



Spotlight



Energy Independence and IndianOil

Dr. APJ Abdul Kalam's address on the occasion of IndianOil's R&D Foundation Day

I am delighted to be here in the midst of members of IndianOil R&D Team during their foundation day. IndianOil R&D team is carrying out important research work in the areas of refining technology, analytical sciences and petroleum products application. During the last 36 years, the R&D Centre of IndianOil has carried out research in the hydrocarbon sector and has led many products to industrial applications. I am happy to know that the Centre has filed over 280 patents in India and abroad and is having industrial partnership with Institutions like Korea Institute of Science and Technology, Korea Gas Corporation, UC Davis, Inter-cat USA and Total France. I congratulate all the members of R&D Centre of IndianOil both past and present for making significant contribution for the growth of the Petroleum refining, processing and evolution of standards for biofuel in the country. My greetings to all the members of IndianOil R&D community on this Foundation Day. I was thinking what thoughts I can share with you. I have selected the topic "Energy Independence and IndianOil".



Business Profile of IndianOil

From the study of IndianOil, I find that the turnover of IndianOil is around rupees 2,50,000 crore in 2007-2008. Company is making very marginal profit even with this large turn over due to the purchase of crude oil at near 100\$ a barrel, whereas the selling price of major fuels like petrol, diesel, kerosene and gas are controlled by the government. The use of fossil fuel has the following problems: (1) The reserve of fossil fuel is continuously coming down and may not last for over 5 to 6 decades (2) the cost per barrel is continuously rising and is putting extreme pressure on our economy (3) the carbon-di-oxide emission pollutes the atmosphere and is continuously degrading the environment.

Energy independence has to be realized by restructuring our energy resources by adding more nuclear power plants, large number of solar power plants, wind energy based power plants and hydel power plants and reduce emphasis on coal and oil based power plants. In the transportation sector, we have to use large proportion of bio-diesel and ethanol. This area falls within the purview of IndianOil and the R&D centre of IndianOil has to multiply its R&D capacity through partnership with large number of academic institutions and national research and development organizations both in the public and private sector.

Under these circumstances, the IndianOil has to find other sustainable oil resources which will not only be cost effective but also be environment friendly. These requirements can be met through development of solar energy, hydrogen energy, bio-fuel energy, emulsified fuels and Coal Gasification. So the prime focus for IndianOil R&D Centre for the next decade has to be on six areas which include fuel conservation measures-all together will enable the country to realize its goal of energy independence well before 2030.

Hydrogen fuel

Hydrogen holds the potential to provide a clean, efficient, reliable and affordable supply of energy for meeting the growing energy needs in India's economy while protecting the environment and

ensuring energy security. Transition from the present fossil fuel based economy to hydrogen economy will require many challenges to overcome specially in the areas of production, storage, delivery, applications, creating infrastructure, economics and public awareness on safety and standards.

Efficient Hydrogen Fuel, Power Package

During my visit to Iceland in 2005, I had a unique experience, which I would like to share with you. Friends, the President Ólafur Ragnar Grímsson of Iceland and myself with our teams were travelling in a hydrogen fuelled bus. The bus also took us to a Hydrogen Fuel station and we filled up Hydrogen gas in the fuel tank and we continued our journey and discussions. I am aware that, hydrogen operated motorcycles, three wheelers and small generators have been developed in the country. In addition, Polymer Electrolyte Membrane Fuel Cell (PEMFC) and Phosphoric Acid Fuel Cell (PAFC) technologies and fuel cell - battery hybrid van have been developed. Particularly the Fuel cell powered automobiles will become a reality in the world. In India, an electric car company in collaboration with DRDO has developed a hybrid vehicle which can be run with a fuel cell and the cost per kilometer will be just 40 paise in addition to the pollution free operation of the Car. It can be seen upper stage of GSLV rocket system that puts communication satellites in the orbit is powered by 70% liquid oxygen and 30% liquid hydrogen. ISRO has established production facilities for liquid oxygen and liquid hydrogen.

Now we have to concentrate on hydrogen production. Some of the routes which IndianOil R&D centre can follow are :

- Microbial degradation of wastes like bagasse and other biomass materials including splitting hydrogen from the hydrogen sulphide in the sewerage water.
- Electrolysis of water for producing hydrogen gas using Polymer Electrolyte Membrane Water Electrolyser (PEMWE)
- Steam reforming of methanol.
- Coal gasification, offers one of the most versatile and clean ways to convert coal into electricity, hydrogen and other valuable energy products.

Researchers have reported successful production of Hydrogen from water using certain proprietary process. The Hydrogen production process uses Solar Concentrator to extract Hydrogen from water at a temperature of 850 degrees Celsius. This is a promising area where the researchers of IndianOil R&D Centre can work with academic institutions and BARC who are working in the area of developing solar concentrators. We need substantial amount of computer modeling and simulation for establishing the process and subsequently optimizing the catalyst and the solar concentrator dish elements. The Solar concentrators can be used for heating, thermal based air conditioning, electrical power generation, hydrogen production, and other applications. I have seen one of the largest solar concentrator at Mount Abu which is used for feeding 15,000 people at a time. I am sure, the researchers of this R&D centre can definitely make important contributions in these developments with their vast experience in dealing with petroleum refining and processing.



Emulsified Fuels

With stringent emission norms beyond Euro IV being implemented abroad now, it has come to light through actual experience with several vehicles that for the Oxides of Nitrogen and particulate emission control, mere use of Ultra Low Sulfur diesel produced after huge investment and used with diesel particulate traps and selective catalytic reduction (SCR Catalysts) using ammonia do have difficulties after huge procurement cost. Emulsified fuels are found to give much better emission reduction towards reduced particulate and Oxides of Nitrogen emission reduction along with fuel saving that it is now implemented in most of the developed countries. In India, we are now successfully burning in a boiler in an industry emulsified diesel fuel with 25% water straight away

saving 25% of the diesel fuel. The emulsified fuel costs 20% cheaper than the diesel fuel. If one such small boiler using emulsified fuel can save 40 litres of diesel in a day and equivalent amount of cash spent on the fuel, please think about the huge fuel savings and the cost benefits for over thousands of boilers and several external fired equipments running with oil in India. The savings for the country in oil import bill will be over 20% the present level. While combusting emulsified fuels for industrial firing needs no modifications it needs encouragement and educating the users. For automobile applications, IndianOil R&D need to work with the engine manufacturers and the universities for adjustments of engine parameters and the components. Emulsified fuels will cut emissions and will bring down the operating costs including captive power generation costs.

Next area of research could be polymers in energy since polymers are one of the products coming out of refining process.

Solar Energy Research

Conventional photovoltaic cells, based on amorphous silicon, have quantum efficiency of less than 20%. Even, Gallium Arsenide (GaAs) based PV cell with multi junction device could give maximum efficiency of 30%. This low efficiency has restricted the use of solar cells for large application for power generation. Therefore, the present research trend is on the use of Carbon Nano Tube (CNT) based PV cell.

The CNTs provide better electron ballistic transport property along its axis with high current density capacity on the surface of the solar cell without much loss. Scientists have established the fact that the alignment of the CNT with the polymer composites substrate is the key issue and this aligned CNT based PV cells would give very high efficiency in photovoltaic conversion. The polymer composites increase contact area for better charge transfer and energy conversion. In this process, the researchers could achieve the efficiency of about 50% at the laboratory scale. The optimum efficiency was achieved with the aligned CNTs with poly 3 - octyl thiophene (P3OT) based PV cell. P3OT has improved the property due to polymer - and nano tubes junctions within the polymer matrix. High electric field within the nano tube splits the exciton to electrons and holes, and enables faster electron transfer with improved quantum efficiency of more than 50%. During my visit to US in October 2007, I have seen quality CNT being produced in laboratory scale at Rice University and high efficiency photo voltaic cell being produced in the Arkansas University laboratory. In India, CNT is now being produced at DMSRDE (Defence Materials and Stores Research & Development establishment) Kanpur.

I am sure, researchers assembled here would like to work in this area of research in partnership with nano technologists in academia and other research institutions so that development and commercial manufacture of aligned CNTs with P3OT based high energy solar cells can be realize fast. This will totally change the energy scenario and accelerate the energy independence of India and many other countries in planet earth. Now I would like to talk about biofuel particularly Jatropha based bio-diesel.

Innovative Jatropha farming

Few months back, I met Dr. DN Tiwari, former Member of Planning Commisison, who has done excellent work in Jatropha area. Under his leadership a team has worked near Allahabad and converted 735 hectors of waste land into Jatropha producing land leading to earning of rupees fifty thousand per hectare. Also, the village has realized energy independence through the use of bio-fuel. The villagers do not use kerosene for cooking or petrol-diesel for running their generators and jeeps. Jatropha cultivation has also been used as a heat shield for banana plantation during summer. Thus, through innovative use of Jatropha social, economic and environmental security has been realized by the 735 farmers in a village.

Research, Development and Production of Jatropha Plantation

India's waste land is spread in different regions with different climatic conditions and also falls in the category of rain fed or irrigated land. To cater to this variety of soil and climatic conditions research is required to determine the particular plant variety which will give the maximum yield of Jatropha seeds for a given soil condition and the maximum yield of oil from that particular seed. Also research is required to find varieties of species and hybrids which will start yielding Jatropha seeds early within a year and higher yield per plant. Based on this research seed farm or stem farm are required to be created for each state and the selected proven seedlings or seed must be provided to the farmers including the know-how on the number of plants and pattern to be used per hectare, preparation of soil prior to plantation and the right time of planting the seeds. Later, farmers should also be advised to use the right type of fertilizers and organic pesticides including trimming methodology and the periodicity. Also farmer should be given advice on friendly intercropping plants which can co-exist with Jatropha and provide enhanced revenue to the farmers. Finally it has to result in establishing number of high yield Jatropha seed banks in the country. I am aware that IndianOil R&D centre has made a full-fledged specification for bio diesel produce from Jatropha. Also IndianOil has successfully carried out blending studies in ethanol and bio diesel and today, the entire petrol sold in IndianOil outlets has 5% blending of ethanol. Now there is a need for IndianOil R&D to go for backward integration and support research for quality jatropha plantation.

Research, Development and Production of High Cetane Synthetic Diesel from Algae

Specific strains of algae have established to yield 150 times more oil than seeds in very much less area with less water requirements. Algae can be easily grown in all places in modules of troughs, ponds and also with brackish water. Oil extraction from algae is a carbon neutral technology as the green house gas carbon di oxide and oxides of nitrogen are consumed for the algae growth while it releases oxygen to the air. Global warming gas emissions from the refineries, power plants, cement plants can be nullified with algae cultivation and extraction of bio-fuel and for securing carbon credits for the country. Some of the Indian patents are being used by European countries pioneering in bio-fuels to upgrade the biofuels from the vegetable seeds and also from algae into second generation High Synthetic Diesel having cetane index above 80 along with good cloud point and excellent combustion properties on par with diesel fuel from Fisher -Tropsh process at very much reduced cost than the petro die sel. This fuel can also be used as an emulsified fuel to further reduce the cost. High Cetane Synthetic Diesel could be used as a Cetane Improver additive to improve petro diesel properties at much reduced costs without costlier refinery process and without the need to spend more energy in the refineries.

Bio-fuel for energy independence and strengthening rural economy

Cultivation of Jatropha and Algae for bio-fuels will make the farmers and the rural poor to improve their earnings and their life. This will improve the rural economy with great employment potential for revolutionizing India with improved per capita income with other associated benefits for the nation. Today morning, I saw a news report that Oil PSUs are joining together and investing 600 million dollars in Brazil for production of ethanol. I dream that oil PSUs will join together and invest one billion dollar in India for producing bio-diesel from Jatropha from plantation to esterification.



Crushing and Esterification

Some of our agricultural universities have developed small sized bio-fuel plants and technology is available for 600 liter per day production. There is need to scale up this plant further and produce standardized plant in the range one to five tonnes per day capacity for installation in different regions. Also there is a need to identify plant manufacturers who can produce quality standardized plants in different regions across the country and also undertake trouble free maintenance of the plant. IndianOil should undertake indigenous design and production of cost effective, high efficiency, seed processing, crushing and esterification plants for commercial availability including exports. Specialization of IndianOil in building oil refineries can lead to the establishment of high efficiency esterification plants for bio-diesel.

Efforts in this direction will help the industry with fabrication of plants and increased industrial activity leading to employment potential for the skilled technicians and engineers. At the same time energy intensive industries like sugar, distilleries, cement plants, power plants and the like will also be benefited with alternate fuel availability for their full or part of operation requirements at economical costs thus reducing the import burden of oil.

Automobile Manufacturers

It has been reported that some four wheelers, trucks and heavy vehicles have been run fully on bio-fuel without any change to the automobile power plant. In other cases, successful tests have been conducted in running cars to specified distance with 10% blending of bio-diesel. There is a need for IndianOil to work with automobile manufacturers in partnership with Universities to carry out research for determining the optimal blend of bio-fuel without modification to the engine or the modification required for the engine for 100% utilization of bio-fuel. The automobile test agencies can become certifying agencies.

Conclusion

The energy scene in the 21st century is going to see a major shift. Very soon, oil and gas will see its finiteness. It is high time that we realize this factor and work towards the fuel of the future. I suggest

that the R&D centre of IndianOil should think now about re-aligning its research contribution from petroleum to alternate futuristic fuels. In this context, I would like to make following suggestions for your consideration:

- a. The research, development and innovation promoted by IndianOil R&D centre should aim to make IndianOil come within 50 ranks in the Global Fortune 500 ranking before the year 2015.
- b. IndianOil should aspire to become within the first three largest oil company of the world from the existing 20th position before the year 2015.
- c. Research focus has to be on extraction of more and more fuel from sour crude using the existing plant with suitable augmentation of infrastructure.
- d. Enhancing the R&D funding of IndianOil R&D centre from the existing Rs.100 crore per annum to at least Rs.1200 crore per annum before the end of 11th five year plan with specified mission towards energy independence.
- e. Promoting concentrated research for making plant based bio diesel and ethanol equivalent to fossil fuel based diesel and petrol in Cetane and octane characteristics.
- f. Carrying out research for commercial production of High Cetane Synthetic Diesel from algae.
- g. Promoting indigenous design and development of large scale highly efficient ethanol and bio diesel plants.

My best wishes to all members of R&D Centre of IndianOil success in their mission of assisting the nation in working towards achieving energy independence by the year 2030.

May God bless you.