PROMPT

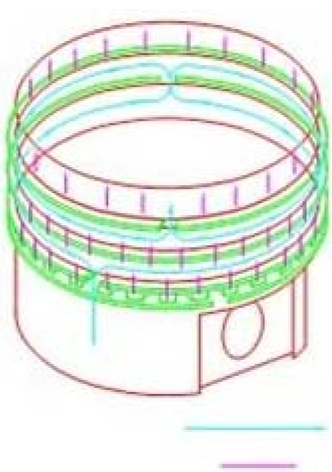
C-K Engineering
Innovative Solutions

Piston/Ring Optimizing Model for Performance Technology

Ring Pack Key Features

- Windows-based program with tree interface for selecting desired data entry screens
- Ability to consider approximately forty input variables including ring face profiles, ring cross sections and piston land geometries and engine geometry operating conditions
- Modeling of ring conformability to permit ring-to-bore orifice areas and pressure variations to be considered
- Modeling of two and three piece oil rings
- Calculation and display of specific outputs
- Gas Flow – positive and negative
- Ring movement, Ring force – top/bottom groove
- Ring Twist
- Oil film thickness
- Friction – individual rings

Oil Flow Paths



Minimum Recommended Hardware Requirements:

- 200 MHz Pentium computer
- 32 MB RAM
- 4 GB hard disk drive
  - 21 MB for program files
  - 4-21 MB per analysis
- Super VGA monitor (17”)

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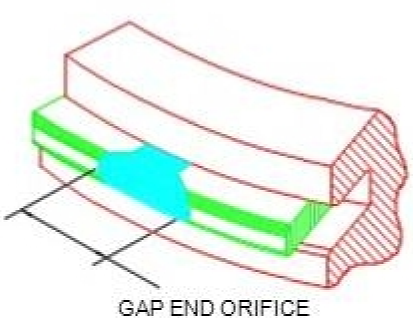
PROMPT is a state-of-the-art Windows-based cylinder kit Analysis model. Cylinder kit dimensional data is entered Through use of an input tree to access data entry screens. Default values are available for use in cases where Complete data may not be available. However, use of Default values may decrease the precision of results.

PROMPT is a fourth-generation cylinder kit model that has Evolved over thirty years of effort to develop an effective Analysis and methodology to understand the effect of more Than forty dimensional variables on cylinder kit performance.

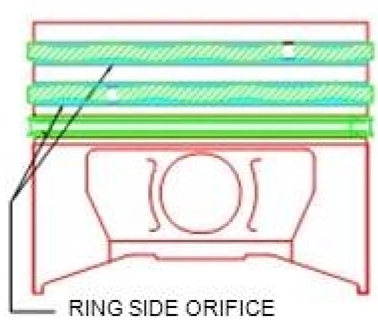
By using combustion pressure, data from an engine at the Speed and load conditions under consideration, the PROMPT model can be used to optimize mean value, Tolerance, and relationships among variables .

The model considers the total effect of orifice area for Top, second and oil rings. The total effect orifice area Is comprised of the three orifice areas shown below.

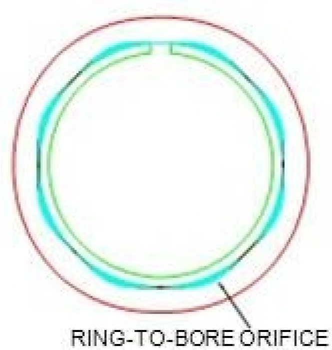
Ring Gap End



Between Ring Side and Groove Side



Between Ring Face and Cylinder Bore



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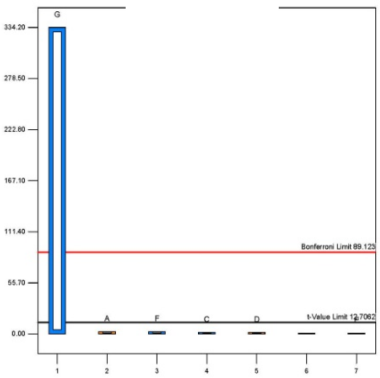
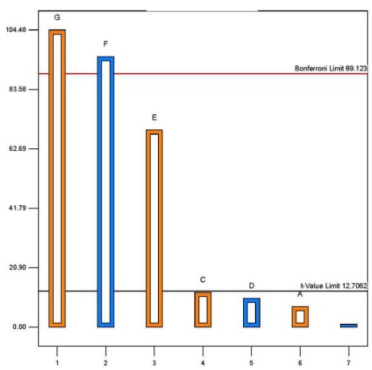
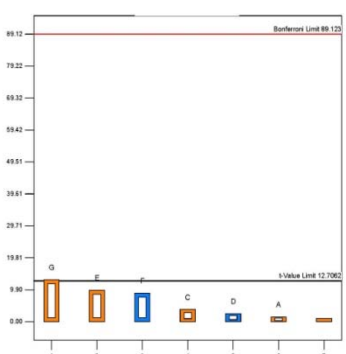
Reverse blowby



Hydrocarbon



Friction



The basic model and its related methodology for planning the study and reducing the resultant data have been successfully applied to improve the performance of:

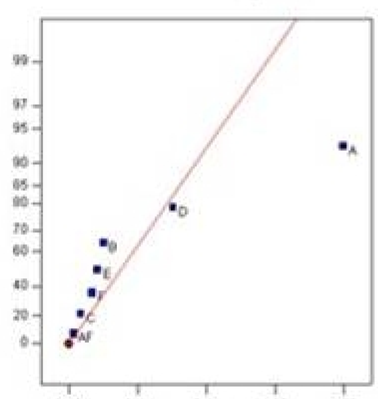
- Small industrial/lawn mower engines
- Automotive engines
- Diesel engines ranging in size from a few horsepower to several thousand horsepower
- High-performance (race) engines

In order to achieve this improved performance, the model utilizes entered cylinder kit geometry data and the combustion pressure diagram developed in the engine at the speed and load conditions of interest.

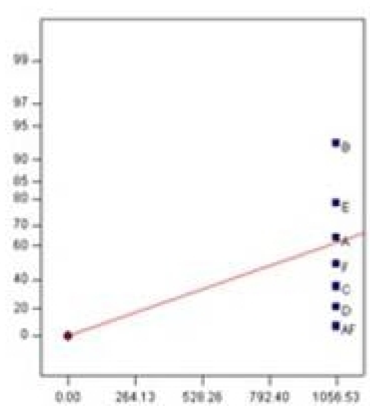
The model treats the cylinder kit as a series of orifaces/accumulator volumes to calculate:

- Blowby (quantitatively)
- Oil consumption (qualitatively
- Friction (quantitatively)
- Hydrocarbon emissions

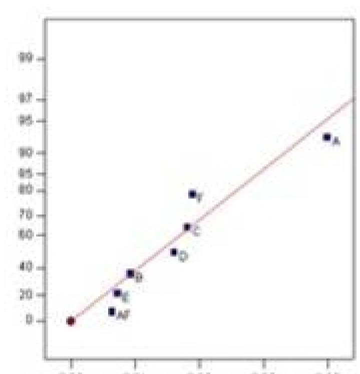
Oil Consumption



Blowby



Friction



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Design of Experiments (DOE)

Design of Experiments (DOE) has been utilized to effectively plan studies considering as many as 12 of the possible variables and evaluate their effect on oil consumption, blowby, and friction. Typical Half-Normal and Pareto graphs provide a ranking of the importance of each variable studied.

Factors affecting oil control, blowby, and friction include:

Engine
- Load
- Speed
- Design

Cylinder
- Bore geometry
- Bore finish

Piston
- Top land diameter
- Top land width
- Top ring groove width
- Second land diameter
- Second land OD corner chamfer
- Second ring groove width
- Second ring groove root diameter
- Third land diameter
- Third land OD corner chamfer beneath second ring groove

Crankcase pressure/vacuum

Top ring
- Width
- Radial wall
- End clearance
- Chamfer size at gap end
- Non-flatness (twist)
- Groove non-flatness
- Void area ring face to cylinder bore
- Face profile

Second ring
- Width
- Radial wall
- Ring end clearance
- Chamfer size at gap end
- Groove non-flatness
- Void area ring face to cylinder bore
- Tension
- Material modulus
- Free shape

Oil ring
- Width
- Radial wall
- Gap end chamfer size
- Groove non-flatness
- Void area ring face to cylinder bore
- Tension
- Material modulus
- Expander load and distribution
- Face profile
- Drain back area

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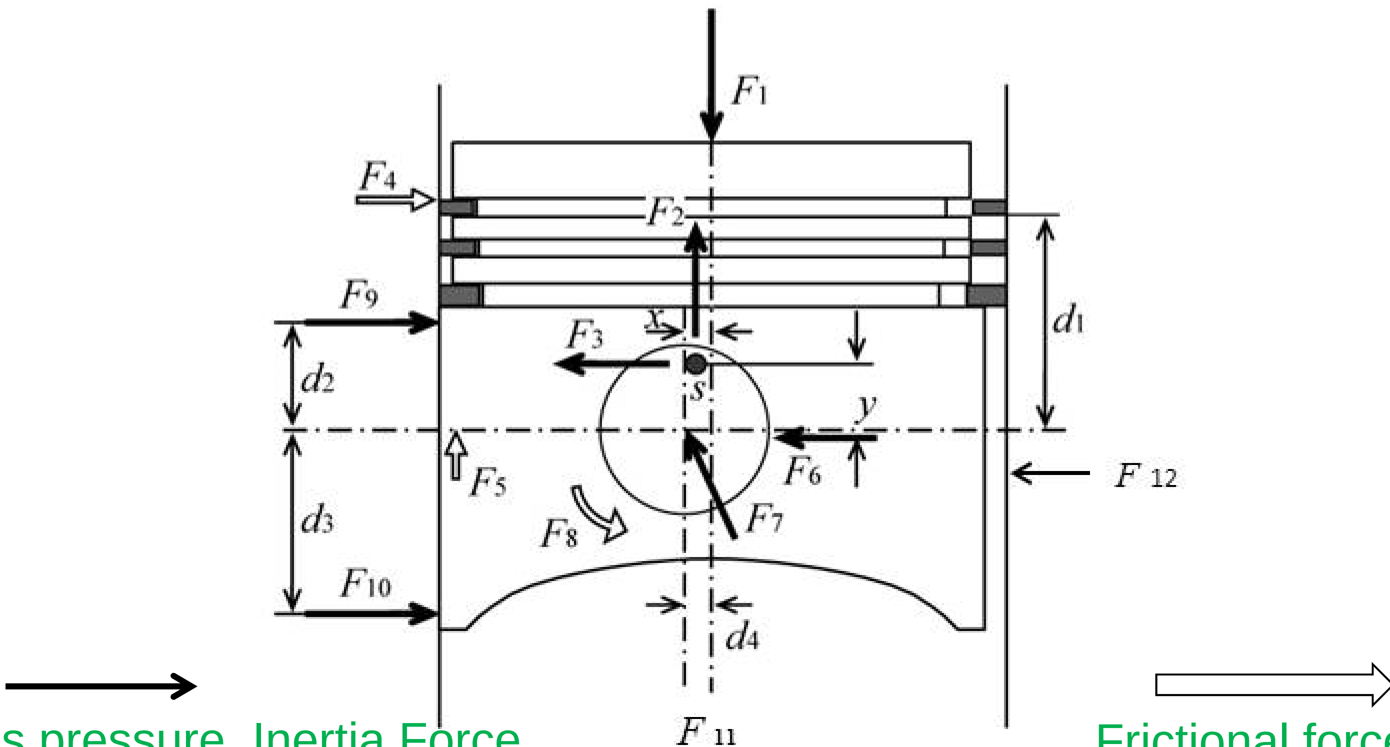
Piston Motion Modeling

Piston Motion – High Accuracy Measurement Under Running Conditions



Gas pressure, Inertia Force, Bearing Resistance, Piston Skirt Axial Profile

Frictional force, Frictional torque

F1 : In cycle pressure
F2: Vertical inertia force
F3: Horizontal inertia force
F4: Frictional force on ring groove
F5: Frictional force between skirt and cylinder
F6: Inertia force of connecting rod
F7: Reaction force from connecting rod
F8: Frictional force on pin-boss section
F9: Reaction force of upper skirt
F10: Reaction force of lower skirt
F11: Crankshaft offset with respect to cylinder bore £
F12: Skirt to bore clearance
x,y: Position of the center of gravity
D1,2,3: Piston dimensions
D4: Piston-pin offset
S: Skirt Profile