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Comparison of the Efficiency of R20 (D-size) Dry Cell Battery Brands used in Uganda

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Abstract: **This paper presents the efficiency of the D-size dry cell brands commonly used in Uganda. Six dry cell brands, Tiger Head Red (THR), Tiger head extra (THE), Panasuper (PS), Panasonic (PN), Energizer (EG) and Durasonic (DU) were evaluated on ideal household conditions in accordance to the International Electrochemical Commission (IEC) and European Union (EU) final report on portable battery standards. Each brand's average capacity was found when being used in a household radio and torch.**

The study revealed that Energizer (EG) performed best and Tiger Head Red (THR) least in a radio while as in a torch, Tiger Head Extra (THE) performed best and Panasuper (PS) least. This showed that different battery cell brands perform differently in different household devices.

Keywords: **Efficiency, R20 (D-size) Battery dry cells, Household devices.**

1. INTRODUCTION

Alkaline batteries, commonly known as zinc-carbon, are the most commonly used batteries in the world according to the European Union Commission (EUC, 2013). Batteries are available in either single use (primary batteries) or multiple use (secondary batteries) models. The primary batteries, when they are dead, they are dead, while as the secondary batteries when they are dead they can be recharged and used again (Liard B, 2009).

According to Linden and Thomas (2001), primary batteries make up approximately 37% of the worldwide market compared to the portable rechargeable batteries that take up 16% while as the start, lighting ignition automotive batteries take up 30% share of the market in US dollars.

During its application, a dry cell uses a paste electrolyte with only enough moisture to allow the flow of current and can operate in any orientation without spilling since it contains no free liquid making it suitable for portable equipment (Aryton W. E, 2008). The more the spontaneity of the chemical reactions in the battery cell, the higher the voltage and the current produced by the cell to efficiently operate a household device at room temperature. The functionality of any battery cell depends on the chemistry of the cell, the temperature under which the cell is being operated, self-discharge and the internal impedance and its effects (Dingrado and Laurel, 2007), (Giambattista, *et al*, 2010).

As the use of primary battery cells continue to grow world over, the general awareness of the efficiency of the different brands and the tendency to question their reliability in terms of cost and depreciation has increased.

In Uganda, the national standard regulator, the Uganda National Bureau of Standards, always approves the battery cells to be sold on the Ugandan market (UNBS, 2017). However, this approval does not communicate the best battery cell brand; hence this leaves room to the consumer wanting to know which brand is the best when used in household appliances at room temperature. We now report an investigation on the efficiency of D-size dry cell brands commonly used in Uganda

2. MATERIAL AND METHODS

2.1 SELECTION OF THE DRY CELL BRANDS AND HOUSE HOLD DEVICES

During the period of study between February and June 2018, a pair of each five newly stocked R20 (D-size) battery cells of different brands was bought from Shoprite supermarket in Kampala City, Uganda. These brands were, Tiger Head Red (THR), Panasonic (PN), Panasuper (PS), Tiger Head Extra (THE) and Durasonic (DU). The house hold devices used were a brand new, radio and torch, all bought from Shoprite supermarket, Kampala City, Uganda.

2.2 METHODS

As shown in figure 1, each pair of battery cells was fitted in a battery holder and using connecting wires to act as conductors for the current and electrons, they were connected to the voltmeter and thereafter to the ammeter to find the initial voltages and currents of each pair, which were 3.0 V and 3.0 A respectively. The voltmeter and an ammeter were used to obtain the rated battery voltages and current of each battery brand under test in a radio and a torch.

Figure 1: Shows how the initial Voltages and Currents of the battery cells were found

Each pair of the battery brand cell was inserted in the radio and at a uniform volume of radio operation, for the same radio station in the same laboratory under the same temperature; the radio was operated for three hours for three intervals of each operation. The final delivered currents (on the Ammeter) and voltages (on the Voltmeter) of every after three hours of each operation were obtained and then the discharge current gotten. The discharge current was the value of the initial current minus the final current (current got every after three hours of radios operation). Figure 2 shows how the final currents were got on the ammeter.

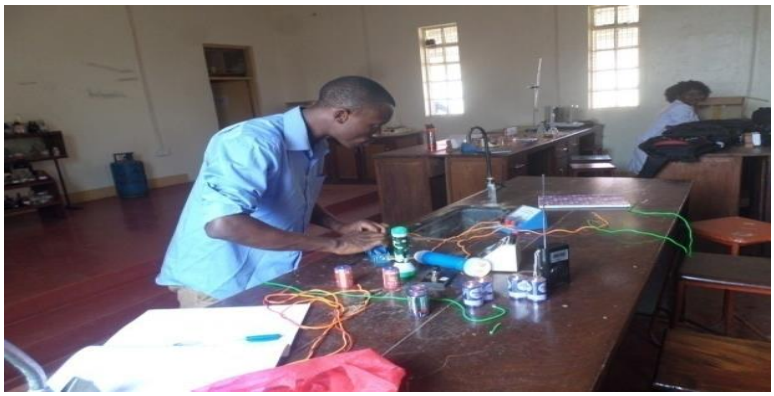

Figure 2: Shows how the final currents of the battery cells were found

This discharge current was then substituted into equation 1, to determine the delivered current (capacity).

$$C = It \qquad 1$$

At constant conditions of operation of the radio, the resistance was considered constant, hence, C is the delivered capacity, t is the discharge time (operation/service time of the radio) which was three hours for each interval of the radio's operation. The procedure was repeated for all the Dry cell battery brands that were under study in a radio and thereafter in a torch.

3. RESULTS AND DISCUSSION

The results of final current, discharged current, capacity; for every three hours interval of the radio's operation and the average capacity are shown in table 1while as for the torch are shown in table 1.

Table 1: Final current, discharge current, capacity and average capacity of the different dry cell battery brands as operated in the radio

Battery cell	Initial Current (A)	Final Current (A)	Discharged Current (A)	Capacity (Ah)			Average Capacity, (Ah)
				C_1	C_2	C_3	
Panasonic (PN)	3.00	2.45	0.55	1.65	1.50	1.80	1.65
		2.50	0.50				
		2.40	0.60				
Tiger Head Red (THR)	3.00	1.25	1.75	5.25	5.10	4.95	5.10
		1.30	1.70				
		1.35	1.65				
Panasuper (PS)	3.30	2.20	0.80	2.40	3.00	2.55	2.65
		2.00	1.00				
		2.15	0.85				
Tiger Head Extra (THE)	3.00	1.85	1.15	3.45	3.30	3.45	3.40
		1.90	1.10				
		1.85	1.15				
Durasonic (DU)	3.00	2.00	1.00	3.00	3.45	3.30	3.25
		1.85	1.15				
		1.90	1.10				
Energizer (EG)	3.00	2.25	0.50	1.50	1.80	1.50	1.60
		2.15	0.60				
		2.30	0.50				

Table 2: Final current, discharge current, capacity and average capacity of the different dry cell battery brands as operated in the torch

Battery cell	Initial Current (A)	Final Current (A)	Discharged Current (A)	Capacity (Ah)			Average Capacity, (Ah)
				C_1	C_2	C_3	
Panasonic (PN)	3.00	1.90	1.10	3.30	3.45	3.45	3.40
		1.85	1.15				
		1.85	1.15				
Tiger Head Red (THR)	3.00	1.80	1.20	3.60	3.45	3.60	3.55
		1.85	1.15				
		1.80	1.21				
Panasuper (PS)	3.30	0.35	2.65	7.95	7.80	8.10	7.95
		0.40	2.60				
		0.30	2.70				
Tiger Head Extra (THE)	3.00	2.25	0.75	2.25	2.40	2.10	2.25
		2.20	0.80				
		2.30	0.70				
Durasonic (DU)	3.00	1.25	1.70	5.10	4.95	4.95	5.00
		1.30	1.65				
		1.30	1.65				
Energizer (EG)	3.00	1.40	1.60	4.80	4.50	4.35	4.55
		1.50	1.50				
		1.55	1.45				

As seen from table 1, Energizer performed best and Tiger Head Red least in a radio while as in a torch as seen from table 2, Tiger Head Extra performed best and Panasuper least.

Based on the intended objective of this study, comparing the efficiency of R-20 (D-size) dry cell battery brands available on Ugandan market by comparing their discharge rates through performance in an house hold radio and torch. Discharge rate or C- Rate is the amount of current that the battery can sustain for one hour in a device while remaining within a specified voltage range.

From table 1 and figure 1, it was revealed that Panasonic brand proved to be the most efficient in comparison to the capacity values since efficiency depends on the capacity which significantly improves at low discharge rate of the battery which practically refers to longer times of discharge while as in table 2 Tiger Head Extra proved to be the best. Hence, Panasonic brand performed best because it lasted the longest and Tiger Head Red lasted shortest in a radio and Tiger Head Extra performed best and Panasuper least in a torch, among the D- size battery brand cells available on Ugandan market.

4. CONCLUSION

At household conditions of operations, there is a variation in capacity of different battery cells in particular house hold devices. In this study, the radio and the torch were the only household devices that were looked at. However, other house hold drainage devices such as a clock or remote control need to be looked at.

From the study, different household devices have different discharge rates for the same battery cell brand and it is seen that different battery manufacturers' labels many times do not exactly reflect exact performance of their battery cells meant for market advertisement

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