

**REPORT ON EXPERIMENTATION FOR ETHANOL
AS A TRANSPORT FUEL IN PAKISTAN**



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SECTION 1

EXECUTIVE SUMMARY

This report is result of the keen interest and participation of HDIP in the testing of ethanol as a fuel for the transportation. Previously Road Run testing was done by the Clean Power Pvt. Ltd. on Santro car which had an EFI engine. The fuel tank of car was used in fuel supply to engine. According to HDIP, the testing database needs to be enhanced in a further controlled environment for deeper analysis. Thus **testing was repeated together by HDIP and CPL on carburettor operated car with alteration in fuel supply.** The alteration in fuel supply was to cater the un-used quantity of fuel in the tank after each test.

In this testing, representatives of HDIP (a Senor Scientific Officer and a staff member) personally participated and had observations with highly calibrated laboratory equipment in order to get accurate results.

There were no problems in engine starting, missing, knocking, acceleration and exhaust. These attributes remained same as with gasoline. The fuel efficiency of engine was comparable with the results of previous testing. The results of previous testing by CPL and latest testing by CPL & HDIP are compiled in section-2.

The handling concerns of ethanol are not directly under the scope of engine's fuel efficiency test. However, during experience of using ethanol in these tests, CPL tried to simulate its experience of using ethanol in small volumes into possible commercial scenario and has developed the recommendations accordingly.

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Based on its experience with ethanol, optional use of ethanol as transport fuel is recommended. **A pilot filling station of ethanol (E5 & E10), with blending at the point of sale, shall help to practically evaluate supply chain, logistic and dispensing issues.** This will enhance the database of ethanol usage and also clarify commercial, economic and cultural issues. It will also practically test and verify the findings and subsequent recommendations by CPL at large scale. CPL's findings and recommendations are mentioned in Section 3 and Section 4 respectively, which have been developed after the series of experiments by CPL alone and CPL & HDIP.

Presently, CPL is in phase of long term testing of ethanol in a motor bike with different blends and under different road conditions. This is being done to continue the enhancement of database.

We are extremely grateful to interest and participation of HDIP in the efforts to evaluate ethanol as fuel in Pakistan. We also acknowledge the patronage by Planning Commission and Alternative Energy Development Board to all efforts in this direction.

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SECTION 2

DETAILS OF EXPERIMENTS

2.1 INTRODUCTION

Use of ethanol as substitute fuel is internationally recognized. It is already in practice in different countries. The objective of these experiments was to confirm the previous testing by using carburettor operated cars.

A modification was made for car fuel tank on direction of HDIP in order to accurately monitor the fuel consumption.

2.2 ALTERATION OF CAR

2.2.1 Preparation of Tank

Referring to previous testing by CPL, HDIP showed suspicion about the quantity of fuel used in the car tank. In order to eradicate this confusion, a separate tank was modified by CPL as shown in figure 1.

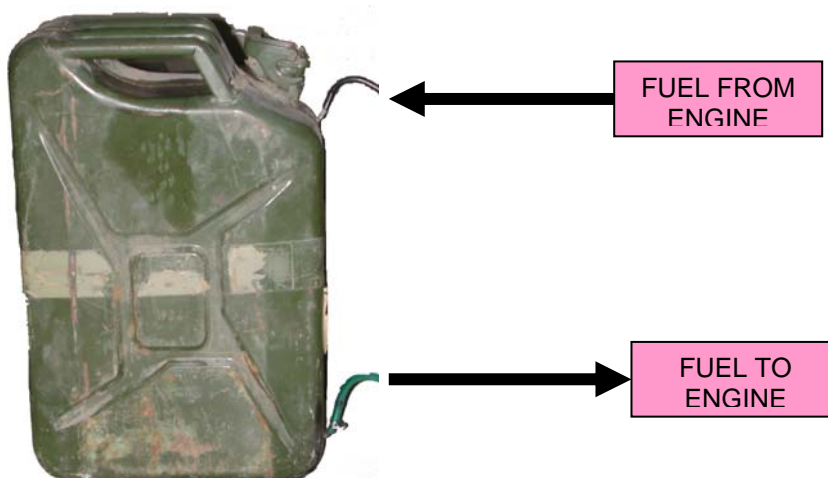


Figure 2.1: Concept of Fuel Supply

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2.2.2 Interface of Tank with Engine

Tank shown in the figure 2.1 was placed on the front seat of the car and was internally piped with engine. Supply from the original car tank was cut off. Modification of car is shown in figure 2.2 and figure 2.3.



Figure 2.2: Interfacing with Engine



Figure 2.3: Placement in Car Cabin

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Alteration of fuel tank was helpful to measure the quantity of unused fuel left in the tank after completion of each test run. It was observed that quantity of unused fuel was approximately same for all readings.

2.3 PROCEDURE

Ethanol was used in a standard petrol car (Suzuki Mehran, 800cc, model 2005). The car engine was in good condition. Testing was performed under the following road conditions.

- Motorway at constant speed of 90 Km/h
- City Roads in Islamabad

For each road condition, following fuel blends were used:

- E5
- E10
- Neat Petrol

2.4 BLENDING EXPERIENCE

Ethanol and gasoline were stored in separate gallons. They were blended in beaker and the blend was pored into the tank connected to engine. **For the purpose of authenticity and conformity of the results, HDIP used its highly precise laboratory equipment for the purpose of blending.**



Figure 2.4: Blended of Ethanol and Petrol

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Straight mixing of petrol and ethanol showed uniformity. The basis of uniformity was observed with colour of solution. **Pink colour of petrol and transparent ethanol became light pink through out the container immediately after mixing.** Clean Power is developing an intelligent dispenser which can take ethanol and petrol from different storage tanks, mix them in desired ratio and dispense the mixture in automobile tank. **The blending at point of sale will remove the constraint of transporting ethanol to oil refineries for blending. Thus shall save associated costs and eliminate role of depots and refineries. The price of ethanol blends will depend upon price of petrol (which is already established) and price of ethanol determined by its demand-and-supply in open market.**

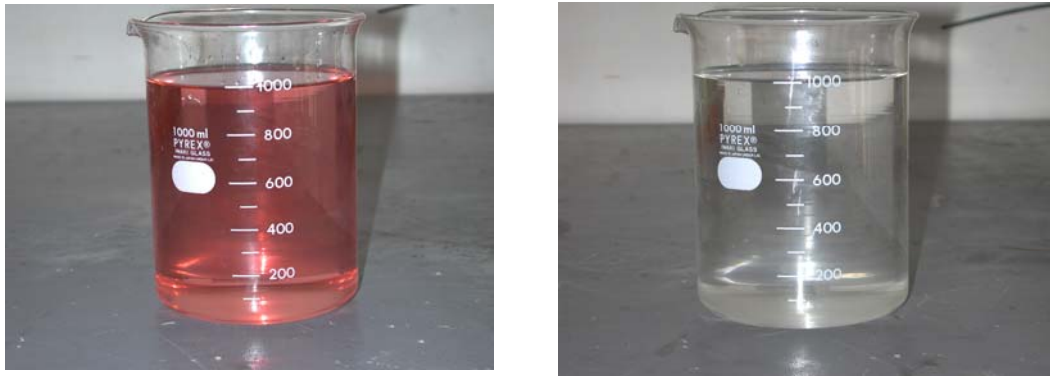


Figure 2.5: Neat Petrol and Ethanol



Figure 2.6: Blends of Ethanol and Petrol (E5, E10, E20)

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2.5 REFERENCES

CPL has witnessed the prevailing procedures and practices in the ethanol distilleries and in OMC's channel to look at the matter from different angles. The local distilleries are already producing anhydrous ethanol which is in accordance with internationally acceptable fuel grade standards. The purity level of anhydrous ethanol at Shakar Gunj Mills Ltd is usually controlled at 99.7% - 99.9%. The international standards of anhydrous ethanol state a minimum level of 99.3% - 99.4%. The storage, handling and transportation practices within the distillery and in export channels are suitably comparable with prevalent conditions of petroleum products and practicable in adoption.

The contact of ethanol with fresh air is avoided, so that ethanol does not absorb moisture. The ethanol producers use **breathing valves of silica gel** at air inlets in storage vessels and transport vehicles to absorb moisture from entering air. It is claimed that this practice does not increase water content by more than 0.1% - 0.2% when measured at foreign destination during export.

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2.6 ROAD RUN DATA

Run Condition	E5 (Experiments by CPL and HDIP)										
	E5 Pumped Lit	Petrol in E5		Ethanol in E5		Total Cost of E5	Distance		Cost per Lit.	Cost per Km	%age Difference Cost/Km
		Qty (Lit)	Cost	Qty.	Cost		Covered (Km)	per Lit. (Km/Lit)			
90 Km/h	2.37	2.2515	127.5475	0.1185	2.9625	130.51	38.9	16.4135	55.0675	3.355	1.966
CITY	0.8	0.76	43.054	0.04	1	44.054	8.2	10.25	55.0675	5.372	1.608

Run Condition	E10 (Experiments by CPL)										
	E10 Pumped Lit	Petrol in E10		Ethanol in E10		Total Cost of E10	Distance		Cost per Lit.	Cost per Km	%age Difference Cost/Km
		Qty (Lit)	Cost	Qty.	Cost		Covered (Km)	per Lit. (Km/Lit)			
100 Km/h	10	9	509.85	1	25	534.85	159.9	15.99	53.485	3.345	-1.085
120 Km/h	5	4.5	254.925	0.5	12.5	267.425	68.1	13.62	53.485	3.927	8.360
CITY	5	4.5	254.925	0.5	12.5	267.425	69.9	13.98	53.485	3.826	15.582

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Run Condition	E10 (Experiments by CPL and HDIP)										
	E10 Pumped Lit	Petrol in E10		Ethanol in E10		Total Cost of E10	Distance		Cost per Lit.	Cost per Km	%age Difference Cost/Km
		Qty (Lit)	Cost	Qty.	Cost		Covered (Km)	per Lit. (Km/Lit)			
90 Km/h	4.85	4.365	247.2773	0.485	12.125	259.4023	88.2	18.18557	53.485	2.941	14.062
CITY	0.8	0.72	40.788	0.08	2	42.788	8.7	10.875	53.485	4.918	9.928

Run Condition	E20 (Experiments by CPL)										
	E20 Pumped Lit	Petrol in E20		Ethanol in E20		Total Cost of E20	Distance		Cost per Lit.	Cost per Km	%age Difference Cost/Km
		Qty (Lit)	Cost	Qty.	Cost		Covered (Km)	per Lit. (Km/Lit)			
100 Km/h	2.5	2	113.3	0.5	12.5	125.8	39.5	15.8	50.32	3.185	3.753
120 Km/h	5	4	226.6	1	25	251.6	64.2	12.84	50.32	3.919	8.545
CITY	5	4	226.6	1	25	251.6	64.5	12.9	50.32	3.901	13.928

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Run Condition	Neat Petrol (Experiments by CPL)									
	Petrol Pumped Lit	Petrol		Ethanol		Total Cost	Distance		Cost Per Lit.	Cost per Km
		Qty (Lit)	cost	Qty.	cost		Covered (Km)	Per Lit. (Km/Lit)		
100 Km/h	5	5	283.25	-	-	283.25	85.6	17.12	56.65	3.309
120 Km/h	5	5	283.25	-	-	283.25	66.1	13.22	56.65	4.285
CITY	5	5	283.25			283.25	62.5	12.5	56.65	4.532

Run Condition	Neat Petrol (Experiments by CPL and HDIP)									
	Petrol Pumped (Lit)	Petrol		Ethanol		Total Cost	Distance		Cost Per Lit.	Cost per Km
		Qty (Lit)	cost	Qty.	cost		Covered (Km)	Per Lit. (Km/Lit)		
90 Km/h	2.35	2.35	133.1275	-	-	133.1275	43.7	18.59574	56.65	3.046
CITY	0.8	0.8	45.32			45.32	8.3	10.375	56.65	5.460

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2.6 ROAD RUN RESULTS

Experiments by CPL			
Run Conditions Km/h	DISTANCE COVERED PER LITRE		
	PETROL	BLENDS OF ETHANOL	
		E10	E20
100	17.12	15.99	15.8
120	13.22	13.62	12.84
CITY	12.5	13.98	12.9

Experiments by CPL and HDIP			
Run Conditions Km/h	DISTANCE COVERED PER LITRE		
	PETROL	BLENDS OF ETHANOL	
		E5	E10
90	18.596	16.414	18.186
CITY	10.375	10.250	10.875

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COST PER LITRE OF FUEL				
PETROL	ETHANOL	BLENDS OF ETHANOL		
Rs /Lit.	Rs/Lit	E5	E10	E20
56.65	25	55.0675	53.485	50.32

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SECTION 3

FINDINGS

- i. There was no problem of starting the engine. Every time, engine started instantaneously. Average self duration was less than 01 second.
- ii. There was no sign of knocking and missing.
- iii. The engine temperature gauge remained at the same level as for petrol. This means, if there were any temperature variations, they were off-set by the temperature thermostat.
- iv. The acceleration of car was same for petrol, E5 and E10. The acceleration was very slightly less for E20 at speed of 100 kph and above. The reduced acceleration was definitely insignificant as compared to acceleration loss with use of CNG.
- v. The fuel efficiency varied under different conditions and with different blends.
- vi. No problem was faced during handling, storage, transportation and blending of ethanol during these tests.

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SECTION 4

RECOMMENDATIONS

Based upon the testing by Clean Power and its practical experience in using ethanol, following is recommended:

1. Use of Ethanol as a fuel is recommended.
2. For some initial period, use of ethanol be made optional rather than mandatory.
3. Specialized dispenser unit may be used for blending at the point of sale. **Such a specialized dispenser is under development at Clean Power.**
4. Government may sponsor sale of E5 & E10 at specific points as **Pilot Project for Ethanol Filling Station.** This is for broadening the usage database and clarification of parameters like supply chain, storage, handling and transportation etc. **Clean Power is willing to under take such project.**

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