Diyala Journal of Engineering Sciences

ISSN 1999-8716
Printed in Iraq

Vol. 10, No. 2, pp. 39-47, June 2017

REAL-WORLD DRIVING CYCLE: CASE STUDY OF BAQUBAH, IRAQ

Ahmed Al-Samari
Lecturer, Mechanical Engineering Department, College of Engineering, University of Diyala
(Received: 11/5/2016; Accepted: 12/6/2016)

ABSTRACT: - This work presents a new real world driving cycle for Baqubah city, Iraq. The crucial factor for estimation of fuel consumption and emissions is the driving cycle. The suggested method is to generate microtrips, which calculated from real world driving cycle data and then choose the most frequent of them. The constructed driving cycle (1052 seconds) compared with some standards driving cycle including New York, federal test procedure, urban dynamometer driving schedule, united states, Japan and European driving cycle (NY, FTPCOL, UDDS, US06, JPN, and EUDC) light vehicle driving cycles. The parameters such as acceleration, deceleration, and idle percentage are presented to give an initial impression about this driving cycle. The results for these parameters for Baqubah driving cycle were 50.34%, 48.52%, and 25.61% respectively. Moreover, the average speed of Baqubah driving cycle was 21.63 km/h (13.45 mph). These results give strong encouragement considering hybrid electric vehicles for Baqubah city.
Keywords: Driving cycle, Real world driving cycle, Micro-trips, Driving cycle characteristics.

INTRODUCTION

Vehicles' exhaust emissions considered as a major source for air pollution in addition to the other pollution sources. Moreover, fuel consumption by vehicles has a great share in energy depleting. Car fuel consumption and exhaust emissions are impacted by driving forms under different traffic conditions. The Driving Cycles are speed-time profiles which consider driving patterns in a highway, suburban or city. They are used to simulate driving circumstances on a laboratory chassis dynamometer for assessment of fuel depletion and exhaust productions [1].

There are two major groups of driving cycle including governmental and non-governmental. Depending on governmental driving cycles, exhaust emission conditions are enforced by governments for car emission certification. The FTP-75 used in the USA, the NEDC used in Europe and the J10-15 used in Japan, are models of governmental driving cycles. Non- governmental driving cycles, for example the Hong Kong driving cycle [2], are used in research for energy preservation and pollution estimation.

There are two methods for building a driving cycle. The first method is a driving cycle collected of several driving modes of constant acceleration, deceleration and speed, and is referred to as ‘‘modal’’ or ‘‘polygonal’’, for example NEDC and ECE driving cycles [3-6]. For the second method, a driving cycle is resulting from real driving information and is referred to as a ‘‘real world cycle’’, such as FTP-75. The real world cycles are more dynamic, reproducing more fast acceleration and deceleration forms practiced throughout driving situations[7-9].

Enhancement of an on road vehicle driving cycle for the city of Baqubah in Diyala province, Iraq was investigated in this study, based on numerical study of the driving statistics. Despite there was no driving cycle study for this city particularly, driving cycles were developed for another city as same as driving patterns conditions [6]. There is no doubt that gathering a real world driving cycle data and developing a new real world driving cycle is much better for crucial understanding of the energy consumption and exhaust emissions particularly. Therefore, the main goal of this study is to develop a real world driving cycle for the city of Baqubah, Iraq.

2. THE PROCEDURE

A specific strategy planned to generate the new Baqubah driving cycle. The essential consideration of this strategy is to consider the all traffic conditions of the collected driving data. Therefore, the generated driving cycle is going to reflect precisely the actual and total driving data [6]. The driving cycle is built considering five significant parameters including the percentage deceleration, acceleration, idle, cruise, and the mean speed. The phases involved in this procedure are: gathering of driving information (speed–time), generation of micro-trips, data analysis, and construction of driving cycle. The vehicle used for logging activity was KIA SPECTRA (2008), which the specifications of it are detailed in Table 1. The procedure stages are specified below.

2.1. Driving data

In this study, a car-chip device is hired for data collection. The car-chip device, shown in figure 1 [10], is an advanced device for vehicle tracking and monitoring, by directly plugged to the On-Board Diagnostics (OBD II) outlet. Moreover, this method of data collection can be considered more accurate than other studies that used devices working based on GPS tracker due to signal loosing, delaying or noising [1]. Driving data (speed–time) collection is achieved by a private car moving in different places of the city of Baqubah. Most of these moves were between the center of Baqubah and the Engineering College of Diyala University, which is about 7 km, one way trip. Moreover, there were different trips between kid's school shopping centers.

3. FINDING THE MICROTRIPS

The most important step in this work is to define the micro trip and analyze it. Micro trip defines as the driving duration between two stops. In other words, the vehicle activities are separated based on the stops of the vehicle. The micro trips are analyzed based on several parameters, such as acceleration, deceleration, average speed, cruise and idle percentage.

3.1 Defining the Baqubah driving cycle

The generated microtrips to be analyzed. Based on the maximum and minimum tolerance limits, the parameters (i.e. acceleration, deceleration, cruise and idle) are compared to each other. First micro trip is compared to all other microtrips. The related microtrips in their parameters are grouped together. This process is repeated with the all generated microtrips. After finishing the comparison, the most frequent microtrips are selected. The selected microtrips are connected together in series based on the number of microtrip's frequency. The most microtrips frequent are come first. If the duration of the generated driving cycle was not sufficient, then the other microtrips can be added to get a sufficient all driving cycle duration. The total microtrips number decreased significantly according to this strategy. According to this driving cycle building strategy, an enormous amount of data, which is about (200 km) activities in Baqubah city collected by the Car Chip device, is become a new much shorter driving cycle 6.33 km and 1052 seconds duration. The considered parameters of the new driving cycle acceleration, deceleration, cruise, idle percentages were 50.34%, 48.52%, 0% 25.61% respectively. Matlab program used to build the code that can generate the microtrips and calculate all these parameters.

4. BAQUBAH CITY STUDY

This methodology is illustrated using a case study based on the data collected from Baqubah city, in Iraq. Baqubah city is an important city as a political and business center of Diyala province. The Diyala province population is about two millions people and growing rapidly. The routes in the city sort off rough and have enormous number of check points due to security violence's occurring rate over there. As a consequence, average speeds on the city roads are greatly reduced and range between 10 km/h and 30 km/h.

4.1. Baqubah Driving cycle development

Broad, time and speed data which represents about 200 km from vehicle activities in Baqubah city was collected using the car-chip device. The measured parameters of the new driving cycle acceleration, deceleration, cruise, idle percentages were 50.34%, 48.52%, 0% 25.61% respectively. Moreover, the average velocity is calculated (21.63 km/h). The total duration of the Baqubah driving cycle achieved is 1052 seconds, figure (2). Figures (2,3,4) may give an impression about the vehicle activities(i.e. acceleration, deceleration and idling percentage). Moreover, Table (2) gave detailed information about the generated driving cycle in comparison to the others.

4.2. Assessment of Baqubah driving cycle

In order to assessing the generated (Baqubah) driving cycle, it is compared to some other known standard driving cycles for light weight vehicles such as FTPCOL, NY, UDDS, US06, JPN, and EUDC Mode, which are showed in figures (3-8) respectively. The comparison between characteristics of the Baqubah and standard driving cycles presented in Table 2.

4.3 Validation of Baqubah driving cycle

The built driving cycle is validated by comparing the important parameters such as average speed, acceleration, deceleration, idle, and cruise. The comparison was between the base data, which is collected using the car-chip device (33512 second for 7 days activities) and the generated driving cycle (1052 second). Moreover, three other days of the vehicle activity were selected to be compared. Three random days in addition to all data gathered are selected and investigated in comparison to the generated. Figures (9-11) show real-world driving cycles for Monday, Wednesday and Saturday respectively. The agreement between the base data information and the generated driving cycle was reasonable as shown in Table 3.

5. CONCLUSION

A methodology for development of driving cycle using micro-trips extracted from real-world driving data is developed in this paper. The exclusivity of the methodology is that the driving cycle is constructed considering important parameters of the time–space profile; the percentage acceleration, deceleration, idle, cruise, and the average speed. Therefore, this approach is expected to be a better representation of mixed traffic response. The driving cycle for the city of Baqubah in Iraq is constructed using the proposed methodology and is validated and compared with the existing (standard) driving cycles. The parameters such as acceleration, deceleration, and idle percentage are presented to give an initial impression about this driving cycle. The results for these parameters for Baqubah driving cycle were 50.34%, 48.52%, and 25.61% respectively. Moreover, the average speed was 21.63 km/h.

REFERENCES

1. Fotouhi, A and M Montazeri-Gh, "*Tehran driving cycle development using the k-means clustering method.*" Scientia Iranica **20**(2). p. 286-293, 2013.
2. Boulter, PG and JA Cox, "*A REVIEW OF EUROPEAN EMISSION MEASUREMENTS AND MODEL FOR DIESEL-FUELLED BUSES.*" TRL REPORT 378, 1999.
3. de Haan, Peter and Mario Keller, "*Real-world driving cycles for emission measurements: ARTEMIS and Swiss cycles.*" BUWAL-Bericht SRU (255). p. 52, 2001.

4. Ergeneman, M, C Sorusbay, and A Goktan, "*Development of a driving cycle for the prediction of pollutant emissions and fuel consumption.*" International Journal of Vehicle Design **18**(3-4). p. 391-399, 1997.
5. Hung, WT, HY Tong, CP Lee, K Ha, and LY Pao, "*Development of a practical driving cycle construction methodology: A case study in Hong Kong.*" Transportation Research Part D: Transport and Environment **12**(2). p. 115-128, 2007.
6. Kamble, Sanghpriya H, Tom V Mathew, and GK Sharma, "*Development of real-world driving cycle: Case study of Pune, India.*" Transportation Research Part D: Transport and Environment **14**(2). p. 132-140, 2009.
7. Lin, Jie and DA Niemeier, "*Regional driving characteristics, regional driving cycles.*" Transportation Research Part D: Transport and Environment **8**(5). p. 361-381, 2003.
8. Nutramon, Tamsanya and Chungpaibulpatana Supachart, "*Influence of driving cycles on exhaust emissions and fuel consumption of gasoline passenger car in Bangkok.*" Journal of Environmental Sciences **21**(5). p. 604-611, 2009.
9. Montazeri-Gh, Morteza, Hirbod Varasteh, and Mojtaba Naghizadeh, "*Driving cycle simulation for heady duty engine emission evaluation and testing.*" SAE transactions **114**(4). p. 1506-1524, 2005.
10. DAVIS. "*Carchip*". [cited 20/3 2016]; Available from: http://www.carchip.com/PhotoGallery/index.asp.

Table 1: The test vehicle specifications

Engine	Curb Weight	Drive	Transmission	Cylinders	Horsepower	Torque	Cargo Capacity	Seating Capacity
2.0L	2701 lbs.	2WD	5-Speed automatic	4 Cylinders	138 HP	136 @4500	12 cu. ft.	5/5

Table 2: Comparison between Baqubah-real-world and standard driving cycles.

	Baqubah	NY	FTPCOL	UDDS	US06	JPN	EUDC
Duration (Sec)	1052	598	1874	1369	600	135	400
Distance (km)	6.33	1.90	17.77	11.99	12.89	0.66	6.95
Max velocity (km/h)	68	45	91	91	129	40	120
Average velocity (km/h)	21.63	11.41	34.12	31.51	77.20	17.57	62.44
Maximum acceleration (m/sec^2)	3.31	2.91	1.60	1.60	3.52	0.86	0.90
Maximum deceleration (m/sec^2)	-4.12	-2.42	-1.60	-1.60	-2.95	-0.86	-1.50
Average acceleration (m/sec^2)	0.237	0.20	0.20	0.20	0.30	0.17	0.10
Average acceleration (%)	50.33	36.39	44.48	44.96	48.59	37.50	76.81
Average deceleration (m/sec^2)	-0.24	-0.20	-0.20	-0.20	-0.30	-0.16	-0.10
Average deceleration (%)	48.53	37.56	40.37	40.37	47.25	37.50	13.72
Idle time (%)	25.26	52.75	24.16	24.67	10.48	34.56	10.47
Cruise time (%)	0	0	1.60	1.09	52.58	0	20.70

Table 3: Comparison between Baqubah and base data (samples) real world driving cycles

	Baqubah driving cycle	All Week driving cycle	Monday driving cycle	Wednesday driving cycle	Saturday driving cycle
Duration (Sec)	1052	33518	4645	2906	4371
Distance (km)	6.33	203.08	21.99	19.11	28.57
Average velocity (km/h)	21.63	21.81	17.04	23.68	23.53
Average Acceleration (m/sec^2)	0.24	0.19	0.18	0.21	0.20
Average Acceleration (%)	50.33	42.75	36.87	46.49	43.63
Average deceleration (m/sec^2)	-0.24	-0.19	-0.18	-0.21	-0.20
Average deceleration (%)	48.53	40.46	35.00	41.09	42.35
Idle time (%)	25.26	37.96	47.89	31.11	35.32

Figure 1: The Carchip used for gathering driving data

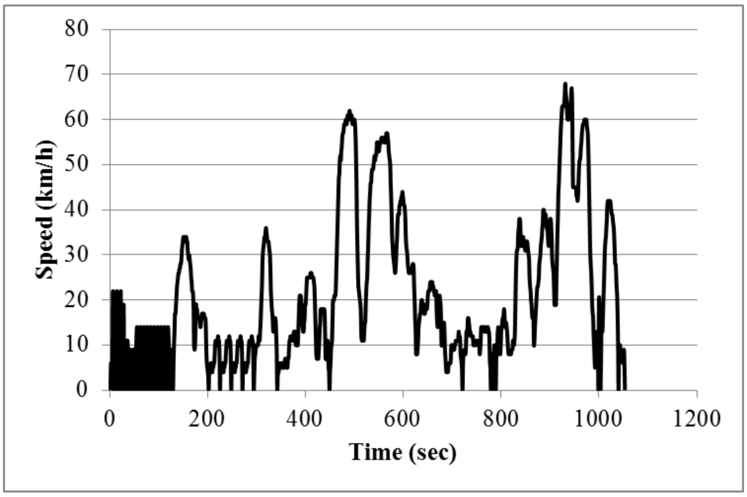

Figure 2: Baqubah driving cycle

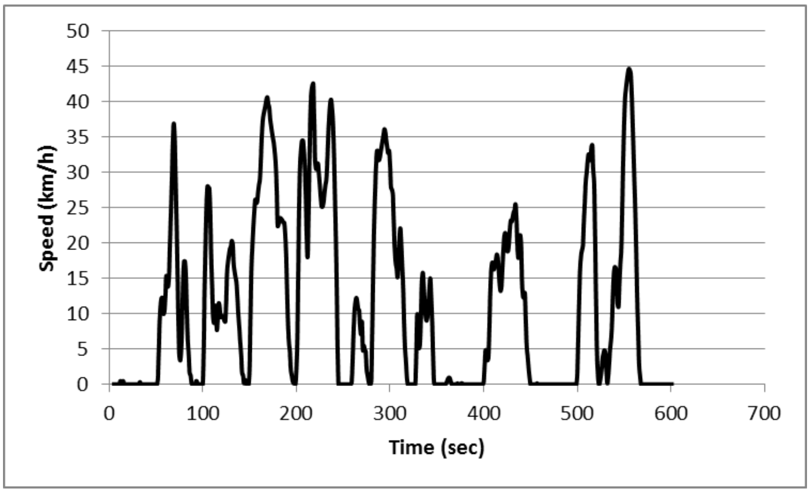

Figure 3: NY driving cycle

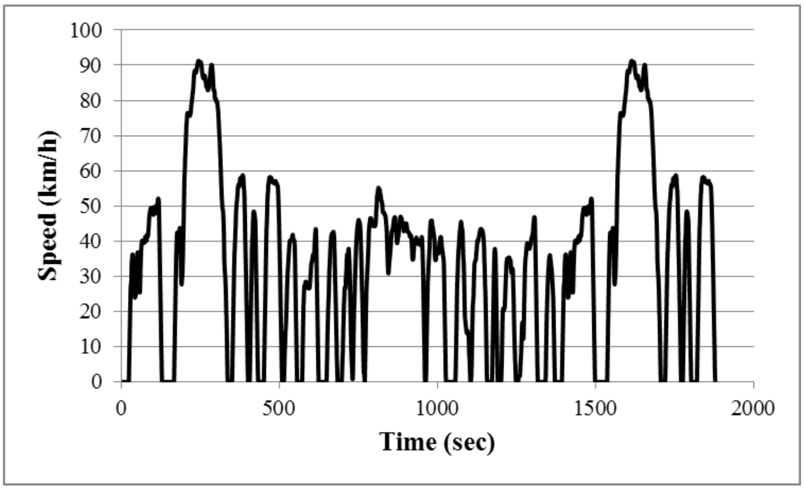

Figure 4: FTPCOL driving cycle

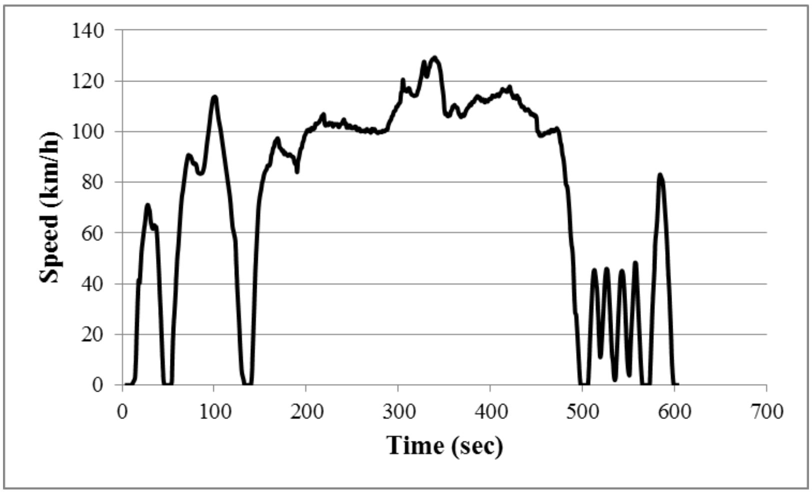

Figure 5: US06 driving cycle

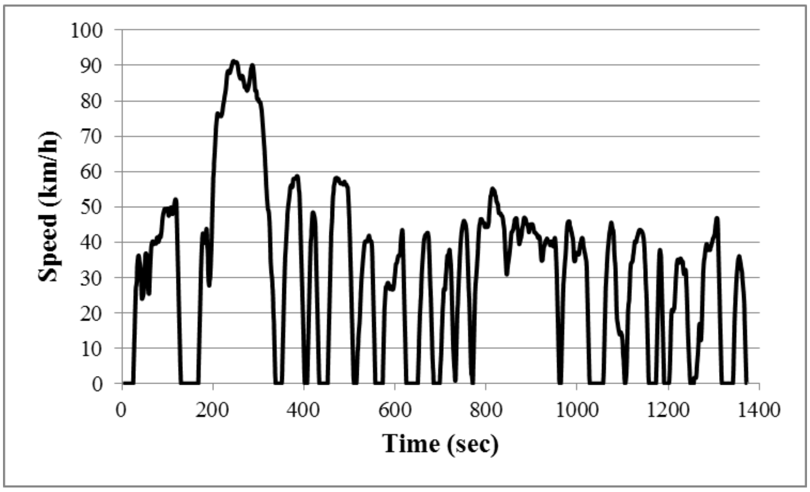

Figure 6: UDDS driving cycle

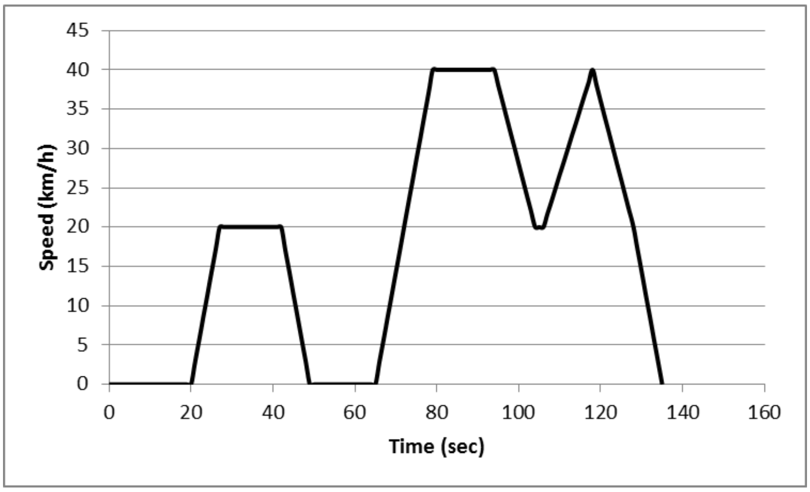

Figure 7: JPN driving cycle

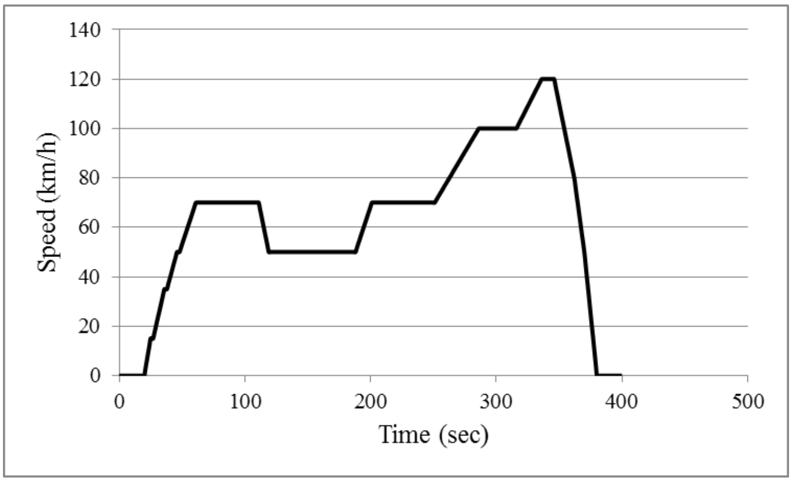

Figure 8: EUDC driving cycle

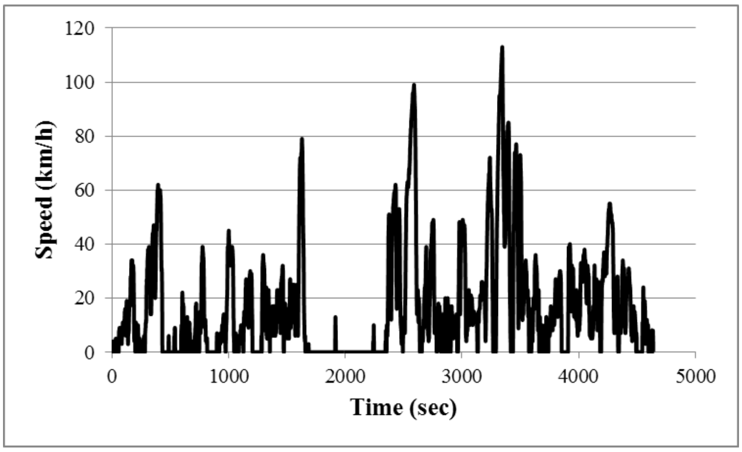

Figure 9: Monday driving cycle

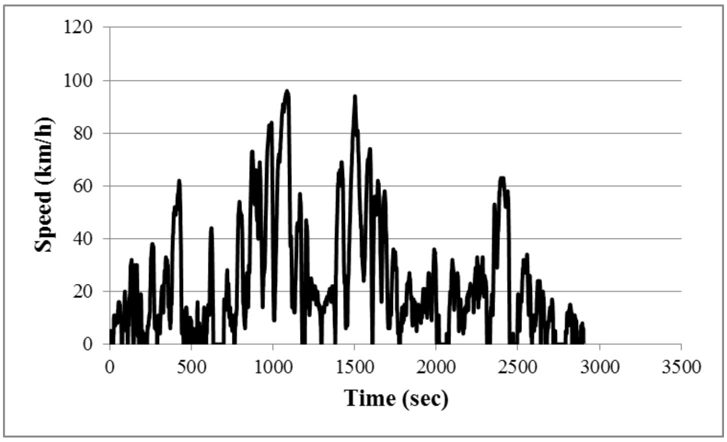

Figure 10: Wednesday driving cycle

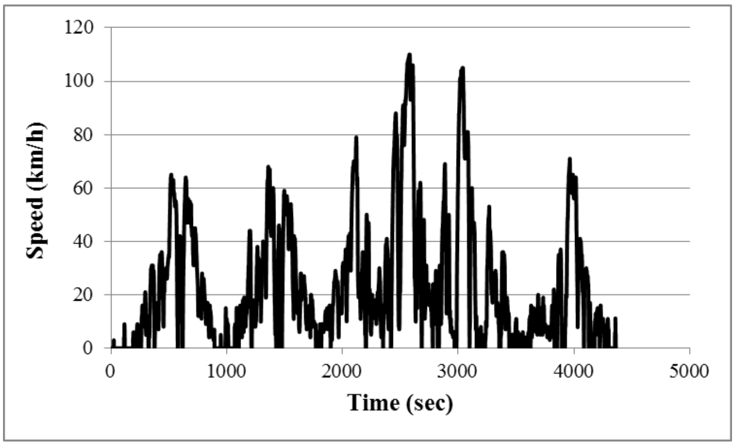

Figure 11: Saturday driving cycle

دورة القيادة الحقيقية لمدينة بعقوبة في العراق

الخلاصة

هذا البحث يستعرض دورة سياقة جديدة حقيقية لمدينة بعقوبة في العراق. العامل الحاسم بتقدير استهلاك المركبة للوقود و كذلك الانبعاثات هو دورة السياقة. الطريقة المقترحة هي توليد رحلات صغير و التي تمثل نشاط السيارة بين توقفين. بعد ذلك نقوم باختيار اكثر هذه النشاطات تكرارا لتوليد دورة السياقة الحقيقية. الدورة الحقيقة للسياقة الجديدة قورنت مع العديد من الدورات للسياقة القياسية و المشهورة. العوامل مثل التعجيل و التباطئ نسبة التوقف تم حسابها في هذا البحث. اظهرت النتائج ان التعجيل و التباطئ و نسبة توقف المركبة كانت 50.34% و 46.52% و 25.61 % على التوالي. بالاضافة لذلك كان معدل السرعة حوالي 21.63 كم\ساعة. هذه النتائج تشجع و بشكل كبير استخدام السيارات الكهربائية الهجينة في مدينة بعقوبة.