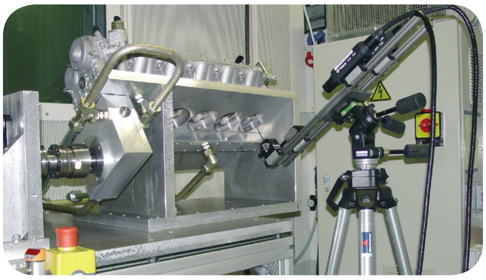
Valvetrain Analysis

The automotive industry pays more and more attention to the development of the valvetrain. Especially regarding the increasing complexity of valvetrains high-resolution and dynamic testing equipment becomes ever more important. Reproducibility of results and short calculation times for vast amounts of data require special evaluations.

The ROTEC valvetrain software module features a series of valve motion analyses including, for example, the calculation of valve seating velocities and accelerations during valve closing as a function of camshaft and / or crankshaft speed. The program also determines significant intermediate results for verification purposes such as the angular positions during closing versus speed. The calculations incorporate the dimensions and units of the input signals (mm, m and inch). Camshaft or crankshaft angle may be used as the angular reference system for the calculations. The input data are measured valve lift, velocity or acceleration signals together with the shaft speed. The latter is acquired using either an incremental encoder or a toothed wheel with a magnetic pickup. All units may be normalised to crank or cam angle. Non-linear response, temperature compensation and offset correction of special sensor signals are also included.



Geometry

The analysis provides overview plots of valve lift, velocity and acceleration. Minimum or maximum of all three input values as well as the angular position of these extremities can be determined. Values of lift (so-called @lift) during valve opening or closing may be correlated with the corresponding shaft angles, valve velocities and accelerations. The following three analyses are available:

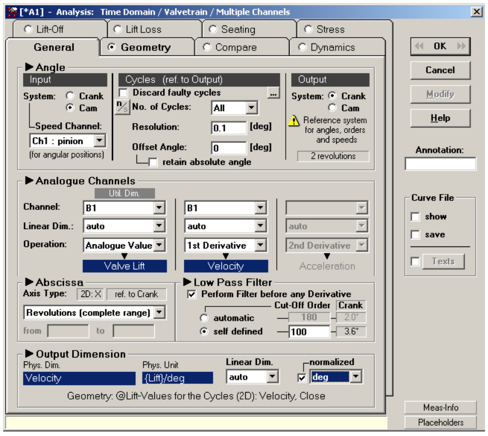
3D-Plots (Overview) Valve lift, velocity or acceleration is plotted as a 3D-curve. Every cycle results in a slide for the curve looking along the speed axis of the shaft.

Min-/Max-Values (Extremities) Each cycle privides one data point for a 2D-curve. In each cycle the maximum or minimum value of lift, velocity or acceleration can be determined for the corresponding values of shaft angle.
@lift-Values (Open and Close) Each cycle provides one data point for a 2D-curve. A specific value of lift is found within each cycle.

The **valvetrain** module determines the shaft angles for open@lift, close@lift, the duration of opening to maximum lift and subsequent closing. These data points may be correlated with the corresponding valve velocities and accelerations.

Compare

Used for a comparison of all cycles of a 3D-curve with a reference curve. All possible comparisons lead to a new 3D-curve. A cycle is the difference between the original curve of the valve lift, velocity or acceleration and the reference curve, all plot versus the chosen angle. The reference curve can be taken for either the original 3D-curve, a file or a table.



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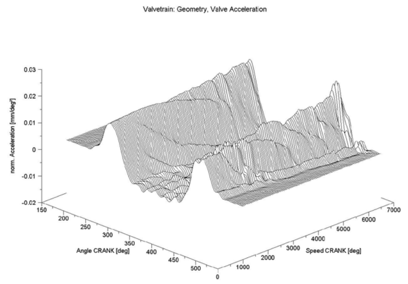


Dynamics
Provides an insight into valvetrain dynamics at different closing values @lift. Extremities within a given angular range relative to the valve closing position are investigated (e.g. valve bouncing).
The extremity value or its angle position can be calculated. Angular reference system is the working cycle, i.e. angular positions are absolute and not relative to angular positions @lift.

Lift Loss
Describes valve behaviour due to component deflections and valve lash giving way. A kinematic lift curve (=2D-reference curve) is required for the comparison with the measured dynamic lift curves for each cycle. The kinematic lift curve is obtained from either the 3D-output curve, a file or a table. Three analyses are available:

Pre-lift loss is the value of the kinematic lift curve where it first crosses a set threshold (angle, dynamic opening). **Apparent lift loss** is the difference between the kinematic and dynamic lift at this position.

Angle, dynamic closing is the first position where, beginning at maximum lift and looking down the angle axis, the value of lift falls below its predetermined value.

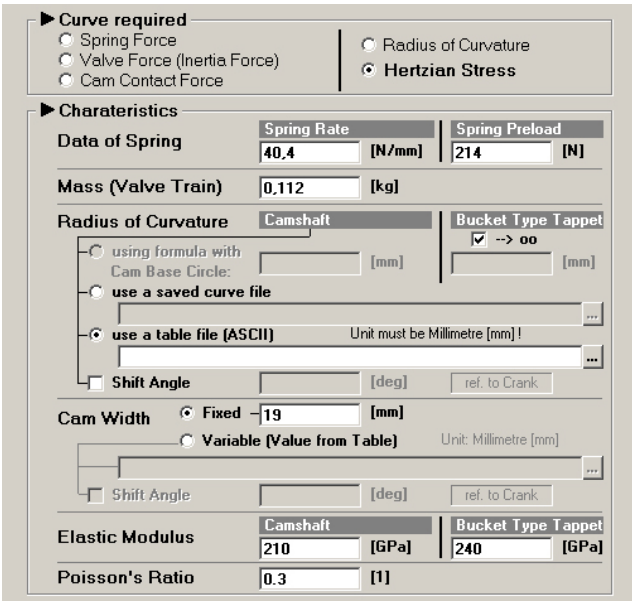
Kinematic lift close is the value of the kinematic lift curve at the angle of dynamic closing, total hub loss is the difference between kinematic and dynamic lift at the angle of dynamic closing.

Seating
The valve seating velocity is the valve velocity at the valve close angle. There are two ways of determining this angle:

- close@lift, i.e. at a pre-determined lift value with the valve approaching the valve seat
- dynamic close (c.f. lift loss)

Lift-off
Allows special analysis of the difference between the dynamic and the kinematic lift curve for determining the angle of lift-off.

Hertzian stress
Hertzian stress is investigated together with intermediate results for cam and tappet component stress. Valve lift, velocity and acceleration data are input as utility parameters. Material characteristics and geometric dimensions of the valvetrain components are also required for input.



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