

White Paper: KidneyLoop Stainless Steel Container A Safe Household Water Purification Solution

Subtitle: Clean Water for Families Using a Durable, Plastic-Free Design

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Abstract

The KidneyLoop Stainless Steel Container is a household-sized variant of the KidneyLoop water filtration system, designed to provide clean water for families of 46 people using a durable, plastic-free design. Housed in a 5-gallon stainless steel container, the system uses solar-powered UV-C disinfection and dual 0.1 m filtration to remove 99.9% of bacteria, delivering 2 gallons of clean water every 15.52 minutes. A 3-gallon top compartment holds dirty water, which gravity-feeds through a central U...

1. Introduction

The KidneyLoop Stainless Steel Container addresses the need for a safe, household-sized water purification system, using food-grade stainless steel to avoid plastic and ensure drinking water safety. With a total capacity of 5 gallons (3-gallon top compartment, 2-gallon bottom compartment), the system delivers clean water in 15.52 minutes per 2-gallon batch, making it ideal for families of 46 people.

Acknowledgment: The development of this design was enhanced through collaboration with Grok, an AI assistant created by xAI. Grok contributed to calculations, design iterations, and documentation.

2. Design and Functionality

2.1 System Components

- Stainless Steel Container: 5-gallon 304-grade cylinder (10" diameter, 14.7" tall), split into a 3-gallon top and 2-gallon bottom compartment.
- Top Compartment: 3 gallons of dirty water, sealed with a stainless steel lid and silicone gasket.
- First Filter: 0.1 m, located at the divider outlet.
- UV-C Tube: 14.7-inch long FEP tube (0.197" diameter), wrapped in 4.5m UV-C LED strip (265275 nm, 3W/m). Housed in reflective foil-lined stainless steel sleeve.
- Second Filter: 0.1 m, before the bottom compartment.

- Bottom Compartment: 2 gallons, dispensed via stainless steel spigot.
- Pump: 12V DC (5W, 0.5 gal/min), recirculates water through UV tube.
- Solar Panel: 20W, 12V (16" x 10").
- Battery: One 12V 2Ah (24Wh), rechargeable.

2.2 Disinfection Mechanism

- Tube Volume: 0.25 fl oz; Surface Area: 9.1 in².
- UV Intensity: 13,500 mW / 9.1 in² = 1,483.5 mW/in² (230 mW/cm²).
- Flow Rate: 0.275 fl oz/sec; Exposure = 0.91 sec per pass.
- Dose: 210 mJ/cm² per pass (99%), 3 passes = 99.9% reduction.
- Cycle Time: 256 fl oz / 0.275 = 930.9 sec = 15.52 min per 2 gallons.

2.3 Power System

- Power Use: 18.5W (13.5W UV-C + 5W pump).
- Battery Life: 24Wh / 18.5W = 1.3 hours.
- Solar Recharge: 20W panel recharges battery in ~1.2 hours.

2.4 Safety Features

- UV-C containment via foil-lined stainless steel sleeve.
- All water-contact parts are food-safe.
- Minimal user interaction. UV glasses recommended during setup.

3. Performance Metrics

- Capacity: 5 gallons (3 dirty, 2 clean).
- Efficiency: 99.9% bacterial removal in 3 passes.
- Cycle Time: 15.52 minutes for 2 gallons.
- Flow Rate: 0.275 fl oz/sec.
- Weight: 49.4 lbs full (89 lbs empty).

4. Materials and Cost

(Refer to previous structured cost breakdown, omitted here for brevity.)

5. Use Cases

- Rural Families: Access clean water for cooking, drinking, and hygiene.
- Off-Grid Homes: Operate fully on solar.

- Urban Households: Non-toxic, plastic-free purification.
- Community Centers: Serve 46 people per cycle.

6. Advantages and Limitations

Advantages:

- Food-grade stainless steel (plastic-free).
- 99.9% bacteria removal in 15.5 minutes.
- Solar operation with battery backup.
- Safe, chemical-free design.
- Open-source CC0 license.

Limitations:

- Higher initial cost vs. flat tray.
- Stationary; not designed for portability.
- 1.3 hours battery runtime.

7. Conclusion and Vision

The KidneyLoop Stainless Steel Container is a reliable, open-source household water purifier designed for long-term safety and sustainability. It purifies 2 gallons every 15.5 minutes and is ideal for homes without reliable access to clean water. With no plastics, chemicals, or proprietary components, the design is fully public domain and adaptable across regions and scales.

Vision for Impact: This system can empower communities globally to access clean water affordably. Whether in a rural village, a disaster zone, or an off-grid home, it provides resilience, autonomy, and dignity. With collaboration and refinement, the KidneyLoop could become a foundational technology in solving the global water crisis.

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