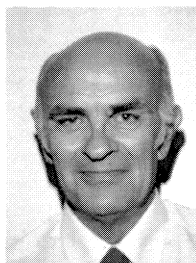


# APPLICATION OF SINGLE MEMBRANE TYPE FLEXIBLE POWER TRANSMISSION COUPLINGS

by

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## INTRODUCTION

The purpose of a flexible coupling is to transmit torque from a driver to a driven machine. It is the responsibility of the application engineer to assure that the coupling selected will transmit this torque with a minimum of extraneous forces and perturbations. The advantages of the single membrane type coupling in accomplishing this purpose will be discussed herein.

## DISCUSSION

### *General Application Considerations*

In addition to the basic torque transmission requirements of torque/horsepower and speed, there are numerous other considerations which must be recognized in the selection of a coupling for a given application.

Shaft end configurations and the distance between shaft ends should be determined as early in the engineering phase as possible. These two items affect both maintenance installation and removal accessibility, and influence the ability to fine tune torsional spring rates, as required.

Parallel alignment transients and overhung weight limitations are also governing factors and are, in turn, related to coupling spacer length, shaft end configuration and membrane design.

Axial transients due to thermal growth must be reviewed prior to the coupling selection. Some coupling applications require axial movement capabilities in excess of 0.75 inches. This necessitates a special design for single membrane couplings.

Ambient conditions of temperature, humidity and corrosive components in the atmosphere must be included in the design parameters to ensure the provision of appropriate metallurgy and protective coatings.

### *Advantages of Single Membrane Design*

The advantages and disadvantages discussed here are relative to gear type couplings. Some *multiple* membrane

couplings provide the same advantages and disadvantages.

The design philosophy of the single membrane coupling involves no surface-to-surface sliding friction. All movement within the coupling due to misalignment is absorbed by controlled flexure of the membrane. No lubrication is required and, if the coupling is properly designed and installed, it has an infinite life expectancy. The exception to this infinite time span is found when wear and/or damage occur, due to disassembly and reassembly for other maintenance activities. The coupling *per se* requires no maintenance.

Since misalignment results only in flexure of the membrane, the forces resulting from misalignment are smooth, predictable and repeatable. This eliminates the unknowns in the system due to the uncertainties of determining friction factors. It also removes any uneven forces during a single revolution of the rotors which can be caused by poorly machined gear surfaces of "proud" teeth in the gears.

### *Disadvantages of Single Membrane Design*

The diameters of single membrane couplings are generally larger than those of gear couplings of the same torque transmission capability. In some applications this creates a space problem, as well as an installation and removal problem. In addition, the windage created by the larger diameter can generate excessive heat in the coupling guard.

The amount of heat generated by windage can be approximated by using manufacturers' calculation methods. The heat generated is a function of the coupling guard length and diameter relative to the coupling membrane diameter and coupling speed (Figure 1).

Heat generation can be reduced if it is possible to increase the diameter of the coupling guard. If this is *not* possible, then provision must be made for the circulation of air through the coupling guard by judicious placement of vents, drains and breathers.

Although axial forces generated by large thermal growth transients are predictable, the single membrane is essentially a limited end float design and the changes required to provide long axial travel are considerably more complicated and expensive than those involved in a gear coupling. Manufacturers use various methods for this accomplishment. One method is to use multiple membranes, as shown in Figure 2. Another is to use a convoluted membrane, as shown in Figure 3. These methods require that the spacer be installed "cold" with a prescribed amount of prestretch or precompression to provide a relatively relaxed membrane in the "hot" or running condition. These methods have been used very successfully.

Examination of Figures 4 and 5 indicate that the single membrane is contoured to provide optimum curvature throughout the flexure range. This precludes overstressing the membrane material at any point within the range of misalignment specified. When specified misalignment limitations are observed, the membrane will not be subjected to sufficient deformation to cause fatigue. To further assure that the mem-

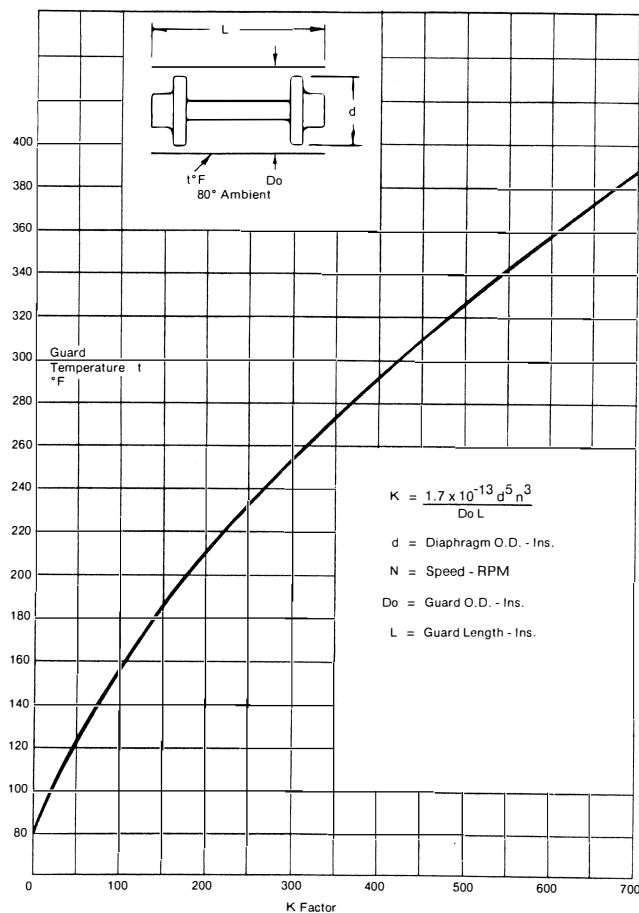


Figure 1. Temperature Calculating for Coupling Housings K Factor.

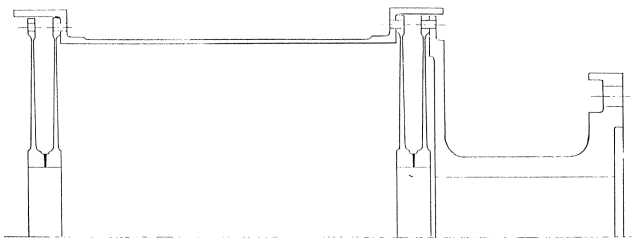


Figure 2. Multiple Membrane.

branes will not be subjected to pitting or corrosion and resultant stress risers, the manufacturers provide the membrane assemblies with very carefully applied protective coatings. These coatings are subject to mechanical damage during installation and removal. Reasonable care must be exercised when handling the coupling components to avoid damage to the coatings.

#### Balancing Requirements

The increasing use of higher speeds and higher horsepower in modern turbomachinery applications has been accompanied by a rising incidence of problems with coupling unbalance.

These problems can be divided into two categories:

- Insufficient balancing accuracy by the coupling manufacturers.
- Lack of repeatability of the balance accuracy upon disassembly and reassembly.

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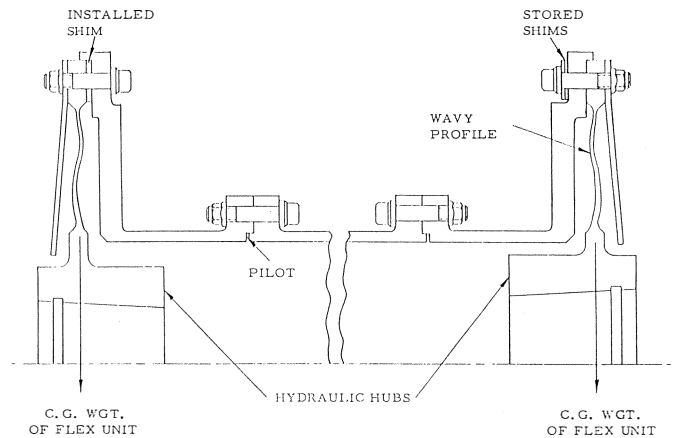


Figure 3. Convoluted or Wavy Membrane (Note piloted fits to conform with API 671).

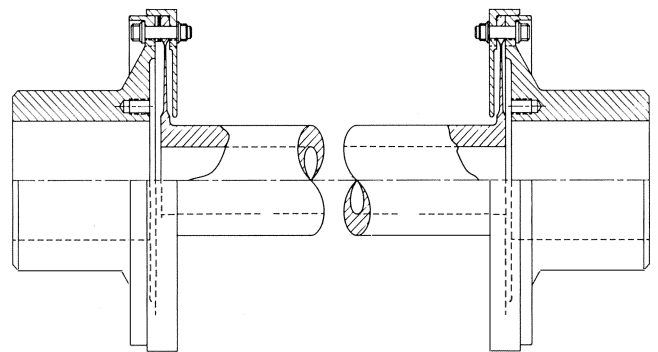


Figure 4. Standard Single Membrane Coupling (Note piloted fits at membrane periphery to conform with API 671).

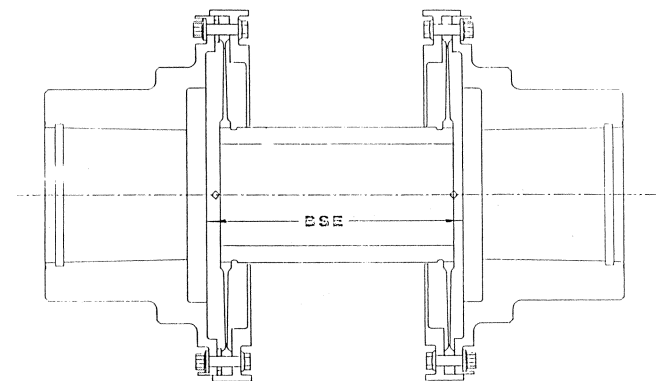


Figure 5. Standard Single Membrane Coupling.

Manufacturers build couplings to their own standards unless specified otherwise by the purchaser. These standards include parameters on the coupling residual unbalance. A high degree of experience and expertise is essential to the process of setting up specifications for coupling residual unbalance in order to provide an adequately balanced coupling for a particular application without spending money needlessly for excessively stringent requirements. This is normally incorporated by the manufacturers of the driver and driven equipment, based on the analysis of the rotor response due to the unbalance in the overhung coupling weight. The end users' applica-

tion engineer should be cognizant, however, of the residual unbalance requirements, and should review the procedures and fixtures used by the manufacturer for the purpose of providing a coupling balanced to the needs of the application.

Since flexible couplings consist of multiple components, and have been built for flexibility, it is necessary to use specially designed jigs and fixtures to hold all of the components in a straight and concentric position during balancing. The accuracy of the pre-balance of the jigs and fixtures and their capability to hold the coupling assembly in accurate alignment during balancing can add to the balancing errors.

Couplings must be disassembled after balancing in order to install them in the machine, thus opening the door for additional possibilities for unbalance to enter. These possibilities include the question of accuracy of the component balance of bolts and nuts and the component pilot surface eccentricities.

Because of the many possibilities for balancing errors, unbalance in a machine train often occurs, either on the test stand or during field commissioning, which can be traced back

to the coupling. Assuming that the machine train has adequate vibration monitoring equipment, the coupling unbalance can be separated from residual unbalance in the driver and driven rotors by using an organized procedure. One such procedure is described in *High Speed Rotating Machinery Unbalance, Coupling or Rotor*, by Anthony R. Winkler, Test Engineer for Dresser/Clark, Olean, New York. His paper covers the methods and equipment required to obtain data regarding unbalance in a machine train, which will aid in making a decision regarding corrective action for such unbalance.

American Petroleum Institute Standard 671 is a comprehensive specification for the purpose of coupling purchase. It is important, however, that the engineer using this standard be not only aware of the contents, but also have a working knowledge of the *reasons* for the requirements therein.

