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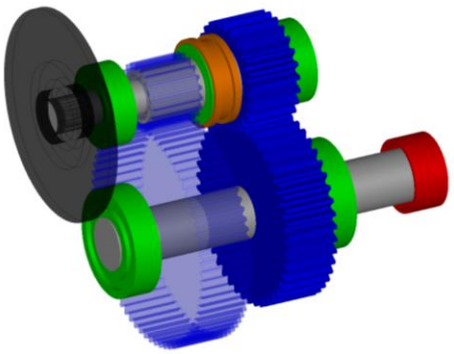
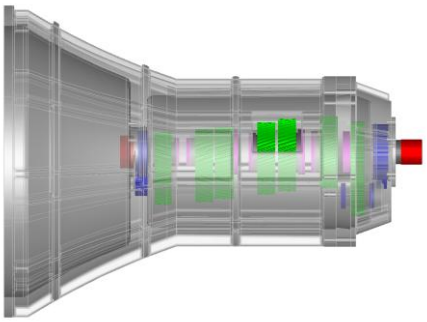
KISSsys: Calculations for Gear Shift

Vehicles

Conventional vehicle gearboxes include a gear shifting mechanism which can be constructed in several different ways (sliding gears, constant mesh, synchromesh, multi-disc clutching etc.). One of the most common designs is the synchromesh gear shifting. The shifting between two gear speeds can be supported by a synchronizer, which will adjust the speeds of the components before the actual gear engagement.





Synchronizers in KISSsys

Ever growing demand of special calculations for the vehicle based components has lead to a development of the synchronizer calculations in KISSsys.

The KISSsys model “Synchronizer” contains the entire process with clutching, speed synchronization and engagement.

The synchronization procedure can be analyzed using the internal script language of KISSsys and standard calculations. For this purpose, the procedure of a Borg-Warner-type synchronizer – with its partial sequences – was implemented.

Synchronizer Calculations

The synchronizer calculations in KISSsys are performed in two steps. First the kinematic calculation is used to determine the speed and inertia to be synchronized. After that, the actual synchronization process is calculated.

SETTINGS	Calculate
Type of calculation	Calculate time
Shifting from:	Gear1
Shifting to:	Gear2
Max Operating Force [N]	25
Total "Changing" Time [sec]	0.324
Inertia to synchronize [kgmm^2]	12574

After that, either the operating forces (at given synchronization time) or the required synchronization time (at given operating force) can be calculated.

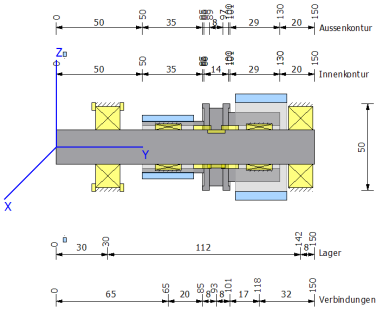
Synchronizer Definition

The conditions of the synchronizer and the calculations itself can be easily configured via a single table.

Synchronization

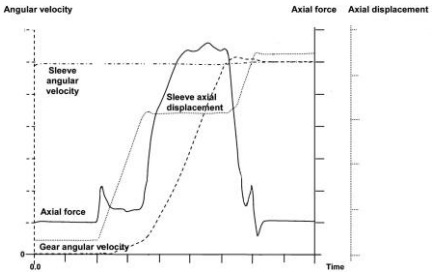
SYNCHRONIZER		SETTINGS	Calculate
Cone size [mm]	56	Type of calculation	Calculate time
Cone length [mm]	10	Shifting from:	Gear1
Cone angle [°]	5.8	Shifting to:	Gear2
Spline diameter [mm]	65	Max Operating Force [N]	25
Spline end angle [°]	45	Total "Changing" Time [sec]	0.324
Spline "back" angle [°]	5	Inertia to synchronize [kgmm^2]	12574
Friction coefficient (cone)	0.09		
Friction coefficient (splines)	0.15		
Cone material	Eigene Eingabe	RESULTS	
Friction material	SINT D39	Synchronization time [sec]	0.206
Cone area [mm^2]	1768.3	Reduced Inertia before [kgm^2]	0.18027
Cone mass [kg]	0.020027	Reduced Inertia after [kgm^2]	0.048547
Axial force on Synchronizer [N]	148.75	Speed difference [rpm]	-577.3
Min end angle [°]	20	Frictional energy [Nm]	3.7093
		Frictional power [W]	1201.8
Operation mechanism		Heating of the cone [°C]	0.41158
Ratio	7	Thermal expansion [mm]	0.00026506
Efficiency	0.85		

The table includes the specifications for the synchronizer as well as the operating and calculating conditions.
The synchronizer body and the synchronization rings can be visualized and positioned in the shaft modelling editor. Naturally, the defined elements can also be seen in the KISSsys model layout.



Synchronization Steps

The synchronization process can be divided in several steps: The movement of the synchronizer towards to the contact (disengage of the gear), synchronization of the speeds, the engagement of the synchronizer ring and the 2nd bump with final “free” sliding and the end of engagement. All these steps will be calculated automatically.

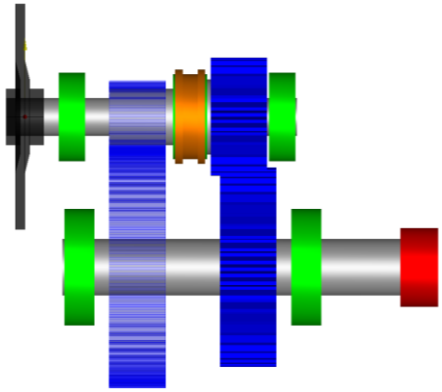


Known Issues

The full dynamic behaviour of the synchronization procedure cannot be simulated because of the semi static approach of KISSsys.

The KISSsys model is still in development at this moment. We are collecting experience for the reliability in practical application.

Further Developments



Further development will include the sizing of the synchronizer based on given forces and synchronization time.

KISSsoft is further developing vehicle based calculations for the clutches (Drive clutches, multi disc clutches…) and also for the brake component calculations.

For further information or for the free test version of the current KISSsoft Release, please contact us:
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