文章编号：1004-2970（2014）05-0010-03

电动汽车技术路线对车用燃料和环保问题的影响

罗艳托*　马根萍　蔡德洪　王梦茜
（中国石油天然气股份有限公司规划总院）

罗艳托等．电动汽车技术路线对车用燃料和环保问题的影响．石油规划设计，2014，25（5）：10～12

摘要　分析了传统（油电/气电）混合动力汽车（HEV），插电式混合动力汽车（PHEV）、纯电动汽车（AEV）、燃料电池汽车（FCV）等各种电动汽车技术路线的优劣势，提出传统混合动力汽车、插电式混合动力汽车是燃油汽车向纯电动汽车发展过渡期的阶段性产物，纯电动汽车、燃料电池汽车是电动汽车中远期发展的方向。预测了电动汽车发展对车用燃料消费结构及环保问题的影响。根据国内电动汽车发展现状和推广规划，预测了国内电动汽车的发展规模。建议国内电动汽车发展应采取政府引导、市场选择的模式，政府应加大在电动汽车技术研发和基础设施建设上的投入等。

关键词　电动汽车；车用燃料；环境保护

中图分类号：U469.72　　文献标识码：A　　DOI：10.3969/j.issn.1004-2970.2014.05.003

电动汽车包括传统（油电/气电）混合动力汽车（HEV）、插电式混合动力汽车（PHEV）、纯电动汽车（AEV）和燃料电池汽车（FCV），未来电动汽车采取何种技术路线一直是各国争论的焦点。传统油电混合汽车一直是日本的强势产品，以丰田品牌为首的油电混合动力汽车销量一直稳居电动汽车销量榜首。但是，近期美国市场插电式混合动力汽车和纯电动汽车市场占有率显著增加，而中国也明确新能源汽车产业只包括纯电动汽车、插电式混合动力汽车和燃料电池汽车。目前，欧洲、美国、日本等也在加大燃料电池汽车的研发和推广力度。

1　电动汽车技术路线

1.1　汽车行业过渡期的阶段性产物

传统混合动力汽车和插电式混合动力汽车是过渡期的阶段性产物，电动汽车无论采取何种技术路线，要想广泛推广，技术成熟度、充电便利性、价格接受度是必须考虑的 3 个因素。

1.1.1　传统混合动力汽车

传统混合动力汽车在技术成熟度、价格接受度上均占有领先地位，且对充电设施的依赖程度低，已率先推广。截止 2013 年底，全球传统混合动力汽车保有量达到 856×10^4 辆，是插电式混合动力和纯电动汽车的 24 倍。其中，日系混合动力汽车被公众认可度较高，仅本田一个品牌 2011 年销量 80×10^4 辆、2012 年销量 120×10^4 辆、2013 年销量近 130×10^4 辆，连续 3 年创新高。电动汽车推广较好的美国，2013 年传统混合动汽车销量近 50×10^4 辆，是插电式混合动力和纯电动汽车销量的 5 倍。但是，由于传统混合动力汽车依靠汽油发动机充电，仅在汽车慢速行驶及倒车时使用电池，节油率只有

* 罗艳托，女，高级工程师。2006 年毕业于中国石油大学（北京）化学工程与技术专业，获博士学位。现在中国石油天然气股份有限公司规划总院主要从事炼油、市场专业的研究工作。地址：北京市海淀区志新西路 3 号，100083。E-mail：luoyantuo@petrochina.com.cn

20%～30%，使用成本下降不明显，从根本上不能摆脱对石化能源的依赖。而且，多加一个发动机就多消耗电，维修保养复杂。因此，被认为只是燃油车向插电式混合动力车、纯电动车过渡时期的阶段性产物。但是，不是每个国家发展电动汽车必经的阶段。

1.1.2 插电式混合动力汽车

插电式混合动力汽车可以单独依靠外部设备充电，且可以设置全电动状态工作（即可以 100%替代燃油），只有电池耗尽时才使用汽油，使用成本下降显著。插电式混合动力汽车进入市场较传统混合动力汽车晚，是近几年才进入市场的车型。但是，它以售价亲民、续驶里程与传统车相仿、且不完全依赖充电设施等优势更贴近用户需求，短期内具备加快普及的条件，在欧洲、美国、日本渐受追捧。2013 年美国插电式混合动力汽车销量 2.6×10^4 辆，保有量达到 7.3×10^4 辆。但是，插电式混合动力汽车也非零排放，同时要兼顾纯电动和传统燃油两套驱动系统。插电式混合动力汽车的这些特质注定了其承担从燃油车向纯电动过度的另一个重要角色。由于充电设施普及不够，在较长一段时间内，这个角色不可或缺，在未来多元化电力驱动的交通体系中，插电式混合动力汽车还会有一席之地。

1.2 纯电动是未来电动汽车的发展方向

纯电动汽车完全靠电力驱动，动力系统相对简单，但是，纯电动汽车价格高、对充电设施的依赖程度大。近两年，随着纯电动汽车技术的进步、上市车型的增多和竞争日趋激烈，纯电动汽车购车成本和前期使用成本大幅降低。据美国著名市场资讯公司 IHS 的报告统计，2013 年几乎所有纯电动车企业为了刺激销售，都采取了大幅降价行动；电动车锂电池生产商 LG（供应雪佛兰沃蓝达）和松下（供应特斯拉 ModelS 电池）之间的价格战也帮助拉低了终端价格。使用过程中，用电成本不足燃油车的 1/8。2013 年美国纯电动汽车销量超过 7×10^4 辆，是插电式混合动力汽车销量的 3 倍，使美国纯电动汽车保有量超过插电式混合动力汽车保有量，跃居第二位。2014 年 1 月，美产特斯拉凭借续驶里程等优越性能以 1 300 辆的销量跃居美国纯电动汽车销量榜首，同时，大力向欧洲、亚太地区推广。

1.3 燃料电池汽车是远期电动汽车发展的趋势

燃料电池汽车在新能源汽车中被公认为环保性能最好的。燃料电池通过氧氢化学反应产生电力，尾气排放只有水，可以真正做到无污染。与纯电动汽车相比，燃料电池车的燃料补给时间更短，在 3 分钟内便可完成燃料补给，续驶里程更长，可达到约 600km，是普通锂电池车的 3～5 倍，而且氢能源取之不尽，这些优势都是纯电动汽车所不能与之相比的。

目前，欧洲正在加大氢燃料电池汽车的推广力度，其中，荷兰已有氢燃料公共汽车示范运行；荷兰、德国等国已达成共同开发推广氢燃料电池汽车的协议；英国政府计划 2030 年前英国氢燃料电池汽车保有量达到 160×10^4 辆，2050 年前氢燃料电池汽车市场占有率达到 30%～50%。

美国在氢燃料电池汽车的推广和电池技术研究方面也在不断加强，2013 年美国能源部宣布投资 900×10^4 美元用于氢能与燃料电池技术的发展，并计划 2020 年推广不少于 250×10^4 辆燃料电池汽车。

日本计划从 2015 年开始面向普通消费者普及燃料电池汽车，2025 年使燃料电池汽车和加氢站实现商业化运作。丰田、本田、现代、上汽等多家车企纷纷宣布将在 2015 年前后推出燃料电池车型[1]。

2013 年联合国着手制定氢燃料电池车标准，国际标准一旦确定，燃料电池汽车就可以依据标准进入量产，市场推广也将提速。燃料电池电动车即将迎来它的发展契机。电动汽车发展趋势目前正从传统混合动力车型向插电式混合动力、纯电动汽车发展，未来将朝着更清洁化的（氢）燃料电池电动车方向发展。

2 电动汽车发展对车用燃料结构及环保问题的影响

目前，全球传统混合动力汽车仅有 856×10^4 辆，由于节油率只有 20%～30%，替代汽油、柴油等传统车用燃料非常有限。全球插电式电动汽车和纯电动汽车保有量仅有 35×10^4 辆，替代汽油、柴油更是微乎其微。传统混合动力车型节油率低，插电式和纯电动汽车基数小，无论采取何种技术路线解决不了目前汽车尾气排放和局部地区雾霾天气等环保问题。但是，电动汽车的发展速度不容忽视。

电动汽车是世界汽车工业未来转型的方向，汽车燃料也将随之发生革命性的变化。根据壳牌公司的研究预测[2]：液态的碳氢燃料从 2000 年约 98%的占有率，将下滑到 2060 年约 22%的占有率，汽油、柴油等内燃机燃料将逐步退出历史舞台。相反，气态的碳氢燃料（如天然气）的使用率从 2000

年开始稳定提升，约在 2050 年将达到顶峰，随后从 2060 年前后开始下滑，同样是不可再生能源，也将逐渐退出。从 2030 年开始，电力、氢气逐步接管汽车能源市场，到 2040 年和 2060 年市场占有率将分别超过 20%和 60%，到 2070 年，乘用车市场有望全面脱离对化石燃料的依赖，电动汽车将得到全面普及，汽车尾气排放等环保问题有望得到根本性的解决。车用燃料结构变化趋势见图 1。

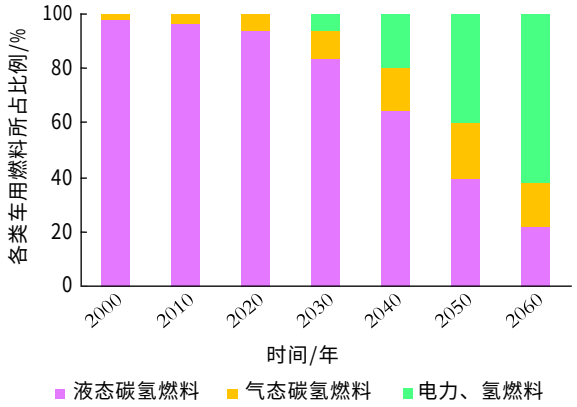

图 1 车用燃料结构变化趋势

3 国内电动汽车发展现状及建议

3.1 国内以纯电动和传统混合动力车型为主

中国推广电动汽车较欧美国家晚，近几年推广力度较大，也初见成效。截止 2013 年底，国内电动汽车保有量达到 8×10^4 辆，其中纯电动汽车 3.4×10^4 辆，（传统）混合动力汽车 4.6×10^4 辆；国内车企在插电式混合动力汽车油电深度混合技术上存在缺憾，加之投入不足，导致国内插电式混合动力汽车在 2013 年刚刚起步，小规模生产的插电式混合动力车型只有比亚迪 F3DM、一汽红旗牌等几款车型。

3.2 未来电动汽车推广加速

根据国内电动汽车的产销情况，以及第二轮新能源汽车的推广计划，预计 2014 年国内电动汽车保有量将达到约 15×10^4 辆。受政策导向影响，未来新增车型将以纯电动、插电式混合动力车型为主，传统混合动力车所占比例大幅降低。如果第二轮新能源汽车推广目标能够实现，到 2015 年，国内电动汽车保有量将超过 30×10^4 辆。中国作为电动汽车推广的排头兵，2013 年新能源汽车销量已列全球第四位，未来也将领跑电动汽车等环保车辆的推广，车用燃料随之转型也不可避免。国内电动汽车保有量及汽油、柴油替代量变化趋势见图 2。

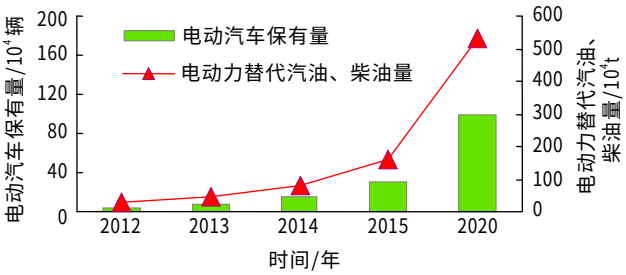

图 2 国内电动汽车保有量及汽油、柴油替代量变化趋势

3.3 采取政府引导、市场选择的模式推广电动汽车

国内电动汽车发展应采取政府引导、市场选择的模式。根据技术成熟度和市场需求发展电动汽车，并兼顾国内车企的技术水平和生产能力。要大力推广电动汽车，放开市场，直接引进国外技术相对成熟的电动汽车，减少补贴，由市场调节，技术上兼收并蓄。要保护和扶持国内电动汽车生产企业的发展，因此，需要根据国内车企的技术成熟度选择合适的技术路线。

3.4 加强在技术研发和基础设施上的投入

要广泛推广电动汽车，不能依赖政府补贴和公共用车拉动，只有在私有用车领域推广开来，才能真正实现电动汽车的商业化。国内发展电动汽车，投资应更多地放在技术研发和基础设施建设上，而不是补贴某些用户和车企。国内车企技术上对外依赖程度大，应加强研发投入，做好技术储备和广泛推广的准备。另外，应提前做好充电站、充电桩等配套设施的规划和建设。一方面可以考虑新建配套设施；另一方面可以考虑现有公共资源的优化利用，如，在现有加油站、加气站的基础上增加充换电站服务，解决电动车用户的充电之忧。

参考文献：

[1] 节能与新能源汽车网.节能与新能源汽车月报(2013 年 11 月).http://www.chinaev.org, 2013-11-18.

[2] 壳牌石油公司.New Lens Scenarios. http://www.evdays.com/html/2013/1105/xny43862.html, 2013-11-05.

收稿日期：2014-03-17
编辑：廉践维

ABSTRACTS
OF ARTICLES

1 Asset Integrity Management for Natural Gas Purification Plant

Chen Gengliang, Li Jin

The essence of Asset Integrity Management (AIM) is to implement risk management for asset. The basic goals, fundamental principles, ALARP (As Low As Reasonable Practice) criterion and 14 key elements of AIM were set forth in this paper, as well as risk identification, risk assessment and risk control. In natural gas purification plants under PetroChina, a whole set of effective risk assessment techniques are currently established on the concept of risk management and a solid technical foundation for AIM is laid down. It is suggested that a series of researches about AIM for purification plant should be carried out and a management system platform need to be developed as soon as possible.

5 Tendencies towards Informationization Development of Manufacturing Enterprises

Wang Hua

The essence of enterprise informationization is the combination of information technology and manufacturing technology. The rapid development and wide application of information technology have made a profound impact on enterprise operation pattern. All aspects on enterprise operation like production, management and decision-making have been supported by informationization system. New tendency towards to new informationization development of enterprises was then driven by information technologies and their integration with industry. New technologies with logistics, live, video, mobile and smart were typical of these new trends and their successful application in enterprises promoted the constant progress of decent enterprise management level and scientific decision-making level.

10 The Influence of Electric Vehicle Technique Path to Vehicle Fuels and Environmental Protection

Luo Yantuo, Ma Genping, Cai Dehong, et al.

The advantage and disadvantage of technique path for traditional (oil-electricity & natural gas-electricity) hybrid electric vehicle (HEV), plug in hybrid electric vehicle, absolute electric vehicle (PHEV) and fuel cell vehicle (FCV) were analyzed. HEV and PHEV are transition type from oil vehicle to absolute electric vehicle. Absolute electric vehicle and fuel cell vehicle are electric vehicle development trend in long terms. The Influence of electric vehicle development to vehicle fuels and environmental protection were forecasted. The development scale of domestic electric vehicle in future was predicted based on its current situation and development plan. It was suggested the government guiding and marketing selection mode should been adopted for domestic electric vehicle development and the investment on R & D of EHV and infrastructure development should be increased by the government.

16 Analysis of Operating Imported LNG and Domestic Gas in the Same Pipeline System

Liu Ye, Yang Lina, Wen Yunhao, et al.

Annual assumption of liquefied natural gas (LNG) is significantly increasing in recent years due to sustainable global growth of LNG trade and production. China has been massively increasing imports of LNG and quickly developing LNG engineering. Nature gas in China will be increased to 12% of all primary energy supplies by 2020. However, multiple energy supplies with different quality and heating value in the same pipeline system may influence urban heating system and electricity production unit. The criterion of exchangeability for multiple gas supplies in the same pipeline network was described, and technologies of LNG and natural gas pipeline networks operated in developed countries were introduced. The possibility of transporting LNG via national gas pipeline system in China was analyzed by taking Beijing and Shanghai as examples and exchangeabilities for supplying LNG with higher heating values was suggested.

20 Evaluation Technique on Energy Saving Potentiality in Pumping Well Ground System

Sun Dong, Tang Shu kai, Mu Lei

As the most important energy consuming equipment of oilfield enterprise, the energy consumption management of pumping unit is the important precision management content for oil production plant, and energy saving potential evaluation on energy consumption management of pumping ground system has significant meaning to its energy saving management. The concept of energy saving potentiality to pumping unit was set forth. Based upon the analysis of energy loss model of pumping unit ground system, the minimum loss calculation method was proposed according to ground system indicator diagram and pumping unit structure parameters. The effectiveness of this technology was shown in field applications.

27 Comparison of Two Types of Compressor Drivers for Long Distance Natural Gas Pipeline

Ai Yong, Zhang Fukun, Wu Quan, et al.

Gas turbine and high frequency electric motor are two types of common compressor drivers for long distance natural gas pipeline. By the end of 2013, China (including trans-Asia pipeline) has installed about 220 sets of compressor units, approximately 5,000MW ISO power in total. With the sequent construction of imported natural gas pipelines and continual improvement of domestic natural gas pipelines, compressor localization will be promoted while more and more compressor units are going to be put into use. The differences of gas turbine and high frequency electric motor regarding to their configuration and performance, start up and stop, typical malfunction, maintenance and economy were compared and analyzed, and the reference of compressor drive's alternative for long distance natural gas pipeline was thence provided.

30 Research & Application of Surface Process Technology for Caoshe Oilfield with Carbon Dioxide Flooding

Xue Hua

Carbon dioxide flooding is a technology that takes carbon dioxide as oil displacement agent to enhance oil recovery with its properties of reducing crude viscosity and expanding its volume when mixed with it. At present, carbon dioxide flooding in China is in the experimental stage, and has not been in the stage of large-scale industrial application. The experimental project of carbon dioxide flooding to enhance oil recovery was implemented with good economic benefits in Caoshe oilfield. Based on the project, feed gas purifying process, product carbon dioxide transportation process, carbon dioxide injection process and output gas recycle technology were expounded, which could be used for reference to other projects of this kind.

33 Computer Optimization of Water Injection Pipe Network for Infilling Wells in Old Oilfield

Guo Baihe, Li Zili, Bi Haisheng, et al.

Infilling wells in old oilfield can solve a series of problems, happening in the later stage of oilfield development, like changing ground water injection system while increasing production. In most situations only experiences were used before for the design of the layout of connection of oilfield water injection pipe network, which was a kind of dendritic pipeline network with complex calculation, the solution, therefore, could not be optimum for the project. According to the situation of infilling wells in old oilfield, computer optimization math model was put forward to get the optimum operation scheme. Having applied the math model in the existing water injection pipe network in old oilfield, the water injection pipe network with infilling wells was then hierarchically optimized, mainly including pipe network layout optimization and parameter optimization. It was shown in practice cases that the result from computer optimization was better than manual work.

40 Preliminary Study on Construction of Oilfield Automation Production Command System

Li Xin, Huang Shaowei, Tong Huining, et al.

For the purpose of boosting closer combination of industrialization and informationization, automation monitoring system was constructed in production sector of North China oilfield. In order for the production parameters acquired by automation system playing greater roles and enhancing the support function of collected data in oilfield production management level, a new set of oilfield automation production command system was developed. In this paper the objective of oilfield automation production command system construction, system framework and primary functions were described. The unification of production process monitoring, production control and production scheduling on the same platform were provided by production command system for the realization of united storage management of production data, and hence the united data platform could be provided for data analysis in the future.