

Voith Turbo

**VOITH**

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**Modern drive technology with hydrodynamic  
couplings for Coal-Mine Applications**

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**Cv of Klaus Maier**

# 1 Abstract

Fluid couplings have been used extensively in separate several applications for decades, showing their simplicity and naturally beneficial torque transmission characteristics. Various designs of constant-fill (passively controlled) fluid couplings were developed to meet the ever changing drive requirements and they continued to increase in power and complexity. Voith Turbo developed several types of couplings (extended delay fill + annular soft start chamber) to meet the requirements. The Voith coupling was widely accepted as the best hydrodynamic soft-start technology available and has been successfully applied to thousands of drive applications.

The technology continued to advance through the 1990's. In an effort to remain competitive, many mines had to increase their net clean coal capacity and/or reduce their cost per ton. These challenges resulted in the need for increasing the capacity and reliability of the mine's systems, which forced operators to consider actively controlled and cooled drive systems. Various drive technologies were being developed or used to meet the demands of complex systems, each with their unique set of advantages and disadvantages. This paper is not intended to compare the technologies of these various drive systems, but to give an overview of the history, applications and development of modern Hydrodynamic coupling.

## 2 The Voith Group

Voith, today an internationally active group in business sectors such as

- Paper technology
- Power plant technology
- General power transmission technology

with a workforce of currently 30,000 employees, began with the development and the production of "Föttinger" devices, i.e. hydrodynamic couplings and torque converters, as early as 1930. Conveying technology in mining has been an important business field for Voith for over 50 years.

As separate factory, Voith Turbo, was founded in Crailsheim in 1956 especially for the production of hydrodynamic couplings. The factory now has 900 employees and produces turbo couplings for mining and conveying technology, variable-speed couplings for power stations and the oil and gas industries, as well as retarders for buses and trucks. Up to now, more than 1 million hydrodynamic couplings have been produced there. With the aid of our large test department, hydrodynamic couplings and torque converters have been developed and are continually being developed further.

The capacities of Hydrodynamic couplings range from approx. 3 kW up to 30 MW per drive.

### 3 Principle of Hydrodynamic Couplings

The expression hydrodynamics derives from the Greek language and means hydro = water and dynamics = theory of drive and energy, thus hydrodynamics means fluid mechanics/energy.

In order to give some insight into this topic of fluid mechanics and to better understand the hydrodynamic coupling, it is important to shortly present the basics.

The whole matter is composed of the Euler turbine equation and the Bernoulli equation.

For us only one formula is important, which is:

Torque =  $\lambda \cdot F \cdot D^5 \cdot \omega^2$ , as indicated below.

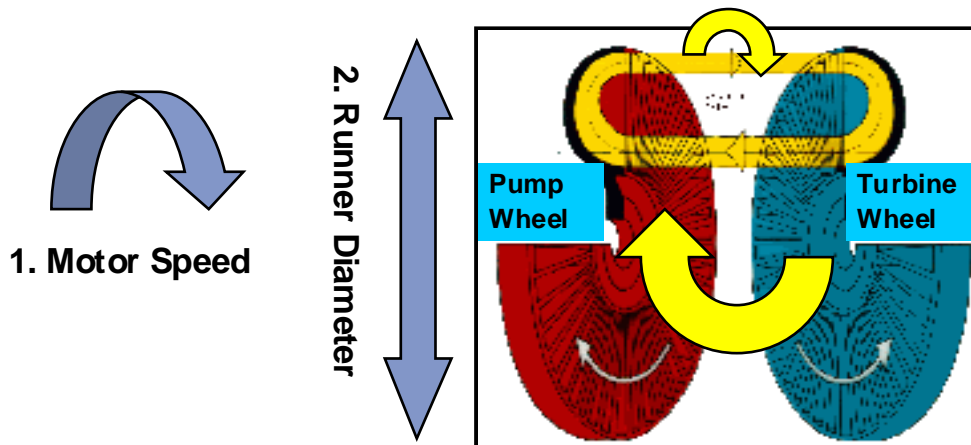
$$T = \lambda \cdot \rho \cdot D_p^5 \cdot \omega_p^2$$

Hydrodynamic coupling development originated with a patent taken out in 1905 by the young electrical engineer Dr. Hermann Föttinger. The shipbuilding company where he worked (Stettiner Vulkan) ordered him to link the upcoming high-speed steam turbine with the low-speed propeller. He was thus faced with the problem that the form of power supplied did not comply with the power required. Such problems of power control and conversion still have to be solved in modern drive technology.

Föttinger's proposal of hydrodynamic power transmission led to development of the three "Föttinger devices" named after him - torque converter, hydrodynamic coupling and hydrodynamic brake.

Both the hydrodynamic coupling and hydrodynamic brake represent special designs of the Föttinger converter. The relevant terminology and definitions, mechanical design, operating and design principles are established.

Hydrodynamic couplings are often grouped separately among shaft coupling options, due to the torque conversion principle employed. The conversion of external mechanical energy into internal hydraulic energy and vice-versa enables power transmission characteristics to be influenced in many ways. Hydrodynamic couplings can therefore be used for all kinds of mobile and stationary drive applications.



$$T = \lambda \cdot \rho \cdot D_P^5 \cdot \omega_P^2$$

The torque transmission is effected via the so-called pump side to the turbine side.

You have to imagine that the pump side accelerates the fluid, which means that same is brought to a higher energy level. This energy is then again transformed into torque via the turbine side.

First of all, the motor speed is essential, as I mentioned before, second are the diameters of the runner, and third is the fluid quantity and/or the fluid density. These three basic criteria are important for determining the respective size of the hydrodynamic coupling and the torque transmission.

# 4 Research and Development

## 4.1 Operating Fluid

As you all know, mineral oil is used as operating fluid of the hydrodynamic coupling in most of the cases. At present this is the usual and most common fluid and is therefore well-known. Many empirical tests have shown, that use of other fluids is also possible.

For example synthetic oil, which has in particular, been developed further considering the environmental aspects.

Furthermore, esters which should be considered specifically. Ester can increase the power transmission, but the environmental aspects still need to be examined.

The latest operating fluid used, is water. Within the last few years, considerable progress could be achieved. However, I would like to point out that using this fluid means a particular challenge, especially as to the materials used and the little necessities around a hydrodynamic coupling.

But for the user it is the best.

Handling, function and environmental issues becoming an easy task.

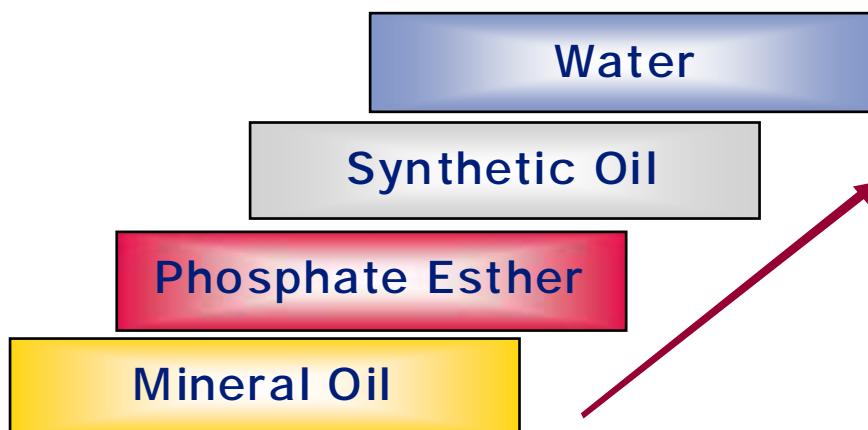
Water is more or less available everywhere and has no negative effect on the environment!

Therefore the hydrodynamic coupling is a "kiss" function.

**Keep it simple and easy!**

## Research and Development

Operating Fluids





## 4.2 Profiles

Voith meets the various requirements on drives in systems with a comprehensive range of hydrodynamic couplings which are normally installed in the drive line between electric motor and gearbox.

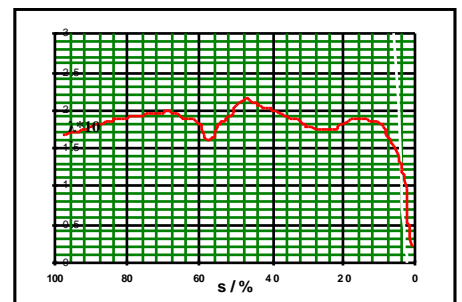
A precondition for the fulfilment of the ever increasing requirements on drives is continuous further development of the components used in such an application. The ongoing development of Voith turbo couplings means on the one hand that the product range is increased, starting from the constant-fill coupling type T up to the fill-controlled type TPKL; on the other hand it also means that components with key functions, especially the runner profiles which have a significant influence on the torque characteristics of the coupling, are constantly optimised.

Which you can see here.

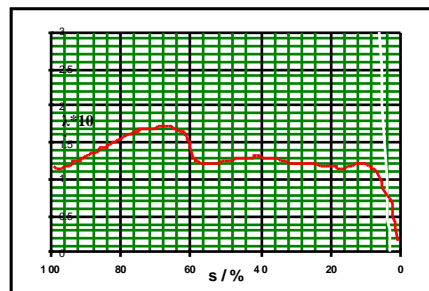
The development of smooth torque transmission with different profiles.



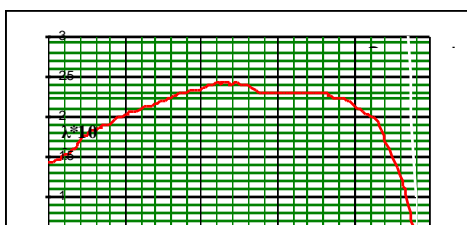
Mixed Profil



Stepped Profil with Plate



Stepped Profil



# 5 Applications

## 5.1 Applications of conveying technology for belt conveyor drives

### 5.1.1 Requirements to be met by the drive units

Increasing conveying quantities, longer conveying distances, higher capacities and increased requirements of operating safety lead to permanently growing requirements on the drives of modern belt conveyors. The belt is the most expensive system component and is thus decisive for the investment costs and economic viability of the whole plant. For this reason the drive units should effectively protect the belt and increase its useful life but should naturally be operationally safe and economical as well. A drive should meet the following requirements:

- n Unloaded motor start
- n Utilisation of economically priced, low-maintenance squirrel-cage motors
- n Smooth build-up of starting torque up to break-away of the belt conveyor
- n Limitation of maximum torque during start-up
- n Adaptation of the start-up torque to the prevailing load condition
- n Reduction of longitudinal oscillations of the belt
- n Load adaptation with multi-motor drives
- n Staggered activation of the motors with multi-motor drives, in order to avoid a summation of inrush currents
- n Easy handling and compact design
- n Low-wear and low-maintenance operation
- n Possible use of water as operating medium, especially for underground mining applications



In applications for belt units we differ principally between constant-fill hydrodynamic couplings and fill-controlled couplings.

## 5.1.2 Constant-fill couplings / Coupling types

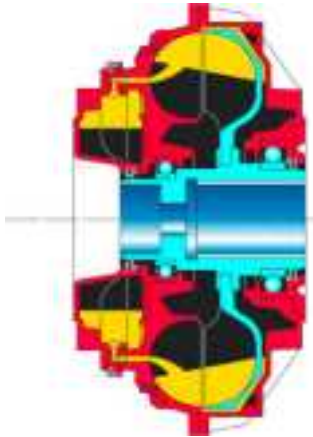


Fig. 1

The turbo coupling **type TV (Fig. 1)** with delay chamber is normally used with low drive outputs. In the fitted delay chamber, part of the operating fill is held back during the start-up process. A lower torque is thus transmitted during the start-up process and the conveyor belt is evenly accelerated, while the operating medium flows from the delay chamber into the working area

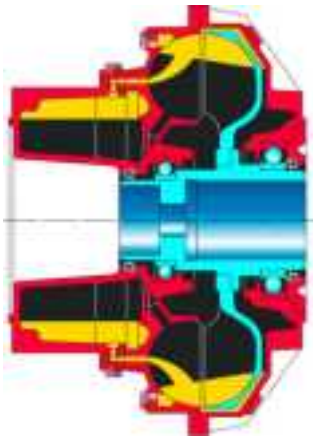


Fig. 2

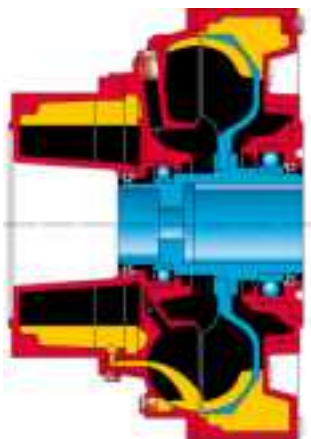


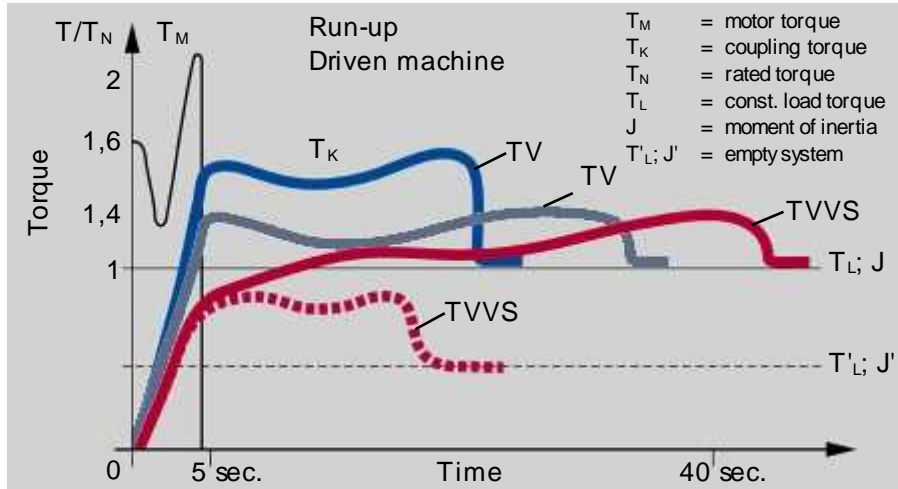
Fig.3

By using a turbo coupling of **type TVV (Fig. 2)** with enlarged delay chamber, the start-up torque is further reduced and the conveyor belt accelerated even more smoothly. This coupling is used for larger drive capacities

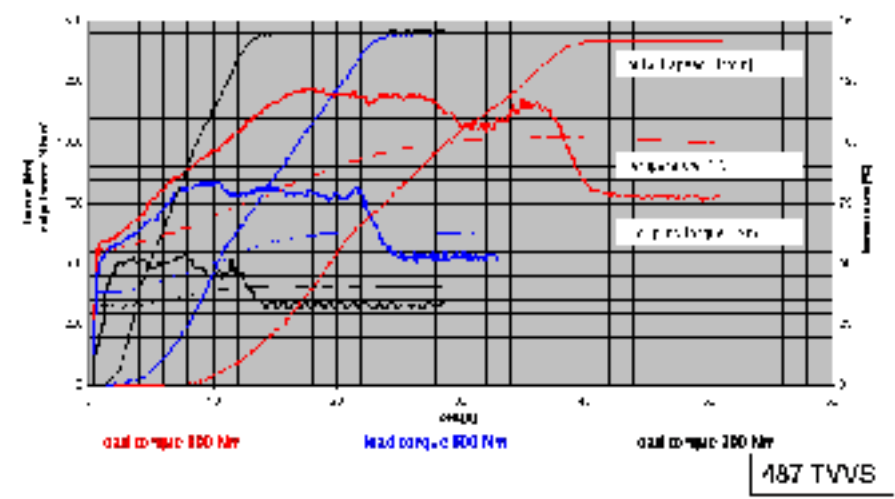
Even higher requirements made by the drive are met with the turbo coupling **type TVVS (Fig. 3)** with an additional annular chamber. Since, immediately after motor start-up, most of the operating fluid remains in the annular chamber and the delay chamber, the torque transmission is very low and builds up slowly when the enlarged delay chamber is draining. This leads to an extraordinarily smooth start-up, very good start-up torque limitation and hence makes this coupling type the ideal choice for driving long conveyor belts with vertical and horizontal curves.

### 5.1.3 Characteristic curves

The graph below shows the principle torque characteristics of the coupling types described above:



When starting up an empty or partially loaded belt conveyor, the start-up torque is reduced to values below the nominal torque of the loaded conveyor. This coupling type is the only coupling with constant-fill that can adapt the start-up torque to the individual load and is therefore the ideal belt conveyor coupling.



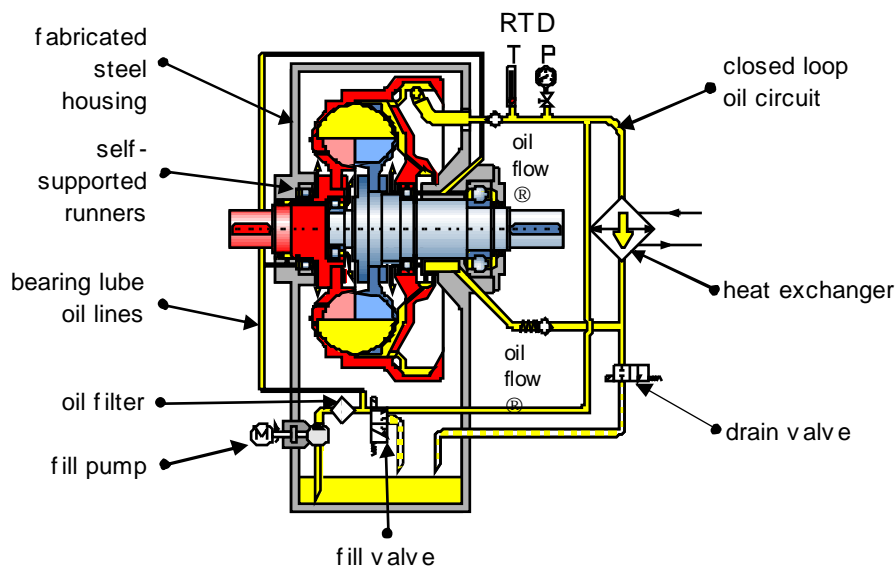
## 5.1.4 Fill-controlled couplings

If there are additional demands on the conveyor drive, e. g.

- starting torque limitation  $\leq 140\%$  related to the effective output
- extremely long start-up periods
- high frequency of start-ups
- load-independent constant start-up time
- controlled run-down
- creep speed
- active load-sharing with multi-motor drives

our product range is completed by fill-controlled couplings.

Here, type TPKL has proven itself in the market as a technically superior solution.



*Cross-section-/ schematic of TPKL function*

Power is transmitted in the couplings in the well-known hydrodynamic mode.

The working circuit (impeller / turbine wheel) is superimposed by an external cooling circuit.

For this purpose, hot operating medium is flowing from the nozzles, located at the coupling runner periphery, into the pump ring rotating at motor speed, where it is absorbed by means of a discharge pump pointing against the flow. Here the kinetic energy of the fluid is converted into flow and pressure.

The hot fluid is flowing through an external cooler directly back into the coupling, very high starting frequencies are possible.

A housing-integrated oil supply system feeds fluid into or takes fluid from this circuit. Normally, this process is controlled by solenoid valves.

In this way the coupling fill is infinitely adjustable between 0 and 100 %, i.e. between empty and full.

The cooler is selected individually for the relevant drive configuration.

The torque transmitted depends directly on the coupling fill level and the relevant output speed.

Contrary to the constant fill coupling, the fill level of fill-controlled couplings is actively adjusted during operation.

Basically, the following applies:

- A control system takes over this level control.
- The higher the fill level, the higher the torque transmitted.
- This means the fill level must be increased appropriately from 0 to 100 %, without exceeding a set torque value.

**Three control methods are available:**

### A) Load-independent torque limitation

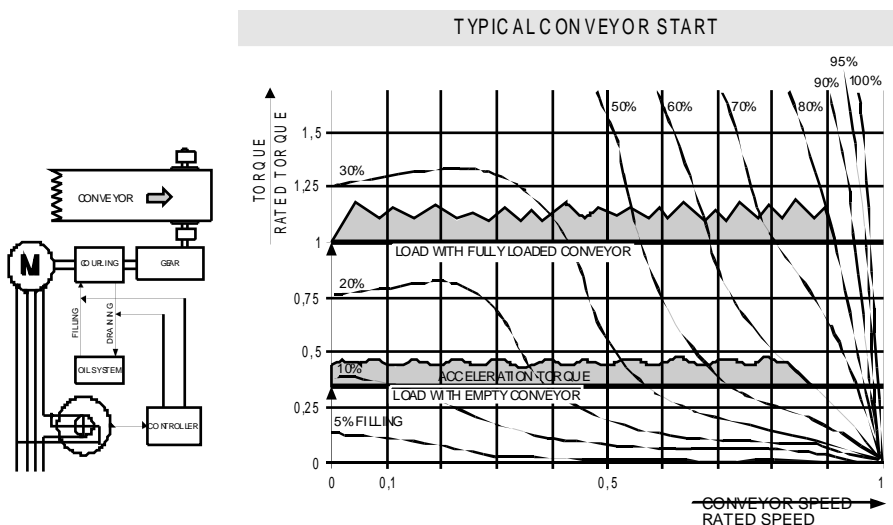
For all load conditions the same max. torque limitation applies. This value corresponds to the maximum permissible belt pull to be introduced into the belt conveyor.

Depending on the load condition, this results in different run-up times.

### B) Load-adapted acceleration

Assuming that the loading and thus the power demand does not change during standstill, the power required for restart is known in order to break away the conveyor. Therefore the actual power demand, before stopping the conveyor is recorded (constant close loop control). This power value is multiplied with the selectable starting factor serving as control limit value for run-up.

The belt pull is the maximum value defined as upper limit for the variable limit value.





## Application example

## - for Constant-fill couplings

### Potash Mine Germany

Conveyor data:

- length: 1500 m
- capacity: 800 t/h
- belt speed: 3,4 m/s
- drive configuration: 4 drives at 2 head pulleys
- motor power: 4 x 200 kW at 980 rpm
- coupling type: 750 TVVS
- commissioning: 1990



### Lignite Mine, Indonesia

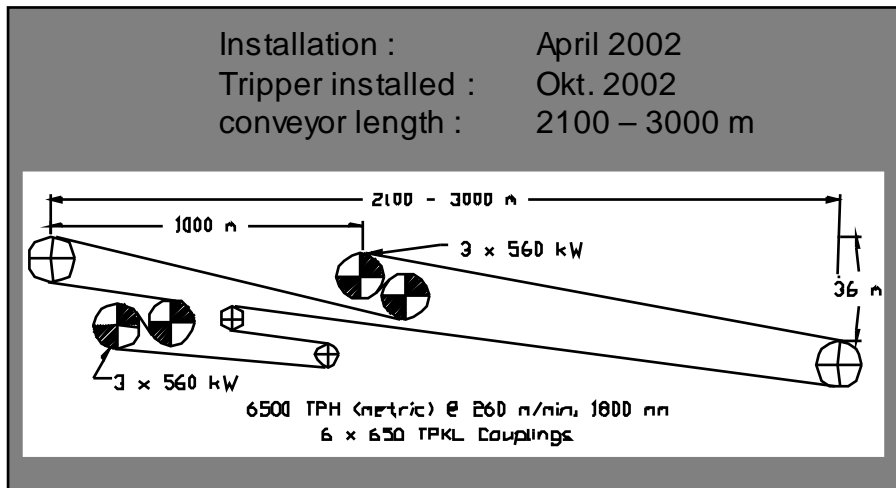
Conveyor data:

- length: 2060 m
- capacity: 1600 t/h
- belt speed: 3,8 m/s
- drive configuration: 1 drive at head pulley
- motor power: 1 x 500 kW at 1480 rpm
- coupling type: 750 TVVS
- commissioning: 1996



## - for Fill-controlled coupling

### Tripper Booster Conveyor in New Mexico Conveyor Profile



#### Conveyor data:

- length: 2100 to 3000 m
- capacity: 6500 t/h
- belt speed: 4,5 m/s
- drive configuration: Tripper Booster Conveyor  
3 drives at head pulleys  
3 drives at booster pulleys
- motor power: 6 x 560 kW / at 1780 rpm
- coupling type: 650 TPKL
- commissioning: October 2002

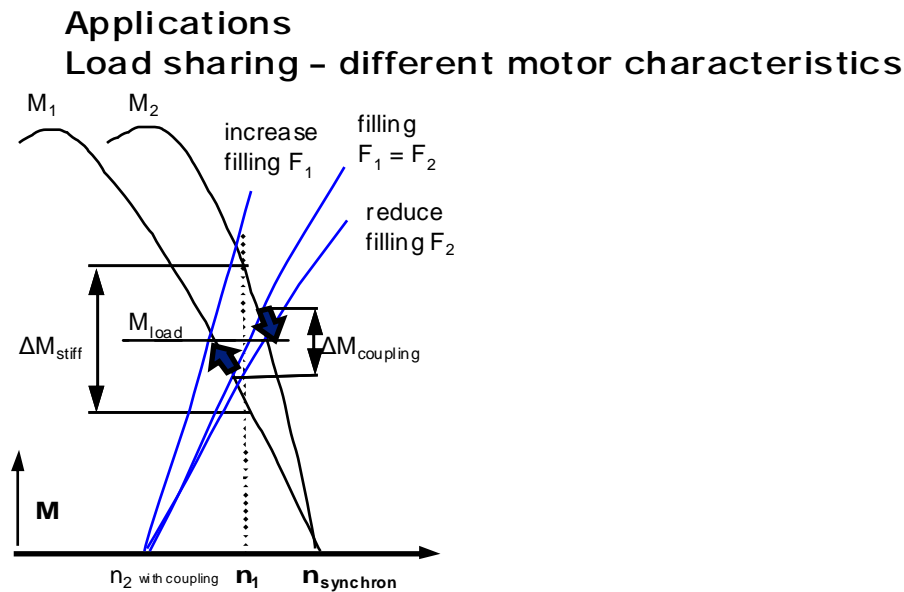


### 5.1.5 Advantages

The use of **regular asynchronous motors** and a larger performance range are the essential and important advantages for drives of conveyors with hydrodynamic couplings. Furthermore, there are other advantages, such as the **relieved run-up of the motor**, the **vibration-reducing** or the **vibration-cutting function** of the hydrodynamic coupling, the **considerable reduction of the torque** applied into the belt and material to be conveyed, the **important protection of the complete drive system by limiting the torque during an emergency stop** or a **jam up condition** (Lockrotor situation) as well as the possibility of **limiting the torque to 140 %**, and in some cases even below, and also the **load compensation with various motor characteristics**. In my opinion, this is very important for conveyor belts.

We call it a **natural physical way**.

As depicted below, the hydrodynamic coupling has got the property to even out different motor characteristic curves and thus different speeds by altering the filling.



## 5.2 AFC

### Task of Conveying Technology for AFC drives

#### 5.2.1 Requirements to be fulfilled by the drive

Modern high-performance AFC's are characterised by high conveyor capacities with longer and longer conveyor lengths. This increases the requirements made of the chain conveyors. On the one hand they require more power due to the length and the higher conveying capacity and on the other the requirements of operational safety increase due to the reduction in mining operations. The general requirements made of an armoured face conveyor drive can be formulated as follows:



1. almost load-free start-up of the asynchronous motors
2. sequential start of the individual drive at multi-motor drives
3. automatic torque limitation on start-up, no stalling of the motor over pull-out torque
4. smooth, quick torque build-up on the chain
5. torque build-up against blocked conveyor and holding of the motor pull-out torque
6. repeated start-ups without thermal problems
7. clockwise and counter-clockwise running of the conveyor to release blockages
8. automatic load sharing
9. simple control

The following additional requirements of the drive unit can be made particularly with AFC's of higher output:

10. very high thermal capacity
11. possibility of inspection run/creep speed
12. chain tightening in connection with a locking brake

### 5.2.2 Constant-fill couplings with centrifugal valves

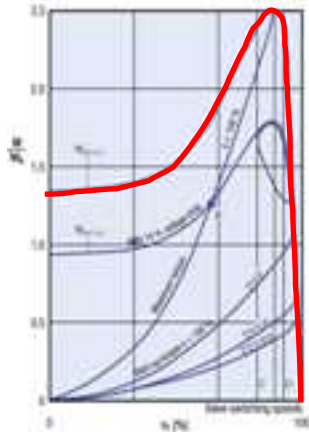
For small and medium outputs up to approx. 550 kW drive output, Voith constant-fill turbo couplings TVF, TVVF and TVVFS have been used for approx. 40 years.

These coupling types have two major operating characteristics:

- The refilling of the operating fluid from the working chamber into the delay chamber is controlled by centrifugally controlled valves.
- The draining of the delay chamber and the refilling time of the operating fluid into the working chamber can be adjusted to the system conditions via adjustable nozzles.

The interaction of nozzle and valve function allows optimum protection of squirrel-cage motors. As a result, the available pull-out torque of the motor can be fully utilised, even if the conditions are unfavourable, e. g. because of a voltage drop

### Applications Principle - Coupling with Valve Function T..V.F.



Motor characteristic curve  
at nominal voltage

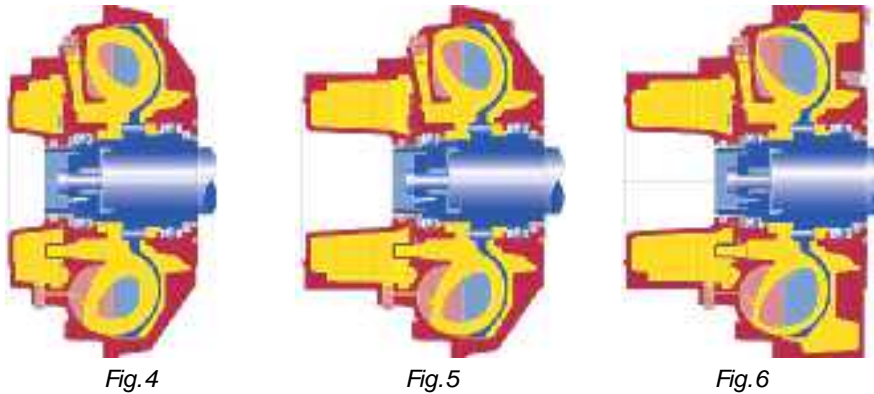


Motor characteristic curve  
at voltage drop

The Turbo Coupling type **TVF** (Fig.4) is usually used with lower drive outputs. The Turbo Coupling type **TVVF** (with enlarged delay chamber, Fig.5) and **TVVFS** (with additional annular chamber, Fig.6) offer

- an even better relief of motor during start-up
- a higher thermal capacity

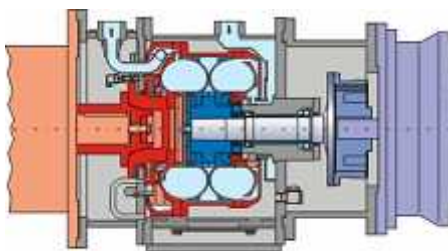
and are therefore particularly used with higher drive outputs.



All types of the constant fill couplings presented are also available in spherical graphite iron and with water as operating medium.

### 5.2.3 Fill-controlled couplings

For higher outputs, fill-controlled couplings, also known as drain-type couplings have been used for approx. 12 years.



These can be self-supported, self-supported only at the output side and completely supported externally and are situated between the motor and the gearbox. The material of the housing is stainless steel or galvanised constructional steel. The protected enclosed running wheels are made of aluminium, with nominal outputs of the coupling above 800 kW of propeller bronze. These couplings are generally operated on the armoured face conveyor with water. With the symmetrical arrangement of 2 circuits "back-to-back", the couplings can be produced with a smaller diameter. In addition, the axial forces and the cavitations are better controlled. Fill-controlled couplings have electromagnetically operated inlet and outlet valves and can be controlled actively. Before starting the conveyor, the motors can be started individually in order to reduce the load of the electric mains. The individual couplings are completely emptied in this case.

For the actual start-up of the conveyor, all couplings can then be filled simultaneously or individually according to a defined start-up sequence. The advantage of this coupling type is that the operating medium water directly absorbs the heat produced when starting up and the heat is then passed out of the coupling with the operating medium. Subsequent flowing cold water can then absorb heat again. Due to the large specific heat capacity of water (twice as high as with mineral oil) and the utilisation of the temperature spread of approx. 20 °C up to 60 °C, relatively low quantities of water are required.

By using additional cooler in the closed loop water consumption could be further minimised.

## 5.2.4 Application examples

### - for Constant-fill couplings

#### Coal Mine Poland



VTC 562 TWVVF

Motor power 200 kW at  
1480 rpm

AFC Drive, Coal Mine in  
Poland

#### Coal Mine Australia



VTC 650 TUWVFS

Motor power 450 kW at  
1480 rpm

AFC Drive, Coal Mine in  
Australia



## - for Fill-controlled couplings

### Coal Mine China

- IXinghongzhuang mine of the Yanzhou Group
- 2 x 562 DTPKW2
- Output 700 kW each.



### Coal Mine Germany

- Prosper Mine
- 2 x 562 DTPKW2.
- Output 800 KW each



### 5.2.5 Advantages

1. Load free motor start-up
2. Optimum protection of squirrel cage motor
3. Full use of the pull-out torque of the motor
4. Starting the AFC-drive under voltage drop conditions

Additional for fill-controlled couplings

5. Ramping of a AFC-start
6. Creep-speed.

## 5.3 Tasks for Crusher drives

Today's requirements for crushers, particularly for coal crushers, do not differ considerably from those decades ago.

Now as ever, one would like to have a relieved motor run-up, perhaps also with star-delta control. And you surely want to have an overload protection in order to protect the unit against destruction in the worst case.

Vibration damping and shock absorption as well as start-up against high mass moments of inertia. And all this in very dusty environment.

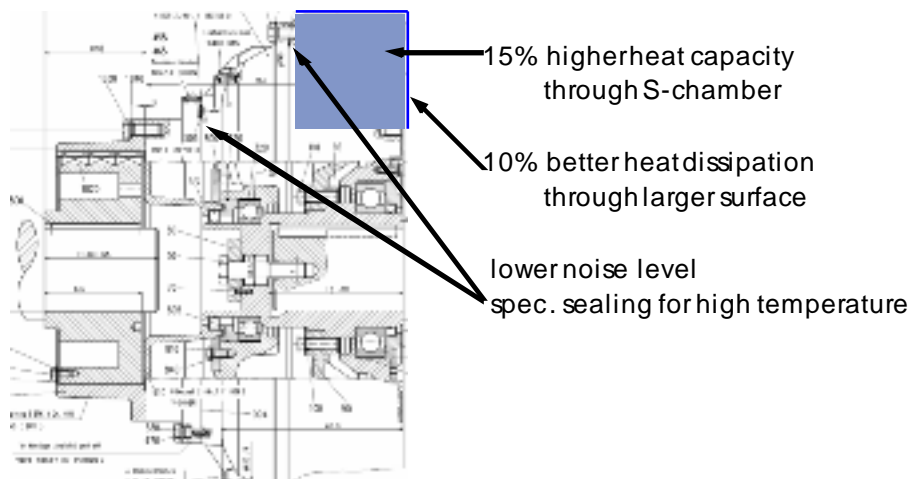
A hydrodynamic coupling is just ideal for this purpose. It meets all these requirements.

Voith has developed some special design (TVS-X) for this purpose.

This coupling has got a 15 % higher heat storage capacity and a 10 % higher heat dissipation. This results in a lower heating speed, thus you may operate in the overload area for a longer period of time. Therefore, you have a higher unit capacity guaranteeing practical operation.

### 5.3.1 Applications

#### Application TVS-X



Here are some applications for

### Coal Mine China



VTC 650 TUWVF

Motor power 400 kW at  
1480 rpm

Stage loader, Coal Mine China

### DBT-Crusher Stage loader

VTC 650 TUFB

1500 rpm

Motor power 400 KW



Operation of all these couplings is also possible with water as medium,  
as far as long the coupling temperature allows same.

### 5.3.2 Advantages

1. Load free motor start-up
2. Overload protection
3. Shock absorption
4. Vibration damping
5. For heavy-duty environmental conditions

# 6 ATEX

## Potentially Explosive Atmospheres

For many years, Voith Turbo hydrodynamic couplings have been reliably used in explosion hazardous areas.

According to latest ATEX 100 a regulations, the Voith hydrodynamic coupling has been verified especially with regard to the new safety requirements for explosion production of mechanical components.

Voith turbo hydrodynamic couplings are specially adapted for the use in different explosion hazardous areas and various drive applications, like coal mines.

Attached is a classification into the various zones, zone 0 (e.g. underground) to zone 2 normal environment. For the coal mines generally zone 0 and zone 1 apply, conditioned by the danger of exposure to dust caused by the coal.

### Explosive Zone classification

**Areas subject to explosion hazards are divided into zones depending upon the degree of risk**

	Presence of hazardous explosive atmosphere	no active sources of ignition
<b>Zone 0</b>	continuously or for long periods	in normal operation and rare incidents of malfunctioning and in the event of two independent faults
<b>Zone 1</b>	occasionally	in normal operation and in the event of frequently occurring disturbances
<b>Zone 2</b>	infrequently <u>and</u> for short periods	in normal operation

Here, special requirements regarding the design and the application of all kinds of drive systems need to be taken into consideration. There are different standards / requirements to hydrodynamic couplings all over the world. We only compare here German and British standards for underground applications. This comparison shows which different types of fluids and materials are required.

## Explosive Constant filled couplings for mining

Different safety standards - different adaptations of couplings

Standard of safety		
	„German“	„British“
Operating fluid	water/emulsion synthetic oil <sup>1)</sup>	water/emulsion synthetic oil <sup>1)</sup>
Material	Silumin (Al)	cast iron (GGG)

- 1) Sometimes mines also use mineral oil  
 Voith Turbo Couplings are in particular adapted to operating fluid water.  
 - Material and surface treatment  $\bar{\sigma}$  to avoid corrosion  
 - sealings, lubrication  $\bar{\sigma}$  to ensure long service time with low maintenance requirements

Voith hydrodynamic couplings are approved for both standards and have been successfully used for many years in the coal mining industry.

Some indications regarding the use of Voith hydrodynamic couplings for zone 1 and zone 2 as well as for different temperature categories.

## Explosive Available scope of supply according to ATEX Standard range industries

Voith Turbo couplings

- n All standard couplings  
constant fill  
types T; TV; TVV; TVVS
- n Zone 1 und 2 (gas),  
Zone 21 und 22 (dust)
- n Temperature class  
T3 (200 °C); T4 (135 °C)



# 7 Latest Development

## 7.1 BTM - Real-temperature gauge

A sensor is screwed into the hydrodynamic coupling. It permanently controls the fluid temperature and transfers same via a control box e.g. to a control room.

The advantages are:

### Permanent Health Check

- In case of deviation to the regular operating temperature indication to VTC leakage or alteration of machine properties.

### Process System optimization

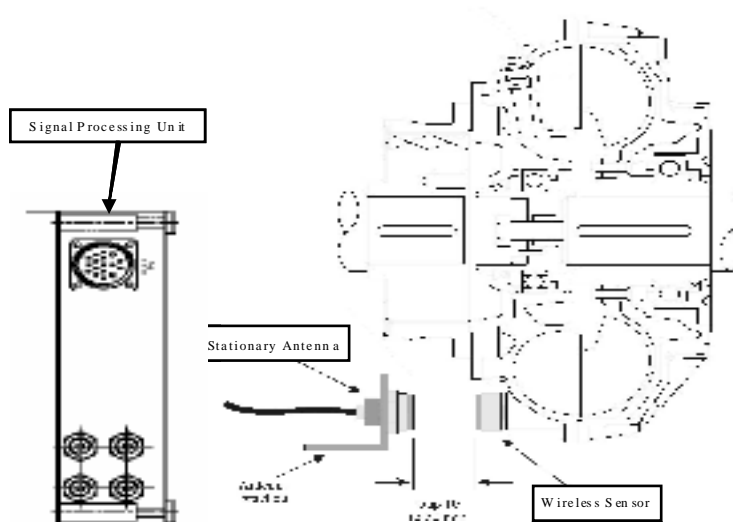
The temperature signal may be used for controlling the process optimization.

- For multi-motor drive systems determination of the startup sequence
- Temperature-dependent number of starts
- No unnecessary waiting periods (cooling down)
- Feed control, e.g. for crushers
- This results in

**Increased operating safety!**

**Less breakdowns, higher operating time, thus higher yield**

## BTM





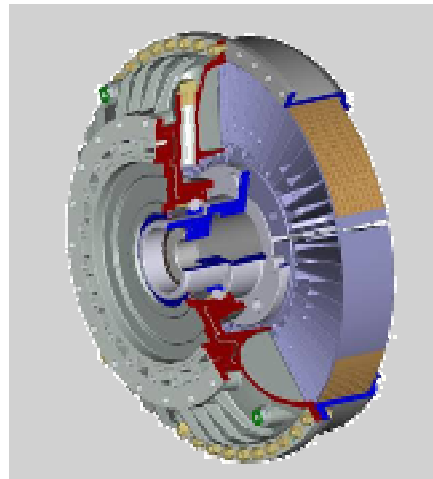
## 7.2 TurboSyn

TurboSyn® is a

- combination of a hydrodynamic startup coupling with a mechanical lock-up clutch.
- The inner wheel of the TurboSyn consists of separate segments. They are pivotal attached to the hub and radially turn outwards after the driven machine was accelerated mainly hydrodynamical. A frictionally engaged connection is created between inner wheel and coupling shell.
- Result: The differing speeds of outer part and inner part are being synchronized. Nominal operation is without slip, i.e. less energy consumption and higher power transfer.
- Use is intended for individual drives which require the advantages of hydrodynamics for start-up (motor relieve, smooth acceleration) and which can work in nominal operation without slip.
- Typical fields of application: mills, fans, conveyor belts - also Retrofit!

### TurboSyn Functional principle

Functional principle  
of the world-wide  
Voith patent



### Advantages

Energy savings

- **Lowering operating expenses**  
The somewhat higher investment is amortized already after 1,5 - 3 years.

Better exploitation of motor power

- **Increase of fan output of up to 10 %**
- **Increase of unit speed of 3 - 5 %**

This results in the fact that the **throughput increases** with the flow rate section remaining the same and thus unloading and loading times may be shortened.

The line load is reduced with the flow rate section remaining

the same and the result are lower loads on the support roller bearings and thus an **extended lifetime**.

The TurboSyn® may be installed without any major conversion measures instead of a Voith turbo coupling installed so far.

- **Minor conversion measures**
- **Low investment costs**

Due to the mechanical lock-up of the TurboSyn® during nominal operation the relative motion of the bearings is omitted.

- **No or rare change of bearings (wearing parts) needed**
- **Low maintenance costs**

In case of operational breakdowns which lead to overload of the unit, the coupling separates the high moment of inertia of the motor from the drive system **thus avoiding overload and consecutive damages on the drive system**.

### **7.3 TurboSim - Customer profit that convinces**

Here, start-up is simulated with a hydrodynamic coupling, e.g. conveyor drives, AFC-drives or crusher drives.

The advantages of start-up and operational simulation are

- Optimum adaptation of the coupling to the unit
- Unit run-up and limit registration may already be simulated beforehand
- Determined limit values are in connection with BTM and may be used in combination for control.
- Presentation of multi-motor drive systems
- Load-time function - effects of overload situations may be simulated.

#### **Benefits**

Thus safety of selection is very high with the risk during the design phase being very low.

Operating safety is very high, thus there are less downtimes, longer operation periods and more output of coal.

## 8 Summary

My presentation tried to show you as good as possible, considering the short time available, how we meet the requirements of different drive arrangements with the assistance of the hydrodynamic couplings or Fluid Couplings as it commonly known in the industry.

The hydrodynamic coupling itself is adapted to the more exacting requirements on account of its developments. The calculation programme permits to calculate the coupling performance, thus enabling a general advance statement. The hydrodynamic coupling itself is a high-tech and cost saving, low maintenance drive solution, for many applications in coal mines and more.

Handling the hydrodynamic coupling with care results in very low down times and very high profits at the same time.

The couplings offer you considerable advantages compared to other drive solutions.

At present and in the future, we do not only need competent solutions, but also guaranteed results.

## 9 References

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- Hoeller H.  
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VDI-Report No. 977 1992
- Hydrodynamic Couplings for conveyor Drives  
Klaus Maier  
Beltcon 11

### Curriculum Vitae of Klaus Maier

At present Head of Constant Fill-couplings  
of Voith Turbo GmbH & Co. KG

Working experience includes 4 years as project engineer for variable speed drives, 4 years as production manager for Voith in India and 3 years as world wide service manager for Voith start-up components

Obtained a Dipl.-Ing degree of the University Heilbronn/Germany