

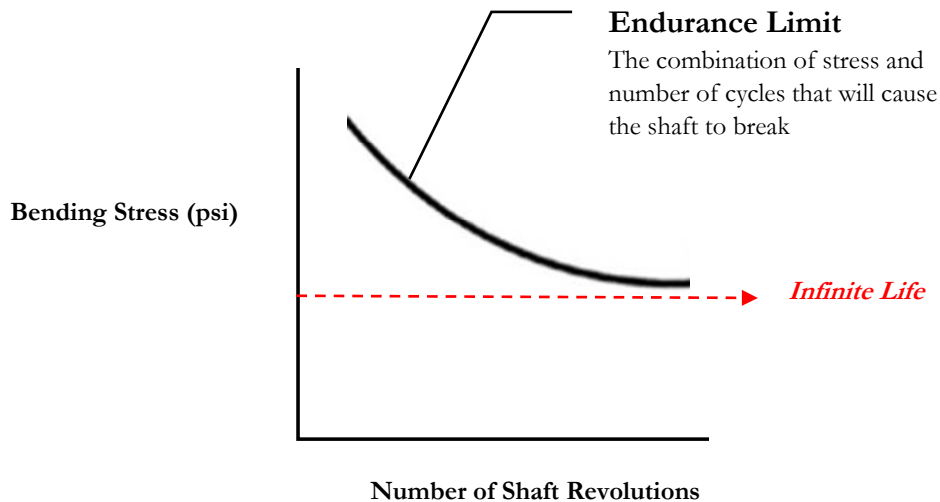
Pump Improvement Note

SUBJECT: Pump Shaft Breakage

PPS PIN #101

Discussion:

Pump shafts should never break. They are normally designed such that the stresses are below the endurance limit, resulting in “infinite life”.



**Boiler Feed Pump Shaft
with Fatigue Failure in
Threaded Area**

In general, if the stresses are below 50% of the tensile strength the shaft will have infinite life.

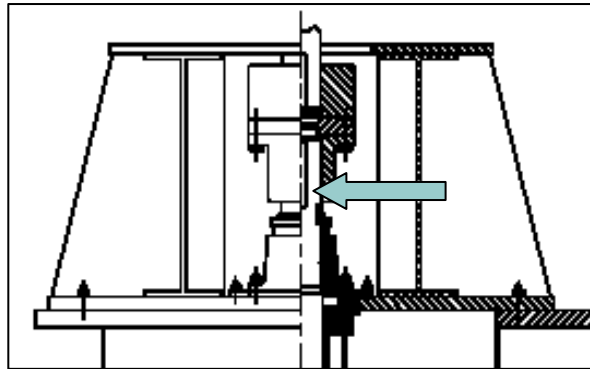
However, the endurance limit can be reduced by 50% or more by stress risers and the corrosive effects of fluid.

Typical causes of pump shaft breaks:

- **Lack of proper radius in threads, keyway or split ring (stress riser)**
- **Wrong material**
 - Inadequate tensile strength
 - Material susceptible to pitting or stress corrosion cracking
 - Liquid more corrosive than expected
- **Excess loading**
 - Operation at low flow rates
 - Running with high vibration / transients / excessive starts
 - Runout of axially loaded parts
- **Design**
 - Shaft too skinny—inadequate design margin
- **Residual stresses from processing**
 - Improper stress relieve
 - Prior straightening



SUBJECT: Pump Shaft Breakage



Circulating water pump with shaft break at drive keyway due to excessive design stresses (Shaft is too skinny)

Recommendations for shaft failure analysis:

- o **Inspect shaft** for proper radii in keyways, threads, and split ring grooves
- o **Check for perpendicularity** of thrust collar, balance drum, and split rings
- o **Determine nature of failure** from fracture surface. It is important to determine how the fracture *started* – we know how it ended...
- o **Review water chemistry** vs. material selection
- o **Review design stresses** (some OEM's used excessive stresses to minimize shaft diameter, resulting in increased failure rate)
- o **Review maintenance history** of shaft
 - Stress relief
 - Any heat or cold straightening
- o **Consider material or design upgrades** to increase design margin