KERONE
Kerone Engineering Solutions Limited

COLD PLASMA **STERILIZATION**

In Association with SVCH-Technologii, Moscow (Russia)

ISO 9001:2015 | ISO 14001:2015 | ISO 45001:2018

ABOUT US

KERONE is now renowned for serving the specialized needs of customers with the best quality and economical process of Heating /cooling and drying products, manufactured in a high-quality environment by a trained and qualified workforce (special purpose machinery)

KERONE is a pioneer in application and implementation engineering with its vast experience and team of professionals.

KERONE is devoteded to serve the industry to optimize its operations both economically and environmentally with its specialized heating and drying solutions.

KERONE is having immense expertise in manufacturing and implementing various types of engineering solutions.

KERONE is possessing employee strength of more than 280+ experts continuously putting efforts for happy industrial engineering solutions.

WHY CHOOSE US

> Enhance the value of customer operation through our customer need centric engineering solution.

With decades of expertise, cutting-edge technology, and a customer-centric approach, Kerone Engineering offers tailor-made heating solutions that prioritize quality, flexibility, and cost-effectiveness. Benefit from our commitment to excellence, post-sales support, and innovative solutions for your unique heating needs. Choose Kerone Engineering for reliability, performance, and unmatched value.

MISSION

- To enhance the value of customer operation throughi our customer need centricengineefing solution
- We are cominitted to provide our customers, unique arid best in class products in Industrial heating drying and cooling segment with strategic tie-up for the technical know-how with renowned leader in the industry specific segment

VISION

- Turn into a world leader in providing specialized, top-notch quality and ecological industrial heating, cooling, and drying solutions across the globe.
- To attain global recognition as the best of quality and environment-friendly engineering solution company.

What is Plasma?

Plasma is the fourth state of matter, alongside solid, liquid, and gas. It consists of ionized gas particles, meaning the electrons have been stripped away from the atoms, leaving behind positively charged ions and free electrons. This ionization process gives plasma unique properties compared to the other states of matter.

Plasma is often found naturally in stars like the Sun, lightning, and the auroras. It's also artificially created in laboratories for various purposes, such as in plasma TVs, fluorescent lights, and fusion reactors. In fusion research, plasma is the medium where nuclear fusion reactions occur, potentially offering a nearly limitless source of clean energy.

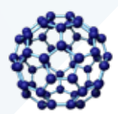
Forth state of matter. Lionized gas charged ions, free electrons and radical).

consisting of positively and negatively activated neutral species (excited and

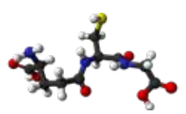
Positive Ions

Negative Ions

Electrons

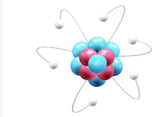


Atoms



Free Radicals

Metastable



Photons

What is Cold Plasma Sterilization

Destroys pathogenic micro-organisms by cold plasma without using corrosive chemical like sodium hypochloride or detrimental UV rays. Safe to operator and environment friendly. Proven capability of destroying bacteriophage, touted as more difficult to destroy than coronavirus.

History

- Sir William Crookes, in 1879.
- 1928, Langmuir and Tanks, while investigating electric discharges at the General Electric Research Laboratory, introduced the term "plasma" to describe the ionized gas.
- Sterilizing properties of plasma was first introduced towards the end of the 1960's, patented in 1968.

Principle

- The e- energy is sufficient to dissociate covalent bonds in organic molecules.
- Single bonds: 1.5 6.2 eV, Double bonds: 4.4 7.4 eV, Triple bonds: 8.5 11.2 eV.
- Free e colliding with gas atoms transfer their energy, thus generating highly reactive species that can interact with the food surface.
- Cold plasma is generated at atmospheric pressure by passing a process gas through an electric field. Electron arising from ionization processes, accelerated in this field, trigger impact ionization processes.

Plasma Sterilization Parameters

- Factors affecting plasma.

- Choice of Gas:
  > Determine effectiveness of sterilization.
  Type of active species present.
  Types of free radicals formed are a direct result of the ionized constituent gas molecules.
  Dictates the intensity and wavelengths of emitted radiation.

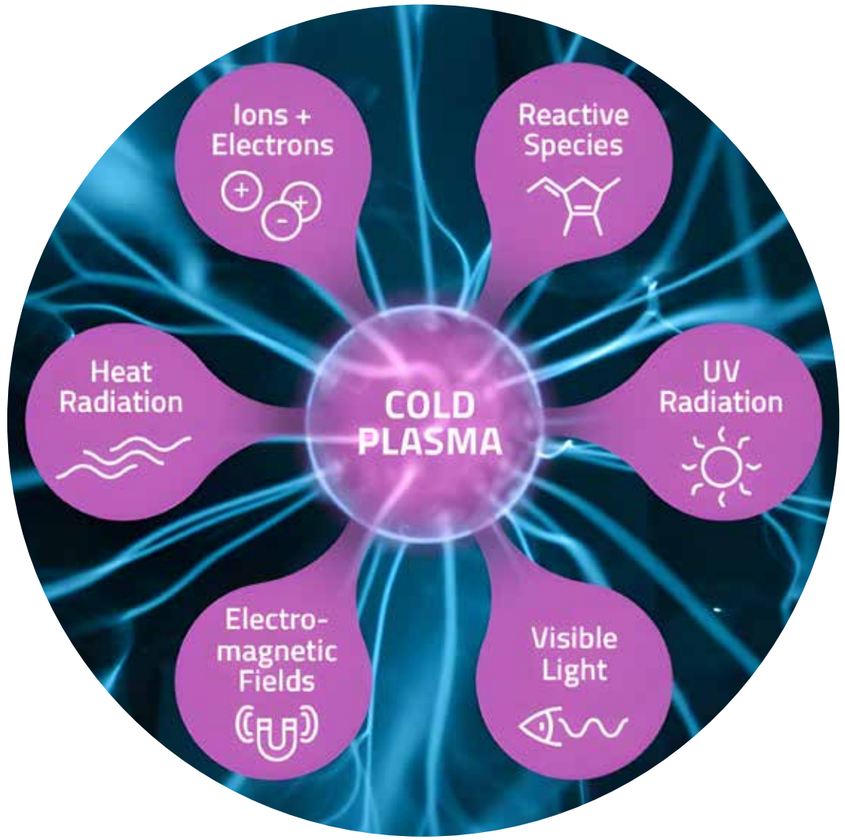
  > Common gas: O2, CO2, O2/H2, O2/Ar, O2/CF4, and H2O2.

  Gas Flow Rate:
  > Increasing the gas flow rate, increases the flux of active species on the medium, which increases the effectiveness of the treatment.

Application

The cold plasma (CP) technique is used for

- Food processing for enhancing antimicrobial activity
- Structural modification
- Decontamination of surfaces
- Disinfection of food-processing instruments.



Categorization of Plasma

- Based on Relative temperature of ions and electrons:
  - Thermal plasma': This plasma have electrons and ions at same temperature i.e. they are in thermal equilibrium with each other.
  - Non-thermal plasma: This plasma have the positive ions at lower temperature (sometimes at room temperature) whereas electrons are much.
- Non-thermal plasma is also called as cold plasma.

Plasma Generation Systems

- Dielectric barrier discharge plasma
- Jet plasma
- Corona discharges
- Microwave plasma
- Inductively coupled plasma
- Capacity coupled plasma

Food Decontamination

When contaminated food is treated with plasma, reactive oxygen species (ROS) and reactive nitrogen species(RNS) act as antimicrobial agents and these include-

- ROS : hydrogen peroxide, superoxide, singlet oxygen etc.
- RNS-Nitric oxide, Nitrogen dioxide radical etc.
- UV radiations.

Directly associated to oxidative stress on exterior surface of microbes cells.

Mood Of Action

The ROS from plasma detrimentally interact with vital cellular biomolecules, such as DNA, proteins and enzymes in cell.

ROS could potentially alter the function of biological membranes via interaction with lipids causing the formation of unsaturated fatty acid peroxides and oxidation of the amino acids and proteins.

Microbes in plasma are exposed to an intense bombardment by radicals likely provoking surface lesions that the living cell cannot repair sufficiently faster (etching).

Content

Gas Pressure

Influences the volatilization rate of the plasma.Increasing the pressure can introduce competing effects in the sterilization process.

Power

Increase in electron density, which allows for a larger volume of active species to interact with the medium

Quantity of Material to be Sterilized

Higher the quantity, reduced efficiency Compensated by gas flow rate and pressure.

Nature of Microorganism, Density and Surface Layer Formation

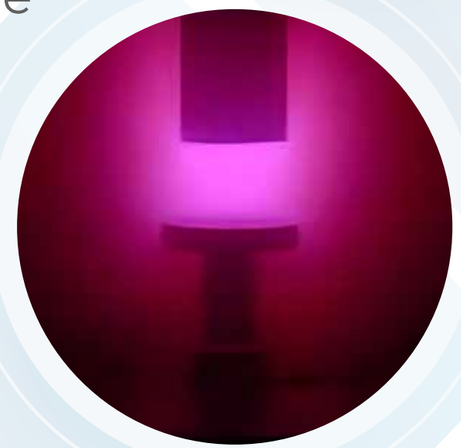
Dependence of active species

Packaging

The presence of packaging inhibits the efficacy of sterilization.

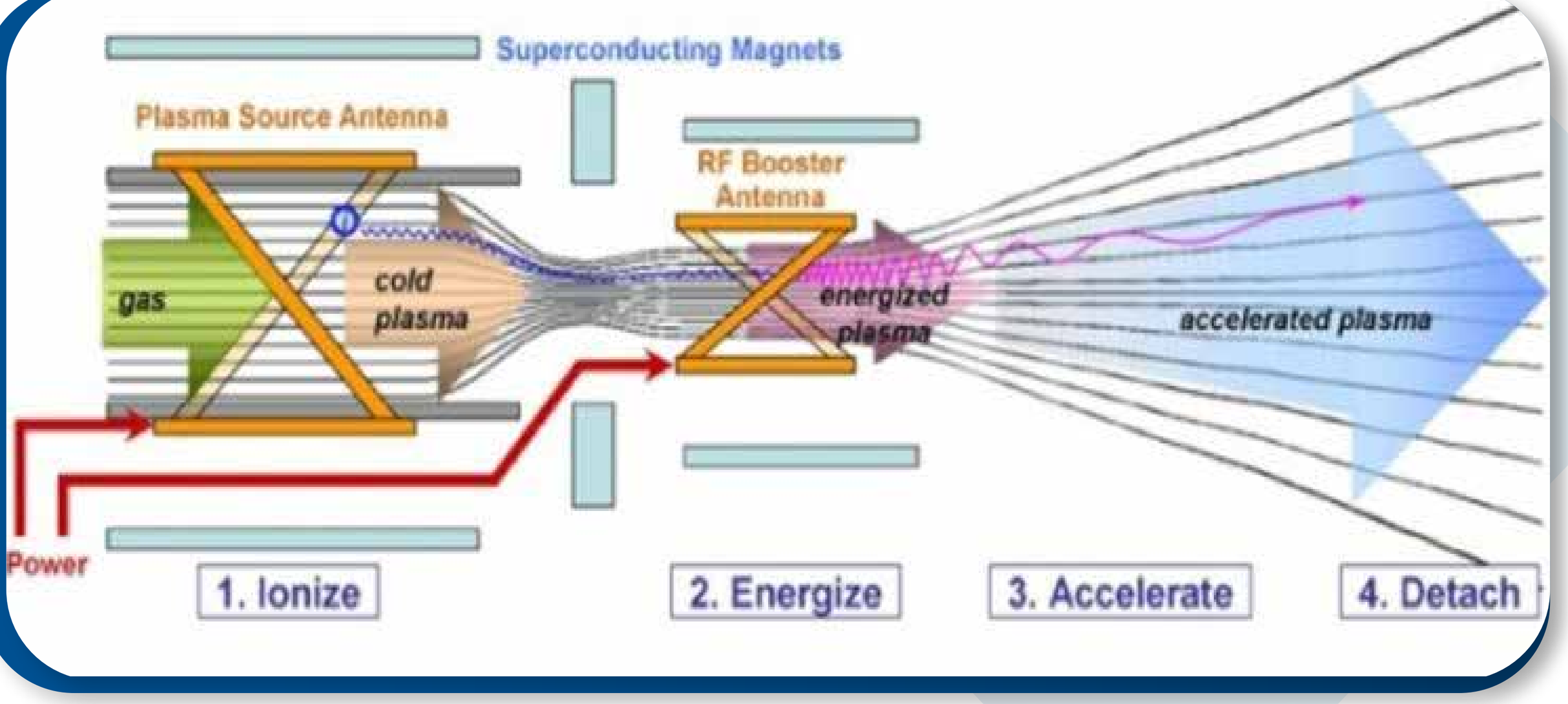
Geometrical Factors

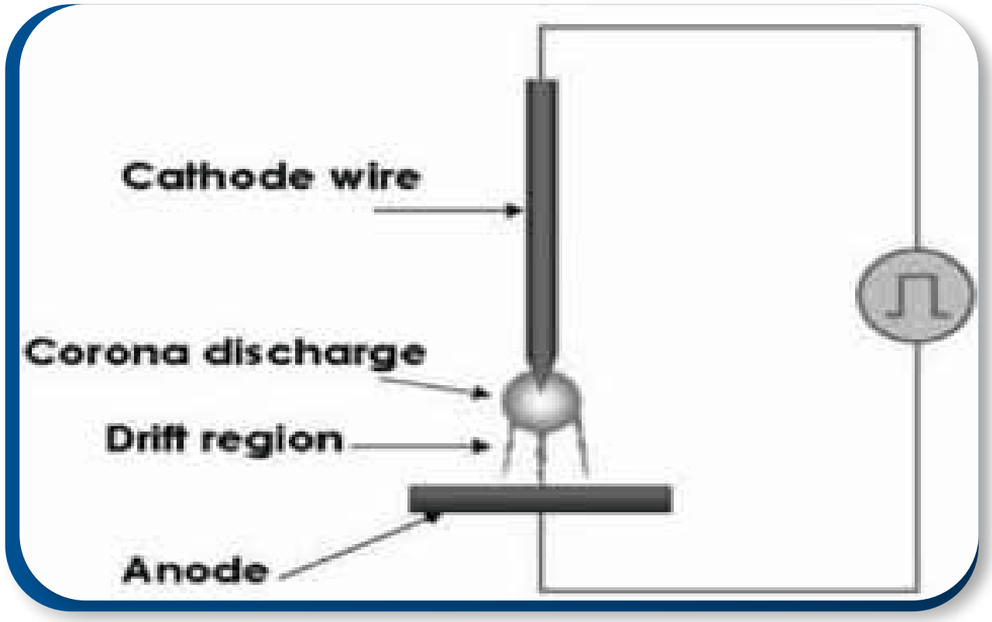
Reactor design strongly influence the concentrations of active species Direct contact and afterglow



Plasma Sources

- Corona discharge
- Dielectric barrier discharge
- Gliding arc plasma generation
- Microwave induced plasma


Superconducting Magnets
Plasma Source Antenna
RF Booster Antenna
gas
cold plasma
energized plasma
accelerated plasma
Power
1. Ionize
2. Energize
3. Accelerate
4. Detach



Corona Discharge

The plasma creates a lighting crown around the wire: that is why this discharge is called "Corona".

Advantage

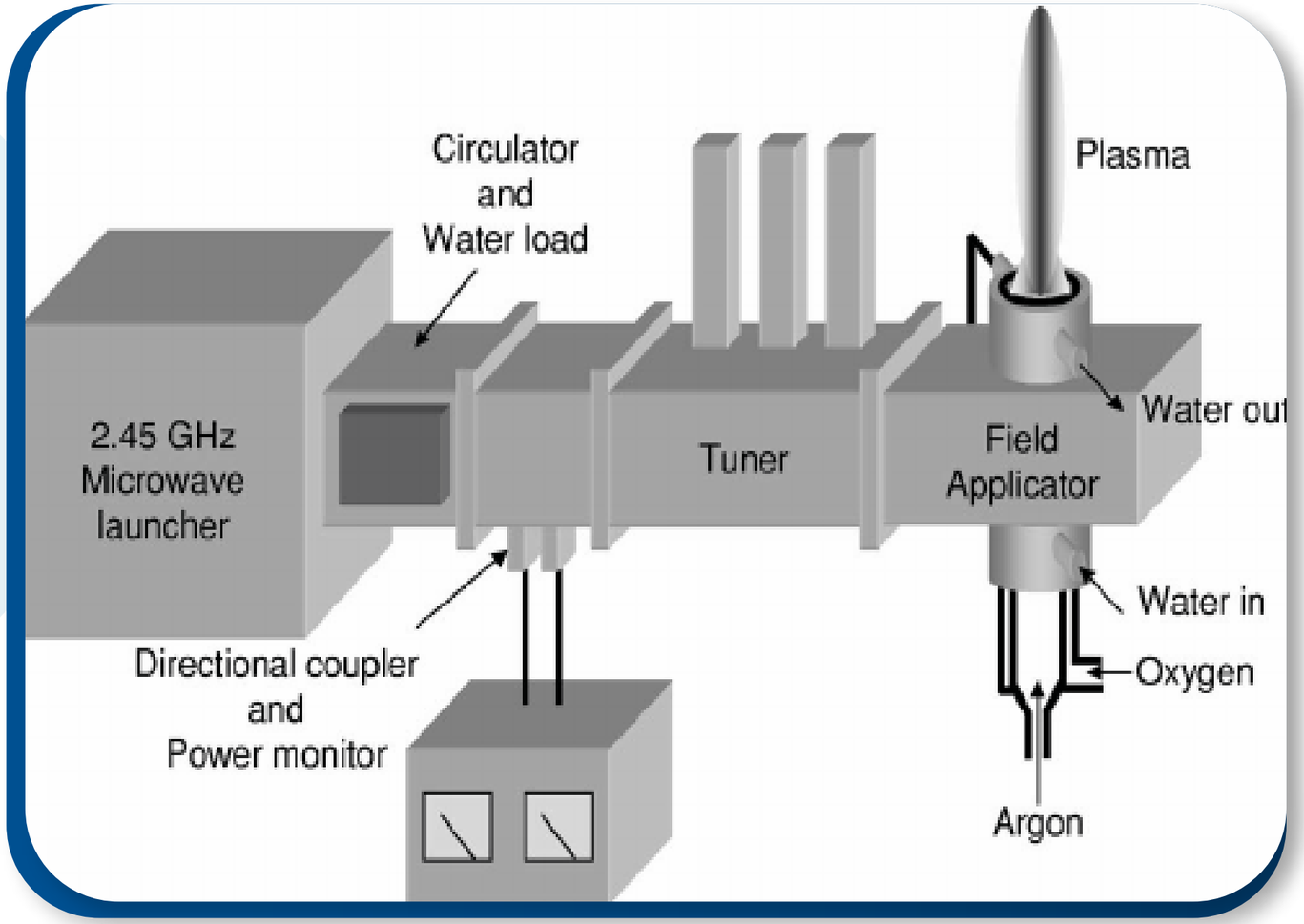
High efficiency, low investment & operational cost

Disadvantage

Audible noise, power loss, insulation damage of devices Uses: Surface treatment for tissue culture, surface treatment of materials to change properties sanitization of water.

Microwave Induced Plasma

Frequency of 300 MHz to 10 GHz. Commonly used wavelength is 12.24 cm, corresponding to a frequency of 2.45 GHz. Range from a few Watt up to several hundreds of kilowatts, the discharge pressure might range from less than 10-2 Pa up to several times atmospheric pressure, whereas many different discharge gases might be used



Cold Plasma in Microbial Inactivation

Cold plasma treatment was given to brown rice cereal bars to decrease the mold growth.

This treatment prevented growth of mycelium on surface of bars for at least 20 days.

It was found that cold plasma treatment decreased the growth of Aspergillums flatus approx. 4 log cfu/g, when power of 40 W with an experiment time of 20 min was used.

Cold Plasma for Food Packaging

Cold plasma can be used for sterilization of different packaging materials such as PET Foils, Polystyrene and Multilayer packaging resulting in minimum 2 log 10 reduction with minimal changes in the packaging functionality.

Studies show that water vapor permeability of packaging material is reduced after plasma treatment.

This can be achieved by deposition of hydrophobic coating on the polymer surface through plasma treatment.

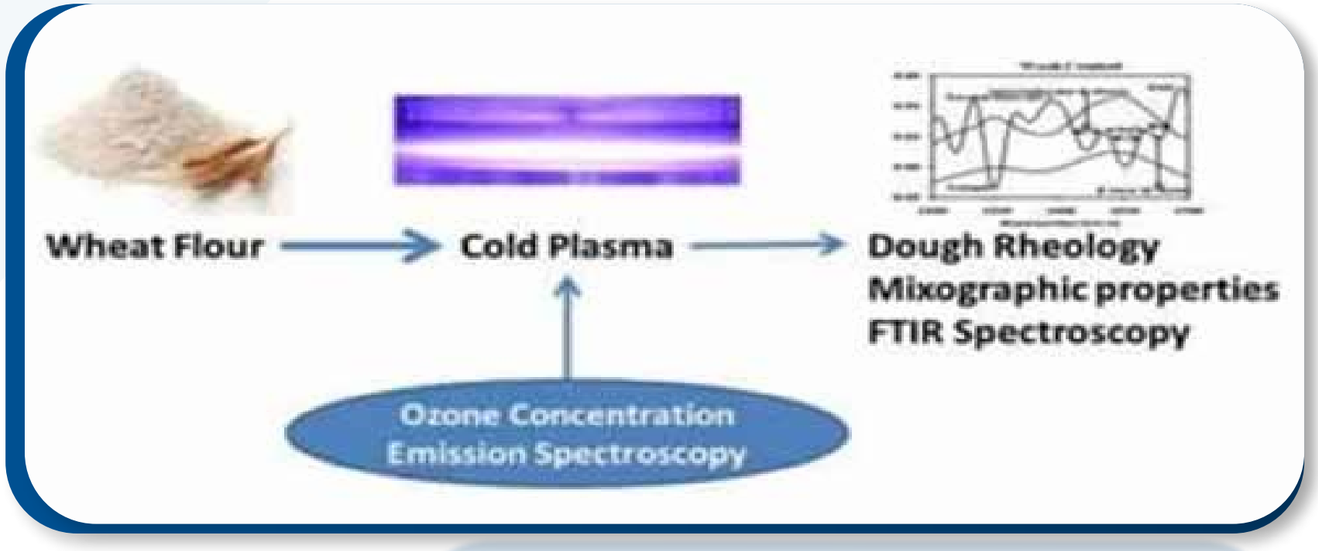
Cold Plasma in Modification of Food Properties

The hydrophobic and hydrophilic nature of food product can be modified by cold plasma treatment.

The nature of proteins and its functionality has been changed in case of gluten by cold plasma techniques

In case of biscuits, the increase in hydrophobic nature of its surface exhibited an increased spreading of oil sprayed and thus reduced oil seepage.

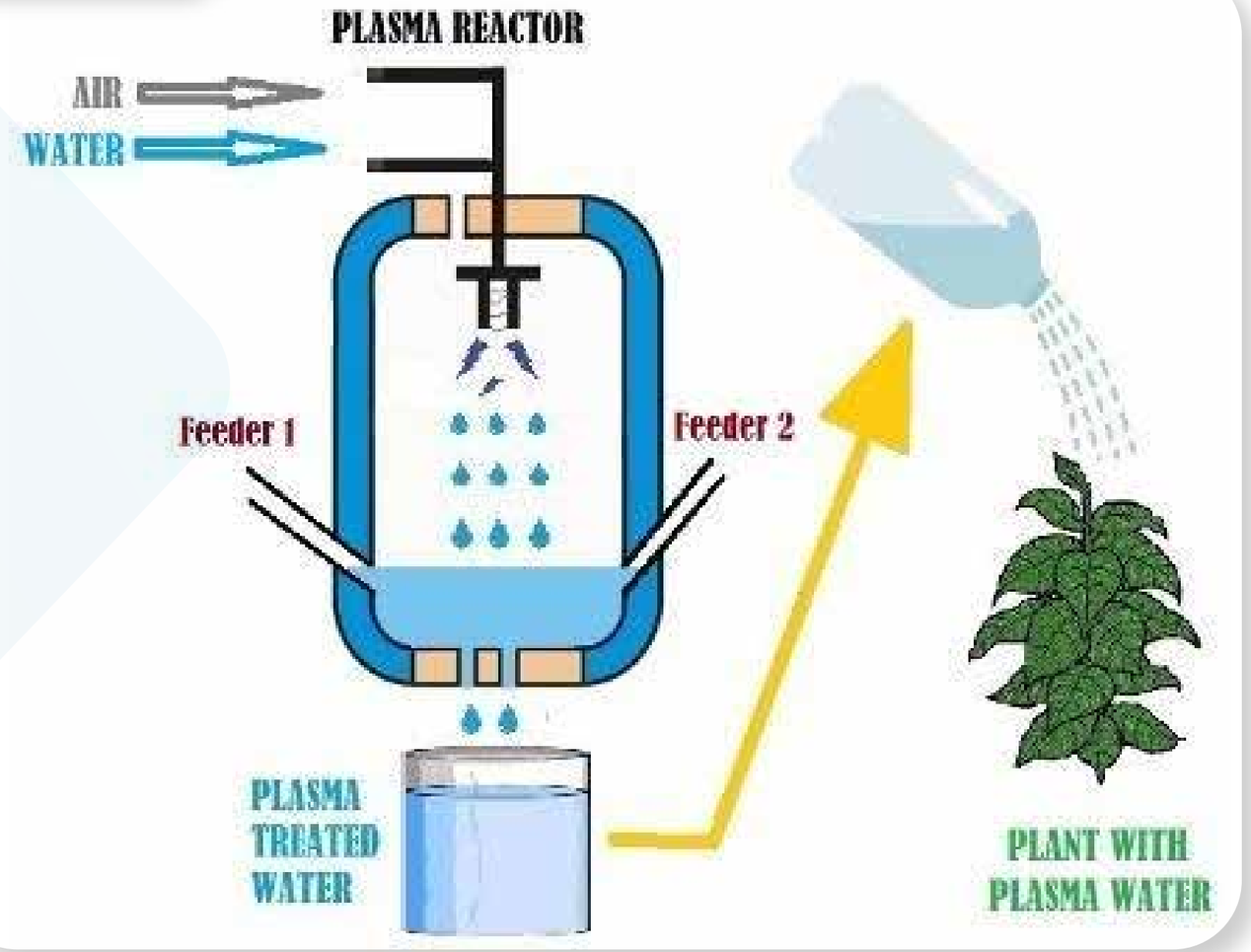
On treatment of wheat flour with cold plasma the secondary structure of gluten becomes more stable and corresponding changes in dough rheology.



Cold Plasma in Waste Water Treatment

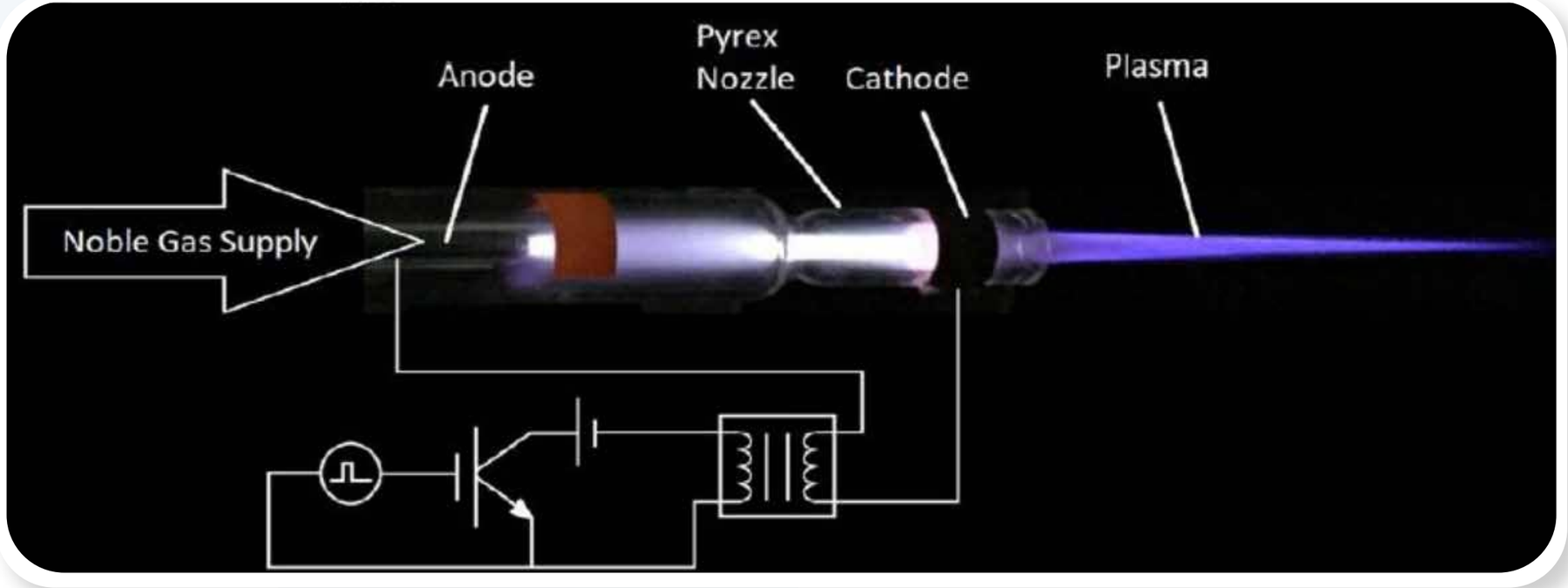
Major investigation have been done on application of cold plasma :

- Industrial effluent
- Organic dyes
- Degradation of pharmaceutical compounds.
- Mineralization of pollutants by using various catalysts.



Advantages

- Wide range of operational conditions
- Clean and has high chemical reactivity



Industrial Uses

- Waste treatment
- Surface treatment
- Ion production
- Analytical chemistry
- Electromagnetic coating

Classification Of Plasma

Plasma is classified based on the following aspects:

Temperature

Thermal plasma / Hot Plasma
Non Thermal plasma / Cold Plasma

Mode

Microwave
Gliding arc
Corona
Dielectric barrier discharge

Pressure

Low pressure
Atmospheric pressure
High pressure

TRUSTED PARTNERS

AFCONS

Technip

TÜV ISO 14001:2004

TOYO ENGINEERING

EIL

LLOYD'S

ZEPPELIN WE CREATE SOLUTIONS

Reliance Engineering Associates Pvt. Ltd.

TATA CONSULTING ENGINEERS LIMITED

SC Shroff Consultants

STERLING & WILSON

THANK YOU

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