TECHNICAL DATA

Basic Theory of Sealing

In order to provide a leak-free joint between any two members of an assembly, one condition must be met: The size of the potential leakage paths must be smaller than the molecular size of the medium to be confined. As long as this is true, total sealing will be achieved. If this condition is not met, the extent of the resulting leakage will be governed by the laws of fluid mechanics and thermodynamics.

Simply stated, the extent of the leakage will be determined by the number of molecules allowed to pass simultaneously through any given section of the joint and the driving force (differential pressure) behind them.

The task relegated to the gasket, therefore, is to yield (or flow) sufficiently into the minute asperities of the two mating members of the joint in order to limit the size of the potential leakage paths to nothing larger than the molecular size of the confined medium. Having done this, the gasket must retain that condition for the expected life of the assembly.

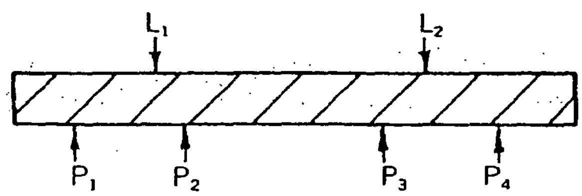
As simple as the foregoing appears, the real problems encountered in any application are caused by the environment of the joint. Such factors as chemical and thermal reaction between the confined medium and the gasket material, system vibrations, relative motion between mating surfaces, and pressure of the confined medium all influence the performance of the gasketed joint. Identification of the magnitude of each of these factors is a necessity prior to successful design of a gasket.

Extension of Basic Theory to the Mechanism of Sealing the Cylinder Head

The Dynamic Case

In order to effectively seal the cylinder head of the typical reciprocating piston engine, adherence to the basic theory of sealing must be embraced. One further factor must be recognized, however. As the firing pressures in the combustion chamber produce assembly deflections of some magnitude, the cylinder head gasket must accommodate them while attempting to seal the combustion gases. The system deflections and the consequential gasket motion result in a reciprocating stress (or load) condition on the gasket and its components. Unless the magnitudes of the operating stress limits on the gasket are considered, success of any gasket would be due strictly to chance.

To completely understand this mechanism of operation, one should refer to an ideal free body force diagram of the cylinder head (FIG. 1). In this figure, L_1 & L_2 are equal and represent the bolting forces. P_1, P_2, P_3 & P_4 are equal and represent the compressive forces common to the gasket. As the figure shows, the system is in equilibrium since the sum of the forces is equal to zero.



As the engine is fired, however, the combustion force must be added, F_V (FIG. 2). The combustion force can be calculated from the firing pressure (peak) and the area over which it acts,

$$F_V = p_{max} A$$