# *SUBMERSIBLE MOTORS*

## *SPLINE WEAR*

Spline wear has been observed for many years on submersible motors and pump couplings. In early 1989 Franklin Electric and Crucible Research conducted an extensive study of this problem on 4" submersible motors. This is a brief summary of that study along with additional observations since the 1989 study by Franklin Electric.

### Why do splines wear?

The 1989 Crucible Research report stated that the spline wear was the result of fretting and abrasion, with the presence of silicon (sand) and calcium (lime) compounding the problem.

The mechanism of fretting failure is:

1. Initial adhesion (or asperity locking) of two coupled materials under load. This is commonly called cold welding.

2. Motion between the shaft and coupling rupture the cold weld, producing free particles that oxidize and become very hard.

3. Continued abrasion from hard oxide debris. The hard oxide debris imbeds itself in the softer material and continues to abrade the harder material on the mating spline. (This explains why the harder shaft material (R36) wears with little or no apparent wear to the coupling.)

Additional observations were corner loading of the spline initiating the wear and roughness of the machined spline surfaces concentrating the loading.

Laboratory testing by Franklin Electric of various pumps with deliberate misalignment, bent pump shafts, pump offset and loose couplings did not cause significant spline wear. Spline wear was however observed with pump misalignment in combination with zero head (pump upthrusting).

Since the above report was issued a higher incidence of spline wear on pumps that do not apply thrust to the motor shaft has been observed. In light of this spline wear as observed on upthrusting motors, we suspect the increased relative movement between the coupling and shaft that this condition allows, increases the possibility of spline wear.

Spline wear has proven to be difficult to analyze, in part because in these applications the failure is usually catastrophic when discovered. The 1989 report did include some spline wear conditions where other failure modes occurred prior to the total spline failure. This provided Crucible Research with much needed partial wear observations. From data obtained in the 1989 study and through investigation of failures the following recommendations can be made.

### Recommendations:

1. Spline couplings should be assembled with waterproof grease and care must be taken to assure the coupling is designed to make use of the spline seal as designed into the slinger of the motor. This is necessary in order to prevent sand from entering the spline area.

2. Coupling density (powdered metal parts) need to be as high as possible.

3. Assure coupling spline is dimensionally correct to provide uniform tooth loading.

4. Avoid pumping conditions that cause upthrusting.