diesel fueled buses in Belgaum.

VI. METHODOLOGY

The following methodology has been adopted for conducting the present study.

- The details of number buses in various depots of Belgaum city have been collected.
- The average daily running kilometer of various buses were collected from Belgaum city depots
- The emission levels of various class vehicles have been collected from Central Pollution Control Board, New Delhi and from other reliable sources.
- Available data has been analyzed with the objective of minimizing vehicular pollution with Bio-Diesel fuels/categories of vehicles

VII. COLLECTION OF DATA

The data of buses has been collected from 3 depots of Belgaum city Transport. The data collected is shown in Table: I. the comparative pollution loads have been collected from various agencies and various research works

Name of Depot	Number of buses
Depot-1	123
Depot-2	148
Depot-3	106

Table 1 Number of buses in various depots of Belgaum city Transport.

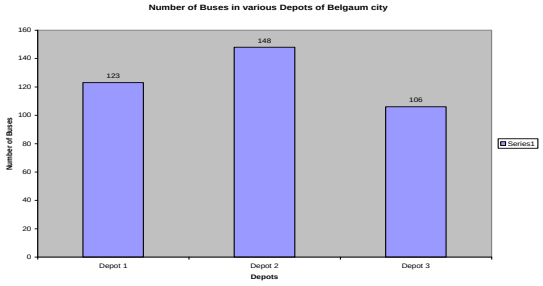

Fig-1: Number of buses in various depots of Belgaum city transport

From Table 1 and figure1, it is seen that the number of buses in all the three depots of Belgaum city consists of 377 buses. All the buses are using diesel fuel.

Table II The average running kilometer per day of various buses in various depots

Depots	150km/day	250km/day	550km/day
Depot 1	32	68	23
Dept-2	65	74	09
Depot-3	5	60	41
Total No Buses	102	202	73

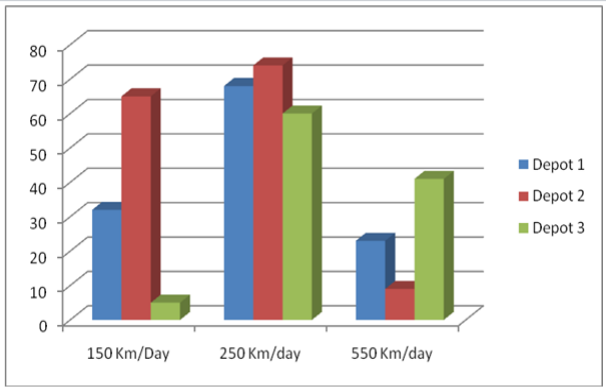

Fig 2: Buses running kilometer/day in various depots of Belgaum city

Table 2 and figure 2 shows various number buses running kilometer per day in and around Gulbarga city. About 102 buses run 150 kilometers/day, 202 buses run 250km/day approximately and 73 buses run almost 550km/day.

Table III Pollution load in gm/km of Diesel Buses

Pollutants	CO	NOx	PM	HC
Diesel	2.4	21	0.38	0.40

{Source: Frailey et al. (2000) as referred in World Bank (2001b: 2),and Dr. SarathGuttikunda, New Delhi, July 2008, Four Simple Equations for Vehicular Emissions Inventory, Simple Interactive Models for Better Air Quality, www.sim-air.org}

Table IV Average Bio-diesel emissions compared to Conventional Diesel

Emission Type	B100	B20
Total Unburned Hydrocarbons	-67%	-20%
Carbon Monoxide	-48%	-12%
Particulate Matter	-47%	-12%
NOx	+10%	+2% t0 -2%

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(Source www.epa.gov/otaq/models/analysis/biodiese/p02001.pdf)

Now by using the data given in table No.3 and 4 we can calculate the pollutants of B100 and B20 Bio-diesel buses as shown in Table No.5.

Table V Reduction in Diesel emissions in gm/km by the use of Bio-diesel in buses

Emission Type	B100	B20
TotalUnburned Hydrocarbons	0.132	0.32
Carbon Monoxide	1.248	2.112
Particulate Matter	0.201	0.334
NOx	23.1	+21.42 or 20.58

Source: Frailey et al. (2000) as referred in World Bank (2001b: 2).

VIII. CALCULATION OF POLLUTION LOADS

This section describes the procedure for calculations of pollution loads. With the help of available data firstly the pollution load of Bio-diesel buses and diesel buses can be calculated for the Belgaum city Transport depots. Now the calculation of pollution loads will be done on the basis of three categories of buses running with 150km/day, 250 km/day and 550km/day. All the calculate loads are shown in tale No. 4, 5 and 6 respectively.

Table VI: Comparative Pollution load in kg/km of Diesel and B100 Bio-diesel fuelled 102 buses running 150km/day

	Pollutant	Pollutant	Pollutant	Pollutant
Fuel	CO gm/km	NOxgm/km	PM gm/km	HC gm/km
Diesel	36720gm/km= 36.72kg	321300gm/km= 321.3kg	5814gm/km= 5.81kg	6120gm/km= 6.12kg
Bio-diesel (B100)	19094.4gm/km= 19.09kg	353430gm/km= 353.4kg	3075.3gm/km= 3.07kg	2019.6gm/km= 2.01kg
% Reduction	48	+10% (Increase)	47	67

Table VI shows Comparative Pollution load in kg/km of Diesel and B100 Bio-diesel fuelled 102 buses running 150km/day and Table VII shows Pollution load in kg/km of Diesel and B20 Bio-diesel fuelled 202 buses running 250km/day.

	Pollutant	Pollutant	Pollutant	Pollutant
Fuel	CO gm/km	NOxgm/km	PM gm/km	HC gm/km
Bio-diesel (B20)	32313.6gm/km= 32.31kg	+327726= +327.7kg Or- 314874= -314.87 kg	4896gm/km= 4.89kg	5110.2gm/km= 5.11kg
% Reduction	12	+2% or -2%	12	20

Table VII: Pollution load in kg/km of Diesel and B20 Bio-diesel fuelled 102 buses running 150km/day

Table VIII: Comparative Pollution load in kg/km of Diesel and B100 Bio-diesel fuelled 202 buses running 250 km/day

	Pollutant	Pollutant	Pollutant	Pollutant
Fuel	CO gm/km	NOxgm/km	PM gm/km	HC gm/km
Diesel	121200gm/km= 121.2kg	1060500gm/km= 1060.5kg	19190gm/km= 19.19kg	20200gm/km= 20.02kg
Bio-diesel (B100)	63024gm/km= 63.02kg	1166550gm/km= 1166.55kg	10150.5gm/km= 10.15kg	6666gm/km' 6.66kg
% Reduction	48	10 (Increase)	47	67

Table VIII shows Comparative Pollution load in kg/km of Diesel and B100 Bio-diesel fuelled 202 buses running 350 km/day

Table IX: Pollution load in kg/km of Diesel and B20 Bio-diesel fuelled 202 buses running 250km/day

	Pollutant	Pollutant	Pollutant	Pollutant
Fuel	CO gm/km	NOxgm/km	PM gm/km	HC gm/km
Bio-diesel (B20)	107184gm/km= 107.18kg	+1081710gm/km= 1081.7kg or 1039290gm/km= 1039.2	16867gm/km= 16.86kg	16160gm/km= 16.16kg
% Reduction	12	+2 or -2	12	20

Table XI shows Pollution load in kg/km of Diesel and B20 Bio-diesel fuelled 202 buses running 250km/day

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Table X: Comparative Pollution load in kg/km of Diesel and B100 Bio-diesel fuelled 73 buses running 550 km/day

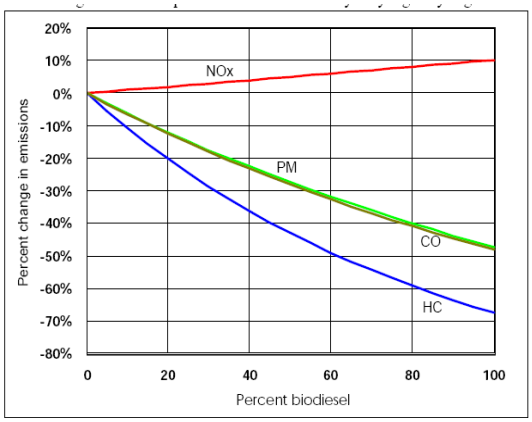
	Pollutant	Pollutant	Pollutant	Pollutant
Fuel	CO gm/km	NOxgm/km	PM gm/km	HC gm/km
Diesel	96360gm/km= 96.36kg	843150gm/km 843.15kg	15257gm/km= 15.25kg	16060gm/km= 16.60kg
Bio-diesel (B100)	50107.2gm/km= 50.10gm/km= Kg	927465gm/km= 927.46kg	8070.15gm/km= 8.07kg	5299.8gm/km' 5.29kg
% Reduction	48	10 (Increase)	47	67

Table X shows Comparative Pollution load in kg/km of Diesel and B100 Bio-diesel fuelled 73 buses running 550 km/day

Table XI: Pollution load in kg/km of Diesel and B20 Bio-diesel fuelled 73 buses running 550km/day

	Pollutant	Pollutant	Pollutant	Pollutant
Fuel	CO gm/km	NOxgm/km	PM gm/km	HC gm/km
Bio-diesel (B20)	84796.8gm/km= 84.79kg	+860013gm/km= 860.13 kg or -826287gm/km= 826.28kg	13410.1gm/km= 13.41kg	12848gm/km= 12.84kg
% Reduction	12	+2 or -2	12	20

Table XI shows Pollution load ingm/km of Diesel and B20 Bio-diesel fuelled 73 buses running 350km/day



(Sourcewww.epa.gov/otaq/models/analysis/biodiese/p02001.pdf)

Fig 3: Reduction pollution levels by the use of B100 and B20 Bio-Diesel buses in gm/km

Table XII: Total Running Kilometer of all the buses of Belgaum City Transport and Their Diesel Consumption

Depots	Total km/day run by all the buses	Average Diesel Mileage kilometer/liter	Diesel required/day
All Depots	130800	5.20 km/liter	25153.84liers/day

The present cost of Diesel per liter in Belgaum city is ₹ 50.25 and the cost of Bio-Diesel is ₹ 23.(As per PCRA). Now by referring to the costs of Diesel and Bio-Diesel at Belgaum-Karnataka state the following table has been prepared and compared and is as shown in the following Table number 13.

Table XIII: Total diesel consumption/day and Cost of Diesel and Bio-Diesel/day and the cost Saved/day by the use of B100 Bio-Diesel

All Depots of Belgaum City Transport	Diesel required/day	Cost of Diesel in ₹	Cost Bio-Diesel in ₹	Cost Saved/Day by the use of Bio-Diesel in ₹
Total Diesel Required/day	25153.84 liter/day	1289134.61	578538.32	710596.29

IX. CONCLUSION

1. By referring the calculated pollution loads it will be concluded that, by use of B100 Bio- diesel in place of diesel fuel in Belgaum city depots, we can reduce the CO from 254.28 kg /day 132.21 kg/day , Particulate Matter (PM) from 40.25kg/day to 21.29kg/day and Hydro Carbon (HC) from 42.74kg/day to13.96 kg/day. It means we can reduce CO by 48%, PM by 47%, HC by 67% and NOx may increase about 10%. This increase in NOx may be reduced by using Catalytic Convertor in the buses.
2. By referring the calculated pollution loads it will be concluded that, by use of B20 Bio- diesel in Belgaum city depots,, we can reduce the CO to 224.28kg/day, Particulate Matter (PM) to35.16kg/day and Hydro Carbon (HC) to34.11kg/day. It means we can reduce CO by 12%, PM by 12%, HC by 20% and NOx may increase or decrease by 2%. The increase in NOx may be reduced by using Catalytic convertors in the buses.
3. By referring table 13 we can conclude that almost about ₹710596.29/day can be saved by all the depots of Belgaum City Transport by the use of 100% blend of Bio-Diesel. It means almost about 56% of cost can be reduced by the use of Bio-diesel in all the three depots of Belgaum City Transport.
4. Almost about ₹ 259367645.85 can be saved per year by the use of B100 Bio-Diesel in Belgaum city.
5. Sustainable Development can be made by the use of Bio-Diesel in Belgaum city Transport buses by reducing the cost of operation and also reducing the

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exhaust emissions by saving the city environment and our earth

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