Blackstone Resources

Blackstone Resources Battery Code (BBC)

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Abstract

Blackstone Resources has a vision that one day all cars will run on electricity and that renewable energy will become sustainable and available in abundance. It is this vision that drove the company to build its portfolio of mining interests in battery metals. However, the company also realises that part of the solution is to encourage and nurture technological advances in rechargeable batteries.

Through its battery technology research, Blackstone Resources has developed an international battery code system that identifies the battery metal mix, chemistry and technology used within various rechargeable batteries. This system is known as the Blackstone Resource Battery Codes (BBC) system.

The BBC coding system was initially intended to be used internally to improve business efficiency within Blackstone Resources. However, in 2018 the company made the decision to make the coding system open-source.

1. Introduction

In science and technology, a battery is a device that stores energy and makes it available in an electrical form. Batteries have been used by mankind since the late 1880s in a variety of different forms, using different technologies. The way a battery works is that it converts chemical energy into electric energy. It is a connected bunch (or "battery") of electro-chemical devices. [1]

There are now so many different types of batteries in existence that it is difficult to keep up. The most recent innovations have been in the -ion series batteries, beginning with lithium-ion batteries in the early 1990s. These rechargeable batteries allow ions to move from negative electrodes to positive electrodes during the discharge process and then back again while charging.[2]

For the last 20 years, Blackstone Resources has built up a portfolio of interests in battery metal suppliers. For most of this period it has invested upstream through battery-metal mining interests in Canada, Norway, Mongolia, Colombia, Peru and Chile. These metals include cobalt, manganese, molybdenum, graphite and lithium.

1.1 Blackstone Resources as a leader in battery technology

Blackstone Resources has a vision that one day all cars will run on electricity and that renewable energy will become sustainable and available in abundance. It is this vision that drove the company to build its portfolio of mining interests in battery metals. However, the company also realises that part of the solution is to encourage and nurture technological advances in rechargeable batteries. That is why it has set up a battery technology programme to support this goal.

Blackstone Resources plans to invest in projects alongside a number of leading academic institutions, to improve current battery technology. Battery technology is at present holding back humanity from becoming more technologically advanced across a number of fields, which includes the introduction of electric cars and better energy storage that will make renewable energy sustainable.[3]

1.2 Why the BBC coding system was developed

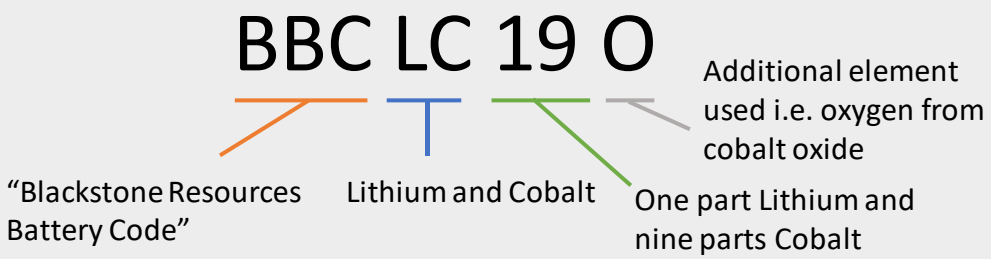
Through its battery technology research, Blackstone Resources has developed an international battery code system that identifies the battery metal mix, chemistry and technology used within various rechargeable batteries. This system is known as the Blackstone Resource Battery Codes (BBC) system.

The BBC coding system was initially intended to be used internally to improve business efficiency within Blackstone Resources. However, in 2018 the company made the decision to make the coding system open-source. Its intention is to help fulfil its corporation citizen requirements to the academic community and help realise its vision quickly by working in collaboration with other corporate partners.

The company also hopes that the BBC coding system will help governments and recyclers depose or reuse lithium batteries in a more environmental manner. The coding system could also be used to educate the public on the type of battery used and allow the future commoditisation of single form-factor rechargeable batteries. This is similar to how standard battery nomenclature is used today in batteries that are sold over the counter i.e. the AA and AAA lettering that comes from the American standard specification for dry cells.[4]

2. How the coding system works

The BBC system developed by Blackstone Resources has been designed to be scanned or read easily by battery manufacturers and recyclers.



1. Identifies the code as a BBC designation.
2. Shows the composition of the battery, starting with the technology type (L, A or N):

   Technology type
   L for Lithium (Li) i.e. Lithium-ion technology
   C for Cobalt (Co) i.e. Aluminium-ion technology
   N for Nickel (Ni) i.e. Nickel-ion technology

   Other elements
   M for Manganese (Mn)
   S for Silicon (Si)
   G for Graphite (G)
   O for Oxide (O_2)

3. Shows the proportion of the metal or chemical used, which is rounded to the nearest decile percentage.

   For instance, 15% would be denoted at 2 and 14% would be denoted as 1. The numbers in this block always adds up to 10. They are linked the order of lettering, relating to the technology type and other elements used that are defined in the previous block.

4. The final block is meant illustrate any addition elements used in the battery i.e. Silicon.

3. Blackstone designation codes for rechargeable batteries[5]

Designation	Name	Chemical Composition	Applications	Remarks
BBC LC 19 O	Lithium Cobalt Oxide (LCO)	$LiCoO_2$	Mobile phones, tablets, laptops, cameras	Very high specific energy limited specific power. Cobalt is expensive. Serves as Energy Cell. Market share has stabilised.
BBC LNCA 1711 O	Lithium Nickel Cobalt Aluminium Oxide (NCA)	$LiNiCoAlO_2$	Medical devices, industrial, electric powertrain (Tesla)	Shares similarities with Li-cobalt. Serves as Energy Cell.
BBC LM 19 O	Lithium Manganese Oxide (LMO)	$LiMn_2O_4$	Power tools, medical devices, electric powertrains	High power but less capacity; safer than Li-cobalt; commonly mixed with NMC to improve performance.
BBC LFP 163 O	Lithium Iron Phosphate (LFP)	$LiFePO_4$	Portable and stationary needing high load currents and endurance	Very flat voltage discharge curve but low capacity. One of safest Li-ions. Used for special markets. Elevated self-discharge.
BBC LNMC 1333 O	Lithium Nickel Manganese Cobalt Oxide (NMC)	$LiNiMnCoO_2$	E-bikes, medical devices, EVs, industrial	Provides high capacity and high power. Serves as Hybrid Cell. Favourite chemistry for many uses; market share is increasing.
BBC LNMC 1432 O				
BBC LNMC 1522 O				
BBC LNMC 1621 O				
BBC LNMC 1711 O				
BBC AC 28	Aluminium-ion[6]	$AlCl_4$	Still in experimental stages. Yet to be deployed fully.	Aluminium-ion batteries are conceptually similar to lithium-ion batteries, but possess an aluminium anode instead of a lithium anode.
BBC AC 37	Aluminium-ion	Al_2Cl_7		
BBC NZ 55	Nickel-zinc[7]	NiZn	A rechargeable battery used in household appliances.	Designed by Thomas Edison: the inventor of the light bulb. It's been around for more than 100 years.
BBC NF 55	Nickel-iron	NiFe	Used in Europe's mining operations because of their ability to withstand vibrations, high temperatures and other physical stress	A very robust battery that is tolerant to overcharging and short circuiting.
BBC NC 55	Nickel-cadmium	NiCd	Once widely used in power tools, flashlights and remote-control cars	NiCd rapidly lost market share in the early 1990S TO NiMH and Li-ion batteries.
BBC NH 37	Nickel-hydrogen	NiH_2	Used for energy storage in space probes	While the energy density is only one-third of a lithium battery, it has a very long life
BBC NM 55	Nickel-metal hydride	NiMH	Used in digital cameras and other high-drain devices, where over the duration of single-charge use they outperform primary (such as alkaline) batteries. They are also used extensively in electric vehicles.	A NiMH battery can have two to three times the capacity of an equivalent size NiCd, and its energy density can approach that of a lithium-ion battery.
BBC LNMC 1333 OG	Lithium Graphite/NMC	$LiNiMnCoO_2$	The battery of choice for power tools, e-bikes and other electric powertrains.	This is a standard NMC-type lithium battery, where graphite is used to speed up charge times.
BBC LT 46 O	Lithium Titanate Oxide	Li_2TiO_3	Used in some electric vehicles, such at the Mitsubishi i-MiEV. Honda also uses them in it Fit EV electric bike.	The lithium-titanate battery is a type of rechargeable battery which has the advantage of being faster to charge than other lithium-ion batteries.

4. Battery characteristics

Designation	Name	Voltage	Capacity	Lifecycle
BBC LCO 19	Lithium Cobalt Oxide (LCO)	3.0-4.2V	150-200Wh/kg	500-1000
BBC LNCA 1711	Lithium Nickel Cobalt Aluminium Oxide (NCA)	3.0-4.2V	200-260Wh/kg	500
BBC LMO 19	Lithium Manganese Oxide (LMO)	3.0-4.2V	100-150Wh/kg	300-700
BBC LFP 163	Lithium Iron Phosphate (LFP)	2.5-3.65V	90-120Wh/kg	1000-2000
BBC LNMC 1333	Lithium Nickel Manganese Cobalt Oxide (NMC)	3.0-4.2V	150-220Wh/kg	1000-2000
BBC LNMC 1432				
BBC LNMC 1522				
BBC LNMC 1621				
BBC LNMC 1711				
BBC AC 28	Aluminium-ion[6]	2.65V	800-1,060Wh/kg	10,000
BBC AC 37	Aluminium-ion	2.65V	800-1,060Wh/kg	10,000
BBC NZ 55	Nickel-zinc[7]	1.2V	19-25Wh/kg	30-50 years
BBC NF 55	Nickel-iron	1.6V	100Wh/kg	800
BBC NC 55	Nickel-cadmium	1.2V	40-60Wh/kg	2,000
BBC NH 37	Nickel-hydrogen	1.25V	55-75Wh/kg	20,000
BBC NM 55	Nickel-metal hydride	1.2V	250-1,000Wh/kg	180-2,000
BBC LNMC 1333 OG	Lithium Graphite/NMC[8]	3.6V	120-200Wh/kg	500-3,000
BBC LT 46 O	Lithium Titanate Oxide	2.3V	70-80Wh/kg	15,000-20,000

5. The use of BBC Codes during the recycling process

Although lithium-ion batteries and other newer based -ion battery technologies are only mildly toxic, their sheer volume of usage has led to tighter scrutiny on how they are recycled.[9] This is to minimise the negative environment impact from their disposal. This will become especially relevant in the next few decades as the expected usage of such batteries is expected to increase substantially.[10] This is being driven by the electrification our global road network across both developed and emerging market economies. It will also be driven in the future by the rising use of battery storage on smart energy grids and renewable energy projects. Recycling will be an important process for minimising the external costs from one of the largest structural trends in human history. [11]

6.1 How the battery recycling process works

The battery cells are chopped into small pieces and heated until the metal liquifies.[12] Non-metallic substances are burned off, leaving a black slag on top that a slag arm removes. The alloys settle according to weight and are skimmed off like cream from raw milk, while still in liquid form.

Some recyclers do not separate the metals on site but pour the liquid metals directly into what the industry refers to as “pigs” (65 pounds, 24 kg) or “hogs” (2,000 pounds, 746 kg). Other battery recyclers use nuggets (7 pounds, 3.17 kg).[13] The pigs, hogs and nuggets are shipped to metal recovery plants where they are used to produce nickel, chromium and iron for stainless steel and other high-end products. To reduce the possibility of a reactive event during crushing, some recyclers use a liquid solution or freeze lithium-based batteries with liquid nitrogen.

6.2 Battery recycling in currently an energy intensive process

Battery recycling is energy intensive. Reports reveal that it takes six to ten times more energy to reclaim metals from some recycled batteries than from mining.[14] The exception is the lead acid battery, from which lead can be extracted easily and reused without an elaborate process. To some extent, nickel from NiMH can also be recovered economically if available in large quantities. The challenge, however, lies with recycling lithium-ion batteries and batteries of a newer technology type.

Each country sets its own rules and adds tariffs to the purchase price of a new battery to make recycling feasible. In North America, some recycling plants invoice by weight and the rates vary according to chemistry. Due to poor metal retrieval value, lithium-ion commands a higher recycling fee than most other battery types. New recycling methods are, however, being developed can retrieve valuable battery metals by electrolysis. This is also known as chemical recycling. The process is said to be more cost effective and produces higher yields with less pollutants than traditional smelting.

6.3 How BBC Codes can be used

Recycling lithium-ion, nickel-ion and aluminium-ion batteries is not yet profitable and must be subsidised by governments. This is an incentive to recover valuable battery metals such a cobalt, manganese and lithium. No recycling technology exists today that is capable of producing pure enough lithium for a second use in batteries. Therefore, lithium for batteries is mined. However, second-hand lithium is used for lubricants, glass, ceramics and other applications. Once -ion battery recycling becomes a mainstream reality, BBC codes could be used to simplify and enhance the sorting process.

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