Aspiration Assisted Needle Biopsy Device

Battery Selection

**General:**

Looking for a secondary battery (i.e. something rechargeable that can supply high power discharges) that can maintain 12 V supply over 500mA-1.5A pulse currents.

**Motor Characteristics**:

* 12 V operating voltage
* 10 A stall current
* ~500mA - 2A operational current
* Each operation (cutting and exiting) is about 20 seconds in length with the motor assumed to be operating at maximum PWM.
* ~1.0 A is a reasonably safe estimate for a general current.
* ~ 20 operations per day.

**Requirements:**

* Rechargeable
* Long lasting (ideally more than 5 hours of continuous use)
* Charging Time: 1-3 hours at most

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| *Battery Type* | *Notable Elements* | *Potential for Use* |
| Lead-Acid Batteries (flooded, VRLA, SLA) | Flooded types need to be upright so can’t be used for mobile applications. Similar for VRLA. SLA can be moved. Low self-discharging rate and no memory effect. Take 8-16 hours for full recharge. Recharging can be very technical. Custom battery chargers could explode. | Low |
| Nickel-Cadmium (NiCAD) | Discharge volage of 1.2 V per cell with this being consistent until near full discharge. Discharging is quite high with the battery lasting 2-3 months. Mobile, higher energy density, low cost. Suffers from memory effect. ~10 hour constant charge at maximum. May require full discharge. Float charger. | Low |
| Nickel Metal Hydride (NiMH) | Less memory effect but require full discharge or else crystallization will occur. Nominal voltage of 1.2 V per cell. Higher energy density but shorter work life than NiCAD. RC vehicles and power tools applications. Complex recharging process. | Medium |
| Lithium-Ion (Li-ION) | Extremely high energy density. No memory effect and can shelf last ~ 6 months. Good but not great at deep discharging. High internal resistance. No trickle or float charging. Expensive. Around 3 hour charging time. | High |
| Lithium Polymer (Li-Po) | Typically less expensive than Lithium-Ion batteries sharing similar energy density and charging characteristics. Very high internal resistance. | High |

**Comparison of Li-ION and Li-Po Battery**

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| *Lithium-Ion* | *Lithium Polymer* |
| * Lower energy density * More stable with longer lifespan * Many form factors * More robust physically * Safer and more reliable * Lower discharge rates * Bigger and heavier * Generally safer with simpler charging devices. * More pronounced voltage drop near the end of discharge. | * Designed for higher discharge rates * Lighter * Many form factors * Higher energy density * More sensitive to charging conditions * Shorter lifespan with deep discharging * Will require a balance charger. * Faster charging |

**Recharging and Other Considerations:**

The voltage of the battery will likely be within the range of 13-11 Volts. It is important to double check the operating voltage of the motor. It likely will be fine but it would be good to get confirmation on this.

Generally speaking, LiPo and Li-Ion batteries have more involved charging processes with specific chargers, configurations, and demand for a greater level of attention. It would be ideal if this could be abstracted to something similar to the iPhone, where a lot of the balancing technology for the battery has been simplified for easy use.

One potential option is the TP4056 which is an IC that could enable us to charge the Li-Ion or Li-Po with a 5 V USB power source. This type of solution would demand

1. USB Power Delivery or a charging block
2. Charging components like the TP4056 but with balancing features i.e. some battery management system (roughly 3x2 cm).
3. Something to regulate the input voltage from USB
4. A protection circuit to avoid damaging the battery (although built in ones inside the battery might suffice)

**Current Plan:**

To be on the more conservative side let’s assume the motor draws 1A of current during the cutting and exiting stages, each of which will last 10 seconds. This means that the motor alone demands 1000 mA \* 20 / 3600 = 5.5556 mAh. The RP2040 will have to be active to manage the motor, state machine, and sensors. Assuming it runs at 50 mA during idle and that each operation takes 2 hours at maximum, the RP2040 will demand 100 mAh per operation. This means for 20 operations (our optimistic number per battery charge) we will need 2111.112 mAh, suggesting 2200 mAh 3s 12.6 V LiPo or Li-Ion pack may be the right selection. This is still a very rough estimate and does not consider the voltage drop past specified levels of battery discharge. The actual number of operations the charge is good for can still be affected by other current draws, and non-idealities. It would be better to expect ~15 operations off of one charge.

**Looking into products:**

The following are potential batteries that can be purchased:

* Turnigy 2200 mAh 3S 25C LiPo Pack

The following are potential battery management systems with balance that could probably handle the charging of a 12 V 3s pack.

* SparkFun Battery Babysitter - LiPo Battery Manager
* Daly Smart BMS
* JBD BMS (Jikong)
* DROK 3S BMS (12V)

**Boost converter with a single cell charger.**

**Look at step down and step up voltage regulator 12 volt step up regularor**

**6 v motor 4802 4803 with a 6v step up**