

TECHNICAL BULLETIN

OPTIMA X SERIES TOTAL SYSTEM DESIGN

Preparative ultracentrifuges are a staple in life science research labs. Beckman Coulter has long been a leader in useful innovations that aid in the discovery process and contribute to meaningful research. This paper details innovations increasing laboratory safety by total system design and redundant safety systems.



Brilliance
at every turn.



Optima X Series Total System Design

Enhanced laboratory safety by design.

Centrifuges are used worldwide as basic research tools. This paper details design elements of the new Optima X Series ultracentrifuges that provide enhanced safety for modern research laboratories by employing a total system design philosophy.

Ultracentrifuges are ubiquitous in today's labs. Their operation has become routine, and safety is a given. While we have come to take safety for granted, it is not taken lightly by the Beckman Coulter engineering design team. With modern rotors capable of generating speeds of 100,000 rpm and over 1,000,000x the force of gravity, the consequences of a rotor failure can be severe. Forces of 800,000 ft/lbs or greater can be released in a rotor accident. To cope with these forces, ultracentrifuges are held to strict safety standards such as IEC 61010-2-020 for passive safety protection. This regulation is aimed at



assuring safety in case of a maximum credible accident. There are many other safety directives and regulations pertaining to centrifuges that deal with mechanical safety as well as electromagnetic compatibility (EMC).

While safety standards have been instrumental in preventing failures resulting in injuries, rotor accidents still occur each year. Factors such as use of aged rotors, use of rotors in incompatible centrifuges, damaged rotors, and

other mistakes can lead to centrifuge accidents. These accidents cause substantial damage resulting in expensive repairs, loss of time and valuable samples. To prevent these accidents, Beckman Coulter has long innovated to reduce the possibility of centrifuge accidents.

Beckman Coulter designers take a holistic approach to safety. Our product design and testing are conceived and implemented from a total system perspective. The centrifuge and its drive, safety features, software and hardware are all optimized with similarly designed rotors and labware. These parts are all designed and analyzed as a system to maximize performance and safety. This is vital to assuring proper performance and safety as each part contributes to the mechanical dynamics of the whole system. This is why Beckman Coulter does not recommend other manufacturers' products be used in our centrifuge systems. All Beckman Coulter centrifuges have been designed and tested as a complete system, so safety and performance are verified. We cannot make that claim with other manufacturers' components.

To illustrate, one of the ways that Beckman ensures rotor safety is through the engineering of redundant safety systems in our floor-model ultracentrifuges. All Beckman Coulter floor-model ultracentrifuges use an optical overspeed disc and electronic sensing device to prevent rotors from running at speeds above the safe operating range. Over time, these overspeed discs can become scratched or damaged due to age and/or improper handling. Once damaged, they must be replaced. It is possible to apply the wrong overspeed protection disc to a rotor. Let's examine a worst-case scenario. Suppose a Type 19 rotor, weighing 17 kg (38 lbs) fully loaded, was accelerated past its maximum speed due to a misapplied overspeed disc. The resulting rotor failure would be safely contained if used in a suitably tested system, i.e., a Beckman Coulter ultracentrifuge. The failure would result in a fair amount of damage and a substantial monetary loss to the owner of

the centrifuge. In order to avoid this possibility, Beckman Coulter ultracentrifuges utilize a software and hardware system known as Dynamic Rotor Inertia Check (DRIC). The DRIC system works as the rotor is accelerated. Sophisticated software measures various parameters such as energy and inertia values. The software calculates the parameters of energy and inertia used by the rotor in use, and compares that with the parameters of the rotor that is detected by the overspeed disc. If there is a discrepancy, the instrument stops the run with braking to avoid possible damage, and sends a diagnostic message to alert you to this condition.

To put it simply, the Optima X Series ultracentrifuge automatically checks for possible errors in rotor/rotor overspeed disc combination and makes the necessary correction for you. This feature is only available in Beckman Coulter floor-model ultracentrifuges. This feature is a product of our basic design philosophy. Safety is number one, and we use redundant systems to assure that routine errors don't become big expenses. That is not the case with other ultracentrifuges.

Ultracentrifuges produce unique challenges to modern researchers. Their use has become so commonplace that complacency can set in during use. Because of the enormous amount of force generated by these instruments,

this is a mistake. Every year laboratory mishaps occur that damage equipment, strain budgets, and waste valuable time and resources. Oftentimes these mistakes are a result of the tremendous safety measures built into modern ultracentrifuges, as their safe operation is taken for granted. These are systems and not stand-alone pieces. Every centrifuge has characteristics of stiffness and bend for its frame, containment features, door, drive, drive shaft and hub design, etc. These characteristics must be taken into consideration with the design of the rotors they will run and the labware used in those rotors. Each of these components contributes its own unique characteristic features to the system. For this reason, only a holistic approach to design and operation can maximize performance and safety.

To summarize, a centrifuge is a system, not a set of individual parts. Only by designing each piece of the system to the unique characteristics and interplay of dynamics can performance and safety be maximized. Beckman Coulter believes strongly that a holistic approach to design and manufacture leads to better, safer, more accurate research. In short, we believe in taking the extra steps to assure your safety and maximize your research results.



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