Construction, Working, Operation and Maintenance of Fluid Couplings

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The information contained in this article represents a significant collection of technical information about construction, working, installation, operation and maintenance of fluid couplings. This information will help to achieve increased reliability at a decreased cost. Assemblage of this information will provide a single point of reference that might otherwise be time consuming to obtain. Most of information given in this article is mainly derived from literature on the subject from sources as per the references given at the end of this article. For more information, please refer them. All information contained in this article has been assembled with great care. However, the information is given for guidance purposes only. The ultimate responsibility for its use and any subsequent liability rests with the end user. Please view the disclaimer uploaded on http://www.practicalmaintenance.net.

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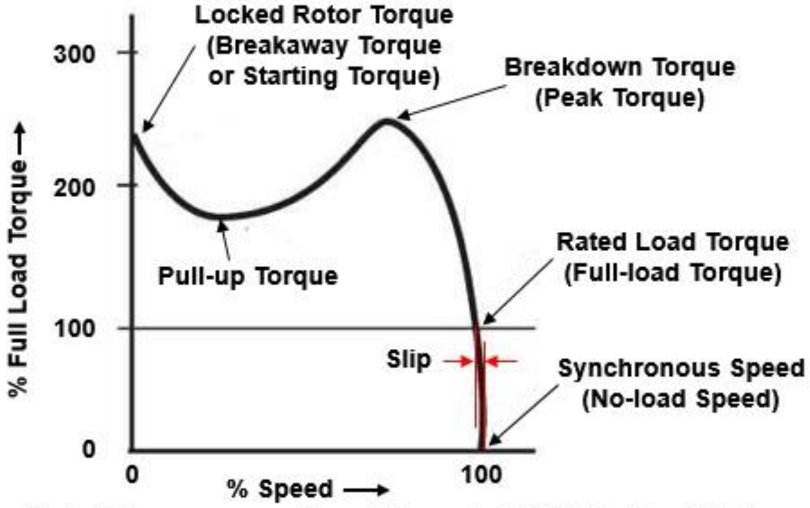
Fluid Couplings

Fluid couplings or hydraulic couplings work on the hydrodynamic principle. In drives consisting fluid couplings, there is no mechanical contact between the driver and the driven machine and power is transmitted by means of a fluid. Due to the mechanical separation between the driver and the driven machine, a fluid coupling enables to achieve two separate value of acceleration in the drive, the fast value of acceleration for the driver and simultaneously the slow value of acceleration for the driven machine. Fluid couplings are often used to drive large inertia machines in combination with squirrel cage motors. They permit a load free acceleration of the motor and consequently with increasing oil fill, provide a soft/gentle quasi steady state start-up of the machine. The maximum torque occurring during the start-up process is restricted to lowest possible level. As fluid coupling allows quick acceleration of the motor and short duration of high value starting current, it results into economical design for electrical system. In addition, systems that use multiple motors can be switched on in a staggered sequence to limit the current demanded during the motor acceleration. This avoids grid overloading caused by simultaneous motor starts.

Fluid couplings are used in drives for conveyor systems such as belt conveyors, bucket elevators and chain conveyors. The smooth application of fluid coupling torque provides a smooth start-up of belt conveyor to protect the belt from damaging stresses. In heavy industry, they are used for applications such as crushers, roller presses, mixers, large ventilators, boiler feed pumps, large compressors, centrifuges, etc. In view of this, information about starting of a machine with a squirrel cage motor, working of a fluid coupling, construction of different type of fluid couplings and their maintenance is given in this article.

Starting of Machine with Squirrel Cage Motor

The squirrel cage motors are probably the most widely used motors in industry today. Simple and rugged design, low-cost and low maintenance are their main advantages.



Typical Torque versus Speed Curve for NEMA Design B Motor

Above figure shows typical torque versus speed curve for NEMA Design B motor.

Locked Rotor Torque (Breakaway Torque or Starting Torque)

The locked rotor torque of a motor is the minimum torque, which it will develop at rest. This capability is true with rated voltage and frequency applied.

Pull-up Torque

The pull-up torque of a motor is the minimum torque developed by the motor when accelerating from rest to the breakdown torque point. For motors that do not have a definite breakdown torque, the pull-up torque is the minimum torque developed up to rated speed.

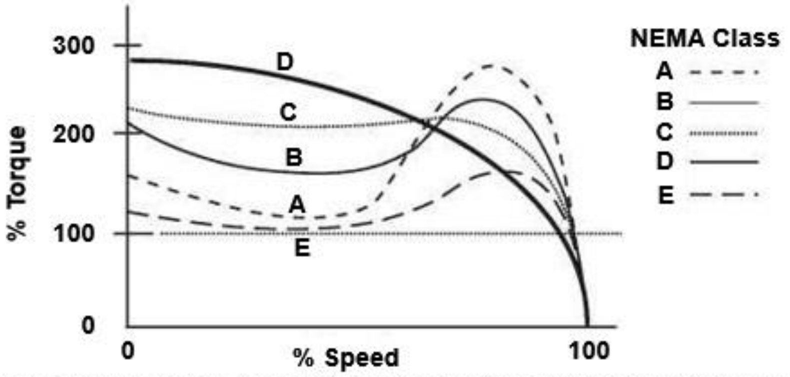
Breakdown Torque (Peak Torque)

The maximum torque developed by the motor during the period of acceleration between the speed corresponding to pull-up torque and the full-load speed.

Rated Load Torque (Full-load Torque)

The rated load torque of a motor is the torque necessary to produce the motor's rated horsepower at rated-load speed. (Note: Rated load speed is normally considered base speed. Base speed means actual rotor speed when rated voltage, frequency, and load are applied to the motor.)

NEMA classifies low voltage AC induction motors into several classes with respect to locked rotor, pull-up, breakdown torques, and running slip.



Typical Torque versus Speed Curve for Various NEMA Design Classes

Above figure shows typical torque versus speed curve for various NEMA Design classes.

In general, NEMA Design A motors have low to moderate locked rotor torque, low pull-up torque, high breakdown torque, high starting currents, and small running slip (slip ≤ 5%).

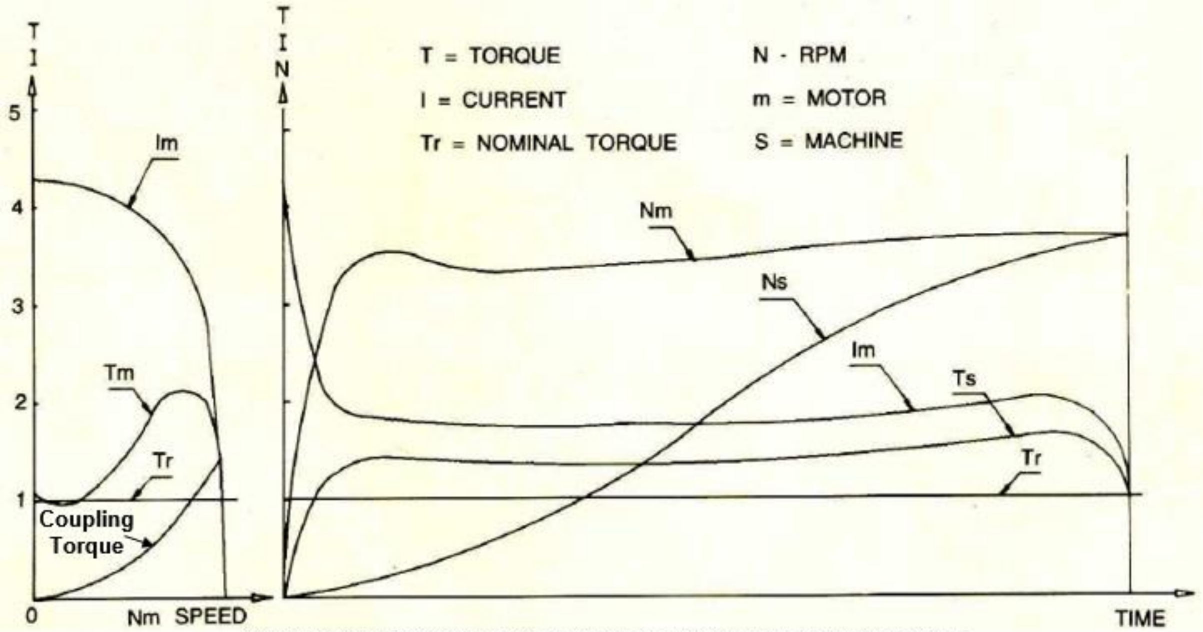
NEMA Design B motors have moderate locked rotor torque, moderate pull-up torque, medium to high breakdown torque, moderate starting current, and moderate running slip (≤ 5%). Design B motors are the most popular motor design, commonly referred to as general-purpose motors, and used in most applications.

NEMA Design C motors have moderate to high locked rotor torque, high pull-up torque, medium breakdown torque, medium to low starting current, and medium running slip (≤ 5%).

NEMA Design D motors have high locked rotor torque, high pull-up torque, moderate to low breakdown torque, low starting current, and high running slip (5-13%). The high slip values make this motor suitable for applications with changing loads and subsequent sharp changes in the motor speed, such as in machinery with energy storage flywheels, punch presses, shears, elevators, extractors, winches, hoists, oil-well pumping, wiredrawing, etc. This motor design is usually considered a "special order" item.

NEMA Design E motor is similar to Design B, but has a higher efficiency, high starting current and lower full-load running current.

It may be noted that slip of the motor increases with the classes (low slip with A & B classes and high slip for C & D classes) which would result in lower running speeds and higher losses. NEMA Design B and Design C motors are most commonly applied to belt conveyors. NEMA Design C motors are usually chosen for direct coupled loads; the high pull up torque giving more available torque for acceleration of the load through starting.



Starting of Machine by Squirrel Cage Motor with Fluid Coupling

A fluid coupling allows the AC motor to start unloaded. The load accelerates slowly based on the transmitted torque from the coupling, while the coupling absorbs slip energy.

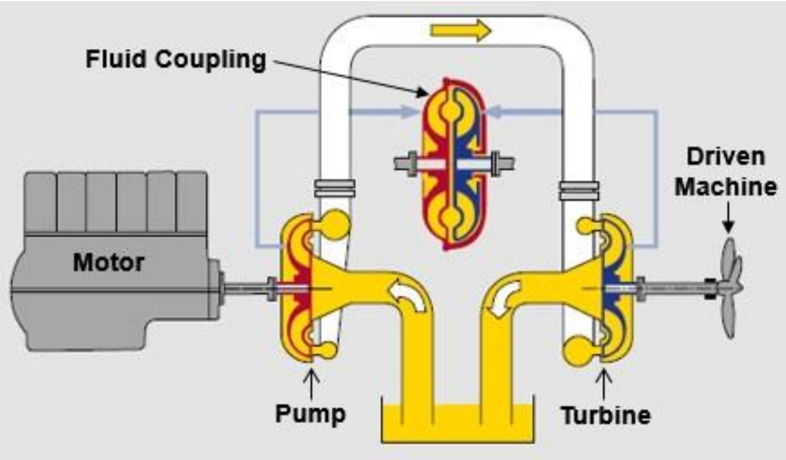
As shown in above figure, when the motor is started, the torque transmitted is zero and then increases as parabolic curve. The motor torque 'Tm' is available to accelerate the motor and the primary parts of the fluid coupling. The motor attains the full speed 'Nm', resulting reduction in current drawn 'Im' quickly.

The machine starts when the torque transmitted 'Ts' exceeds the nominal torque 'Tr' to break the machine away. The slip across the coupling reduces as the speed of the machine 'Ns' reaches its normal operating speed.

The curve 'Ts' indicates the torque transmitted to the driven machine. It shows the smooth introduction of torque during starting. The Torque 'Ts' is less than the maximum torque of the motor. The coupling limits the torque transmitted. In the event of machine stalling, the motor is protected by the coupling by increasing the slip. Thus motor protection and machine protection are built in characteristics of fluid couplings. As the motor starting current is low, motor reaches full speed quickly and motor current normalizes very rapidly, motor can therefore be smaller for a given duty and sized only for demand, not for starting torque.

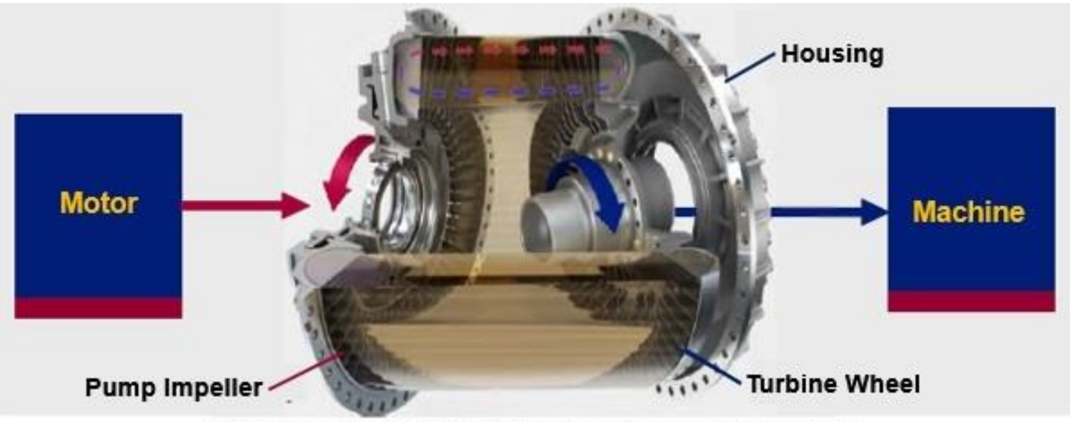
Working of Fluid Couplings

In a conventional machine construction, transmitting of power from the driver to the driven machine occurs predominantly according to the **direct operating principle**, for example through shafts, mechanical couplings or gear units.



Power Transmission by Indirect Operating Principle

As shown in above figure, power can be also transmitted from a motor (a driver) to a driven machine without direct operating principle using a pump, a turbine and associated piping. It can be seen that the power is transferred from the pump to the turbine without any contact (indirectly). Similarly, in a fluid coupling, transmission of power occurs indirectly based on an **indirect operating principle**, principle of **hydrodynamic power transmission**.



Hydrodynamic Power Transmission in Fluid Coupling

As shown in above figure, in a fluid coupling, pump impeller and turbine wheel are enclosed in a leak proof housing (also called casing or shell) for hydrodynamic power transmission. The pump impeller is connected to the primary driver (motor) and the turbine wheel to the driven machine. The pump impeller transfers the introduced mechanical energy to kinetic energy in fluid flow. The higher energy fluid flows centrifically from the pump impeller to the turbine wheel, where a reconversion to mechanical energy (force) takes place. Thus the power is transferred from the pump to the turbine without any contact and thus without wear. Only the bearings and sealing elements are subject to natural wear and tear. Because of the straight radially arranged vanes/blades, the torque is transmitted independently of the direction of rotation and solely by the amount/quantity of oil filling in the coupling.

To generate circulation of the operating fluid for torque/power transmission, a difference in speed is necessary between the pump impeller and turbine wheel. A centrifugal force pressure field is set up that is greater in the faster rotating pump impeller than in the turbine wheel. The difference in speed, usually termed “slip”, at the continuous operating point of the coupling is from 2% to 6%, depending on application and coupling size. Immediately after drive motor start-up, slip is 100%, i.e. the pump impeller is driven at the speed of the motor, but the turbine impeller remains stationary.

Types of Fluid Coupling Designs

Fluid couplings are designed in two types: constant-fill couplings and variable-speed (fill-controlled) couplings.

Constant-fill Couplings

Couplings of this type are mainly used for start-up (to limit torque) and to cushion the torsional vibration of the drive chain. In this type of couplings, various designs mainly differ through adjoining chambers, who's automatically controlled filling and emptying have a significant influence on the start-up behavior.

Constant-fill couplings are sealed to the outside. Filling of the operating fluid in a coupling is carried out before its commissioning. Drive requirements determine the design and filling quantity. The ratio of the operating fluid volume filled to the overall volume of the coupling is called the fill level. The coupling obtains a specific characteristic curve from the fill level. Manually adding or removing operating fluid (at a standstill) enables altering the characteristic curve.

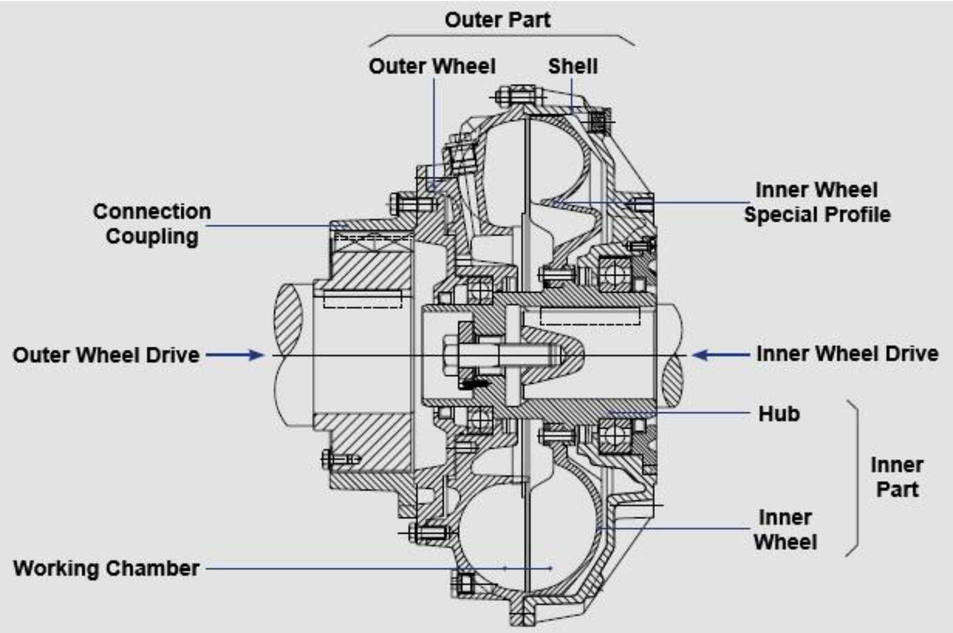
Variable-speed Couplings

Couplings of this type are used to control or regulate the speed of the driven machine over a wide range below the drive speed.

These couplings have devices that seamlessly change the transmission behavior during operation. This mainly occurs by changing the fill level. The fill level can be changed during operation either via a radially movable scoop tube or by controlling the operating fluid inlet and outlet via valves and nozzles. These couplings always have an external fluid circuit for filling changes that can also aid cooling.

Construction and Working of Fluid Couplings

Construction and working of commonly used couplings as per designs of Voith Turbo GmbH & Co. KG, Germany is given in this section.



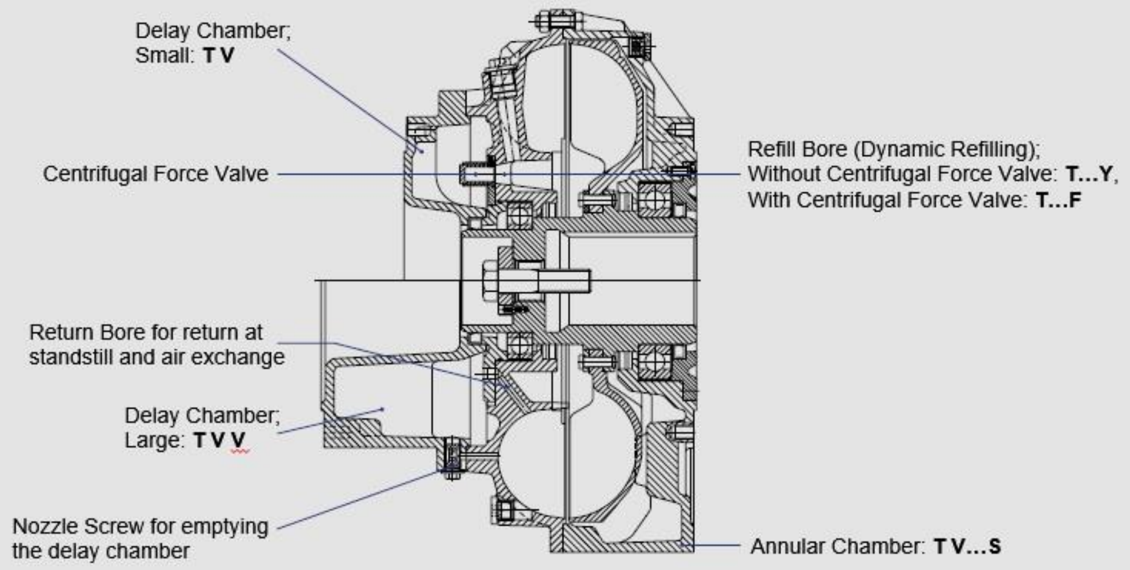
Type T Fluid Coupling with Elastic Connection Coupling

The Voith Turbo fluid coupling Type T (basic design), shown in above figure, consists of a few main components without additional adjoining storage chambers. The shell and the vanned outer wheel forms the working chamber. This working chamber is housed relative to the hub and sealed to the outside. The inner part consists of the hub and the inner (turbine) wheel, which are fixed together.

A fluid coupling is installed between co-axial shafts. Normally a fluid coupling is connected to the shaft of a motor (driving machine). As it is a rigid unit, it is connected to the motor by a flexible connection coupling which absorbs any small assembly misalignment. If necessary or for constructional advantage, a fluid coupling can also be mounted on the motor shaft.

In Type T fluid coupling, the full quantity of operating fluid (usually oil) remains in the working chamber (power transmitting chamber) all the time.

This type of coupling is suitable for conveyors of less inertia. In general, Type T coupling is suitable for conveyor up to 200 m length, and carrying material of medium bulk density.



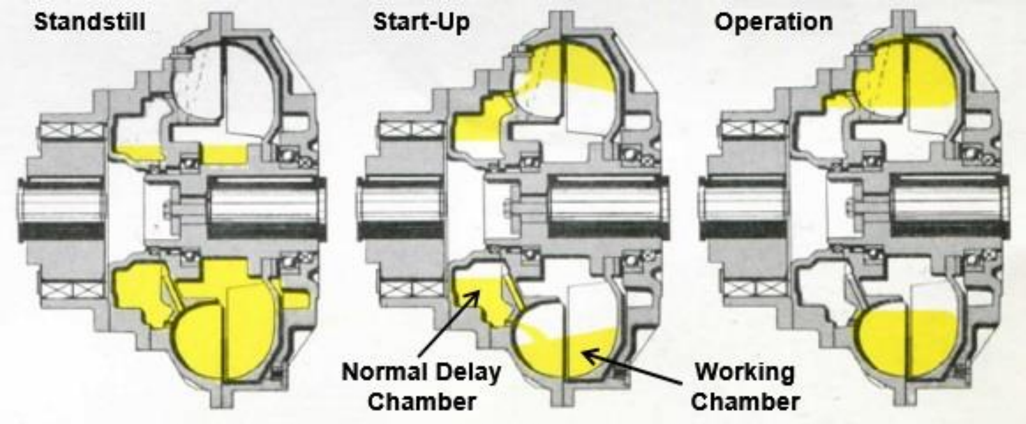
Design Features of Constant-filled Fluid Couplings

Above figure shows design features of constant-filled fluid couplings. They fulfill a variety of requirements for the start-up and operating behavior as needed. The use of adjoining chambers and the volume exchange capability via fixed bores or bores closed with centrifugal force valves enable a great variation of characteristic curves in relation to speed, time and slip.

Voith Type Designation	Design Features	Function Description
T	Basic design	The working chamber filling determines the start-up and operating behavior.
TV	Normal delay chamber	The delay chamber takes in part of the operating fluid at a standstill.
TVV	Enlarged delay chamber	During start-up, the delay chamber empties into the working chamber via nozzle bores.
TV…S	Delay chamber and annular chamber	• The delay chamber and annular chamber take in part of the operating fluid at a standstill. • During motor run-up, the annular chamber also takes part of the operating fluid from the working chamber. • During start-up, the delay chamber empties into the working chamber via nozzle bores.

Note: For information on Types TV…Y and TV…F, please see "Hydrodynamic Couplings - Principles | Features | Benefits" by Voith Turbo (www.voithturbo.com/startupcomponents).

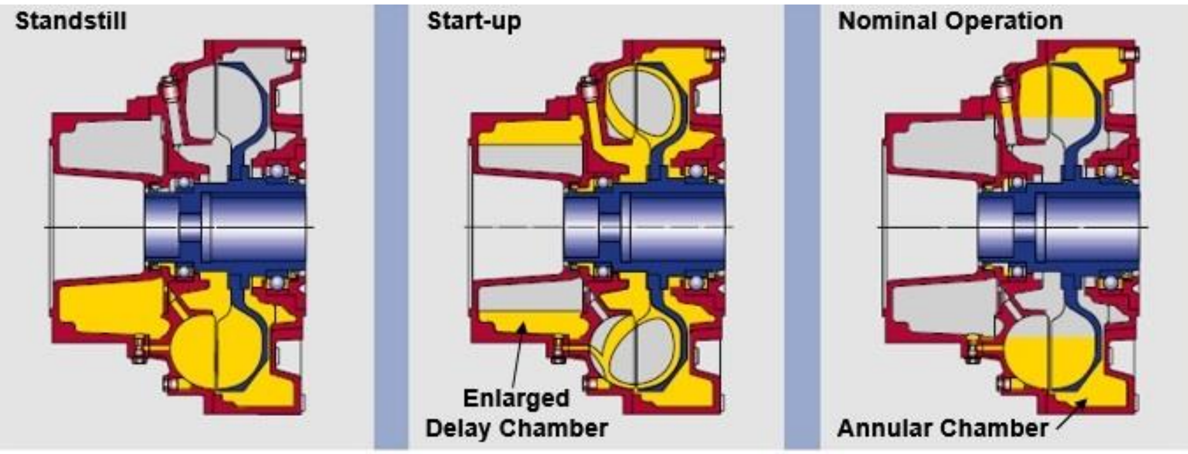
Above table shows description of function for fluid couplings having various design features (for Voith type designation).



Distribution of Operating Fluid in Type TV Fluid Coupling

Type TV fluid coupling with normal delay chamber is having an integral delay filling chamber. The delay filling chamber acts as a temporary store for the working fluid. Above figure shows distribution of the operating fluid in a Type TV fluid coupling. As shown in the figure, when the coupling is standstill (stationary), the operating fluid spreads due to gravity; with the result part quantity of operating fluid is in working chamber and part quantity of operating fluid is in the delay chamber. During start-up the delay chamber retains part of the operating fluid from the coupling circuit and thus decreases the transmitted torque. Only after run-up is completed, this retained fluid flows back into the coupling's working chamber. The flow rate is governed by the in-built size of apertures connecting the delay chamber with the working chamber. This ensures more (compared to Type V coupling) effective relief for the electric motor during start-up.

In general, Type TV coupling is suitable for conveyor length from 200 to 500 m whereas Type TVV coupling is suitable for conveyor length from 400 to 1000 m (it may be noted that conveyor length is influenced by various factors like bulk density, conveyor inclination, etc.).

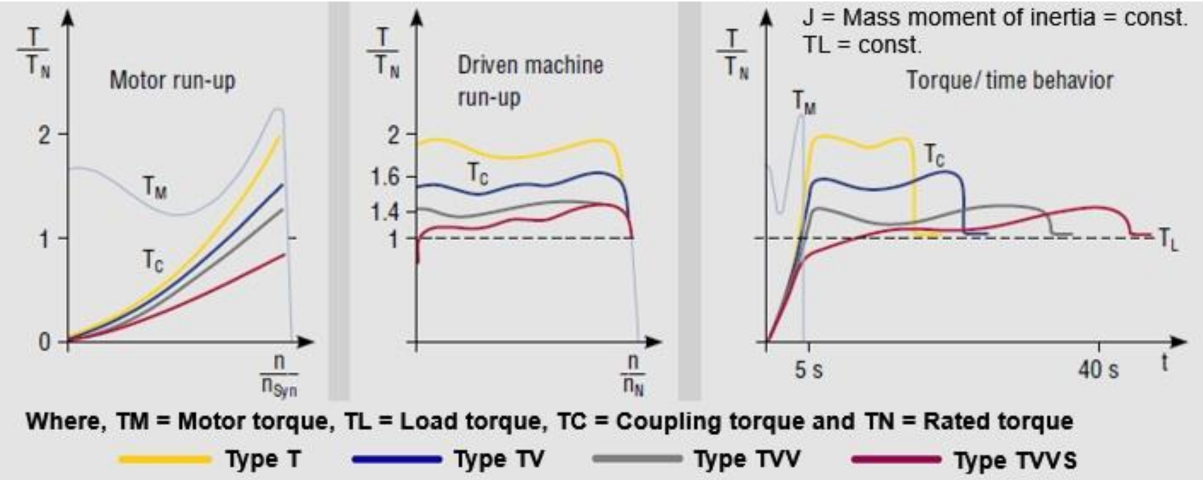


Distribution of Operating Fluid in Type TVVS Fluid Coupling

Type TVVS fluid coupling with enlarged delay chamber is having an enlarged delay chamber and an annular chamber. Above figure shows distribution of the operating fluid in a Type TVVS fluid coupling.

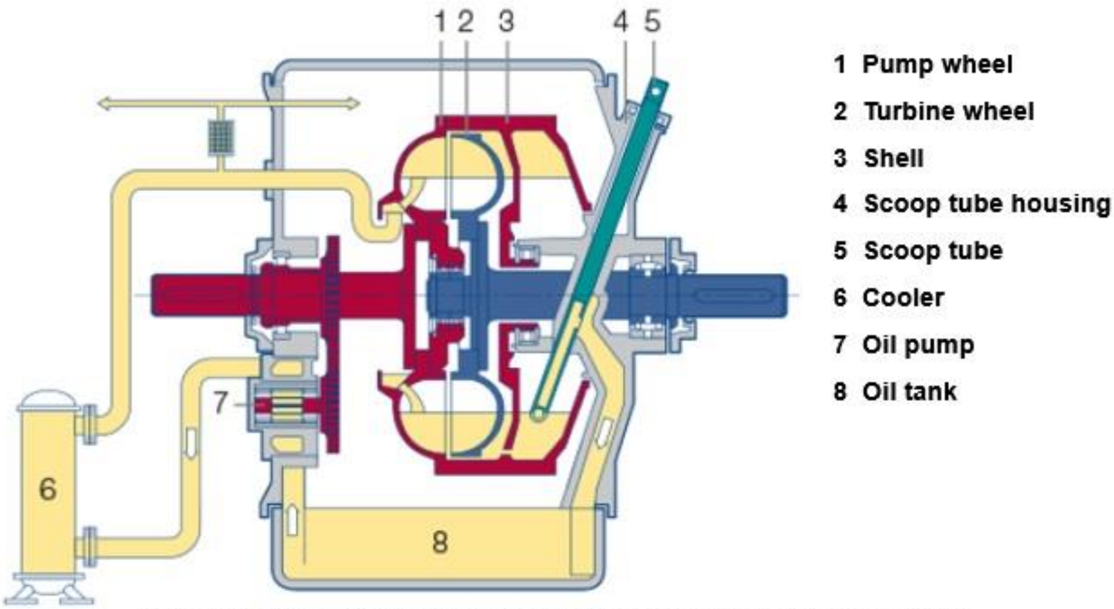
When the motor is started, the portion of operating fluid quantity which is in the working chamber, immediately flows (thrown) into the annular space due to centrifugal action. Thus motor and primary side of the coupling begins the run-up almost without presence of operating fluid in the working chamber. This results into still better performance compared to coupling with enlarged delay chamber.

The machines/conveyor with high inertia can accelerate at ease with this type of coupling. This type of coupling has been used for conveyors up to 2.0 km length. This type of coupling is also used for lesser length high capacity (high power) conveyors when superior performance is needed.



Comparison of Start-up Behavior of Driven Machine with Squirrel Cage Asynchronous Motor

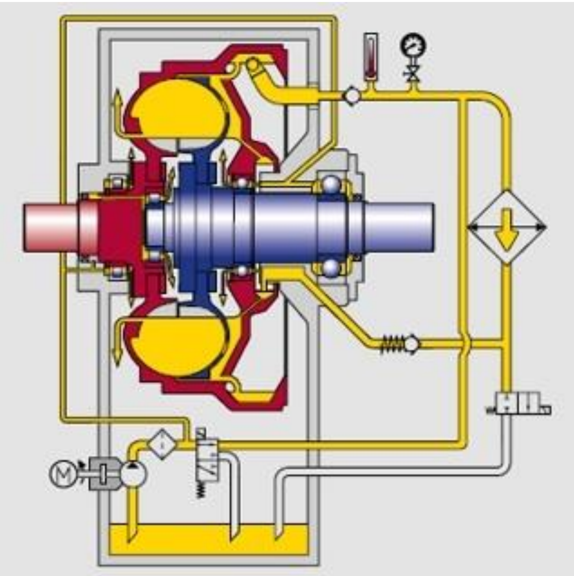
Comparison of start-up behavior of a driven machine with constant load torque and mass moment of inertia while using various Voith coupling types is shown in above figure. The drive motor is a squirrel cage asynchronous motor.



Schematic View of Scoop Tube Type Variable-speed Fluid Coupling

Above figure shows schematic view of a scoop tube type variable-speed fluid coupling. In this type of coupling, the fill level can be changed during operation via a radially movable scoop tube.

When the coupling is stationary, most of the oil is in sump. This allows the motor to run up practically without load, because in this condition motor is practically not connected to load. The motor side of the coupling drives an inbuilt oil pump, which becomes operative with the rotation of the motor. This oil pump injects the oil into working chamber, by means of oil jet. Subsequently, the quantity of oil in working chamber depends upon the position of scoop tube. The stationary scoop tube mouth intercepts the rotating oil, and thereby empty out the oil which is within the radius formed by scoop tube mouth. Thus, oil quantity in working chamber is governed by scoop tube radial position. During start-up phase, the scoop tube position gets automatically adjusted (retracted), which gradually increases the quantity of oil in working chamber. The gradual increase of oil quantity in working chamber results in optimum starting torque steadily for longer time. This allows the design of a machine (e.g. conveyor) with low starting forces.



Fill-controlled Fluid Coupling, Type TPKL

Above figure shows construction of fill-controlled fluid coupling, Type TPKL. This coupling's working principle rests on the metered filling of the rotating working chamber. In this coupling, operating fluid exits the working chamber via nozzles into an annular shell connected to the pump impeller. A dynamic pressure pump (fixed scoop tube) siphons off the operating fluid from this annular shell and then conducts it through a heat exchanger via a catching ring back into the working chamber. This results in an outer, enclosed operating fluid circuit. Working chamber filling changes are carried out indirectly through the addition or removal of operating fluid from this outer circuit. The flow rate of the filling pump depends on the desired fill time of the working chamber.

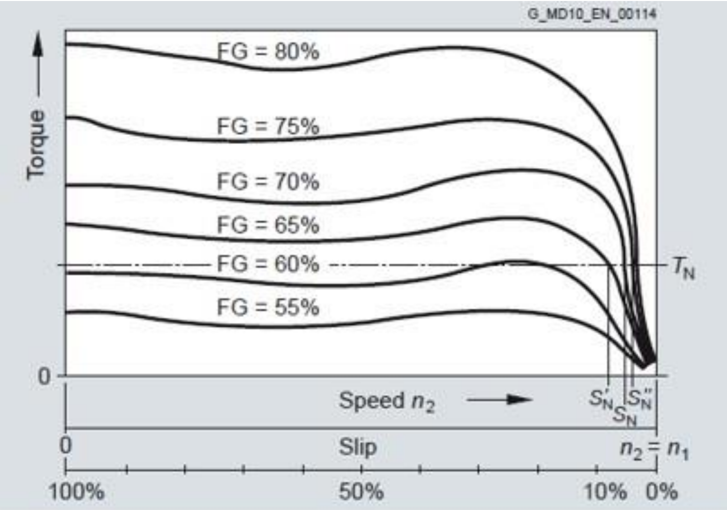
Variable-speed fluid couplings are used principally in conveyor systems with higher powers and long starting times.

Note:
For figures showing various operating conditions (at motor start, acceleration of driven machine, nominal operation and operation at part-load speed), please see "Fill-controlled Fluid Couplings" by Voith (www.voithturbo.com/startup-components).

Special Design Considerations for Constant Fill Couplings

As fluid couplings of constant fill type are sealed to the outside and the exchange of gases or fluids with the environment is not easily possible, measures to limit the thermal inner pressure must be implemented.

To generate the operating fluid circulation, a difference in speed, usually termed “slip”, is necessary between the pump impeller and turbine wheel. Slip multiplied by the transmitted power represents the power loss of the coupling, which is converted into heat inside the fluid/oil filling. The amount of slip heat generated during the start-up process and in normal operation must be released into the environment via the coupling housing surface to prevent an impermissible temperature rise. The rated coupling output is mainly determined by the power loss which can be dissipated at a still acceptable operating temperature or a reasonable set slip limit. A limitation of the start-up frequency (number of starts per an hour) to reduce thermal stress may also be necessary.



Slip-torque Characteristics for Different Filling Levels FG
Graphic Source: FLENDER Standard Couplings, Catalog MD 10.1 • 2009

As shown in above figure, slip-torque characteristic of a Type T, basic design coupling (without a delay chamber) depends on the quantity of fluid filling (% Fill Level, % FG) in the coupling which enables the transmissible torque on starting up to be via the filling level. It may be noted that with a higher filling level, the starting torque increases, while the operating slip and thus the coupling temperature rise decreases. Conversely, with a lower filling level the starting torque decreases, the coupling becomes softer, while slip and coupling temperature rise. It may be noted that starting torque can be reduced without increasing continuous operating slip by using a coupling with a delay chamber (Type TV).

In general, couplings should not be filled more than 80% of their overall internal volume. Otherwise, the excessive internal pressure produced by heating of the operating fluid may cause serious damage to the coupling and may even lead to fatal injury! In view of this, fill opening should be designed such that the maximum achievable fill level is 80 %.

For safety, all constant-fill couplings should also have fusible plugs that release an opening if the thermal stress limit is exceeded. The operating fluid exits from this opening and the power transmission is interrupted.

In addition, mechanical thermal limit switch or thermal measuring unit may be provided.

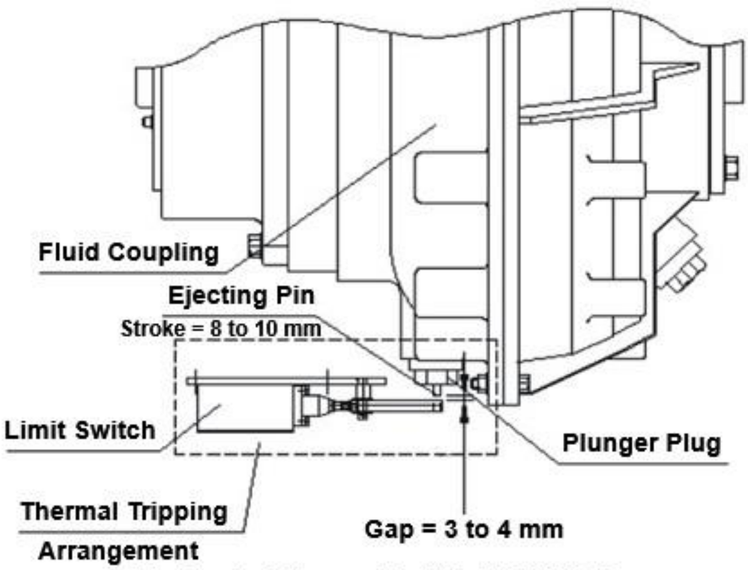
Fusible Safety Plugs

Fusible plugs (one or more depending on design) protect the coupling from irreparable damage through overheating or overpressure. If a fluid coupling is operated with an impermissibly high slip for a prolonged period, the oil (operating fluid) filling and the coupling housing will overheat. If output of the coupling gets blocked, the input power completely turns into heat in heating up the oil. In such situation, the core of fusible plug/s will melt upon reaching a preset temperature and release the oil through this opening/s into the environment. This results in stoppage of power transmission through the coupling, separating the input and output drives. Thus fusible plug can prevent the oil from getting too hot and causing serious damages and fire.

For safety, never replace a fusible plug with one having a higher temperature rating than the recommended one or a screw.

Mechanical Thermal Switch/Plug (MTS/MTP)

By adding mechanical thermal switch/plug, leakage and loss of expensive oil through the fusible plug as well as a risk of contaminating the environment in the event that the coupling overheats can be avoided. The standard fusible plug (with a higher response temperature) remains in the coupling for additional safety.



Mechanical Thermal Switch (MTS/MTP)

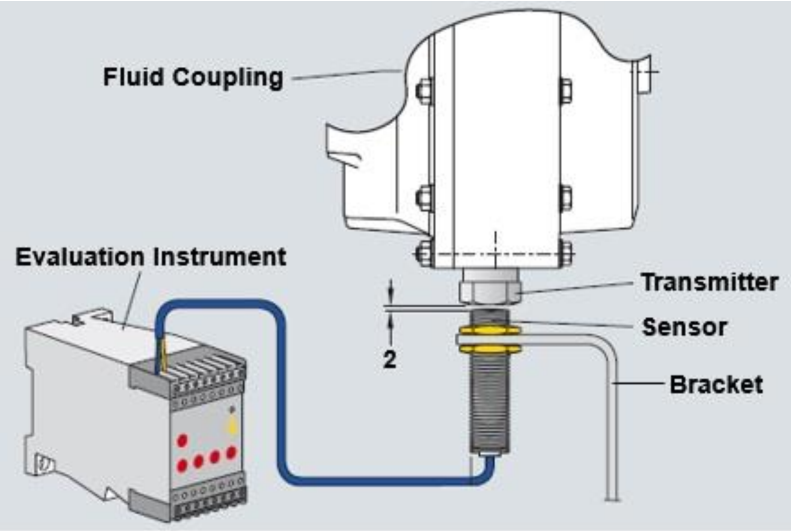
As shown in above figure, mechanical thermal switch consists of a plunger plug screwed on the fluid coupling body (housing). A spring-loaded pin and a chamber filled with solder are integrated in the plunger plug. A cam with limit switch is mounted on stationary base frame. The response/preset temperature of the plunger plug corresponds to the melting temperature of the solder. Below the response temperature, the solder keeps the pin in its initial position. On reaching the nominal response temperature, the solder releases the pin, and a compression spring presses the pin toward the outside (by 8 to 10 mm) which hits the cam (due to coupling's rotation) and operates the limit switch. The switchgear can cut out the drive motor and/or trigger an optical or acoustic alarm signal. As the housing of the coupling remains closed, no oil will escape. However, once the plunger plug of the mechanical thermal switch has responded, it is no longer usable and needs to be replaced.

However, in case of inner wheel drive (motor connected to turbine wheel) and blocking of driven machine, the mechanical thermal switch does not work.

It is recommended to use mechanical thermal switch and fusible safety plug combination for continuous coupling operation temperatures as under:

Continuous Coupling Operation Temp.	Mechanical Thermal Switch	Fusible Safety Plug
≤ 85°C	110°C	140°C
> 85°C to 110°C	140°C	160°C

Non-contacting Temperature Monitors



Non-contacting Temperature Monitoring System

Above figure shows typical non-contacting temperature monitoring system (for example, EOC system by Siemens/A. Friedrich Flender AG). By adding non-contacting temperature monitor with display and relay output, leakage and loss of oil through the fusible plug in the event that the coupling overheats can be avoided. After coupling has cooled down, the system resets. The standard fusible plug (with a higher response temperature) remains in the coupling for additional safety.

To initiate desired action on the coupling reaching response/preset temperature, non-contacting temperature monitors are available in two types:

1. Non-contacting thermal switch unit (e.g. BTS by Voith)
2. Non-contacting thermal measuring device (e.g. BTM by Voith)

Suggested temperature settings for them are as under:

Set Point I (Alarm)	Set Point II (Trip)	Fusible Safety Plug
100°C	110°C	140°C
125°C	135°C	160°C

The thermal switching element (e.g. BTS) must not be used as safety device to limit the maximum permissible temperature of the fluid coupling in potentially explosive atmospheres!

For more information on MTS, BTS and BTM by Voith, please see Installation and Operating Manual for them (www.voith.com/fluid-couplings).

Operating Fluids

In fluid couplings, fluid flow transfers the power from the pump impeller to the turbine runner. Hence the operating fluid is an important design element for the whole system. The density and viscosity of the fluid are of primary importance. Higher the density of the operating fluid, better the transmission capacity. Lower the viscosity, lower the speed losses of the circumferential mass flow in the flow channel. Other important properties are high viscosity index, high specific heat and high operating temperature as another key task is to take in the heat resulting from the power loss and then transfer it to the coupling components.

The operating fluid is selected on the basis of the parameter requirements for the power transmission, the material compatibility and the minimum lubricant capability for antifriction bearings.

HLP (mineral-oil based) hydraulic oils within the ISO VG 32 viscosity class are the standard operating fluids used for fluid couplings. For special cases ISO VG 10 to 46 are usable.

The mineral-oil based operating fluid should fulfill the following requirements.

Viscosity class: ISO VG 32 to DIN 51519
Starting viscosity: less than 15000 mm^2s^{-1} (cSt)
Pour point: the limit is 4°C below actual minimum ambient temperature or lower
Flash point: greater than 180°C and at least 40°C above nominal response temperature of fusible plug
Fire point (for couplings used in hazardous areas): at least 50°C above max. surface temperature
Resistance to aging: aging-resistant refined product
Compatibility with seals: NBR (Nitril-Butadien rubber) and FPM/FKM (Viton rubber)
Cleanliness grade: 21/19/16 as per ISO 4406 (Minimum requirement)

Many fluids including hydraulic oils HLP 32 to DIN 51524, Part 2; lube oil CLP 32 to DIN 51517, Part 3; steam turbine oils LTD 32 to DIN 51515, Part 1; HD engine oils SAE 10W; ATF type A Suffix A (TASA) and type Dexron II meet above requirements and can be used.

Some proposed operating fluids (mineral oils) are as under.

Manufacturer	Designation	Pour Point °C	Flash Point °C
BP	Energol HLP-HM 32	−30	216
Castrol	Hyspin SP 32	−28	200
	Hyspin AWS 32	−27	200
ExxonMobil	Nuto H 32	−24	212
	DTE 24	−27	220
	Mobil SHC 524	−54	234
Kuwait Petroleum	Q8 Haydn 32	−30	208
	Q8 Holst 32	−30	208
Shell	Tegula V 32	−33	211
Total	Azolla ZS 32	−27	210
HP (Hindustan Petroleum)	HP ENCLO 32	−3	190
HP (Hindustan Petroleum)	HP ENCLO VT 32	−37	224
IOC (Indian Oil Corporation)	IOC - SERVOSYSTEM 32	−6	190
IOC (Indian Oil Corporation)	IOC - SERVOSYSTEM HLP 32	−21	200

Note: The above is a small list and is not complete.

Fluidomat Limited (India) recommends use of ISO VG 32 mineral oil for constant fill type couplings and ISO VG 46 mineral oil for variable speed (scoop controlled) fluid couplings.

Mineral oil is often not an option as an operating fluid for primary applications in the underground mining industry or for use in water protection areas. This required the approval of nonflammable or flame-resistant and environmentally friendly operating fluids. Water or HFAE fluids (oil in water emulsions) and HFDU fluids (water-free, synthetic fluids) fulfill the requirements of the underground use.

Coupling Installation

Take care of following points during installation of a coupling. They are listed hear though common because they are very important. Most of the time, they are the causes for an accident or premature failure of a coupling.

Lift the coupling at the slinging points provided on the housing (generally at top). Improper slinging and lifting of the coupling may cause damage of property and personal injuries!

Check the lifting appliances and load suspension devices for sufficient carrying capacity and healthiness (sound condition).

Clean preserved surfaces including the shaft journals and hubs using solvent / emery cloth.

Check radial runout of drive motor and driven machine shaft journals.

Check keys for smooth fit in the keyways and sufficient top/back clearance.

While mounting input and output connecting coupling hubs, unsuitable mounting aids (e.g. hammer, welding/cutting torch etc.) should not be used. It is recommended to carefully heat the hubs to the specified temperature for their mounting and then secure them with the set screw.

Align input and output shaft with each other to the recommended or smaller tolerances. Take care of shafts displacements due to temperature changes (e.g. due to heating of gearbox). Distance between shafts ends should be within specified tolerance. Fully tighten all foundation screws/bolts of input and output units to the recommended torque. Screw/bolt threads should be lightly coated with lubricating oil before their torque tightening.

Check alignment after tightening all screws, and correct if necessary. It may be noted that smaller the amount of misalignment, smoother the running and longer the lifetime of the unit.

Coupling Filling

Constant fill fluid couplings are generally delivered without filling the operating fluid. If the operating fluid is included in the scope of supply, it is shipped in a separate container.

Unscrew the fluid filling plug and fill the coupling with the specified quantity of operating fluid. Impurities in the operating fluid cause an increased wear of the coupling and bearing damages. Make sure that containers, funnels, filling tubes etc., used for filling the coupling are clean. It is recommended that operating fluid is filled through a 25 µm strainer if the operating fluid is a mineral oil.

In general, it is recommended that a constant fill fluid coupling should not be filled more than 80% of its overall internal volume. One should not overfill a fluid coupling. Overfilling would lead to an undue high internal pressure in the coupling, which may destroy it. It is also recommended not to fill a coupling below 40% because it will cause early bearings failure due to insufficient lubrication to the bearings.

Coupling Guard

The coupling temperature rises during operation. For safety, a guard for protection against contact with the hot coupling and rotating parts (the coupling and exposed shaft parts) should be provided. However, ventilation of the coupling must not be impaired.

It is suggested to make the guard from perforated plate having approximately 10 to 12 mm size holes. The guard should be designed to:

- Prevent intrusion of damaging foreign matter (like stones, corrosive steels, etc.).
- Withstand the impacts to be expected without excessive bending/damages, so that the coupling does not contact/rub with the guard.
- Catch spraying solder of fusible plugs.
- Collect operating fluid leaking out to prevent contact with other parts of the equipment (like motor, belt, etc.) which might ignite or catch fire.
- Provide sufficient ventilation to maintain the coupling's maximum surface temperature below the specified limit. Generally, a coupling guard enclosing the coupling on all sides will not cause reduction in coupling ventilation if the perforated plate is with 65% hole section.

Safety

In the event of thermal overload of the fluid coupling, the fusible plug responds (blows-off) and the operating fluid is discharged through it. Please insure the following for safety during such events.

Electrical devices located near the coupling need to be protected against the operating fluid spraying.

The spraying operating fluid cannot get into contact with hot machine parts, sparks or open flames to prevent fire.

The sprayed-off operating fluid cannot get in contact with persons! Danger of burning!

Persons being in the surrounding of fluid coupling have to wear goggles. Spraying off hot operating fluid means a risk of losing sight!

Collect operating fluid leaking out to prevent contact with other parts (motor, belt) which might ignite or catch fire.

In order to prevent danger (e.g. risk of skidding, risk of fire) caused by escaping oil, remove it immediately.

Commissioning and Operation of Fluid Couplings

Commissioning

Never operate a coupling without the coupling guard. Be careful! Loose clothes, long hair, jewelry, rings or loose parts could get stuck and be drawn in or wound up causing serious injuries and damage to the fluid coupling.

Never operate a coupling without operating fluid!

If the motor is started with star/delta connection, switchover from star to delta connection should be effected after maximum 2 to 5 seconds.

Put the coupling into operation and observe any irregularities.

After approximately 1 hour of running, check tightening torques of connecting/flexible coupling fastening screws/bolts.

In case of a multi-motor drive, determine the load of individual motors. Large differences in motor load may be balanced by an appropriate adjustment of the respective coupling fill levels.

Operation

Use only the specified operating fluid as per the operating manual. Do not mix different types of operating fluids.

Operate the fluid coupling only with the filling amount shown in the operating manual. A too low filling results in thermal overload of the coupling and, in case of overfill, the coupling may be damaged by internal pressure.

At start-up the temperature rise in the fluid coupling is higher than at normal operation due to an increased slip. Hence, provide sufficient time intervals between starts to avoid thermal overload. <u>Don't try to clear blockage or over load by frequent starts because fusible plug will blow off due to overheating of the operating fluid.</u>

In case of a coupling with delay chamber, at start-up, the operating fluid is delivered from the delay chamber into the working chamber. On standstill, the operating fluid flows back into the delay chamber. In view of this, <u>provide sufficient time intervals (a few minutes!) between starts</u> to obtain a correct starting characteristic.

Blocking of the driven machine may cause overheating of the fluid coupling and response (blow-off) of the fusible plug thus endangering persons as well as the fluid coupling.

The fusible plug of the fluid coupling will response in case the driven machine is loaded excessively during nominal operation or during running-up.

For monitoring of overload, output speed may be monitored. If the output speed falls below the input speed by more than 10%, switch off power supply.

It is recommended that during continuous operation, oil temperature should not exceed 90°C. Keep the coupling in clean condition. If required, clean the coupling with a grease solvent. For good coupling ventilation it is necessary to check and clean the coupling guard/cover at regular intervals. Be careful with gaskets. Avoid high pressure water jet and compressed air for cleaning coupling and coupling guard.

After the fusible safety plug has melted, shut off the unit to prevent the bearings from running dry. It is recommended that the coupling should not be run more than 60 seconds after fusible plug has melted and oil is drained.

In case of fire, extinguish it using ABC powder or carbon dioxide, <u>never use water</u>.

Maintenance of Fluid Couplings

When the requirements for installation, alignment and operating fluid filling have been correctly complied with, fluid couplings require virtually no maintenance except periodic checking for the following.

Time	Maintenance Work
After the first 500 operating hours	• Check tightening torque of connecting/flexible coupling fastening bolts/screws and foundation bolts. • Check alignment.
After every 500 operating hours or at the latest after every 3 months	• Visually inspect the unit for irregularities such as tightness (missing) of screws, noise, vibrations, etc. • The oil tightness of the filling plug. Oil tightness of the fluid coupling can be checked by holding a clean sheet of paper some 10 cm from the coupling, any oil leaks will be shown up by this paper test. • Check tightening torque of connecting coupling fastening bolts/screws.
After every 5,000 operating hours or annually.	• Check tightening torque of foundation bolts. • Check alignment. • Check flexible elements of connecting coupling for wear / damage and replace them if required. • Check level/amount of operating fluid. Make up the level if necessary.
After every 15000 operating hours, if mineral oil is used as operating fluid.	• Change the operating fluid or check it for aging and determine remaining service life for appropriate action. • If the oil appears dark in color and emits a smell of burning, this is due to overheating. The oil is liable to oxidize or acidify and must be replaced.
On response of a fusible plug.	• After one fusible plug responded, change all fusible plugs and the operating fluid. • Tighten the bolts around the coupling circumference (housing bolts). • Use only genuine fusible safety plugs. The fusible safety plug must not be exchanged for solid screw under any circumstances. • Check operating conditions (blockage/jamming of the driven machine, overloading, etc.). • Check reason for the failure of devices provided for temperature monitoring if provided (MTS, BTS or BTM).

Oil Seals

Because of operating slip, coupling gets heated by approximately 50°C relative to the ambient (cooling air) temperature. With lower outputs, coupling heating will be proportionately lower. If for continuous operation of the coupling an absolute temperature (ambient temperature + coupling heating) of > 85°C is expected, it is recommended that the coupling should be fitted with Viton seals.

Oil Coolers

Oil coolers are used in conjunction with the variable-speed fluid couplings whenever the coupling self dissipation capability is insufficient to meet the internal heat generation. The coolers are supplied in two types: air blast radiator coolers and water cooled coolers (suitable for normal water or salt water).

It is recommended that if the cooler is to be left unused for a period of time, it should be drained and cleaned.

Take care of fins while cleaning of air blast radiator coolers. Oil coolers subject to fouling (scale. sludge deposits, etc.) should be cleaned periodically depending on specific conditions. A light sludge or scale coating on either side of the tube greatly reduces its effectiveness. A marked increase in pressure drop and/or reduction in performance usually indicates cleaning is necessary. Since the difficulty of cleaning increases rapidly as the scale thickens or deposits increase, the intervals between cleaning should not be excessive.

Overhauling

For dismantling and reassembly of a fluid coupling, follow manufacturer's instructions. In general, reassembly is carried out by reversing the dismantling sequence. During reassembly, pay attention to cleanliness. Also take utmost care in fitting of bearings, oil seal / O-rings and alignment of parts.

Normally the individual parts are balanced and are interchangeable. In cases where a particularly smooth, even running is necessary, the fluid coupling is completely balanced and the parts are marked (e.g. 0/0, 1/1, 2/2 etc.) at the factory. Take care of the markings while reassembly. It is a good practice to mark parts before disassembling if parts are not marked.

In case of variable-speed couplings with scoop tube, ensure that the scoop tube is installed correctly for the direction of rotation. Check scoop tip clearance and if necessary, adjust it.

It is recommended that all shaft seals and gaskets be renewed at each dismantling.

Please ensure that the cleaning agent is compatible with the NBR and Viton materials used for sealing.

Troubleshooting

The following table may be used to find the common cause of failures or problems and to take remedial action, if necessary.

Observation	Possible Cause(s)	Remedial Action
Starting behavior of driven machine is not as expected.	Coupling is not filled with the correct quantity of operating fluid.	Correct the quantity of operating fluid.
Driven machine does not reach the specified speed.	Driven machine is blocked or overloaded.	Remove blockage or the cause for overloading.
Operating fluid leaks out of the coupling.	A fusible plug responded due to overload.	Clear the cause for overload.
	There is a leakage from the coupling.	Eliminate the leak from housing joint, filling plug, fusible plug, sight glasses, oil seals, etc.
Increase in vibration.	Foundation bolts are loose.	Tighten the foundation bolts.
	Alignment has got disturbed.	Correct alignment.
	Flexible elements of connecting coupling are defective.	Replace flexible elements.
	Damaged bearings.	Replace the bearings.
	Screw connections are loose.	Tighten to the specified torque.
	Unit is not balanced.	Balance the unit.
Premature wear/damage of flexible element.	Incorrect alignment.	Check distance between shaft ends. Correct alignment.
	Excessive torque.	Remove the cause for excessive torque. Check fill level.
	Contact with aggressive media.	Eliminate cause for contact with aggressive media.
MTS switching element did not respond.	Cam lever (finger) of the switch was not in the correct position.	Install the lever/finger in correct position.
	The switch is not properly connected.	Check and correct the wiring if required.

Advantages of Fluid Couplings

Wear free power transmission due to absence of mechanical connection between the input and output elements.

No-load start-up of motor irrespective of machine load.

Sequential starting of multiple motors to reduce aggregate value of current drawn.

Smooth and controlled acceleration of large inertia driven machines by a simple squirrel cage induction motor.

Motor selection to operating duty/load rather than starting loads resulting in lowering capital cost.

Overload protection for motor and driven machine by limiting maximum torque to a predetermined safe value.

Simple control of torque by changing the fill level (amount of operating fluid).

Automatic unloading of prime mover in case of sustained overload due to response (blowing-off) of fusible safety plug.

Effective dampening of shocks, load fluctuations and torsional vibrations.

Step less speed variation in scoop tube type fluid couplings.

High efficiency due to low slip at rated duty (e.g., 98.5% for TurboBelt 780 TPXL by Voith)

Coupling Selection

As per IS 11592, Selection and Design of Belt Conveyors - Code of Practice:

- The use of flexible couplings shall be preferred up to 30 kW and may also be considered for small conveyors requiring less than 50 kW.
- Fluid couplings shall preferably be used when conveyor power requirement exceeds 30kW.

Coupling	TV	TVV	TVVS	TPKL	TurboBelt 780 TPXL
Power range in kW	37 – 400	37 – 630	75 – 1 500	150 – 4 000	700 – 1 900
Motor speed in rpm	900 – 1 800	900 – 1 800	900 – 1 800	1 500 – 1 800	900 – 1 200
Type T/TP	constant fill			fill controlled	
Thermal capacity	surface cooling			active cooling	
Startup time	up to 25 s	up to 35 s	up to 45 s	up to several minutes	up to several minutes
Service	Design, planning, commissioning, technical analysis, maintenance, training				

Voith's Hydrodynamic Couplings for Belt Conveyors

Graphic Source: Compact Drive Technology for Belt Conveyors, The TurboBelt 780 TPXL by Voith

Above figure shows capacity and startup time for Voith's hydrodynamic (fluid) couplings for belt conveyors. Voith is a global technology group.

Fluidomat (www.fluidomat.com) and Premium/Pembril (www.premium-transmission.com) are leading fluid coupling brands in India.

Note:

Most of the figures and content for this article are reproduced from various publications by Voith Turbo GmbH & Co. KG, Germany (www.voith.com/fluid-couplings).

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