GEISLINGER DAMPER

The Geislinger Damper is capable of adjusting the natural frequency of a system and of reducing torsional vibrations. Thus, it reliably protects the crankshafts, camshafts, intermediate and propeller shafts in all kinds of reciprocating systems. By eliminating the critical frequency, the Geislinger Damper also helps to avoid a barred speed range.

As modern engines tend to create more than one critical frequency, Geislinger has developed dual damper solutions as well as combinations of a Geislinger Damper and a Geislinger Vdamp®. This design flexibility guarantees the best solution for every type of engine.

DESCRIPTION

The damper is usually mounted to the free-end of the crankshaft or camshaft and consists of a primary and a secondary section. Between these, groups of steel leaf spring packs are arranged. These spring packs together with intermediate pieces and the secondary section form chambers which are filled with pressurized engine oil.

The damper’s elasticity is determined by the shape and number of springs. In this way, the torsional system is detuned, and the most critical resonance is eliminated.

If the exterior section vibrates in relation to the inner one, the leaf springs bend and the pressurized engine oil is pumped from one chamber into another. This reduces the relative motion of the two parts and thus dampens the residual torsional vibrations.

APPLICATIONS

- 2- and 4-stroke diesel and gas engines
- Reciprocating compressors

TECHNICAL DATA

- Dimensionless damping factor: 0.2 – 0.5
- Ambient temperature: -10°C to 120°C

ADVANTAGES

- Low life-cycle cost
- Tailored to your system
- Precise calculation and defined properties
- No aging
- Long periods between overhauls
- Condition-based maintenance with Geislinger Monitoring
- PTO/PTI coupling can be integrated
- Geislinger Worldwide After Sales Service

Fatigue-resistant springs

The smallest possible damper for each engine

Tailor-made solutions
Preamble

This catalog replaces all old catalog versions.

The content of this catalog is indicative and - based on new developments - Geislinger reserves the right to change the content without prior notice.

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Should you have questions, remarks or inquiries please contact us per e-mail (info@geislinger.com) or telephone (+43 662 66999-0).

The latest version of all Geislinger catalogs can be found on our website Geislinger.com.
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Description

- **Introduction**

The patented Geislinger Damper is a tuned torsional vibration damper with steel springs and hydrodynamic oil damping and offers the following advantages:

- High damping factor
- Long lifetime
- Low weight, small size
- No ageing of components; no changing of damping or stiffness
- Low wear and maintenance costs
- Unaffected by high temperatures, dirt and oil
- Geislinger Quality
- Geislinger Monitoring

This catalog is a guideline for a damper selection. It should give the essential information to learn about how a Geislinger Damper works and how it can be selected for any preliminary analysis work. We would however recommend approaching Geislinger directly to get our direct support and to fully benefit from Geislinger’s unmatched damper expertise.
Application

4 stroke engines:
Due to continuing progress in engine design, attention must be paid to the problems of torsional vibrations. Thus, it proves necessary to reduce the torsional vibrations by detuning and damping them. These tasks can be solved by a Geislinger Damper. The combination of the high elasticity of its leaf springs together with hydrodynamic damping ensures shifting the major critical speeds out of the engine's operating speed range. In addition, minor torsional vibrations are effectively reduced to obtain a continuous operation within the speed range. Installation of this damper results in lower vibratory torque of the crankshaft.

The Geislinger Damper is also well proven in other applications such as camshafts, intermediate shafts, gearboxes, etc.

Through tests on prototypes as well as installed dampers data referring to damping and elasticity have been gathered and used for torsional models. This guarantees correct calculation; not only of the critical speeds but also of the amplitudes and loads in all parts of the driveline. Damping and elasticity can be adapted within large limits to meet the needs of every installation.

2 stroke engines:
In propulsion systems with two-stroke-crosshead engines the propeller is in most cases directly driven by the low speed engine. A simple intermediate shaft is used instead of a flexible coupling and a main gear. Engine and propeller run at the same speed. The system engine–shaft–propeller is torsionally excited by the cyclic forces of the diesel engine. Continuous increase of engine power results in higher exciting torques and, therefore, in increased torsional vibrations of the system. A Geislinger Damper at the free end of the crankshaft can protect the crank-, intermediate- and propeller shaft and allows for a compact design of the propulsion installation. Normally, an engine operation restricted by a barred speed range can be avoided if a Geislinger Damper is used.

A Geislinger Damper is a tuned torsional vibration damper. Technical data regarding important parameters such as inertia, torsional stiffness, and damping can be varied independently over a wide range. The selection of a Geislinger Damper is based on a torsional vibration calculation. Torsional stress limits of the shaft line according to the classification society are considered.

For a new Geislinger Damper the predicted vibrations have to be confirmed by a torsiograph measurement. The Geislinger Monitoring System can be used to perform this measurement on the first pilot damper to verify the correct damper parameter. In addition to that the Geislinger Monitoring System can also be used for permanent monitoring of a Geislinger Damper.
**Design**

The Geislinger Damper is a tuned torsional vibration damper with steel springs and hydrodynamic oil damping. The major components of a Geislinger Damper are shown in Fig. 1.

**Stiffness**

The steel spring packs represent the principal part of a Geislinger Damper. These steel spring packs can be produced to any desired degree of stiffness without progression steps, independent of the required damping.

The innerstar is bolted onto the free end of the crankshaft and follows its torsional vibrations. Due to its special design the inertia of the damper inner part is small and therefore more space is available for the large inertia of the effective outer part which greatly affects the performance and the required space of the damper.

![Fig. 1](image)
**Damping**

The Geislinger Damper has a very high damping factor.

The radially arranged steel springs are clamped at their outer ends and are engaged in the grooves of the innerstar. Chambers A and B, which are filled with engine oil, are created between the spring packs, intermediate pieces, and the innerstar.

![Diagram of Geislinger Damper showing chambers A and B](image)

A/B = oil chambers

Through the oscillation of the outer part in relation to the innerstar the springs are bented. This movement forces the oil to flow from chamber A to chamber B through designed damping gaps. Depending on the size of this damping gap the flow is more or less restricted, thus creating different rates of torsional hydrodynamic damping.

The Geislinger Damper design is based on the hydrodynamic principal of damping. As a result, the damping factor stays constant over the product’s lifetime because the damper is not affected by wear.

In case of dampers for two-stroke engines fine-tuning of the damping factor can be adjusted in the field.
**Assembly**

The damper has to be mounted to the free end of the crankshaft.

For two-stroke engines, counterweights as additional inertia can be incorporated into the damper.

For four-stroke engines various design options are possible:

- Torque transmit through damper inner part to auxiliaries
- Combination of engine turning wheel with the vibration damper
- Mounting of dampers both inside or outside the engine crankcase

**Oil Supply**

The damper has to be supplied with pressurized oil from the crankshaft or the free end through a central bore.

**Thermal Load**

The capacity of the damper to take high thermal loads is extremely high since most importantly steel is used as material. Furthermore, oil is continuously flowing through the damper and subsequently providing cooling. Adding of cooling fins and a further increase in oil flow can promote extra thermal capacity.

**Quality & Survey**

All dampers will be produced and verified according to quality assurance requirements outlined in ISO 9001-2000 and ISO 14001.

On request, dampers can be provided with certificates of all major classification authorities (e.g. ABS, DNV, Germanischer Lloyd, etc.)

For the survey by a classification society Geislinger requests the following data:

- Name of classification society
- Type of installation
- Shipyard
- Yard hull number
Designation Code

Example one: D 220 / 3 / 1 / V / M

D: Damper
220: Outer diameter of biggest single damper part in cm
    (For examples in this catalog it’s the outer diameter of clamping ring in cm)
3: Version number of a specified type
1: Subversion
V: Adjustable damping ring incorporated in damper design
M: Damper with machined gear for GMS signal pick up

Example two: D 220 / AB

D: Damper
220: Outer diameter of biggest single damper part in cm
    (For examples in this catalog it’s the outer diameter of clamping ring in cm)
AB: Project designation – substituted by a number when a firm order is placed
Selection

Selection Procedure

The sizes given in the technical data only describe the possible range of Geislinger Dampers. In contrary to other damper designs, inertia, stiffness, and damping factor of a Geislinger Damper can be optimised to specific requirements.

We ask you to fill out the enclosed questionnaire and send it to us, so we can evaluate the optimal damper size for your application.

An important dimension – as it determines the damper size – is the outer diameter of the crankshaft flange. To develop a low cost damper this dimension should be as small as possible.

When a Geislinger Damper for a particular engine is produced the first time, the calculations have to be confirmed by torsional vibration measurements. The damper’s characteristics can be estimated very accurately, so that the resonances will occur at the predicted speeds. Only the damping factor might require some adjustment.

Dampers for two-stroke engines are equipped with adjustable damping rings, which allow the damping adjustment on site during testing. Once completed, no further adjustments or tests are necessary as dampers can be delivered with reproducible accuracy.

Selection Criterion: Moment of Inertia

First select a damper with the damper’s outer part inertia in realistic proportion to the engine’s total inertia:

- For 2-stroke engines: 5 to 25%.
- For 4-stroke engines: 10 to 50%.

Selection Criterion: Stiffness

With the Geislinger Damper, assuming infinite damper stiffness \( CD = \infty \), one calculates the first natural frequency of the engine. From the resonance speeds one can already judge which harmonic orders are of importance within the engine speed range. It is on those orders one has to concentrate when tuning the damper.

Knowing which one is the most important order, assuming infinite damper stiffness \( CD = \infty \), black curve) a forced torsional vibration calculation is carried out for this order. As a result the angular amplitudes at the crankshaft free end are known. Their values are plotted as a diagram (Dia. 1)
The next step is to select a suitable damper stiffness. It is known, that with most installations the damper’s natural frequency should be less than the engine’s natural frequency (ω). This formula will give a good first approximation for CD.

\[ C_D < \omega^2 \cdot I_s \]

- \( I_s \) moment of inertia of damper outer part \( \text{kgm}^2 \)
- \( C_D \) torsional stiffness of damper \( \text{Nm/rad} \)
- \( \omega \) phase velocity of the engine \( \text{rad/s} \)

With \( C_D \) fixed as mentioned above a new forced torsional vibration calculation is carried out. As expected, an additional mass and stiffness \( C_D \neq \infty \) result in an additional natural frequency and split the original single resonance into two separate resonances (Dia. 2).

If the crankshaft free end amplitudes (red curve) are plotted one can find two characteristic points: the fixed points FP1 and FP2. Characteristic for them is, that they are common for both vibratory systems \( (C_D = \infty \text{ and } C_D \neq \infty) \). The same results as for \( C_D = \infty \text{ and } \kappa = 0 \) will be achieved for \( C_D \neq \infty \text{ and } \kappa = \infty \). The conclusion is that, whatever rate of damping is defined the curve of any damped vibrations have to pass through these two fixed points. Dampened vibrations pass below the two fixed points if additional system damping is considered. Taking this into account, one can already judge an optimum tuning, without having calculated a damped vibration yet.

One is trying to arrange the fixed points at equal amplitudes (Dia. 4) In Dia. 2 it can be seen that a correct tuning has not yet been achieved. The calculation is repeated with lower damper stiffness. The results are shown in Dia. 3. Now the stiffness is obviously too small, as the position of the fixed points has reversed. Another calculation with stiffness in between gives the optimum. Both fixed points are at the same level (Dia. 4).

At this stage of calculations one can already judge, whether the selected damper size is appropriate or not. Whatever damping factor is selected, the damped curves pass through the fixed points. If the torsional level of the fixed points is too high the damper size is too small. The calculations have to be repeated using a larger damper with a higher mass moment of inertia. The effect is shown in Dia. 5. There is now a greater distance between the resonances and the fixed points are at a lower level.
Selection Criterion: Damping

The damping factor can be determined in various ways.

\[ \kappa = \frac{T_d}{T_{el}} \]

Ratio of amplitudes

The ratio of amplitudes of the damping torque \( T_d \) to the amplitude of the elastic torque \( T_{el} \).

\[ \kappa \quad \text{undimensioned damping factor} \]
\[ T_d \quad \text{damping torque} \quad \text{Nm} \]
\[ T_{el} \quad \text{elastic torque} \quad \text{Nm} \]

Linear viscous damping

Observe the differential equation

\[ I_1 \cdot \dot{\phi}_1 + k (\phi'_1 - \phi'_2) + C_D (\phi_1 - \phi_2) = T_i \cdot \sin \omega t \]

\[ \kappa = \frac{k \cdot \omega}{C_D} \]

The relationship between the undimensioned damping factor \( \kappa \) and the linear viscous damping \( k \) is as follows:

\[ I_1 \quad \text{moment of inertia} \quad \text{kgm}^2 \]
\[ \phi, \phi', \phi'' \quad \text{vibratory angle, -velocity, -acceleration} \]
\[ k \quad \text{linear viscous damping} \quad \text{Nms/rad} \]
\[ C_D \quad \text{stiffness} \quad \text{Nm/rad} \]
\[ T_i \quad \text{exciting torque} \quad \text{Nm} \]
\[ \kappa \quad \text{undimensioned damping factor} \]
\[ \omega \quad \text{phase velocity of vibration} \quad \text{rad/s} \]

The damping factor of a Geislinger Damper can be tuned optimally to the application’s requirements. In case of an alternator set with a single speed the damper acts as a detuner with little damping. If it is a ship’s main propulsion system, a flat curve over the speed range is desired. This is shown in the following example.
Tests confirmed that for a tuned Geislinger Damper the linear viscous damping $k$ is constant within large limits. As the damper’s stiffness $C_D$ can also be considered constant, 

$$\omega = \frac{i \cdot n \cdot \pi}{30}$$

the undimensioned damping factor $\kappa$ becomes a function of the vibratory frequency:

$$\omega$$ exciting phase velocity rad/s  
$i$ harmonic order  
$n$ engine speed min$^{-1}$

It is recommended to take this dependence on the frequency of the undimensioned damping factor into account in torsional vibration calculations.

By means of the undimensioned damping factor $\kappa$ a quick check of the damping magnitude, independent of the damper size, can be made. Similar to the procedure of determining the correct stiffness, one has first to choose a damping factor and then carry out the torsional vibration calculation. It is recommended to begin with $\kappa = 0.5$ for nominal speed. With $C_D$ as calculated above and $\kappa = 0.5$ a new forced torsional vibration calculation is performed. Dia. 6 shows the curve of the damped vibration (bold red curve). As the resonance peaks are very high, the damping factor is selected too low. Dia. 7 shows the result of a repeated calculation with higher damping (e.g. $\kappa = 1.5$). The damping factor is now obviously too high, as the original resonance appears too strong. An optimum will be achieved with a damping in between the first two chosen values, as shown in Dia. 8. The curve of the damped vibration is very flat over a wide speed range and without any distinct resonances.

Has the damper now been matched for the most important order, it is recommended to check the match of the 2 or 3 next important orders as well and, if necessary, to adjust the tuning without making any significant changes to the most important order.

When tuning is completed and the damper data are fixed, one has to ensure that the stresses in the crankshaft are within permissible limits and that the permissible load of the damper is not exceeded.

The damper should be checked for the following:

- elastic torque
- damping torque
- thermal load
- **Selection Criterion: Elastic Torque**

Is the tuning of the damper fixed, one can calculate the elastic torque $T_{el}$ of the damper as vector sum of all harmonic orders.

A guideline for the permissible elastic torques is stated on pages 17-21 depending on each damper size.

- **Selection Criterion: Damping Torque**

As a further result of the calculations the vector sum of the damping torque $T_d$ of the damper is known as well. Because of its design, the damper can transmit only a certain damping torque without the occurrence of cavitation. Cavitation depends on the oil feed pressure and leads to loss of damping, therefore it has to be avoided. The damping torque per 1 bar oil pressure $T_{d,p}$ is stated in the technical data *(absolute value)*.

- **Selection Criterion: Required Oil Feed Pressure**

Is $T_d$ the damping torque to be transmitted, then the necessary absolute oil feed pressure is

$$ p = \frac{T_d}{T_{d,p}} $$
Selection Criterion: Permissible Thermal Load

By means of the formula:

\[ P_{KW} = 5.2 \cdot 10^{-5} \cdot \frac{\kappa}{1 + \kappa^2} \cdot \frac{T^2 \cdot i \cdot n}{C_D} \]

One can calculate the thermal load in the damper due to a single harmonic order and add the values for all orders algebraically. This total thermal load must also not exceed the limits as listed in the technical data.

\[ p \quad \text{absolute oil feed pressure} \quad \text{bar} \]
\[ i \quad \text{harmonic order} \]
\[ n \quad \text{engine speed} \quad \text{min}^{-1} \]
\[ T \quad \text{total vibratory torque in damper} \quad \text{Nm} \]
\[ T_{el} \quad \text{elastic torque in damper} \quad \text{Nm} \]
\[ T_d \quad \text{damping torque in damper} \quad \text{Nm} \]
\[ T_{d,p} \quad \text{damping torque per 1 bar oil pressure} \quad \text{Nm/bar} \]
\[ C_D \quad \text{damper torsional stiffness} \quad \text{Nm/rad} \]
\[ \kappa \quad \text{undimensioned damping factor} \]
\[ k \quad \text{dimensioned damping factor} \quad \text{Nms/rad} \]
\[ P_{KW} \quad \text{thermal load} \quad \text{kW} \]

Technical data for each Geislinger Damper will be tuned individually according to the requirements of each propulsion plant.

The following graphs, tables and installation examples can only be a guideline for your damper selection.

Ideally you should fill out and send us our damper questionnaire. We would then be glad to select the optimal Geislinger Damper for your application.
## Technical Data

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All technical data are without warranty. Modifications of dimensions and design are reserved.
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Permissible Elastic Torque

$T_\omega$ [kNm]

$C_\varphi$ [MNm/rad]

Graph showing the relationship between $T_\omega$ and $C_\varphi$ for various models of dampers.
Examples

- Geislinger Damper - standard design with bearing
- Geislinger Damper - standard design without bearing
Geislinger Damper – standard design without dynamic o-rings
Geislinger Damper for 4-stroke engine with tapered hub
- Geislinger Damper with tapered hub
Geislinger Damper

- Geislinger Damper with sensor pick up
- Geislinger Damper with sensor/angle encoder measurement pick-up
Geislinger Damper with sensor pick up axially
Geislinger Damper with PTO connection
- Geislinger Damper with taper hub and PTO interface
Geislinger Damper for 4-stroke engine with auxiliary gear drive
Geislinger Damper for 4-stroke engine with integrated drive gear
- Geislinger Damper with tapered hub
- Geislinger Damper located outside of crankcase with special sealing
Geislinger Dual Damper configuration
Geislinger Damper with additional mass
Geislinger Damper with laterally removable side plate
Geislinger Damper 2 stroke / external oil supply and sensors
- Geislinger Damper 2 stroke external oil supply, sensors and hydraulic kit
- Geislinger Damper 2 stroke with integrated counter weight
• Geislinger Damper 2 stroke with excentric counter weight
- Geislinger Damper 2 stroke with eccentric counter weight integrated
Geislinger Damper 2 stroke with additional mass integrated
- Geislinger Damper / Coupling combination for free end PTO