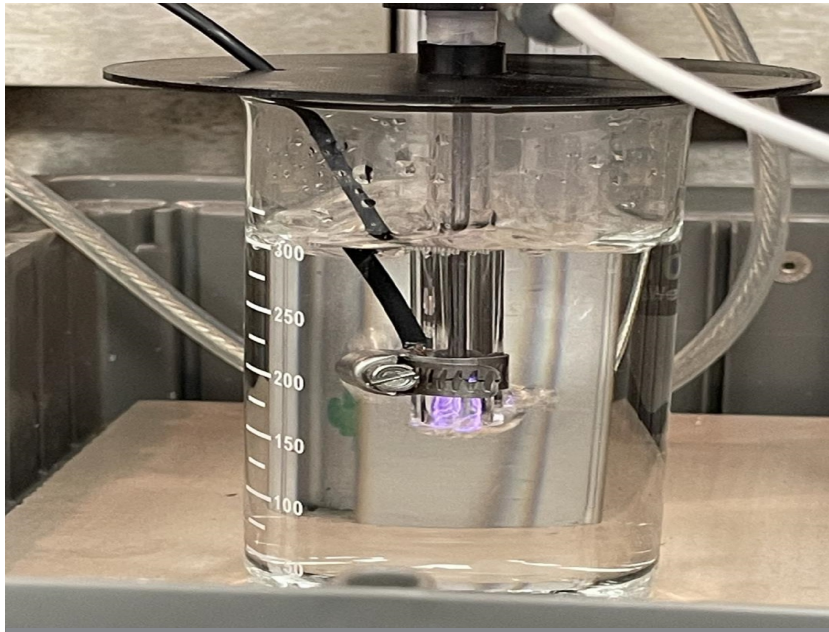


## TECHNOLOGY SOLUTION

### Health, Medicine and Biotechnology



# Plasma Processing of Water and Inedible Biomass for pH Control and Nutrient Recycling

## Plasma Treatment Improves Sanitation and Benefits Plant Growth

Researchers at Kennedy Space Center have developed a technology that generates plasma activated water in pH ranges that allow for the addition of nitrates and other nutrients to the water while maintaining a healthy pH for plants. A plasma torch is used to treat inedible biomass, generating ash containing nutrients useful for plant growth. The same plasma torch is also used to treat water, which results in the formation of nitric acid that lowers the pH of the water. Adding the plasma generated ash to the plasma treated water can balance the pH of the water to make it suitable for plant growth while simultaneously adding nutrients recycled from the inedible biomass to further enhance plant development. Plasma treatment of water to high and low pH extremes can also be used for sanitation purposes, causing pH shock to undesired organisms. The uniqueness of this process is the adjustability of the pH with one system. The same plasma system can be used to treat both the water and the biomass. Additionally, the technology can be used as an on-demand, point-of-use method for producing nitric acid.

### BENEFITS

- Produces nutrient rich, pH balanced water for use on plants to enhance growth.
- Provides the ability to vary pH with one system.
- Simple, condensable system design that reduces complexity and footprint.
- Eliminates the need to handle acid to dissolve plasma treated inedible biomass.
- Capable of on-demand, point-of-use production of nitric acid.



## THE TECHNOLOGY

Early exploratory research with the plasma treatment of water and inedible biomass revealed problems with both efforts. Plasma treatment of water lowered the pH of the water below acceptable levels for plants. Additionally, inedible biomass treated with plasma for nutrient recovery has to be dissolved in acid to enhance that nutrient recovery, and acid can be difficult and dangerous to handle. The technology described here utilizes a single plasma torch to treat both water and inedible biomass. Plasma treatment of the water creates useful species, such as nitrates, to the water which are beneficial for plant growth. However, plasma treatment of water also forms nitric acid, causing the water to be too acidic for plants. Plasma treatment of inedible biomass breaks down the cellulose inside the plant material and reduces it to ash, liberating nutrients such as potassium, calcium, sodium, and phosphorus. Researchers determined that careful dosage of the appropriate amount of the recycled ash to the plasma treated water balances the water's pH level and also adds nutrients that can further enhance plant growth. This method eliminates the need for acid treatment of the plasma treated biomass. For cleaning applications, water can be treated with plasma to either high or low pH extremes for shock sanitation treatment.

The system requires a high voltage power supply and a plasma torch. The torch requires a tube for gas transportation, an electrode inside the tube, and an electrode outside the tube. Air can be used for both treatments. The plasma system can be optimized to condense the system into a lunchbox sized package to generate the treated water and ash.



## APPLICATIONS

The technology has several potential applications:

- Vertical farming
- Hydroponics
- Greenhouses
- Irrigation
- In-situ generation of cleaning agents
- Space based agriculture

## PUBLICATIONS

Plasma Activated Water: A Study of Gas Type, Electrode Material, and Power Supply Selection and the Impact on the Final Frontier (<https://ntrs.nasa.gov/citations/20220016906>)  
Plasma Assisted Acid Leaching of Inedible Biomass for Nutrient Recovery (<https://ttu-ir.tdl.org/handle/2346/89730?show=full>)

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