***Case study for Amber Kinetics on Flywheel design***

***(Pictures will be included later)***

**Introduction:**

Flywheels are used to store energy and applied to different applications .Flywheel systems' ability to capture regenerative energy repetitively that normally would be wasted as heat, delivers significant energy savings and reduced fuel costs while reducing a full range of toxic emissions hence providing clean, reliable and sustainable energy efficiency.

**Method:**

The flywheel works by accelerating a rotor to very high rotational speeds. These can range from 20,000 to 50,000 RPM. The rotational energy Is converted to other forms of energy and when energy is extracted the flywheel loses speed as a result of conservation of energy. Usually electricity is used to turn the rotor of the flywheel inside a chamber under vacuum conditions. The rotors are made of high strength carbon fiber composites and suspended by magnetic bearings to reduce frictional losses. The chamber is under vacuum so losses from air resistance are reduced to the minimum. The vacuum levels can vary a lot but for rail applications <0.01 mbar is a common requirement.

**Challenges:**

Typically, flywheels are planted in the ground and used for outdoor power applications .In areas where the ambient temperature is hot and humid, most of the dry vacuum pumps won’t be able to perform due to their working temperature range .The pumps should be able to run in temperatures up to 50 degree C . Besides the concern for high ambient temperatures, the working fluid may have moisture as well which cannot be handled by standard dry pumps. Rotary vane pumps cannot be used in such conditions, as the oil will get polluted with moisture and even if a moisture trap is used the yearly oil replacement introduces downtime, labor costs and inconvenience.

**Solution:**

The SVF dry scroll vacuum pumps have an ambient working temperature range between -20 degree C to 50 degree C hence they are suitable for outdoor environments as long as sufficient cooling is provided, and the ambient temperature doesn’t exceed 50 degree C. Adequate vacuum levels of less than 0.03 mbar can be pulled in the flywheel chamber which usually has an internal volume of 500 L. The unique patent protected floating scroll technology is designed to push the fluid out of the scroll pockets, hence any moisture will be pushed out from the pump outlet without any issues. The SVF series is tip seal free as compared to standard scroll pumps hence requires no maintenance for over 12,000 hours running time. The flywheel system typically has a life of 5-7 years and the duty cycle can range from 20-60 percent for the vacuum pump thus the vacuum pump can last for the entire life of the flywheel making these units ideal for flywheel applications.