The Finite Element Analysis of The Deflection of The Crankshaft of Rotary Compressor

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Two balancers are used to ensure stability → Imbalance forces → Deflection of crankshaft → Motor performance

How to get it → Deflection of crankshaft

Test → FEM simulation → Build test set-up

Wear → Noise and vibration
FEM analysis

- **Centrifugal inertia forces**
  \[ F_i = m_i \omega^2 r_i \]

- **Imbalance magnetic force**
  \[ F_m = K_m e_m \]
  \[ K_m = \frac{\alpha \pi D l_{ef}}{\delta} \left( \frac{B^2}{2 \mu_0} \right) \]

- **Gas force**
  \[ F_g = R L (1 - \tau) (P_\theta - P_{s0}) \sqrt{2 (1 - \cos \theta) + \frac{\tau}{1 - \tau} (1 - \cos 2\theta)} \]
FEM analysis

Load: Rated load
Speed range: 2400 rpm ~ 5400 rpm

Figure: Deflection Fringe Result
Figure: Calculated Deflection versus Speed of Rotation
Experimental component

Sensor-Ⅰ: is used to measure the direction-x deformation
Sensor-Ⅱ: is used to measure the direction-y deformation
Sensor-Ⅲ: is used to determinate the starting angle

Figure: Experimental set-up
Experimental component

Sensor data without load

Sensor data in rated load

60rpm

2400rpm~5400rpm
### Experimental component

**Orbit of the Top Dead Centre of the Crankshaft**

![Graph showing the orbit of the Top Dead Centre of the Crankshaft](image)

**Measured Deflection vs. Calculated Deflection**

![Graph comparing measured and calculated deflection vs. speed of rotation](image)
Influence factors analysis

Height of the top-flange:

![Diagram showing the height of the top-flange and a graph showing the relationship between deflection and height of the top-flange]
Diameter of the crankshaft:

Influence factors analysis
Influence factors analysis

Average air gap of the motor:
Influence factors analysis

Weight of the rotor

![Image of rotor with weight indicated]

Graph showing the correlation between weight of the rotor and deflection.
(1) The more accurate deflection data was obtained by the improved measurement method.

(2) A simulation method of the crankshaft deflection was established, in good agreement with the experimental results. It is valid for compressor design.

(3) Influence factors: with the increase of the height of top-flange, the diameter of the crankshaft and the motor air gap, crankshaft deflection decreases, and it increases with the increase of the weight of the motor.
Thanks for your attention!