**🧰 Materials List – Toroidal Mercury Vortex Test Rig**

**🏗️ Vessel & Core Structure**

| **Component** | **Specs / Notes** |
| --- | --- |
| **Main Vessel** | Oblate spheroid chamber, ~6–12" diameter |
| **Material** | Borosilicate glass, PTFE, quartz, or ceramic (non-magnetic, high dielectric) |
| **Seal/Gasket System** | Chemically resistant o-rings or Viton for vacuum integrity |
| **Fluid Fill Port** | Threaded port or syringe injection valve |

**⚙️ Mercury or Substitutes**

| **Component** | **Notes** |
| --- | --- |
| **Mercury** | ~200–500 mL (⚠️ toxic — use only with proper fume hood + disposal protocols) |

**🔌 Electromagnetic Induction System**

| **Component** | **Specs / Notes** |
| --- | --- |
| **Induction Coils** | Copper wire (AWG 16–22), 2–3 turns around vessel |
| **Coil Holder** | 3D printed or machined ring with insulation |
| **AC Current Source** | Function generator + amplifier (0.5–5A, 50–400 Hz) |
| **Current Sensors** | Optional: clamp-on AC sensor or Hall-effect sensor |

**🧲 Sensors & Instrumentation**

| **Component** | **Notes** |
| --- | --- |
| **Pressure Sensor** | High-sensitivity MEMS sensor, centered at core |
| **Magnetic Field Probe** | Hall sensor or fluxgate magnetometer, outside coils |
| **Accelerometer (opt)** | Detects vibration from internal resonance |
| **Temperature Probe** | Thermocouple or IR sensor, to monitor heating |

**💻 Data & Control**

| **Component** | **Notes** |
| --- | --- |
| **DAQ Board** | Arduino, ESP32, or LabJack for sensor input |
| **PC Interface** | Python script or serial dashboard for logging |
| **Power Supply** | Isolated bench power for safe coil drive |

**✅ Test Plan – Phase 1: Core Resonance and Field Validation**

**🎯 Objective**

To determine whether applying an AC current to the induction coils around liquid mercury (or substitute) causes:

* Vortex formation
* Toroidal magnetic fields
* Pressure drop or vacuum effects at center

**🔬 Step-by-Step Procedure**

**1. Safety Prep**

* Ventilated hood (if using mercury)
* Grounded enclosure
* Lab gloves, glasses, thermally insulated table

**2. Fill Vessel**

* Fill oblate spheroid with Mercury
* Ensure no bubbles, sealed environment

**3. Coil Calibration**

* Wrap and secure coils around equator
* Check continuity and insulation

**4. Baseline Reading**

* Read pressure, magnetic field, temperature (no current)
* Log baseline for 1 minute

**5. Apply AC Current**

* Start at 50 Hz, 0.5 A → increase in small increments
* Observe for flow motion, audio resonance, pressure drop

**6. Sweep Frequencies**

* Scan 50–400 Hz at intervals
* Record sensor readings at each step
* Look for resonance peaks in:
  + Magnetic field amplitude
  + Core pressure drop
  + External vibration

**7. Analyze EV Growth**

* Map pressure + field to estimate energy density over time
* Compare to your simulated EV plot

**8. Safety Shutdown**

* Ramp down current
* Verify vessel temperature + internal pressure return to baseline

**📊 Expected Indicators of Success**

| **Signal** | **Meaning** |
| --- | --- |
| Core pressure drop | Vortex compression → rarefaction |
| Field intensity increase | Toroidal B-field reinforcement |
| Periodic fluctuations | Signs of resonance |
| Self-sustained swirl (advanced) | Early indication of self-induction |