

# White Paper: KidneyLoop Camel Pack Backpack A Portable Water Purification Solution with Coiled UV-C Tube

Subtitle: Enhanced Efficiency Through Innovative Design for On-the-Go Clean Water

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## ### Abstract

The KidneyLoop Camel Pack Backpack is a compact, portable water purification system engineered for hikers, travelers, and disaster relief teams operating in water-scarce environments. Featuring a coiled UV-C disinfection tube ("spring method"), this design optimizes exposure time within a compact footprint, achieving high efficiency with minimal power. Housed in a 3-gallon hydration backpack, the system uses a 63.9-foot FEP UV-C tube wrapped in 19.5 meters of LED strip, dual 0.1 m filters, and is powered by a 60W solar panel with battery backup. Capable of delivering 1 gallon of potable water every 5.46 minutes with 99.9% bacterial reduction, this innovation offers both mobility and reliability. The coiled-tube breakthrough also scales to larger KidneyLoop systems, accelerating cycle times from hours to minutes. Built for universal access and released under CC0, this solution is a step toward eradicating global water scarcity.

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## ### 1. Introduction

KidneyLoop began as a modular water purification system for household and community use, leveraging UV-C light and fine filtration. In adapting the concept for portability, the Camel Pack Backpack was born. During its development, a breakthrough occurred: coiling the UV-C tube into a helical spring. This innovation increased exposure time without increasing bulk, reducing purification time from 32.32 minutes per gallon to just 5.46 minutes.

The coiled design was later integrated into larger systems like the circular multi-tank build, reducing the cycle time for 25 gallons from 8.04 hours to just 20.92 minutes. This white paper outlines the Camel Pack design, performance, costs, and real-world applications.

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## ### 2. Design and Functionality

### #### 2.1 System Components

- **Hydration Backpack**: 3-gallon capacity; 2-gallon top (dirty), 1-gallon bottom (clean).
- **First Filter**: 0.1 m ceramic/polymer at top reservoir outlet.
- **Coiled UV-C Tube**: 63.9 feet, 0.197 FEP tubing in 4 x 12 coil, wrapped with 19.5m UV-C LED strip (265275 nm).
- **Second Filter**: 0.1 m at bottom reservoir inlet.
- **Solar Panel**: 60W, 12V (24 x 16 inches), mounted externally.
- **Battery Backup**: Two 12V 2Ah batteries (49 min runtime).
- **Tubing & Fittings**: 1/2 inch food-grade tubing.

#### 2.2 Disinfection Mechanism and Efficiency

- **Coiled Volume**: 12.81 fl oz; Surface area: 474.37 in<sup>2</sup>.
- **Radiant Power**: 58,500 mW (19.5m x 3W/m).
- **Intensity**: 123.29 mW/in<sup>2</sup> = 19.12 mW/cm<sup>2</sup>.
- **Flow Rate**: 1.17 fl oz/sec = 10.98 sec exposure.
- **Dose per Pass**: ~210 mJ/cm<sup>2</sup> = 99% kill rate.
- **Cycle Time**: 5.46 min for 1 gallon (3 passes for 99.9%).
- **Single-Pass Option**: Slower flow achieves 600 mJ/cm<sup>2</sup> in 5.2 min.

#### 2.3 Power System

- **Power Use**: 58.5W continuous.
- **Battery Runtime**: 49 min (48Wh total).
- **Solar Recharge Time**: ~48 min full recharge.

#### 2.4 Safety

- **UV Containment**: Aluminum foil and PVC housing.
- **User Safety**: No direct exposure; UV glasses recommended during maintenance.

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### 3. Performance Metrics

- **Reservoirs**: 3 gallons total (2 dirty, 1 clean).
- **Efficiency**: 210 mJ/cm<sup>2</sup>/pass; 99.9% removal in 3 passes.
- **Cycle Time**: 5.46 minutes per gallon.
- **Flow Rate**: 1.17 fl oz/sec.
- **Weight**: ~33 lbs filled; ~25 lbs half-filled.

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### 4. Scaling Impact

- **Circular Multi-Tank Integration**: Single-pass disinfection (600 mJ/cm<sup>2</sup>).

- **Cycle Time Reduction**: 25 gallons in 20.92 min (vs. 8.04 hours).
- **Scalability**: Coiled UV-C fits tank builds without significant space impact.

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### 5. Cost Breakdown

**Online Sourcing (Solar Powered)**: \$593\$675

**Bulk Pricing Option**: \$554\$636

**Local Market Sourcing**: \$443.50\$532.50

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### 6. Use Cases

- **Hiking/Camping**: On-demand clean water from streams.
- **Disaster Relief**: Portable water for crisis zones.
- **Travel Abroad**: Clean water in rural/urban undeveloped regions.
- **Military**: Field-ready integration for soldiers.

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### 7. Advantages and Limitations

#### Advantages:

- 5.9x faster than previous design.
- Portable, solar-powered, off-grid.
- 99.9% bacteria removal.
- CC0 license: Free to build, sell, or share.

#### Limitations:

- Higher cost than flat tray.
- Flow slower than pressure filters.
- Battery life limited to 49 min without sun.
- Full load weight (~33 lbs).

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### 8. Conclusion

The KidneyLoop Camel Pack Backpack is a transformative advancement in portable water purification. Its coiled UV-C tube method delivers rapid, high-efficiency bacterial elimination in a solar-powered, carry-ready format. Originally devised for hiking and disaster relief, its design breakthrough has cascaded into large-scale KidneyLoop systems. Released as public domain, the Camel Pack offers individuals and organizations a chance to bring clean water anywhere without chemicals, cartridges, or restrictions.

Build it. Use it. Share it.

**\*\*Polymath | April 7, 2025\*\***