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### APT-200 series ICP/RF plasma systems

**Application:** The 2<sup>nd</sup> generation ICP/RF (radio frequency) plasma system with regulated up to 80 kW power in plasma plume (power depends on many factors, including plasma gas composition and flow) is developed for continuous operation on different gases, including Ar, air, N<sub>2</sub>, CO<sub>2</sub>, blends of air and O<sub>2</sub>, Ar + O<sub>2</sub>, Ar + N<sub>2</sub>, and others with pressure at the torch output from several Torr to 7 bar. The system allows remote plasma initiation at 1 bar pressure, automatic switching of plasma gases, visualization of the operation parameters as real plasma power and temperature, plate voltage and current, grid current, consumed from grid power, temperature and flow of water in the cooling loops, data logging, etc. Could be used for industrial purposes and at research facilities.

**Components:** The plasma system consists of a Direct Current (DC) Module with dimensions 34" x 50" x 70", weight 1,100 kg (standard); Radio-Frequency (RF) Module with dimensions 36" x 36" x 68", weight about 450 kg; coaxial cable 2-2.7 m; Matching Network 14" x 15" x 28", and plasma torch. Optionally, an integrated gas supply system for two or three gases with dimensions 4" x 4" x 64" pre-calibrated for 6 gases, and remote operator's console are available.

**Parameters:**

- Input voltage – 3 x 480VAC, 60 Hz or 3 x 380VAC, 50 Hz
- Input power – 200 kVA max, 250 A
- Output voltage – up to 14,000 V
- Frequency – 2-5 MHz
- Cooling water – input 1-1/4" NPT female, output 1-1/2" NPT female. Flow rate for full power operation is 60 -70 liters per minute
- Plasma gas flow – from 1.0 to 10 g/s (depending on gas composition and torch power).

**Control system.**

- Standard control system allows selection of manual and automatic operation modes from a 12-inch touch screen on the DC module front door, main parameters visualization, as anode voltage and current, grid current, anode and plasma power, input and output water temperature, water temperature after tube, and water flow rate, plasma plume power and average plasma temperature, data logging.
- Additionally to a set of functions for the standard system, the advanced one offers automatic ignition at 1 bar pressure, transition to different plasma gases, filament voltage control, remote flow and power control, plasma stabilization, gas valves monitoring, diagnostic tools with numerous user prompts, remote control from the operator's console or through profibus, and many others.

Front panel of the DC module and optional remote operator's console are depicted in Fig.3 and Fig.4 correspondingly.

**Prospective applications :**

- (1) Imitation of re-entry conditions for the Thermal Protection Material tests
- (2) Synthesis of new materials - solids and gases
- (3) Gasification of different feedstock - coal, sewage sludge, etc.

- (4) Powders processing for surface modifications, minerals extraction
- (5) High flow and concentration NO<sub>x</sub> production – by 7% (mass).

**Services:**

- Development, production, commissioning, and worldwide maintenance of technologies based on ICP/RF plasma
- RF plasma diagnostics and modeling.

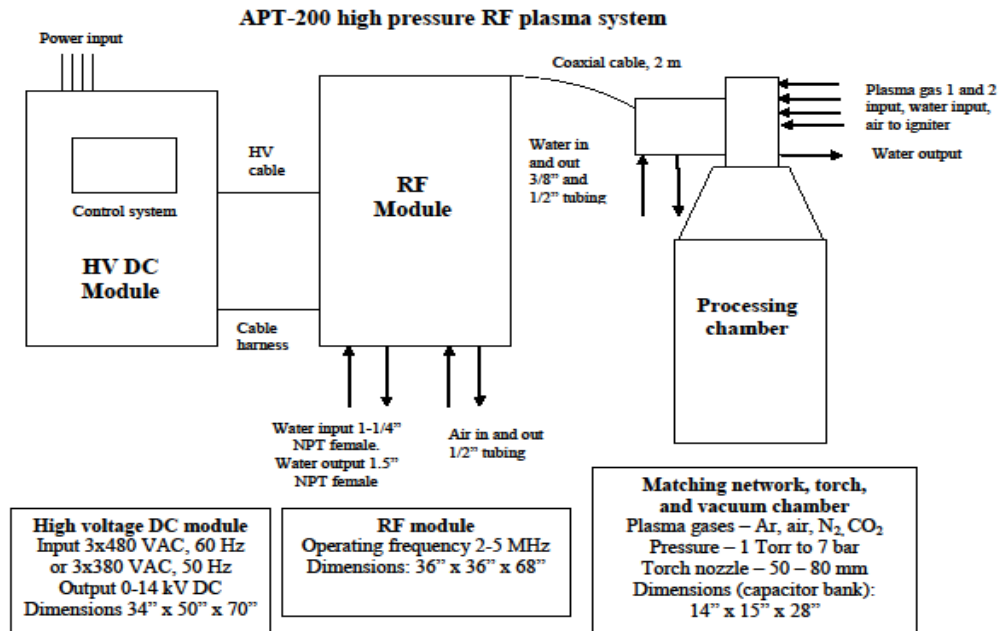


Fig.1. Configuration of APT-200 for synthesis of new materials.

**Main parameters of APT-200**

	<b>Parameter</b>	<b>Value</b>
1	Flow OD at the torch output (prior to flow modifier), mm	80
2	Plasma gases	Ar, air, N <sub>2</sub> , CO <sub>2</sub> , oxygen enriched air, other
3	Plasma gas flow, g/s	1.0 - 10.0
4	Free stream enthalpy, MJ/kg	3.0 – 35.0
5	Average plasma plume temperature, °C	2,500 – 7,000
6	Operation pressure (pressure in induction section)	1 Torr to 7 bar
7	Maximal plasma plume power at the nozzle cross section, kW	80
8	Maximal apparent power consumption, kW	187
9	Plasma generation efficiency – plume power/anode power	0.4 – 0.55



Fig.2. General view of the APT-200 plasma system for material tests

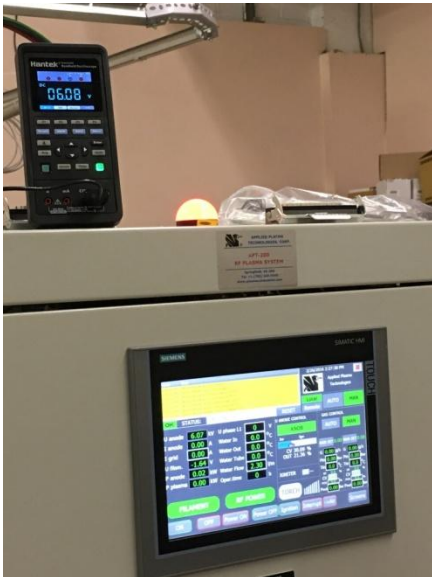


Fig.3. Touch screen with parameters



Fig.4. Remote operator's console



Fig.5. Torch operation and plasma diagnostics by optical spectroscopy