AGN 180 - Unbalanced Magnetic Pull (UMP)

DEFINITION

When a rotor is centrally situated within an alternator's stator, a uniform air gap exists and the magnetic attraction exerting radial forces is in balance.

If either the rotor is displaced from its central position, or the stator or is out of round, the change in reluctance of the magnetic flux paths has the effect of increasing the flux density (magnetic attraction) where the air gap is smaller, and reducing it where the air gap is larger. The magnetic attraction forces are, under these circumstances, unbalanced and this unbalanced condition is referred to as Unbalanced Magnetic Pull (UMP).

DESCRIPTION

The UMP in a three-phase alternator under no-load, caused by dynamic and static eccentricity, is calculated theoretically. The air-gap permeance is expressed as a Fourier series. Analytical expressions of the UMP for any rotor pole-pair number are obtained. Effects of relative eccentricity and pole number on the magnitude of the UMP are obtained. The vibration of a model rotor in a three-phase alternator under the action of the UMP and the eccentric force is analyzed by the numerical method and the harmonic analysis.

UMP is quantified as force over distance and is measured in kNewtons/millimeter (kN/mm). These UMP figures are available for all alternators, based on the 'per mm of air gap' for that alternator.

It is generally accepted that the rotor will not run in perfect concentric alignment with the stator bore, due to manufacturing tolerances of the alternator components. Also, the manufacturing tolerances of the engine, when considering a single bearing alternator. The typical assumption is that the rotor will run displaced from perfect concentricity by <10% of the air gap distance.

This assumption introduces the typical 'in service UMP' for an alternator, which is now based on the following formula:

- (Quoted UMP x Quoted Air gap mm) x 0.1

For example, the in service UMP on a HC5 F-core alternator is:

- Quoted Air gap for HC 5 design is 2.5mm
- Quoted UMP for the HC5F design is 10.25 kN/mm.

- Typical In-service UMP = (10.25 x 2.5) x 0.1 = 2.56kN

Contact Application Engineering for air gap and UMP data for AvK and STAMFORD alternators, at applications@cummins.com.