COJINETES DE FRICCION

BEARING DESIGN SOFTWARE

INTRODUCTION

Cojinetes de Fricción has developed a specific computer science program for the design of bearings. This program evaluates the performance of connecting-rod and main bearings of internal combustion reciprocating engines.

The study comprises the following parts:

A. Calculation of loads exerted on the bearings

The force acting on the bearing is the sum of the force of combustion pressure in the cylinder and the forces of inertia of the piston/connecting-rod/crankshaft mechanism.

Where the curve is not known, combustion pressure throughout the cycle is predicted by using a thermodynamic combustion model (zero dimensional) that makes use of a rate of heat release equation specifically adapted to spark-ignition or to compression-ignition (direct or indirect injection) engines.

For each speed, the inertia forces are calculated from the mass and geometry of the piston/connecting-rod/ crankshaft mechanism.

B. Calculation of lubrication conditions

These calculations are based on the solution to the Reynolds equation for hydrodynamic lubrication, using the Mobility Method.

CURVES OBTAINED

The origin of angles for all curves is established when the piston of cylinder no. 1 is at intake stroke TDC.

1. Combustion pressure diagram

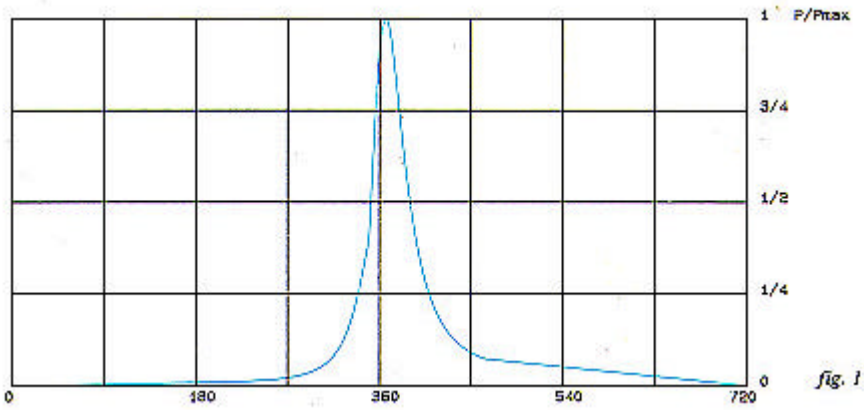

fig. 1

It represents the pressure inside the cylinder as a function of crankshaft angle.

2. Polar load diagram

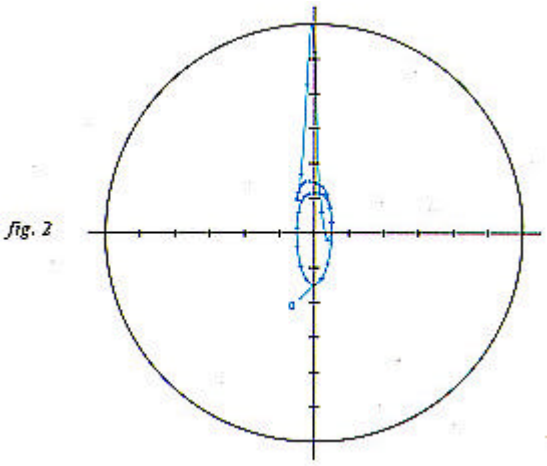

fig. 2

This represents the load exerted upon a bearing during the course of one complete engine cycle. The system of reference remains fixed in the bearing and is so designed that the central vertical line of the diagram coincides with the central line of the connecting-rod in the case of connecting-rod bearing, and with the axis of the cylinder in the case of main bearings.

This diagram allows one to calculate maximum specific pressure of the bearing.

3. Journal orbit diagram

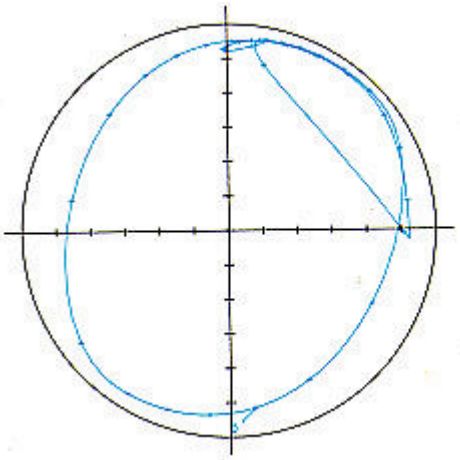

fig. 3

This represents the geometrical situation of the positions occupied by the centre of the journal in the course of one engine cycle.

The radius of the diagram is equal to the radial clearance.

The journal orbit diagram makes it possible to obtain the minimum oil-film thickness, which is one of the most important parameters for describing bearing performance.

4. Oil-film pressure diagram

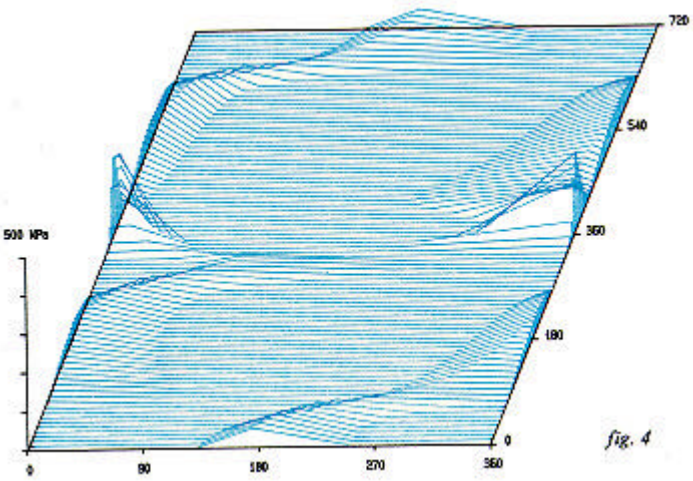

fig. 4

This represents the magnitude and extension of oil-film pressure for each crankshaft angle.

Axis X represents a projection of the bearing, with the values of 0º and 360º corresponding to the highest point of the bearing.

Maximum oil-film pressure enables one to calculate the degree of fatigue strength which the bearing alloy must be able to withstand.

5. Location of oil holes

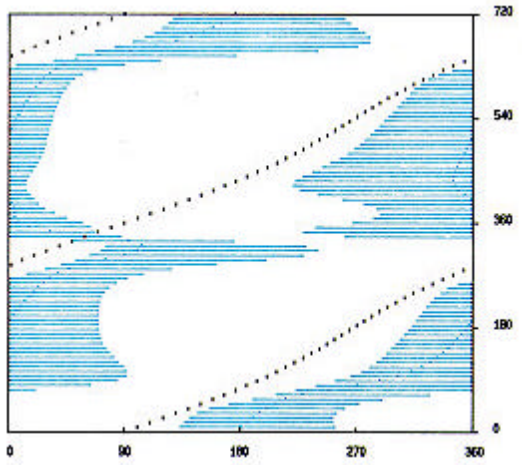

fig. 5

This is a two-dimensional projection of the oil-pressure diagram which allows one to choose where to drill the oil holes for the journal and bearings in order to avoid crossing zones of positive hydro-dynamic pressure (horizontal lines).

As regards the holes in the big-end crankpin, the wavy line is caused by the oscillating movement of the connecting-rod.

The holes in the bearing can be represented by a vertical line crossing the diagram from top to bottom, for a given bearing angle.

6. Relative wear diagram

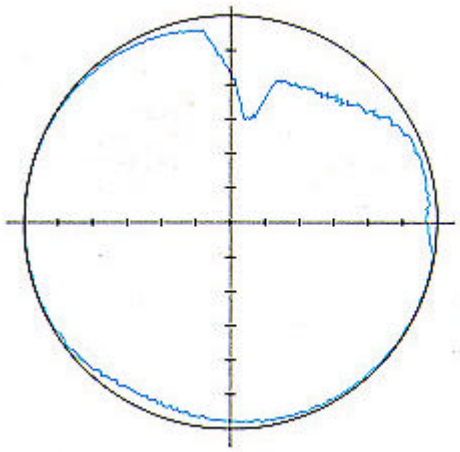

fig. 6

This reflects the duration and proximity of the journal's dwell at varying points along the bearing profile and indicates where bearing wear is most likely to occur. This is where the journal loiters longest under minimum film conditions and proximity of the journal to the bearing is an indicator of probable wear.

The maximum wear value is a non-dimensional number that can only be used for comparison.

FINAL CONSIDERATIONS

The results furnished by this program may not be used quantitatively because of the simplifications introduced in order to solve the Reynolds equation.

All conclusions obtained are the product of a comparison between the results of this study with those of other prior studies of similar engines with known bearing performance.

In this respect, it must be said that the above program has been successfully applied to numerous problems relating to bearings and also supplies the information required to choose the value of important parameters such as clearance, materials, oil viscosity with respect to oil-film thickness and pressure, wear, friction loss and so forth.