

### Bearing Life in Direct and Belt Driven Systems

Belt drive and direct drive are the two basic means of powering fans and blowers. In belt driven systems, the motor is connected to the fan shaft via sheaves and belts. In a direct driven fan system the motor shaft is instead coupled directly to the impeller through the use of a keyed shaft or through bolt. While both cases have a set of motor bearings, belt driven fans have additional sets of pillow block bearings.

Bearing life is often expressed in terms of hours. More specifically, “L<sub>10</sub>” life and average life are most often encountered. In the case of L<sub>10</sub> life, this number represents the number of hours of operation by which 10% of a group of bearings will have failed. Conversely, after operating for this amount of time, 90% of the bearings with this life rating would still be operational. Average life, or L<sub>50</sub> life, represents the “average” bearing life, or when half of a group of bearings can be expected to have failed. L<sub>50</sub> life is expressed as 5 \* L<sub>10</sub> life. A simplified L<sub>10</sub> formula for a constant speed ball bearing is as follows:

$$L_{10}(\text{hours}) = \left( \frac{\text{Rated Dynamic Load}}{\text{Dynamic Load}} \right)^3 * \left( \frac{10^6}{60 * \text{RPM}} \right)$$

Here the main difference between a belt drive and a direct drive fan is in the *Dynamic Load* value. This value represents the composite moment of inertia acting on the bearing as a result of the loading forces. In belt driven fan motor bearings, this force chiefly results from belt tension (B1), but fan imbalance (C1) and component weights (A1) also contribute. On the other hand, direct driven fan bearings experience primary loading due to the weight of the fan wheel (A2), but also fan imbalance (C2) and fan load resistance (B2).

For comparison consider a perfectly balanced, 3 horsepower fan motor selection with negligible component weight. In a belt driven fan system the motor belts would typically be tensioned at 73 pounds, which translates to around 156 pounds of bearing loading. On the other hand, a direct drive system with the same size motor would see a bearing loading of around 20 pounds due to the fan wheel weight.

Direct driven motor bearings typically last longer than their belt driven counterparts as they are not subject to belt tension forces. Direct driven mechanical failures are less likely due to the absence of the sheaves, belts, and extra bearings associated with belt driven systems. The direct connection of motor to fan also allows direct driven fans to more efficiently transfer power. The efficiency and reliability of direct drive systems make them powerful tools to leverage in HVAC design.

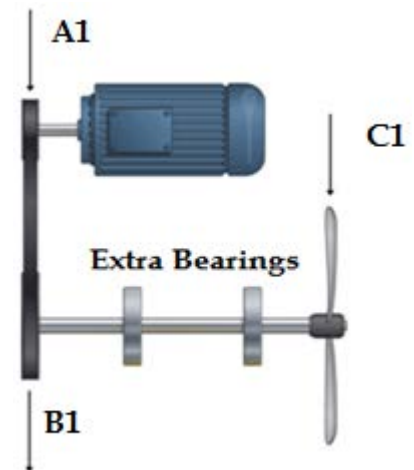


Figure 1: Belt drive bearing forces

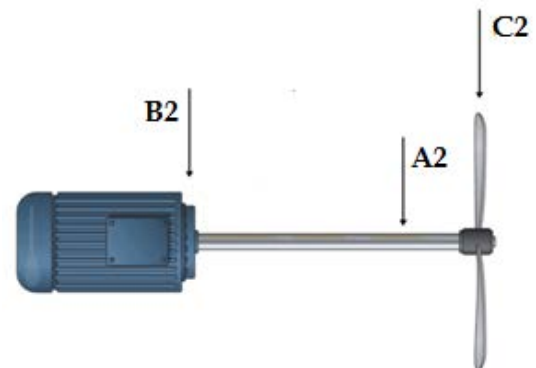


Figure 2: Direct drive bearing forces