Rotor-Mate™

Self Balance Centrifuge Rotor Technology

Gary Howell - June 29, 2010

Market Niche & Effectiveness:
Rotor-Mate self balance centrifuge rotor technology solves a major nuisance in the general and specialty centrifuge market place. Specifically, it frees an operator or robot to process dissimilar specimen size containers within a given sequence and of balancing specimen by offset geometric loading.

Resolution to centrifuge sample handling did not begin with Rotor-Mate. Virtually all modern centrifuges have some form of rotor "gyro" meant to soften the impact of eccentric rotor loads; and they work to a greater or lesser extent. Some centrifuge manufactures have gone to extravagant lengths to solve the nuisance. Agilent, V Spin micro-plate centrifuge, is a fine example. The rotor is suspended up-side-down [bat-like] on a series of springs and elastomeric [rubber] bumpers. Design execution of this machine is exceptional, but the elaborate balancing feature tolerates just 10 grams of eccentric load.

What differentiates Rotor-Mate technology from previous and existing centrifuge gyro designs is the magnitude of the eccentric load tolerance. A present patented embodiment demonstrably and consistently tolerates 200 gram eccentricity with a 10 pound rotor. Simply put, this enormous imbalance tolerance frees the operator or robot to load any specimen size combination in any load order.

Rotor-Mate technology is not limited to 200 gram load eccentricity and may be significantly increased as need dictates; for example, blood bag centrifuge application. Rotor-Mate technology is scaleable up/down for larger and smaller centrifuge rotors and not limited to low speed centrifugation.

Design Theory & Functional Description:
Fundamentally, Rotor-Mate works by allowing the rotor to automatically shift and rotate from its center of geometry to a new center of mass in proportion to the eccentric mass. Conceptually, a Rotor-Mate gyro could be constructed to allow an 8 pound sledge hammer to spin smoothly and reliably with the axle centered on the handle geometry! In this bizarre illustration, the special Rotor-Mate gyro would be constructed to permit the handle to shift radially 10 – 15 inches! The exaggerated, but technically feasible illustration is analogous, in a 2D example, to "old-time" playground see-saw boards with pivot point grooves permitting board re-positioning toward the heavier player. The see-saw is balanced by the overhanging mass of the board. In practice, Rotor-Mate typically allows center of geometry to center of mass re-positioning of 3-4mm with 200gm imbalance and a 10 pound rotor.

But practical rotor mass centering is only a concept thus far in this description. Rotor-Mate Intellectual Property [IP] teaches that mass centering must be unfettered permitting the rotor to move freely around 360 degrees and must be "loosely coupled". The gyro must not forcibly restrict rotor mass center relocation. Many people wonder why there centrifuges walk off the table if unbalanced. It is because they are restricting the rotor from assuming mass center by means of relatively hard mounted bearings - resulting in chassis vibration. Rotor-Mate allows the rotor to move to a decidedly new center of rotation and does so with very little mass centering force opposition.

Due to low or loose coupling force, the phenomenon called resonance, [transition from center of geometry to center of mass] occurs at less than 500 RPM with Rotor-Mate. Resonance transition at low RPM is enabling to successful mass centering because low RPM equals low energy.

Rotor-Mate IP also teaches something of a paradox. The rotor must be free to move, but it must be frictionally damped at some motion threshold. Resonance point characteristics are mathematically render-able, but with difficulty, due to numerous kinematic variables beyond the scope of this text. Suffice to say that a decidedly unbalanced rotor loosely coupled to a movable pivot point can exhibit a wild-ride with radial force vectors continuously and increasingly lagging rotational acceleration vectors.

During resonance, a Rotor-Mate equipped rotor must be frictionally damped BUT only after it has transitioned an acceptable predetermined radial distance. If damped prematurely, force will be induced to the chassis, creating undesirable vibration difficulties not unlike hard mounted bearing applications mentioned above.

Rotor-Mate suspends and locates the rotor axially by means of two free-floating plastic ball bearing and race sets. There are no springs or elastomers or sensors or cantilevers used in Rotor-Mate. These bearings permit the rotor unfettered but limited radial excursion for center of geometry to center of mass rotor relocation. The bearings are fee to move angularly [rotate] with the assembly not unlike typical Conrad bearing applications, BUT bearing race radial movement is restricted by predetermined internal dimensions. During resonance, excessive rotor motion is damped by predicable friction between the plastic bearing balls and the bearing races and suspended metal parts. Because resonance is induced at low rotor RPM [loose coupling], rotor energy is relatively low and minimal frictional damping is sufficient. Bearing stress is therefore minimal allowing considerable bearing longevity.

For proof-of-concept videos, please visit
http://www.youtube.com/results?search_query=rotor-mate&aq=f

http://www.youtube.com/results?search_query=rotor-mate4m&aq=f

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