GRUNDFOS MACHINE TOOL ENGINEERING MANUAL

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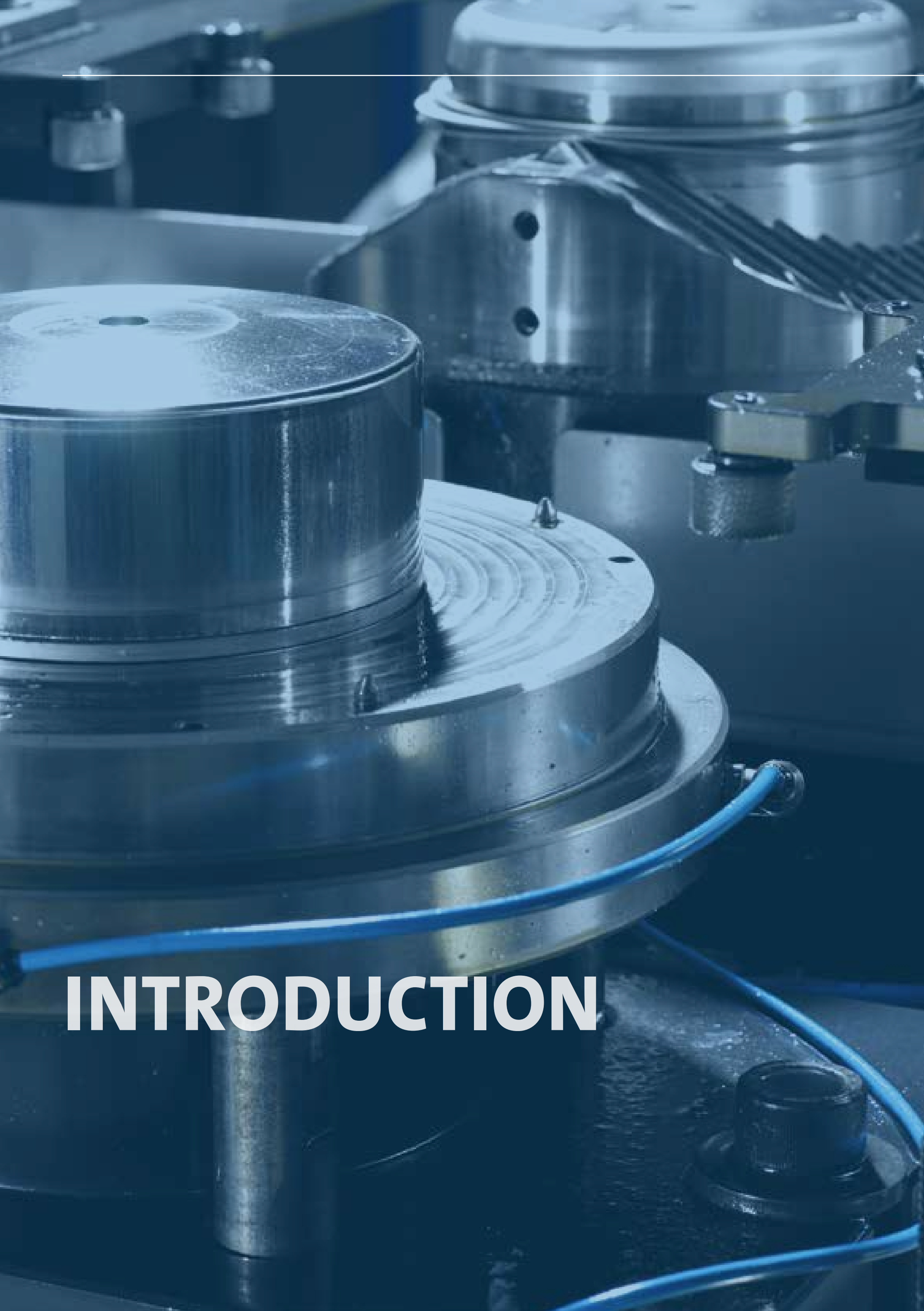
GRUNDFOS

CONTENTS

INTRODUCTION



Introduction

The purpose of this engineering manual is to give an overview of the different applications and processes involved in machining or automotive applications. Furthermore, the aim is to provide an overview of the different pump types used, and the challenges you typically have to deal with when using pumps in these applications. Finally, we describe the different materials handled in these processes.

1 MATERIALS IN MANUFACTURING TECHNOLOGY

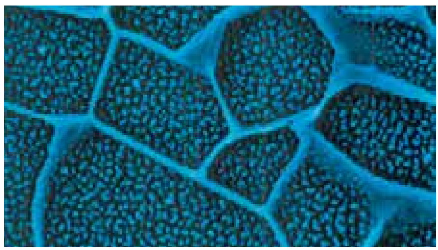
1. Materials in manufacturing technology

Materials are handled in several manufacturing processes to produce components. When we discuss materials, we refer to five main material groups:

- Metals (such as iron, steel, copper)
- Nonferrous materials (such as graphite)
- Organic materials (such as wood, plastic)
- Inorganic nonferrous materials (such as ceramics, glass)
- Semiconductors (such as silicone)
- Furthermore, there are also various material composites (sandwich materials). These are a combination of different materials in a layer-by-layer design.

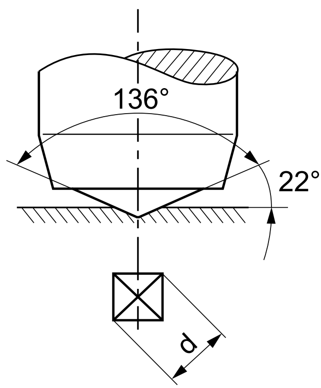
A) MATERIAL CHARACTERISTICS

These materials are classified according to their physical and technological characteristics, explained here:



Physical material characteristic
- Hardness
- Density
- Strength
- Elasticity
- Ductility

Technological material characteristics
- Thermal conductivity
- Cast ability
- Formability
- Machine ability



Physical characteristics
Hardness is the measure of how resistant solid matter is in various kinds of permanent shape change when a force is applied. Macroscopic hardness is generally characterised by strong intermolecular bonds.

The **mass density** or density of a material is defined as its mass per unit volume. The symbol often used for density is P (the Greek letter rho): $p=m/v$

In material science, the **strength** of a material is its ability to withstand an applied stress without failure. The applied stress may be tensile, compressive or shear. It is a subject which deals with load, elasticity and forces acting on the material.

In physics, **elasticity** is the physical property of a material that returns to its original shape after the stress (such as external forces) that made it deform is removed.

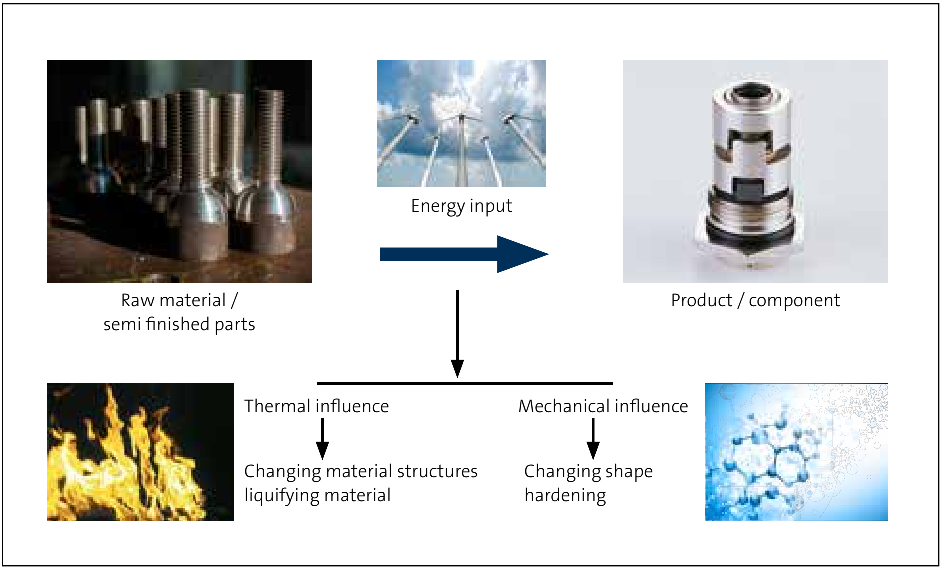
In physics and materials science, **plasticity** describes the deformation of a material undergoing non-reversible changes of shape in response to applied forces.

In physics, **thermal conductivity** is the property of a material describing its ability to conduct heat.

Castability can be thought of as how easy it is to cast a quality part. A very cast-able part design is easily developed, incurs minimal tooling costs, requires minimal energy, and few rejections.

Formability: Metallic materials are able to undergo plastic deformations without damage. Thus these materials can be shaped into desired geometries of semi-finished or finished products.

The term **machinability** refers to the ease with which a metal can be machined to an acceptable surface finish. Materials with good machinability require little power for cutting, can be cut quickly, easily obtain a good finish, and do not wear the tooling much: such materials are said to be free machining. The factors that typically improve materials performance often degrade its machineability. Therefore, to manufacture components economically, engineering is challenged to find ways to improve machinability without harming performance. Machine ability is measured for example by a description of chip formation, surface quality reached after machining, power consumption of machine tool, etc.



When we put one of the materials from the five main material groups through a manufacturing process, we are normally interested in one of the following three things or a combination of them: Changing the shape, hardening the material or changing the surface roughness.

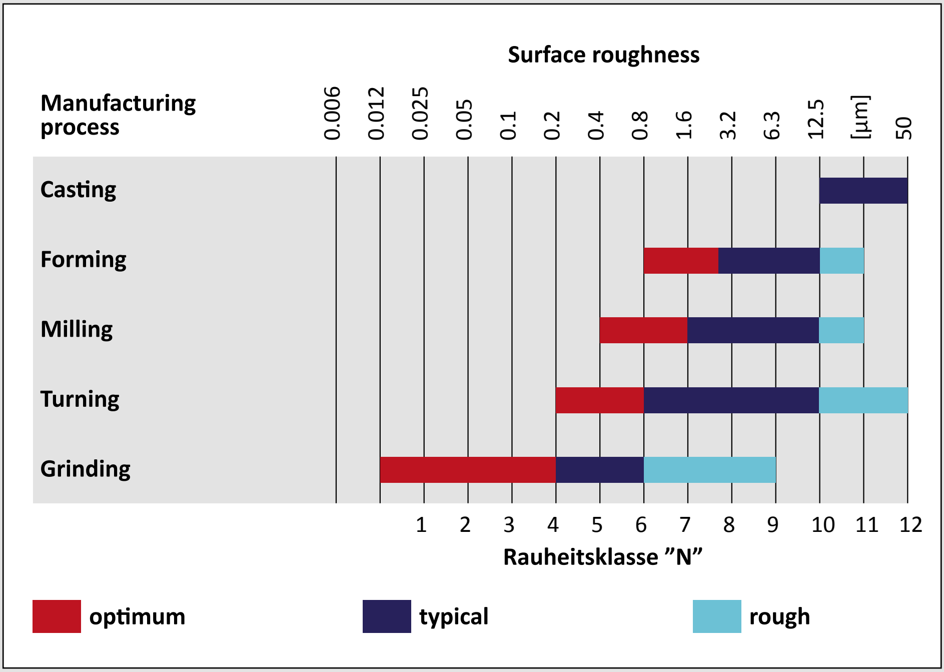
Firstly, the most important aim of manufacturing technology is to give a specific material or material combination by an adequate manufacturing process a required shape, without inducing a material characteristic of the remaining product that leads to product failure while using it within a specific timeframe.

When doing so, the material should be manufactured as accurately (form, gauge, design) as necessary, not as accurately as possible. This saves time and money; however the question here is, how good is 'necessary'?

Within manufacturing processes, all materials will react on the energy input of the process itself. All material reactions can be differentiated in thermal and mechanical reactions. The reaction may not lead to a material characteristic that leads to product failure.

So the art of finding suitable processes and their adequate process parameters is to know how best to combine all requirements on a set of tools, pumps, machines and so on, and then achieving the quickest yet safest (good physical and technological product characteristics) for the different machining operations in use.

When considering surface roughness, the following levels can be reached:



2 MACHINE **TOOL**

2. Machine tool

There are two ways of machining material: Forming and cutting.

Machine tool machining is a cutting process and is defined as the process where material is removed to get a certain shape.

Tools used for the cutting process are made from extremely hard materials, as they need to be harder than the material to be machined.

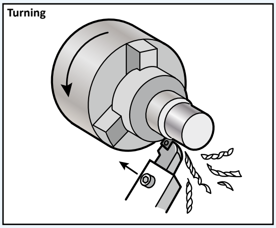
Depending on the shape of the work piece, different methods of machining are used:
- Turning
- Milling
- Boring
- Drilling
- Grinding
- Electrical discharge
- Laser cutting

The machine tool machine is the most important machine in the metal industry, as it has to machine various components for machines, and is therefore called the mother machine.

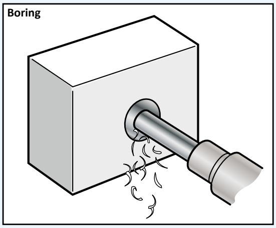
Different operating methods are used:

- Manual machining
- Numeric controlling (NC)
- Computer numeric controlling (CNC)

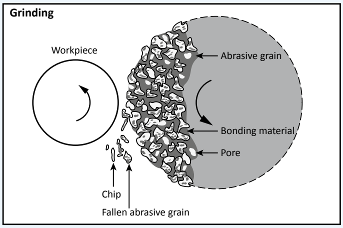
Turning



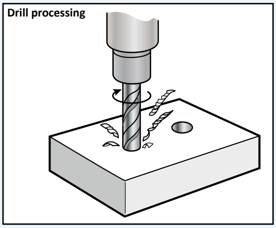
Boring



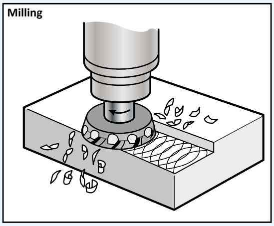
Grinding



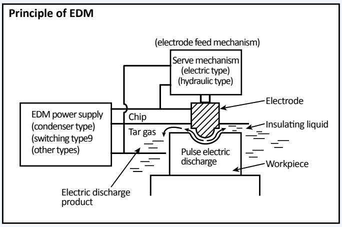
Drill processing



Milling



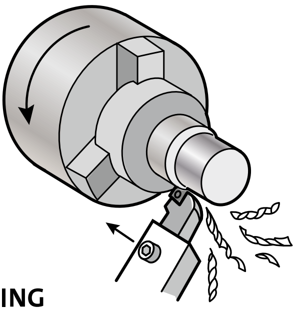
Principle of EDM



A) CNC MACHINES

If we look at the machine doing the different jobs, then operations are normally combined in the same CNC machine. The three operations are turning, drilling and milling.

Turning



TURNING

Turning is a machining operation process which removes material by a rotational cutting, typically as symmetric parts.

During the process cycle, a variety of operations may be performed to the work piece to yield the desired shape of the part, e.g. holes, groves, threads, tapers, various diameter steps and even countered surfaces.

Typically, materials machined in a turning process are metals, alloy, copper, cast iron, aluminium, ceramics, composite, titanium and thermoplastic.

Principle of operation
The operations can be classified as internal and external operations, where external operations modify the outer diameter of the work piece, while the internal operations modify the inner diameter. Parts fabricated completely through a turning operation are often components that are used in limited quantities, prototypes, and customised designs.

Due to the high level of tolerances and surface finishes, it is ideal for adding precision rotational features to a part which basic shape has already been formed.

Typical flow rate and pressure for the coolant in the turning process are 10-120 l/min with pressure from 0.5-15 bar, where the inner coolant features in the turning tools demand up to 80 bar lubricant pressure.

Advantages

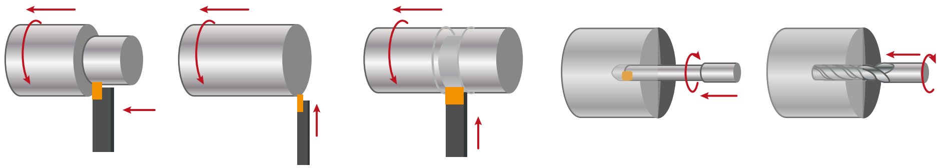
- Machining of all material
- High tolerance level
- Short lead time

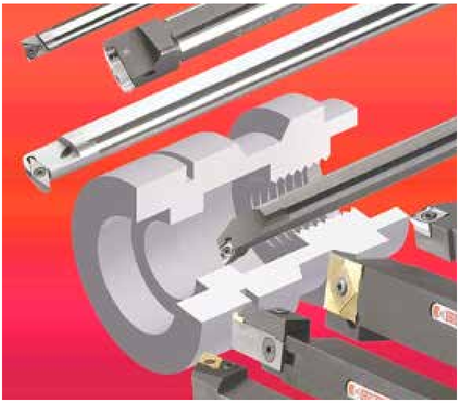
Disadvantages

- Limited to rotational parts
- Work piece may require several operations
- High equipment costs
- Significant tool wear
- hort lead time
- Large amount of scrap

General demands for the pumps used in this process

- variety of pressure and flow
- Shaft seal must be capable of resisting some wearing
- particles
- Designed for viscous media





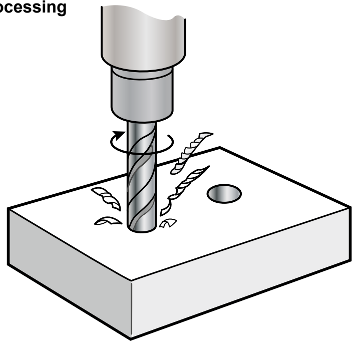
DRILLING

Drilling is a machine operation which removes material from a work piece by drilling.

The operation can perform drilling, tapping, reaming, boring and countersinking.

Typically, materials machined in a drilling process are metals, alloy, copper, cast iron, aluminium, ceramics, composite, titanium and thermoplastic.

Drill processing

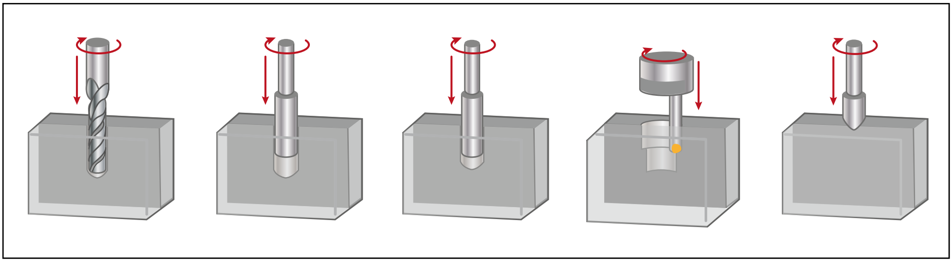


Principle of operation

Drilling operations are typically performed amongst many other operations in the machined part. However, drilling may be performed as a secondary machining process for an existing part, such as casting or forging. Drills used in drill processing remove chips along the groves made by the drill.

Drilling machines include upright drilling machines, radial drilling machines and multi-spindle drilling machines and operations can be performed on a variety of machines, including milling machines and CNC turning machines.

Typical flow rate and pressure for the coolant in the drilling process are 10-250 l/min with pressure from 0.5-25 bar, where the inner coolant features in the drilling tools demand up to 100 bar lubricant pressure, depending on the diameter of the drill.



Advantages

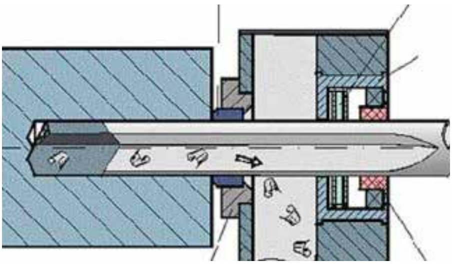
- Machining of all material
- High tolerance level
- Short lead time
- Mass production

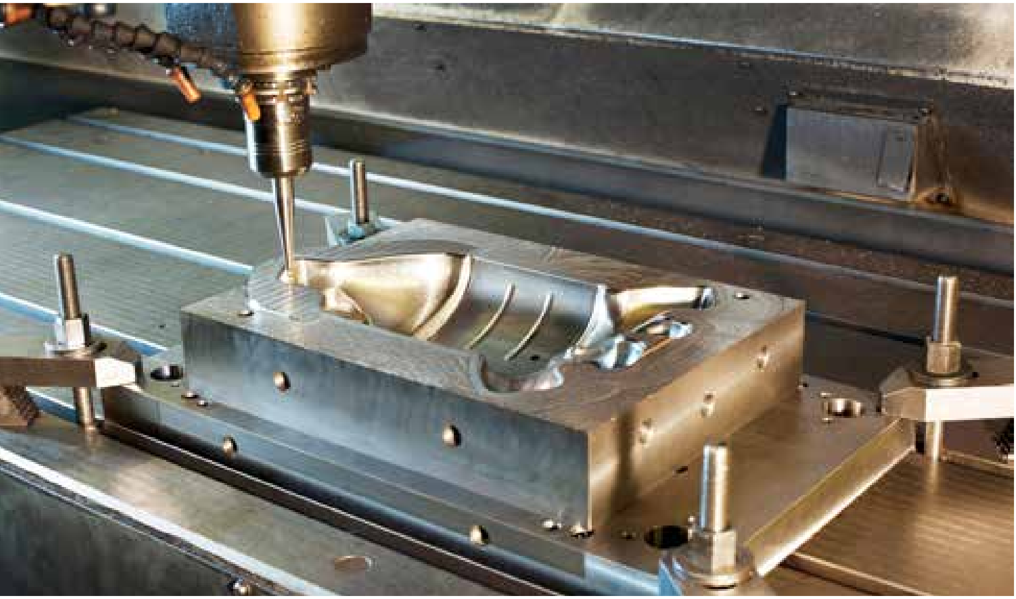
Disadvantages

- Limited shape complexity
- Work piece may require several operations
- High equipment costs
- Significant tool wear
- Large amount of scrap

General demands for the pumps used in this process

- varity of pressure and flow
- Shaft seal must be capable of
- resisting some wearing particles
- Designed for viscous media





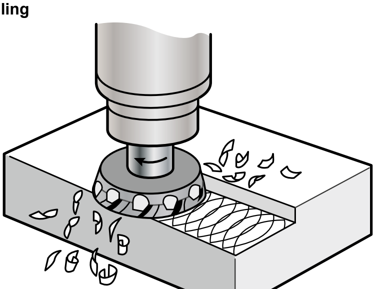
MILLING

The milling machine is a machine tool with a revolving tool called a milling cutter. It can machine planes curved surfaces and grooves.

There are many types of milling cutters, including the face milling cutter (end mill and slotting milling cutter).

Typically, materials machined in a milling process are metals, alloy, copper, cast iron, aluminium, ceramics, composite, titanium and thermoplastic.

Milling

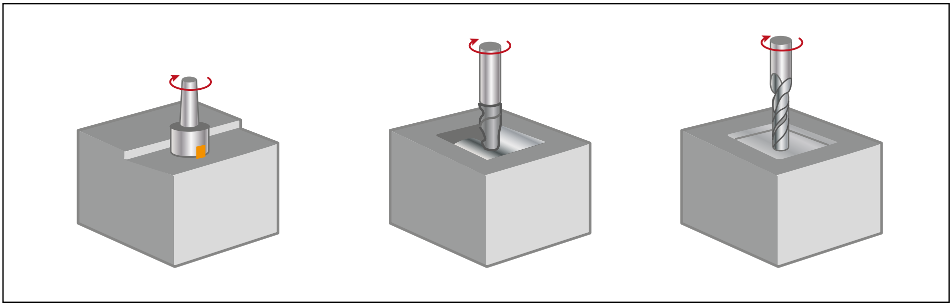


Principle of operation

Milling is typically used to produce parts not axially symmetric and have many features as holes, slots, pockets and even three-dimensional surface contours. Milling machines often produce components in limited quantity, prototypes or tools for other processes, such as moulds.

Due to high tolerances and surface finishes offered by the milling operation, it is ideal for adding precision features to a part whose basic shape has already been formed.

Typical flow rate and pressure for the coolant in the milling process are 10-250 l/min with pressure from 0.5-10 bar. The inner coolant features in the milling tools require up to 80 bar lubricant pressure.



Advantages
- Machining of all material
- High tolerance level
- Short lead time

Disadvantages
- Limited shape complexity
- Work piece may require several operations
- High equipment costs
- Significant tool wear
- Short lead time
- Large amount of scrap

General demands for the pumps used in this process
- varity of pressure and flow
- Shaft seal must be capable of
- resisting some wearing particles
- Designed for viscous media

PUMPS FOR CNC MACHINES

The typical pumps used for CNC machinery are listed below here. Please note that the pumps mentioned are the most common types sold for these applications by Grundfos. If you have preferences for other pump types or constructions, these are available as well.

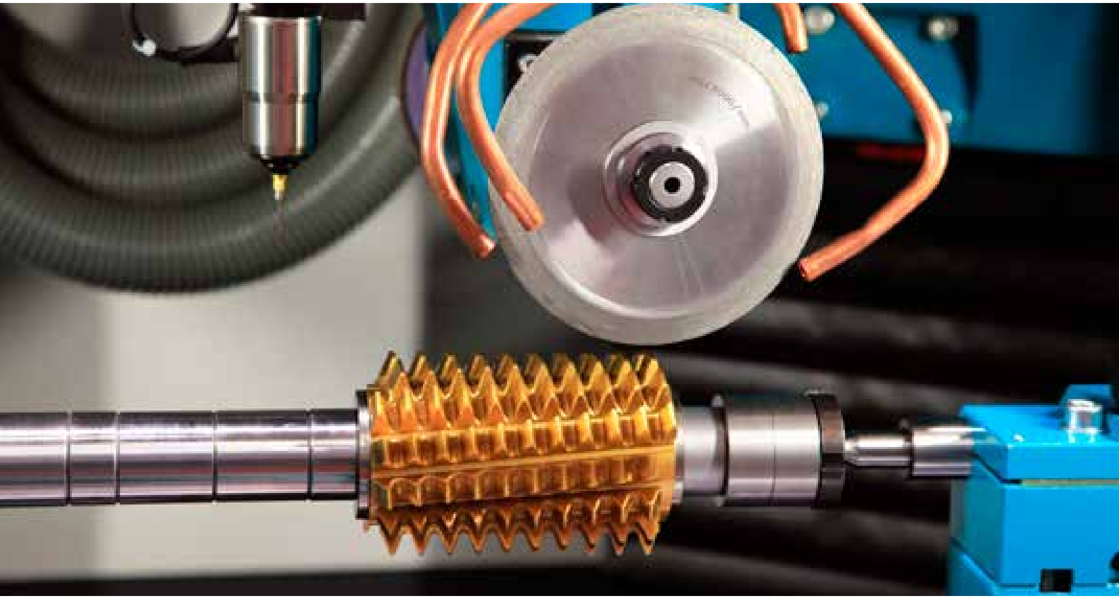
- **MTR** (multistage immersible pump with multiple variants)
- **MTH** (Multistage immersible pump)
- **MTA** (single stage immersible pump with semi open impeller)
- **MTS** (screw spindle pump for high pressure)
- **CR** (Multistage inline centrifugal with multiple variants)

See pages 62-63 for details about these pumps.

Sizing
When sizing pumps for these types of applications, you need to know the following:
- Flow
- Head
- Number and size of particles in the water
- Depth of the tank
- How many start/stops

Typical fail scenarios
Typical mistakes or faults with pumps in these applications are problems related to:
- Water hammer
- Too many starts/stops
- Pumps blocked due to bad filtering

Regarding the different fail scenarios, read more in chapter 9 (from page 58).

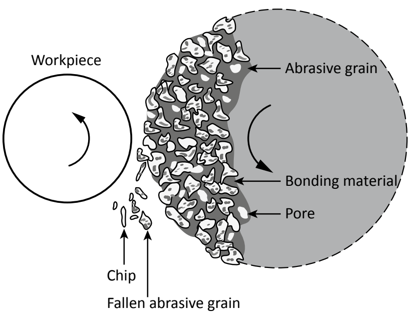


B) GRINDING

Grinding is a process where the material grinded results in a high surface finish with a close tolerance.

The process is a variation of polishing using an abrasive, generally in the form of a solid wheel made of aluminium oxide, silicon carbide or cubic boron nitride.

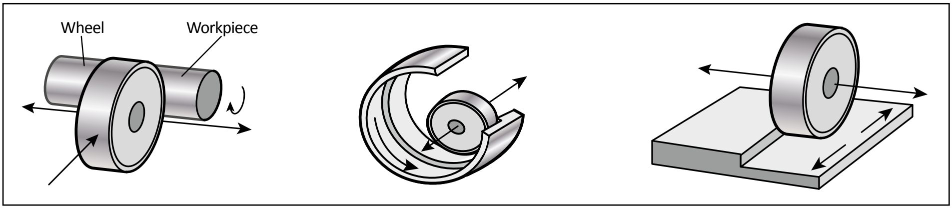
Grinding



Typically, materials machined in a grinding process are metals, alloy steel, cast iron, magnesium, ceramics, titanium and glass.

Principle of operation
Grinding machines use a grinding stone (wheel) instead of a cutting tool to perform machining. Their main characteristic is excellent machining precision and outstanding machined surfaces. Typical and feasible shapes are solid and thin walled cylindrical, cubic and complex materials.

Grinding machines are classified according to the type of machining performed – external cylindrical grinding, internal cylindrical grinding and surface grinding machines. Typical flow rate and pressure for the coolant in the grinding process are 10-200 l/min with pressure from 5-20 bar. Wheel dressing and flushing require pressure up to 80 bar lubricant pressure.



Advantages
- Machining very hard material
- Extremely good tolerances
- High quality surface finishes

Disadvantages
- Limited shape complexity
- High equipment costs
- Significant tool wear
- Large amount of scrap

General demands for the pumps used in this process
- varity of pressure and flow
- Shaft seal must be capable of resisting some wearing particles
- Designed for viscous media

PUMPS FOR GRINDING

The typical pumps used for grinding machinery are listed below here. Please note that the pumps mentioned are the most common types sold for these applications by Grundfos. If you have preferences for other pump types or constructions, these are available as well.

- **MTR** (multistage immersible pump with multiple variants)
- **MTH** (Multistage immersible pump)
- **MTA** (single stage immersible pump with semi open impeller)
- **MTS** (screw spindle pump for high pressure)
- **CR** (Multistage inline centrifugal with multiple variants)

See pages 62-63 for details about these pumps.

Sizing
When sizing pumps for these types of applications, you need to know the following:
- Flow
- Head
- Whether the pumped liquid is water or a kind of oil
- Number and size of particles in the water
- Depth of the tank
- How many starts/stops

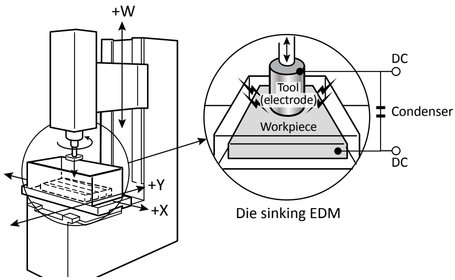
Typical fail scenarios
Typical mistakes or faults with pumps in these applications are problems related to:
- Broken shaft seals due to small grinding particles
- Pump chambers worn out due to small grinding particles

Regarding the different fail scenarios, read more in chapter 9 (from page 58).

C) EDM

EDM (Electrical Discharge Machining) involves an electrical discharge between the work piece and an electrode.

Material is removed because the spark causes melting and evaporation of the material. Typically, materials machined in an EDM process are hard metals, where machining with traditional techniques is not possible, such as Hastalloy, Inconel, cast iron, magnesium, ceramics, titanium, or other materials with sufficient conductive characteristics.

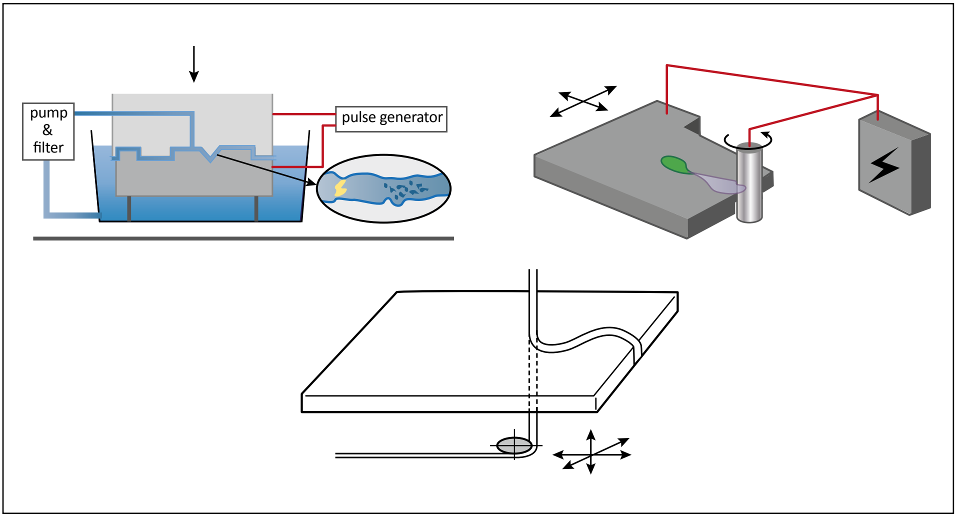


Die sinking EDM

Principle of operation
By applying a large pulse of electrical potential difference between the work piece and an electrode, a spark flash will be created and remove material.

There are two types of EDM – die sinking and wire electrical discharge. Die sinking uses an electrode in a predetermined shape as its tool to machine the work piece, and typical shapes are solid complex geometries. Wire electrical discharge uses a copper wire as an electrode, passed through the work piece, and able to cut shapes in all geometries.

During operation, the work piece is submersed in a bath of dielectric fluid, such as petroleum or demineralised water. Typical flow rate and pressure for the coolant in the EDM process are 10-200 l/min with pressure from 5-25 bar.



Advantages

- Extremely complex shapes
- Very good tolerances
- High quality surface finishes
- No residual stresses on work pieces

Disadvantages

- Limited use due to conductive characteristics of material
- High equipment costs
- Significant tool wear
- Large amount of scrap
- Process is fairly slow

General demands for the pumps used in this process

- varity of pressure and flow
- Shaft seal must be capable of resisting some wearing particles
- Option for stainless steel material

PUMPS FOR EDM

The typical pumps used for EDM machinery are listed below here. Please note that the pumps mentioned are the most common types sold for these applications by Grundfos. If you have preferences for other pump types or constructions, these are available as well.

- **MTR** (multistage immersible pump with multiple variants)
- **MTS** (screw spindle pump for high pressure)
- **CR** (Multistage inline centrifugal with multiple variants)

See pages 62-63 for details about these pumps.

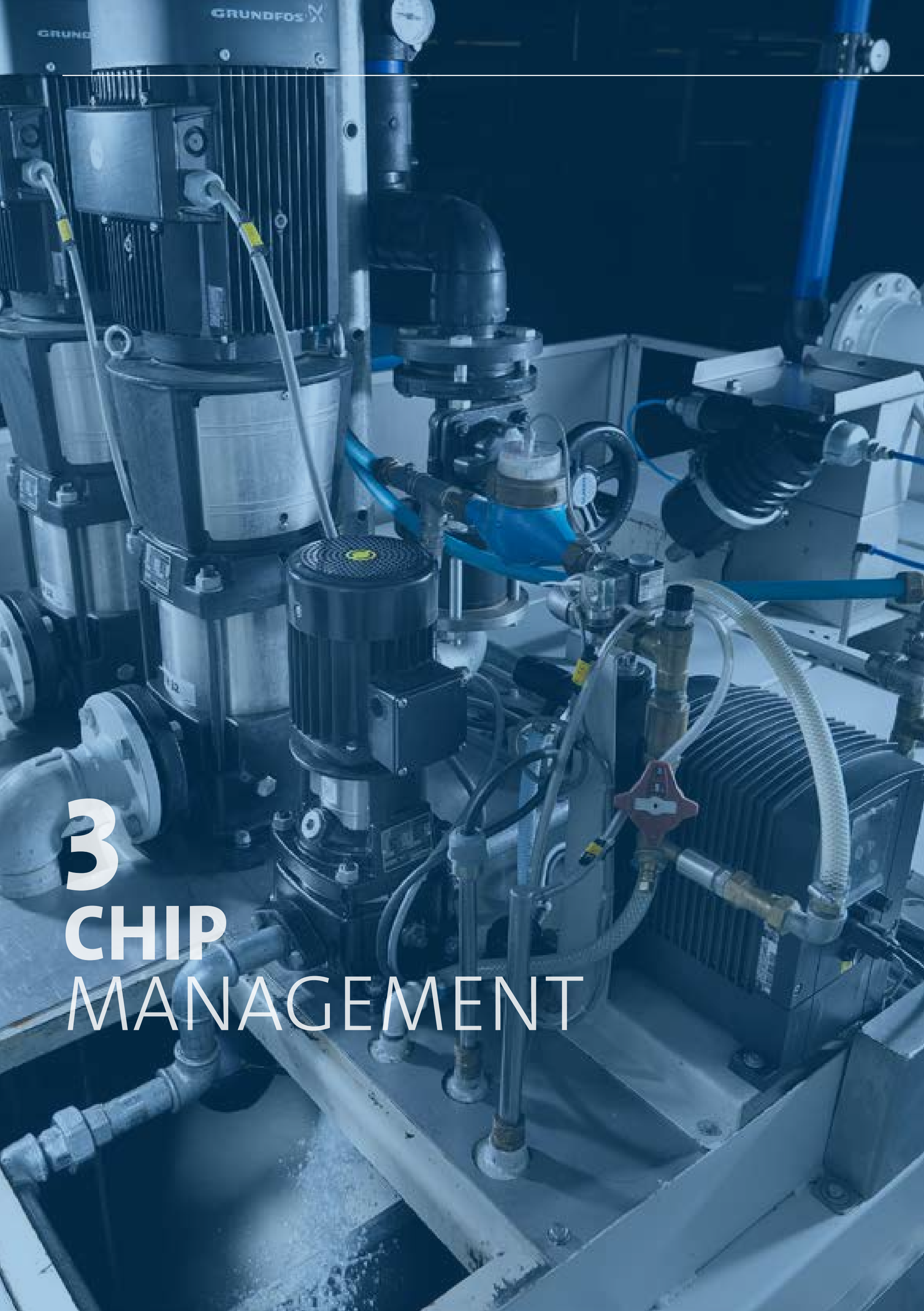
Sizing
When sizing pumps for these types of applications, you need to know the following:

- Flow
- Head
- Whether the pumped liquid is water or a kind of oil
- Number and size of particles in the water
- Depth of the tank
- How many starts/stops

Typical fail scenarios
Typical mistakes or faults with pumps in these applications are problems related to:

- Noise from pump
- Vibration from pump

Regarding the different fail scenarios, read more in chapter 9 (from page 58).



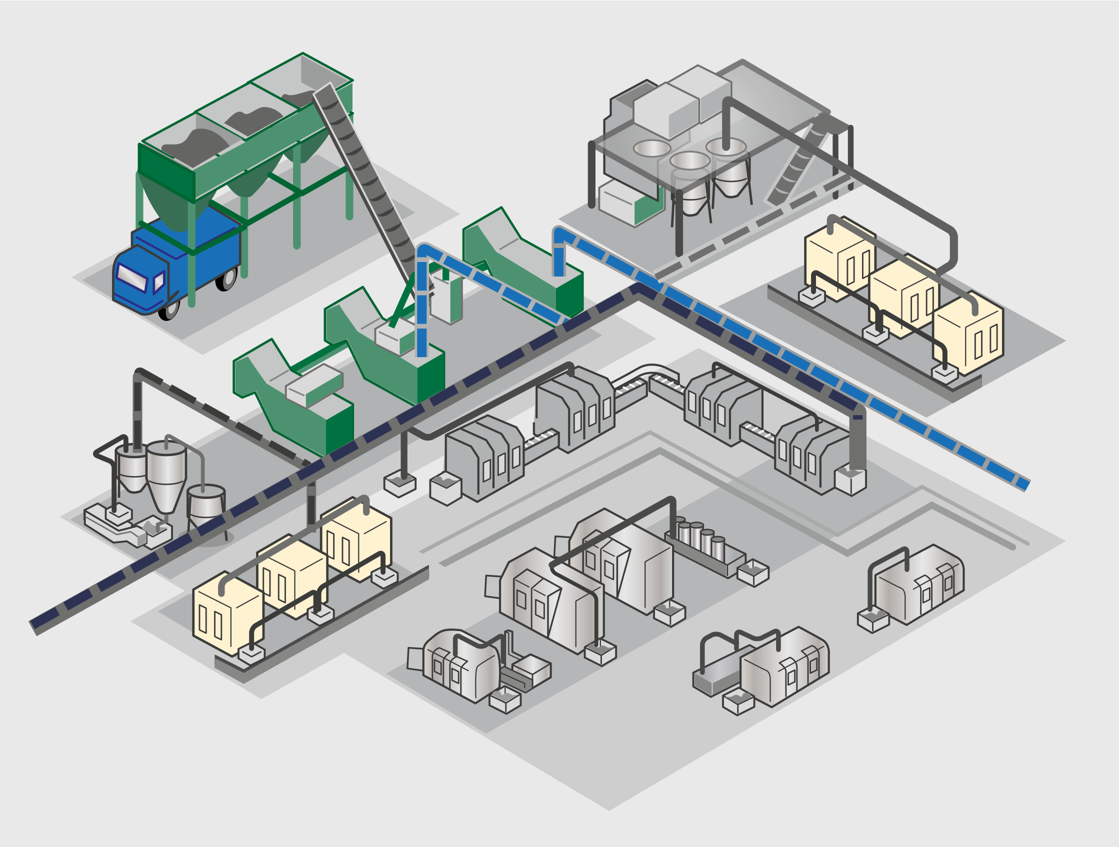
3 CHIP MANAGEMENT

3. Chip management

In general, there are four different types of chip management systems:

- Conveyors
- Lifting stations
- Central filtration
- Single filtration

These systems are used for cleaning coolant liquid for the machine tool machines. Depending on the machining processes, the liquid has to be cleaned to different levels of purity.



A) CONVEYOR

Description
Conveyers are used to remove chips out of the machine tool. Depending on the machining process and the material machined, there are broadly speaking four different systems:

- Drag link conveyer
- Belt conveyer
- Magnetic conveyer
- Screw conveyer

Methods of operation
The conveyer system is used as a filtration system for machining applications where a purity of approximately 500 microns is sufficient.

- **Drag link conveyer:**
  Used for short chips, small parts, sludge, all kinds of materials and often used as pre-filter
- **Belt conveyer:**
  Used for long chips, snarl chips, wool chips and parts especially aluminium
- **Magnetic conveyer:**
  Used for short ferromagnetic chips and parts
- **Screw conveyer:**
  Used for all types of chips in high volume, mostly used in combination with lift stations and chip reducers (crashers)

PUMPS FOR CONVEYORS

The typical pumps used for conveyors machinery are listed below here. Please note that the pumps mentioned are the most common types sold for these applications by Grundfos. If you have preferences for other pump types or constructions, these are available as well.

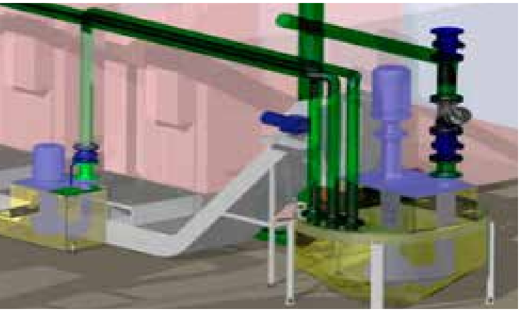
- **MTR** (multistage immersible pump with multiple variants)
- **CR** (Multistage inline centrifugal with multiple variants)
- **MTH** (Multistage immersible pump)
- **MTA** (single stage immersible pump with semi open impeller)

See pages 62-63 for details about these pumps.

General demands for the pumps used in this process
When sizing pumps for these types of applications, you need to know the following:
- Flow
- Head
- Depth of the tank
- Shaft seal must be capable of resisting wearing particles
- Capable of pumping lubricant containing chips
- Capable of pumping media containing air
- Designed for viscous media

Typical fail scenarios
Typical mistakes or faults with pumps in these applications are problems related to:
- Pumps blocked due to bad filtering
- Noise from pumps because of air in the liquid

Regarding the different fail scenarios, read more in chapter 9 (from page 58).



B) LIFTING STATIONS

Description
Lifting stations are used for pumping dirty coolant liquid from the machine tool back to the filtration system.

Methods of operation
Liquid from the machine tool is lead into the coolant tank beside the machine tool. The tank capacity and design depend on the liquid used in the machine. The lifting pump is installed in the tank and ensures the liquid transportation back to the central filtration system.

To ensure the free transportation of liquid containing particles in the pipe, the speed of the liquid must be more than 2.5 m/sec.

PUMPS FOR LIFTING STATIONS

The typical pumps used for lifting stations are listed below here. Please note that the pumps mentioned are the most common types sold for these applications by Grundfos. If you have preferences for other pump types or constructions, these are available as well.

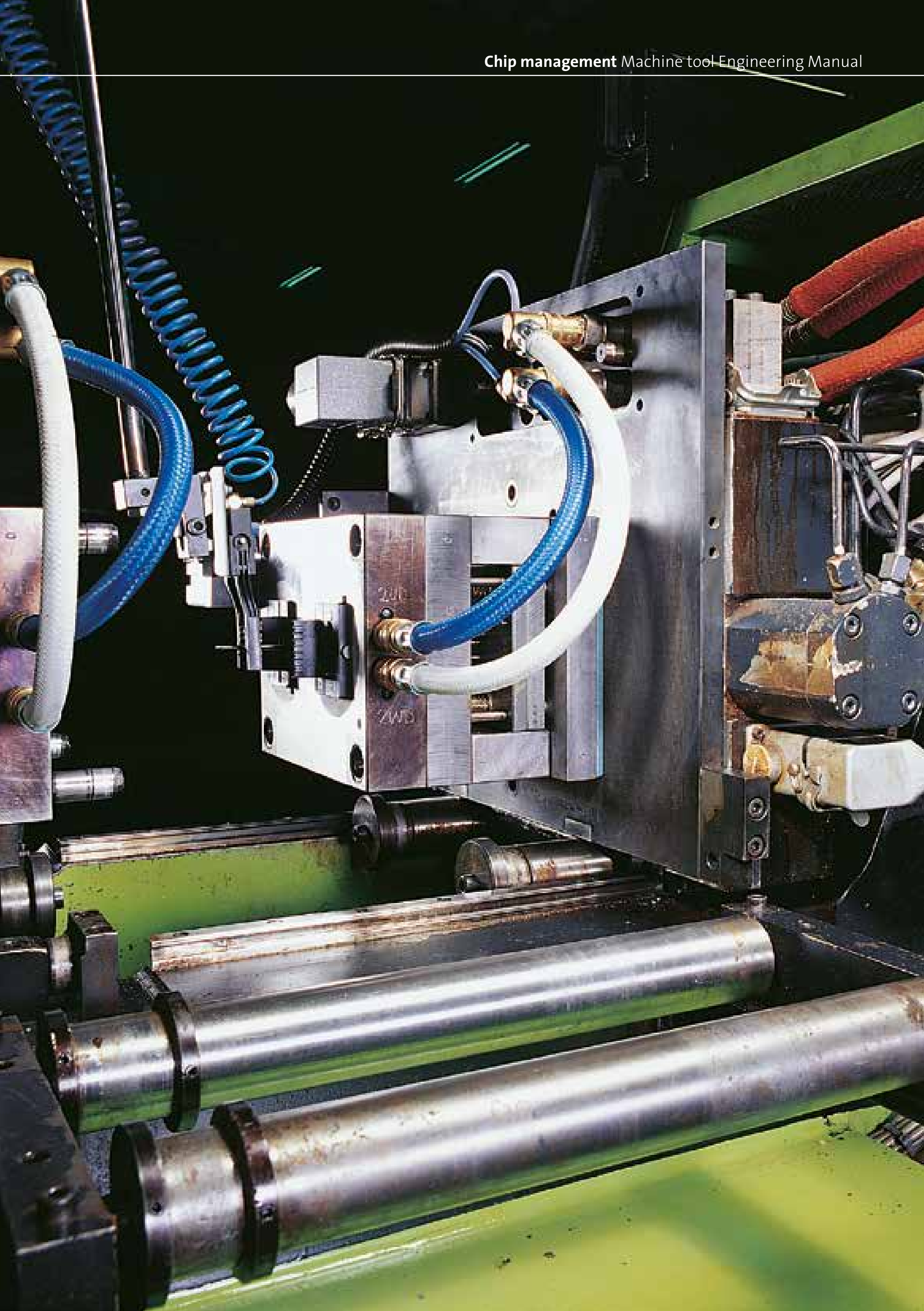
- **MTR** (multistage immersible pump with multiple variants)
- **CR** (Multistage inline centrifugal with multiple variants)
- **MTH** (Multistage immersible pump)
- **MTA** (single stage immersible pump with semi open impeller)

See pages 62-63 for details about these pumps.

General demands for the pumps used in this process
When sizing pumps for these types of applications, you need to know the following:
- Flow
- Head
- Depth of the tank
- Shaft seal must be capable of resisting wearing particles
- Capable of pumping lubricant containing chips
- Capable of pumping media containing air
- Designed for viscous media

Typical fail scenarios
Typical mistakes or faults with pumps in these applications are problems related to:
- Pumps blocked due to bad filtering
- Noise from pumps because of air in the liquid

Regarding the different fail scenarios, read more in chapter 9 (from page 58).



C) FILTRATION

The definition of filtration

- The filtration system is used for cleaning the coolant liquid from the machine tool machines
- Depending on the machining process, the coolant has to be cleaned to different levels of purity
- The tank in the filtration system is used for sedimentation of the chips, and the buffer tank to release the air bubbles

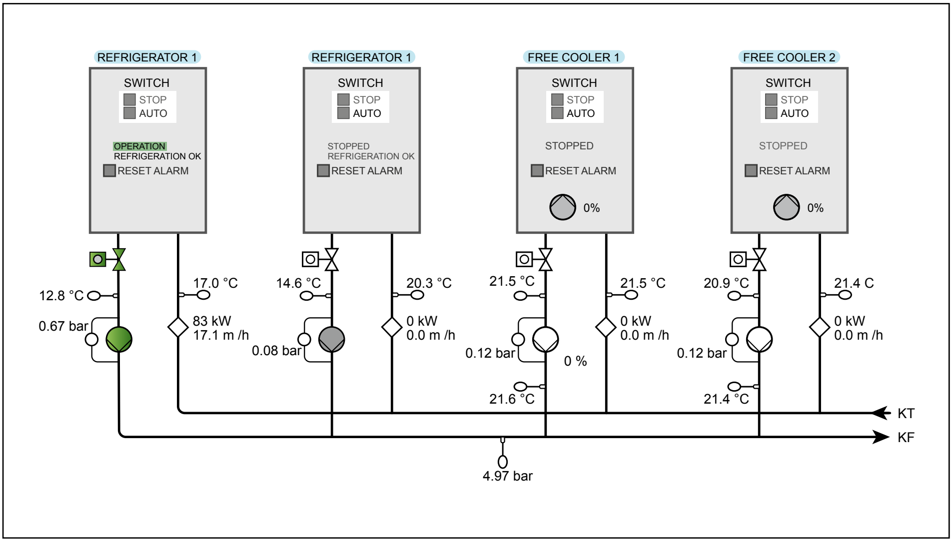
The advantage for using a filtration system

- Optimising the treatment of cooling lubricants
- Reduction of operation costs
- Extension of service life of the coolant, tools and pumps
- No clogging of lines and fittings
- High quality surface on machined part
- Easier to maintain tolerances of parts
- Less machine downtime
- Lower wear to sideways and rotary passages
- Higher grinding rates, because grinding disk pores are kept open
- Better health for operators, clean coolant is less aggressive to skin

Challenges in filtration

- Purity of coolant
- Size of chips in coolant
- Concentration of chips
- Coolant and lubricant mix
- Material to be filtered
- Right pressure to the machines at the right time
- Speed of coolant in pipes
- Pressure loss in pipes and nozzles

Filtration is in general be divided into two different main categories – single filtration or central filtration.



D) CENTRAL FILTRATION SYSTEM

A central filtration system is used where there is a big demand for high volume of coolant to be filtered; for example, where there are more than five machine tool machines.

The coolant lubricant is pumped from small lifting stations placed beside the machine tool machines into the filtration system at pressures up to 5 bar, flow depending on the process.

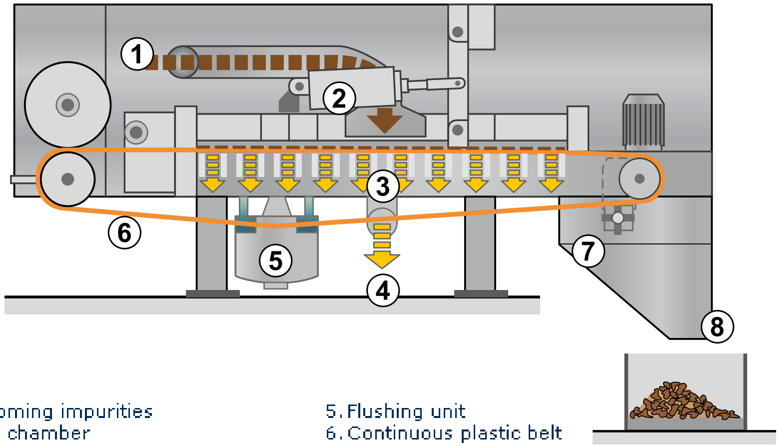
The cleaned coolant is pumped back into the machines at pressures from 5-100 bar, depending on the machining process and the material to be machined.

Filtration systems are designed for different machining needs, and therefore a variation of central filtration systems is available.

Filtration systems

- Pressure belt filter
- Pre-coat filter

Pressure belt filter operation



1. Incoming impurities
2. Top chamber
3. Bottom chamber
4. Discharge of cleansed material
5. Flushing unit
6. Continuous plastic belt
7. Peeling roll
8. Sludge discharge

PRESSURE BELT FILTER

Description

Pressure belt-type filters are used for cleaning contaminated coolants used in the metal shaping industry and in the metal rolling industry. Cleaned coolants have a longer service life, improve the surface quality of the worked material or rolled material and assist the heat exchange at the point of contact.

Methods of operation

Soiled medium is transported from the processing machine into the fouled tank section of the pressure belt filter. A filter pump takes up the soiled fluid and routes it into the sealed, closed filter chamber of the pressure belt filter. The fluid flows through the filter belt and the particles of impurities are trapped on the filter belt, where they form the filter cake.

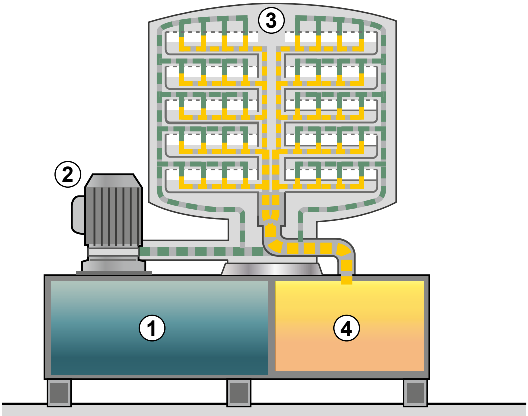
The cleansed fluid is routed to the clean tank section. Machine supply pumps transport the cleansed fluid back to the processing machine.

As the level of impurities (filter cake) on the filter belt increases, the differential pressure in the filter chamber increases. The regeneration process is initiated when the maximum differential pressure is reached, or after a defined time. The fluid inlet is closed and the filter cake blown dry using compressed air. After that, the filter chamber opens automatically and the filter cake is moved out of the chamber on the continuous filter belt and falls into a sludge box.

Advantages

- Very high throughput volume
- Easy local or central installation
- Filtration without the use of filtration aids
- Fully automatic, maintenance-friendly operation
- Continuous supply of your loads with cleansed medium
- Good filter cake build-up thanks to high differential pressure
- High level of cleansing
- Can be used for fine and clear filtration
- High level of process reliability

Hydrostatic filter operation



1. Dirt tank section
2. Filter pump
3. Filter vessel with filter plates
4. Clean tank section

HYDROSTATIC FILTER (CENTRAL SYSTEM)

Description

Hydrostatic filters, with reel, operate based on principle of gravitational filtering. Depending on the requirements placed on the degree of filtering, filter papers with different structures are used. These filters clean emulsions and grinding and cutting oils for machining of steel, castings, aluminium and other nonferrous metals.

We recommend our stainless steel models when handling aggressive fluids, such as wastewater or chemicals.

Methods of operation

Pre-coat filters operate based on filter cake and deep filtration principles. Filtration down to 3µ is possible. Depending on the task at hand, pre-coat filters are available in several variants:

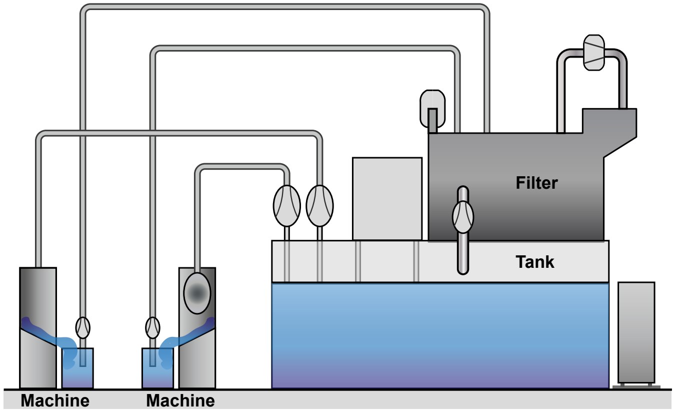
- Manual
- Semi-automatic
- Fully automatic.

Dirty coolant is forced through the filter plates coated with filtration aids. During the filtration process, the so-called filter cake builds up on the filter plates (from impurities trapped by the filtration aids). This helps enhance even more the filtering efficiency during the filtration process. When the filter cake reaches a defined size the flow rate of the filter begins to decline, the pressure in the filter vessel begins to increase and the filter plates must then be cleaned. Cleaning is performed either manually or fully automatically, depending on the design of the unit.

Advantages

- Reliable and long-term filtering procedure
- High level of filtering capacity
- High level of surface quality of the product being machined
- Continuous supply of your machine tool with cleansed coolant
- Fully automatic operation
- Limited or no downtime, depending on the filter facility design
- Low maintenance

Hydrostatic filter operation



E) SINGLE FILTRATION

Single filtration units are relatively small units for filtration of coolant lubricants from 1-2 machine tool machines.

Along with the filtration units, a conveyer is placed to separate the big chips from the coolant. The coolant lubricant is pumped from the machine tool machine into the filtration system, at low pressure and flow depending on the process.

The cleaned coolant is pumped back into the machines with pressure from 5-100 bar, depending on the machining process, and the material to be machined.

Filtration systems are designed for different machining needs, therefore varying filtration and conveyer systems are available:

Filtration systems

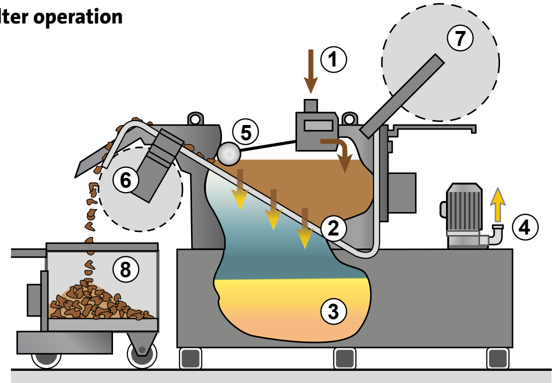
- Paper belt filter
- Vacuum filer
- Edge filter
- Hydrostatic filter
- Drum filter
- Centrifugal filter

Conveyer systems

- Magnetic conveyer
- Screw conveyer
- Drag link conveyer

Filtration is in general be divided into two different main categories – single filtration or central filtration.

Pressure belt filter operation



1. Inlet
2. Filter area
3. Clean tank section
4. Machine supply pump
5. Float switch
6. Reel
7. Filter paper
8. Sludge box

HYDROSTATIC FILTER (SINGLE PROCESS)

Description

Hydrostatic filters, with reel, operate based on principle of gravitational filtering. Depending on the requirements placed on the degree of filtering, filter papers with different structures are used. These filters clean emulsions and grinding and cutting oils for machining of steel, castings, aluminium and other nonferrous metals.

We recommend our stainless steel models when handling aggressive fluids, such as wastewater or chemicals.

Methods of operation

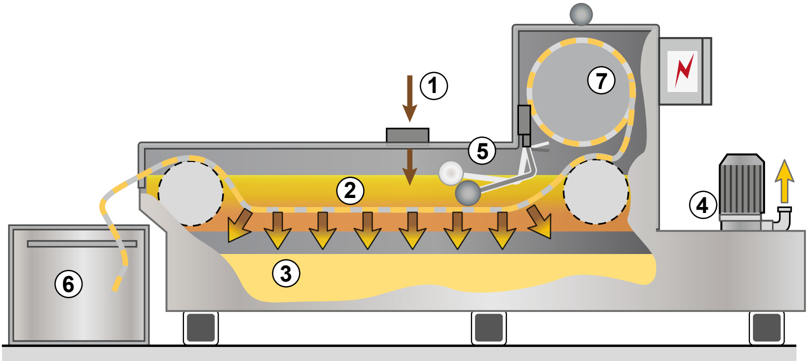
The so-called filter cake is formed as impurities build up on the filter paper. This effect is enhanced even more by the high degree of filtering of the coolant. When the filter cake becomes too large, the filling level rises above the filter area and the throughput rate declines. A float switch activates and controls the geared motor for the reel. The soiled filter paper is wound up on the reel, while simultaneously drawing out the new filter paper, and the filter cake falls into the sludge box.

A supply pump returns the cleansed medium to the processing machine, completing the filter circuit.

Advantages

- Reliable and easy to use
- Fully automatic operation
- Low maintenance
- Continuous supply of machines with cleansed coolant
- Reduction of disposal cost thanks to separation of solid filter paper and the filter cake by the reel

Paper belt filter operation



1. Inlet
2. Belt advance
3. Clean tank section
4. Machine supply pump
5. Float switch
6. Sludge box
7. Filter paper

PAPER BELT FILTER

Description

Paper belt filters operate on the gravity filtration principle. Depending on the level of filtering required, filter paper with different degrees of porosity is used. The filters cleanse emulsions and low viscosity oils used in the machining of steel, castings, aluminium and other nonferrous metals.

Methods of operation

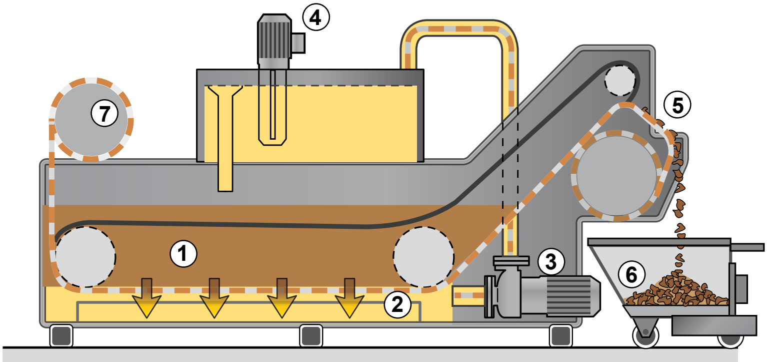
Solid coolant or other process fluids are routed to the conveyer belt of the filter facility. This belt is covered with filter paper and forms a depression, enhancing the gravitational filtering effect. The fluid penetrates through the filter, is cleansed and flows into the clean tank section located below the belt.

A supply pump returns the cleansed medium to the processing machine, completing the filter circuit.

Advantages

- Simple and reliable
- Fully automatic operation
- Low maintenance
- Continuous supply of machines with cleansed coolant
- Ideal for non-complex applications and low throughput rates

Vacuum filter operation



1. Fouled tank section
2. Suction chamber
3. Suction pump
4. Machine supply pump
5. Scraper
6. Sludge carriage
7. Filter paper

VACUUM FILTER

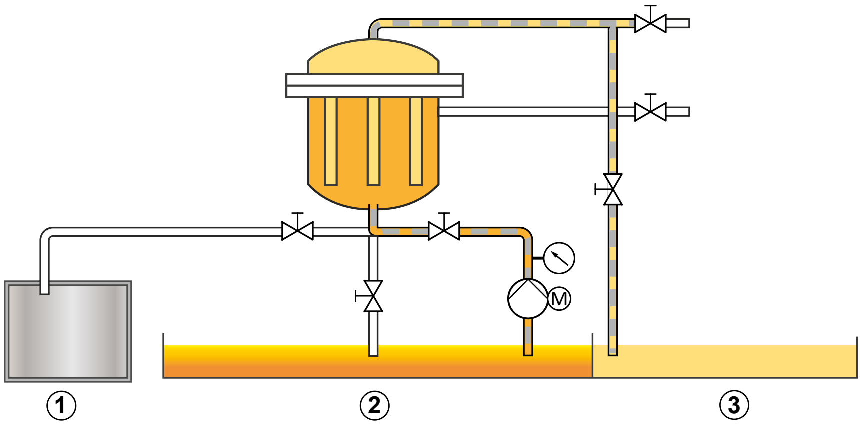
Description
Vacuum belt filter is used for cleaning emulsions and low viscosity oils for the machining of steel, castings, aluminium and other nonferrous metals. The vacuum-chip-exhaustion technology offers a clean and innovative solution to this particular area of application.

Methods of operation
The coolant tank for the filter facility consists of two chambers: the fouled tank section and the suction chamber located below the fouled tank section. The chips exit directly at the level of the machines and are led off in a pipeline (for example to the centrifuge or the bunker).

This vacuum transport requires very little space and there is practically no limit to its flexibility. It requires little maintenance and is no more expensive than other conveying systems.

Advantages
- Easy installation
- Fully automatic operation
- Low maintenance
- Continuous supply of machines with cleansed coolant
- Ideal for oily chips and accumulation of graphite
- High surface quality of the fabricated part being machined
- High filtering capacity with small filter surface area thanks to high vacuum level

Edge filter operation



1. Sludge box 2. Fouled tank section 3. Clean tank section

EDGE FILTER

Description

The plate-type edge filter is for the microfiltering of grinding oils, in particular for tool grinding, and does not require the use of consumables modern machining methods, such as high-speed cutting and high-speed milling. The machining required during manufacturing and sharpening of these high strength tools also places high demands on the grinding oils in the process, as these oils must not only withstand high hydraulic stress, but are also subject to ingress by very fine particles or impurities.

As grinding dust from carbide metals is very fine-grained, filtration using conventional filter facilities, such as belt filters and centrifuges, does not meet the requirements for these applications.

Methods of operation

Filter cartridges are arranged vertically in a pressure vessel, the filter vessel. Soiled oil flows through the filter cartridges from the outside towards the inside, where impurities are deposited around the cylindrical circumference of the cartridges. The machining oil is routed via the clean tank section to nozzles of the grinding machine after being finely filtered.

The differential pressure in the filter vessel increases as the degree of fouling of the filter cartridges increases, resulting in a decrease in the throughput rate. Cleaning is performed quickly by blowing out the dirt and rinsing the filter cartridges. A continuous supply of oil to the grinding machine is ensured at all times by the rapid, automatic cleaning process.

Advantages

- Filtration down to 1 µm
- Automatic operation without use of consumables
- Low maintenance functioning
- Reduction of grinding oil losses
- Minimum follow-up costs
- For use also with materials that are difficult to filter

PUMPS FOR FILTRATION SYSTEMS

The typical pumps used for filtration systems are listed below here. Please note that the pumps mentioned are the most common types sold for these applications by Grundfos. If you have preferences for other pump types or constructions, these are available as well.

- **MTR** (multistage immersible pump with multiple variants)
- **CR** (Multistage inline centrifugal with multiple variants)
- **MTH** (Multistage immersible pump)
- **MTA** (single stage immersible pump with semi open impeller)

See pages 62-63 for details about these pumps.

General demands for the pumps used in this process
When sizing pumps for these types of applications, you need to know the following:

- Flow
- Head
- Depth of the tank
- Shaft seal must be capable of resisting wearing particles
- Capable of pumping lubricant containing chips
- Capable of pumping media containing air
- Designed for viscous media

Typical fail scenarios
Typical mistakes or faults with pumps in these applications are problems related to:

- Pumps blocked due to bad filtering
- Noise from pumps because of air in the liquid

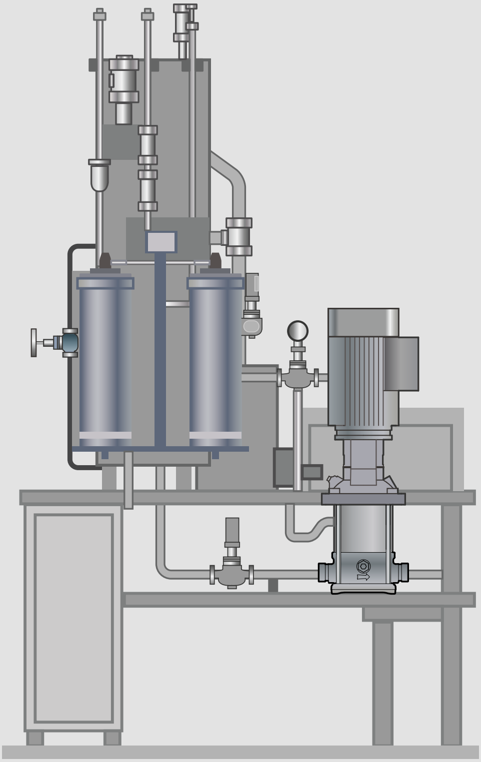
Regarding the different fail scenarios, read more in chapter 9 (from page 58).

4
BOOSTER SYSTEMS

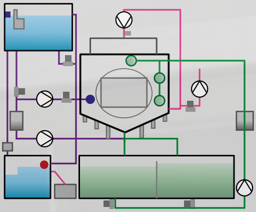
4. Booster systems

For some applications, small booster sets are used if the cooling liquid is taken directly from the filter tank and pumped back into the machine process. Typical booster sets could look like the one below.

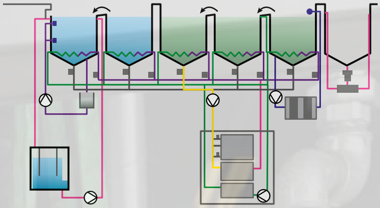
Very often MTR, CR and MTS pumps used for booster applications.



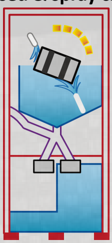
Spray cleaning



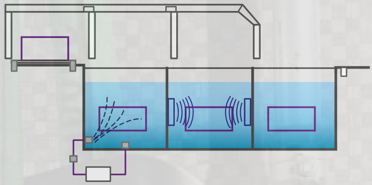
Immersedcleaning



Immersed & spray cleaning



Immersed & ultrasonic cleaning



5 PARTS WASHING

5. Parts washing

The parts washing machines in the metal industry are used for cleaning components after they have gone through a machining process.

Depending on the machining process, the parts will have a certain amount of oil, emulsion, dirt, chips etc. sticking to the surface, which has to be removed before entering the next step of operation. For some parts, the parts washing system is used to remove burs from the surface, such as in motor engines. Regardless of the material to be cleaned, there are several factors influencing the process.

Challenges in parts washing

- Temperature
- Chemistry
- Time
- Washing mechanism (rinsing, degreasing, ultrasound, pressure)
- Component requirements (corrosion protection)

Other important issues are

- Manual/automatic loading
- Individual or batch cleaning
- Size of parts to be cleaned
- Maintenance/repair concept

Methods of parts washing

- Spray cleaning -> Simple geometry/inline with Machine tool machine
- Immersion cleaning -> Advanced geometry/ Central systems
- Ultrasonic cleaning -> Rooted dirt
- Pressure cleaning -> Removal of burs

- The cleaning process is used for the removal of insoluble particles such as dust and chips combined with oil
- The cleaning process is done with relatively low pressure and high volume (except from pressure cleaning)
- Spray cleaning is based on moving the parts through the spray, or moving the spray around the parts being cleaned
- Immersion cleaning is based on the part to be flushed in a bath of media.
- Pressure cleaning is based on a high pressure media jet direct on a certain surface area.
- The normal media used is alkaline

PUMPS FOR PARTS WASHING

The typical pumps used for parts washing are listed below here. Please note that the pumps mentioned are the most common types sold for these applications by Grundfos. If you have preferences for other pump types or constructions, these are available as well.

- **MTR** (multistage immersible pump with multiple variants)
- **CR** (Multistage inline centrifugal with multiple variants)
- **NB/NK** (Single stage pumps)

See pages 62-63 for details about these pumps.

General demands for the pumps used in this process:
When sizing pumps for these types of applications, you need to know the following:

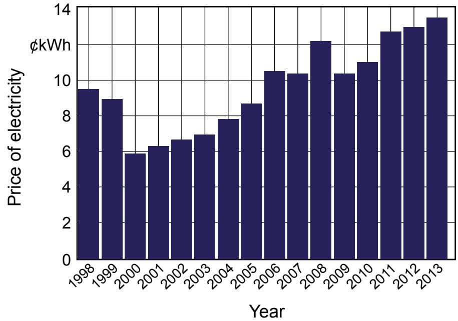
- Flow
- Head
- Stainless steel version
- Compactness
- Shaft seal options
- Semi open impeller

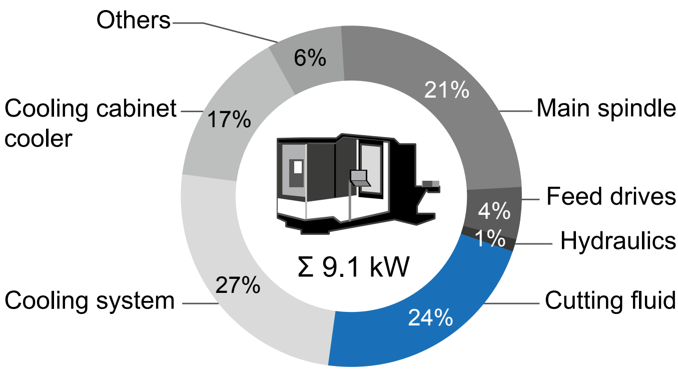
6
ENERGY EFFICIENT **CUTTING FLUIDSYSTEM**

6. Energy efficient cutting fluid system

Since the year 2000, the price paid for electricity has increased by more than 120 %. That is one reason why saving energy saving is an important issue, in addition to environmental considerations. An example is Germany, where 42 % of total electricity consumption is used by industry. Within this sector, about one quarter of the power is required for pumps.

For machine tools, a large amount of the total energy consumption is for the cutting fluid system. In order to work on future concepts for energy efficient machine tools, the Institute of Production Engineering and Machine Tools (IFW) at Leibniz Universitat Hannover cooperates with the machine tool builder DMG Mori Seiki, the tool manufacturer Sandvik Coromant, Grundfos and the supplier of cutting fluid systems Bosch Rexroth Interlit to analyse the relationship between cutting fluid and tool lifetime. Based on these insights, innovative strategies to save a large amount of the energy consumed by the cutting fluid system have been developed.





Tool lifetime vs. coolant volume flow rate
The tool wear behaviour with respect to the volume flow rate of the coolant for a set of different turning, milling and drilling operations has been analysed.

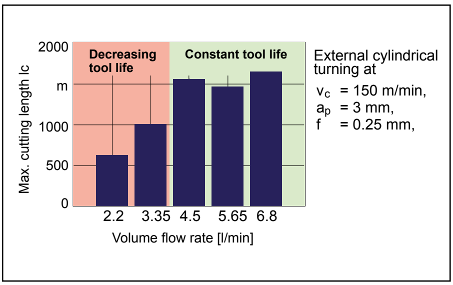
The tests reveal that the volume flow rate of the coolant can be varied within a certain range without changing tool lifetime. The optimal flow rate depends on tool, operation and process parameters. For the given example, the optimal flow rate is 4.5 l/min.

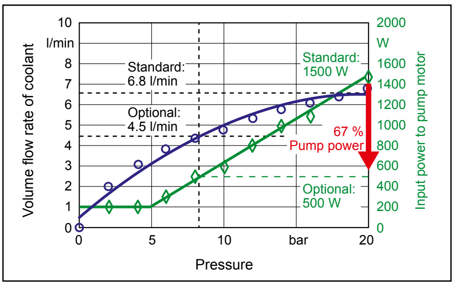
In this case, a reduction of volume flow rate to 4.5 l/min results in a reduction of the input power of the pump by 67 %.

Energy saving strategies
A demonstration work piece is machined to quantify the amount of total energy consumption of a machine tool which can be saved.

The work piece is manufactured in three different ways:

- **Conventional:** The pressure is kept constant at maximum level (red line)
- **Approach 1:** Flow rate control instead of pressure control (blue line)
- **Approach 2:** For each NC-command the optimal flow rate is specified (green line)

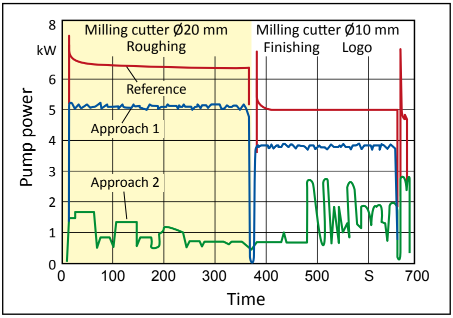


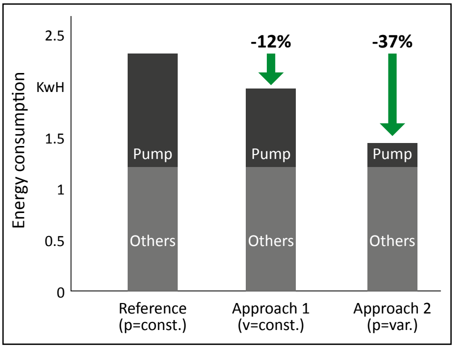


For approach 1 and approach 2, the input power of the pump for the manufacturing process of the demonstration work piece is reduced significantly.

This results in a reduction of the total energy consumption of the machine by 12 % using approach 1 and 37 % using approach 2.

Total energy consumption is reduced by up to 37 %





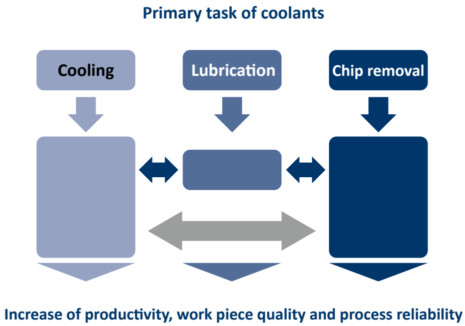
7
COOLING

7. Cooling

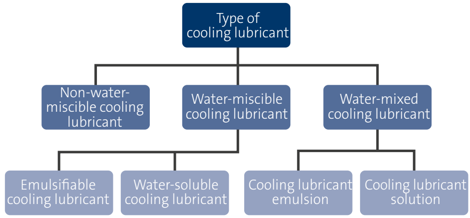
When we discuss 'cooling', we are referring to two different processes. One is the process cooling, meaning the liquid (coolant) used in the open system to keep the machine and process down in temperature. The other is the main cooling system or the cooling system we know it from other industries. In short, the main cooling system transports away heat collected in the process cooling system.

A) PROCESS COOLING

For process cooling, the cooling liquid has three purposes: to reduce thermal load, to lubricate and to remove chips. This is shown below.



The cooling liquids used can be divided into the following:



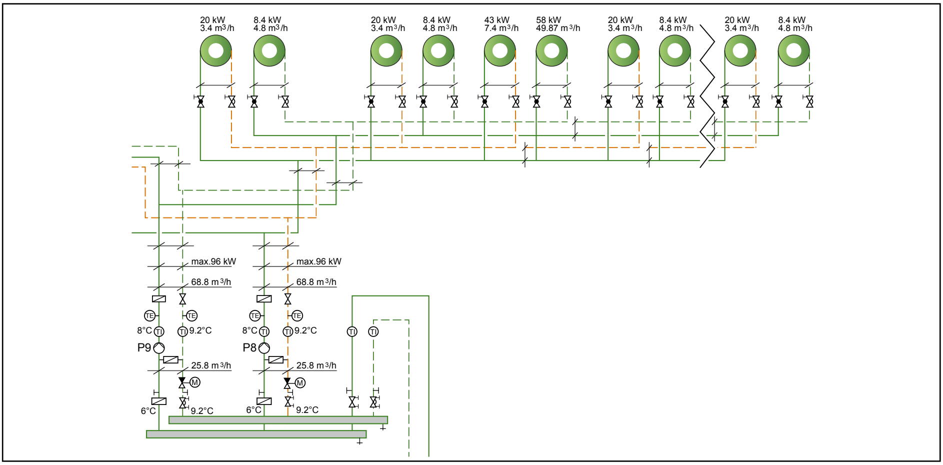
The most commonly used is the water-mixed cooling lubricant emulsion.

B) MAIN COOLING

CONTROL PRINCIPLES AND EXAMPLES

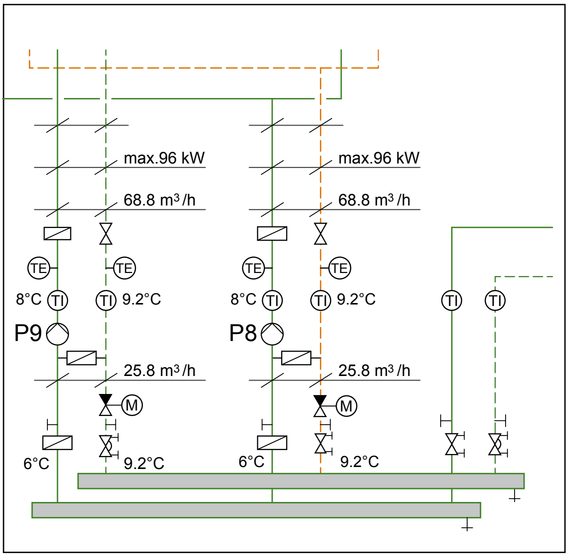
Below are some examples of how to control different cooling loops and what can be done to improve their operation, and thus save energy.

This example is about the supply of cooling water with two main pumps to a number of end users, in this case moulding machines (fig. 24).



The system operates at full speed on the two main pumps and the different loops are regulated by a throttle valve and an on/off valve. The throttle valve is adjusted once during commissioning. This results in a huge energy loss and in different flows through each loop depending on how many are in use. The recommendations from Grundfos for a system set up like this are described in three scenarios.

Scenario 1:
In the first step, we recommend focusing on the two main pumps because this is where the most energy is used, but also because these days they are operated without regulation, and this leads to differentiation in the flow over each moulding machine, depending on the load profile. (fig. 25)



Regulation should proceed by installing frequency converters on each pump, set to maintain constant differential pressure. The sensor should be installed so that it measures the differential pressure directly over the pump (fig. 26). The perfect solution would of course be to measure between the discharge and return pipe farthest away from the pump (fig. 27), but very often it is difficult to determine where it is, and installing measuring cables more than 100 metres away can be costly.

Fig. 26

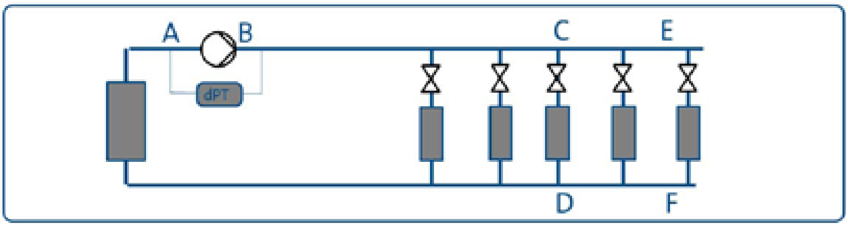
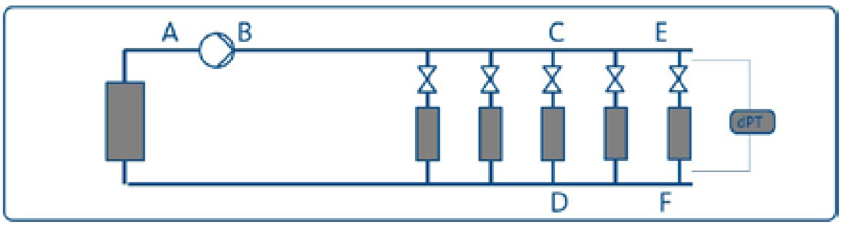


Fig. 27

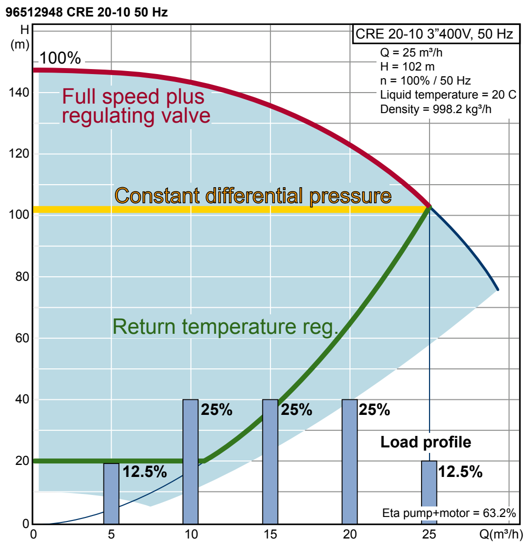


Using the above installation will ensure that the pressure is always maintained at the required level in front of each moulding machine.

Fig. 28 depicts what happens when there is no regulation. The red line indicates where the pump operates when there is no speed regulation. The closure of any valves in the system will entail a slide to the left on the red curve, meaning that the pump will create more and more pressure beyond what is needed. This will result in higher flow in the remaining machines and in a lower Δt. Constant differential pressure ensures that the pressure will always remain the same in the system no matter how valves are opened or closed. The yellow line indicates where it will operate when it runs at constant differential pressure.

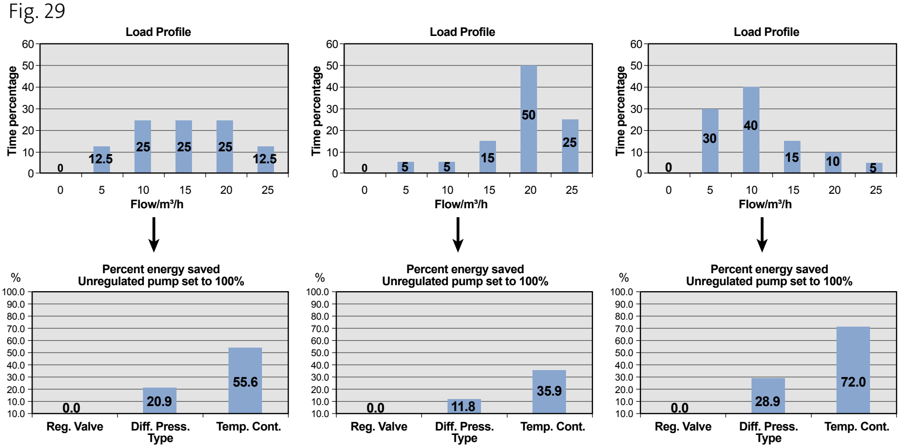
The last curve, the green one, depicts the scenario if the system is regulated on the basis of temperature. Although this is the most economical method, in a system like this it will not work as it only works where there is only one "user" in the system.

Fig. 28



As described above, step 1 ensures that the right amount of cooling water is available in the system and that energy is saved. Fig. 29 shows a comparison of the three different control setups with different load profiles.

Fig. 29



As can be seen from the comparison in fig. 29, with an average load profile an energy savings of around 20.9 % can be achieved by regulating the pumps according to constant differential pressure.

The energy savings in this specific setup with pump P8 and P9 can be calculated as follows. The values below are estimated from the pi diagram in fig. 28.

Flow total:	87.55 m^3/h
Head:	7.5 bar
Hours of operation per year	4800 hours

Operation with no regulation:

$$P_1 = \frac{\text{flow} \cdot \text{head} \cdot 2.72 \cdot \text{hours}}{\eta\ (\text{pump+motor})} = \frac{87.55 \cdot 75 \cdot 2.72 \cdot 4800}{0.8 \cdot 1000} = 107{,}161 \text{ kWh}$$

Saving with constant differential pressure:

P_1 · Diff pres type → 107,161 · 0.209 = 22,397 kWh a year

The above calculations are of course only intended as a guide. If the pressure can be lowered and the system is in operation for more hours, then the saving will of course be much greater. Remember too that if the load on the motor can be lowered through regulation, maintenance costs will be reduced.

Scenario 2:
The same regulation on the main pumps as in step 1. The loop for each moulding machine should be regulated according to discharge temperature. This will result in energy savings and a more constant temperature difference over each machine, and will maintain the flow through each moulding machine at the required level, which in the end will lead to optimal operation regardless of the load profile on the rest of the moulding machines.

Scenario 3:
The same regulation on the main pumps as in step 1, but the pumps have been downsized in relation to pressure. Instead of running at 7.5 bar they should only run at a pressure that overcomes the loss in the main pipes. A pump, instead of the regulation valve mentioned in step 2, should be installed in the loop for each moulding machine. This pump should have variable speed that overcomes the internal pressure loss in the moulding machine.

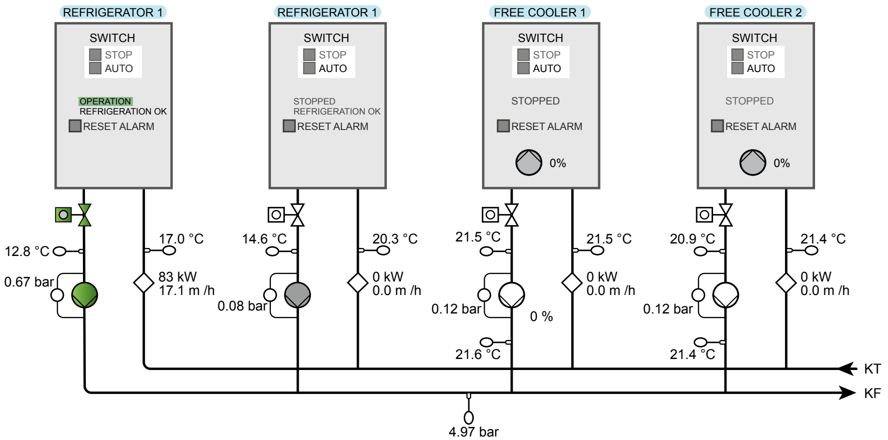
This means that the main pumps can be run at a minimum and in the moulding machines where a certain pressure or flow is needed it can be created on an individual basis with the associated pump. The small pumps for each moulding machine should be controlled according to either the discharge temperature from the moulding machine or constant differential pressure over the machine. Which control is chosen depends on how many cooling loops there are in each machine and how different the pressure drops are over them.

Grundfos setup

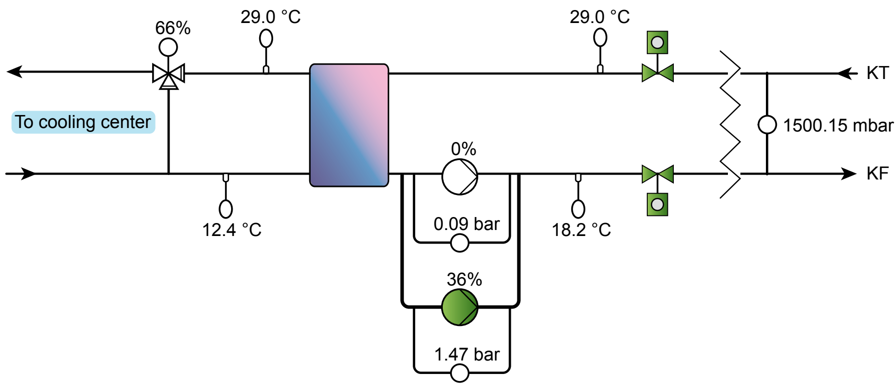
At Grundfos, we produce a number of our own moulding machines. The ways in which cooling water is supplied to them are shown in fig. 30.

First we have the primary side of the system, which consists of the cooling machines and the free coolers. If the temperature outside is optimal the process is run with two free coolers, and if not then the cooling compressors are started.

Fig. 30



The glycol water is led by the pumps to a heat exchanger (fig. 31).



The pressure on the cooling water sent into the moulding machines is maintained by the pumps regulated according to the differential pressure sensor.
The cooling water sent into the moulding machines is used for the secondary processes in the individual machines. Each loop is manually regulated the first time the machine is started. The primary loop (the moulding form) has separate thermic units, because the required temperature differs significantly from mould to mould.

8 FROM SPEED-CONTROLLED PUMPS TO AN INTELLIGENT SYSTEM

8. From speed-controlled pumps to an intelligent system

A pump is always part of a larger system, working together with a whole range of other components. That is why we think beyond the pump and take the entire system into account when developing new solutions. Our E-solutions and Grundfos iSOLUTIONS are both testimony to that.

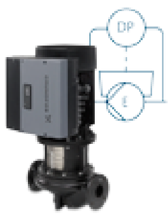
Grundfos iSOLUTIONS is the intelligent approach to optimal pump system and application performance. It offers all the benefits of our pump specific E-Solutions, but adds a whole range of new features based on your specific demands. The result is improved reliability, performance and energy efficiency.

Supreme speed control

Speed control is an essential part of an iSOLUTION. The frequency converter simply adjusts the pump's speed according to the actual demand to offer a variety of benefits:

- **Faster production.** That you can get the needed pressure and flow the second you needed in the tool leads to faster production
- **Longer tool life**. Speed control gives you the right flow and pressure when you need it, theses leads to right temperature and lubrication of the tools and because of that longer life.
- **Energy savings** Speed control reduces energy consumption – and CO_2 emissions.
- **Reduced total cost** Speed control can replace regulating valves, sensors and process equipment, and the quick installation contributes to bringing down the total cost.

PUMP
PRODUCT APPROACH
Standard pumps and external controls with one purpose: Moving liquid from one place to another.



E-SOLUTIONS
EXTENDED PRODUCT APPROACH
Integrated controls enable pumps to adapt to changing demands. Result: Increased comfort and lower energy consumption per pump.

iSOLUTIONS
SYSTEM APPROACH
Optimising the way pumps, drives, controls and protection, measurement and communication units work together as part of one system. Result: System energy savings, component savings, better communication, extended customisation, increased user friendliness.

Customisation your way

With an iSOLUTION your pump can be perfected to suit even very detailed requirements. The customisation options include choice of materials, connection options and special software. The latest advances in software allow our designers to target your specific challenges very, very specifically. See below how an E-solution or iSOLUTIONS matches the specific requirements of the machining industry.

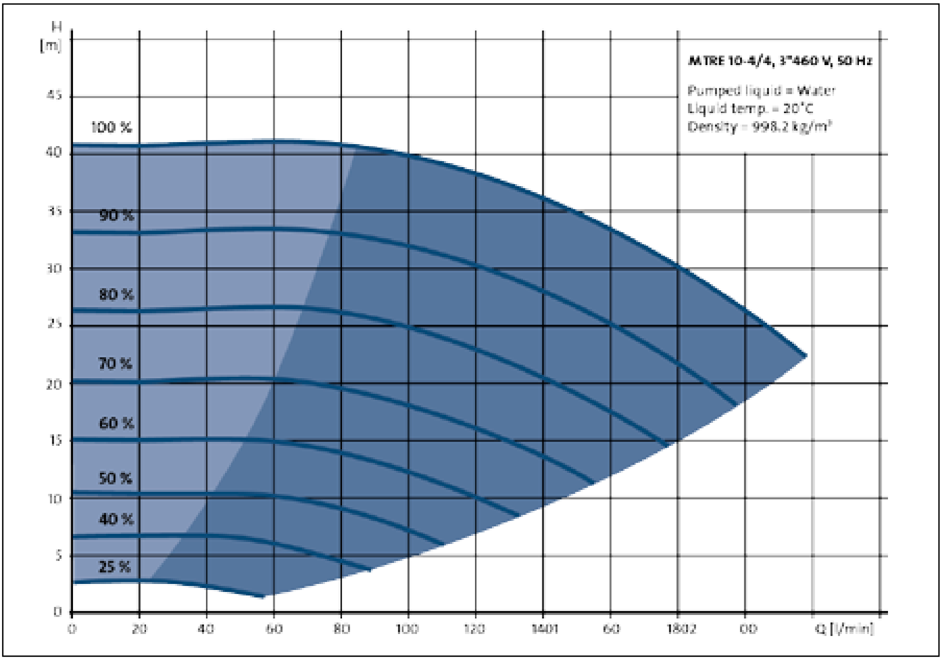
GRUNDFOS E-SOLUTIONS - INTEGRATED INTELLIGENCE

A Grundfos E-solution features pump, motor and frequency drive all in one product. As the frequency drive constantly adapts pump speed according to demand, it is possible to achieve significant pump energy savings.

Constant pressure
The E-pump is able to quickly start and deliver constant pressure in any operating point required by selected tools.

High speed – over synchronous operation
High rpm for very compact pump design, suitable for installations where space is limited i.e. installation in cabinets or machine centers.

Pre-set operating points
Set up the E-pump to operate with several predefined set points to provide the necessary pressure for various demands.



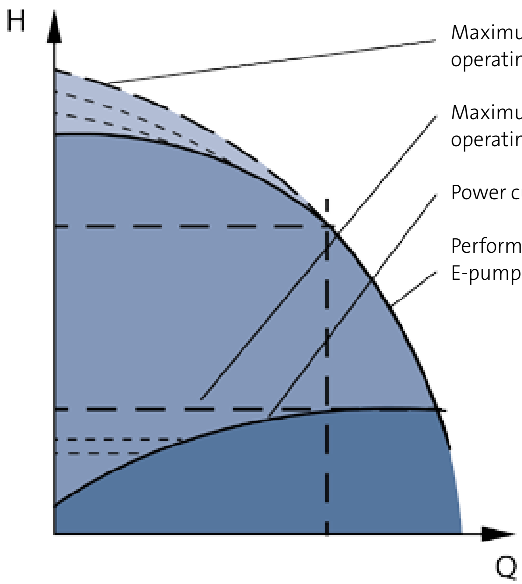
ISOLUTIONS

Limit exceed
Enable your system to change operating patterns or notify you directly if a specific process parameter exceeds a pre-set limit.

Set point influence
Avoid cavitation or excess pressure across the chamber stack by adjusting the set point of the pump. Influence parameters include pressure, flow, etc.

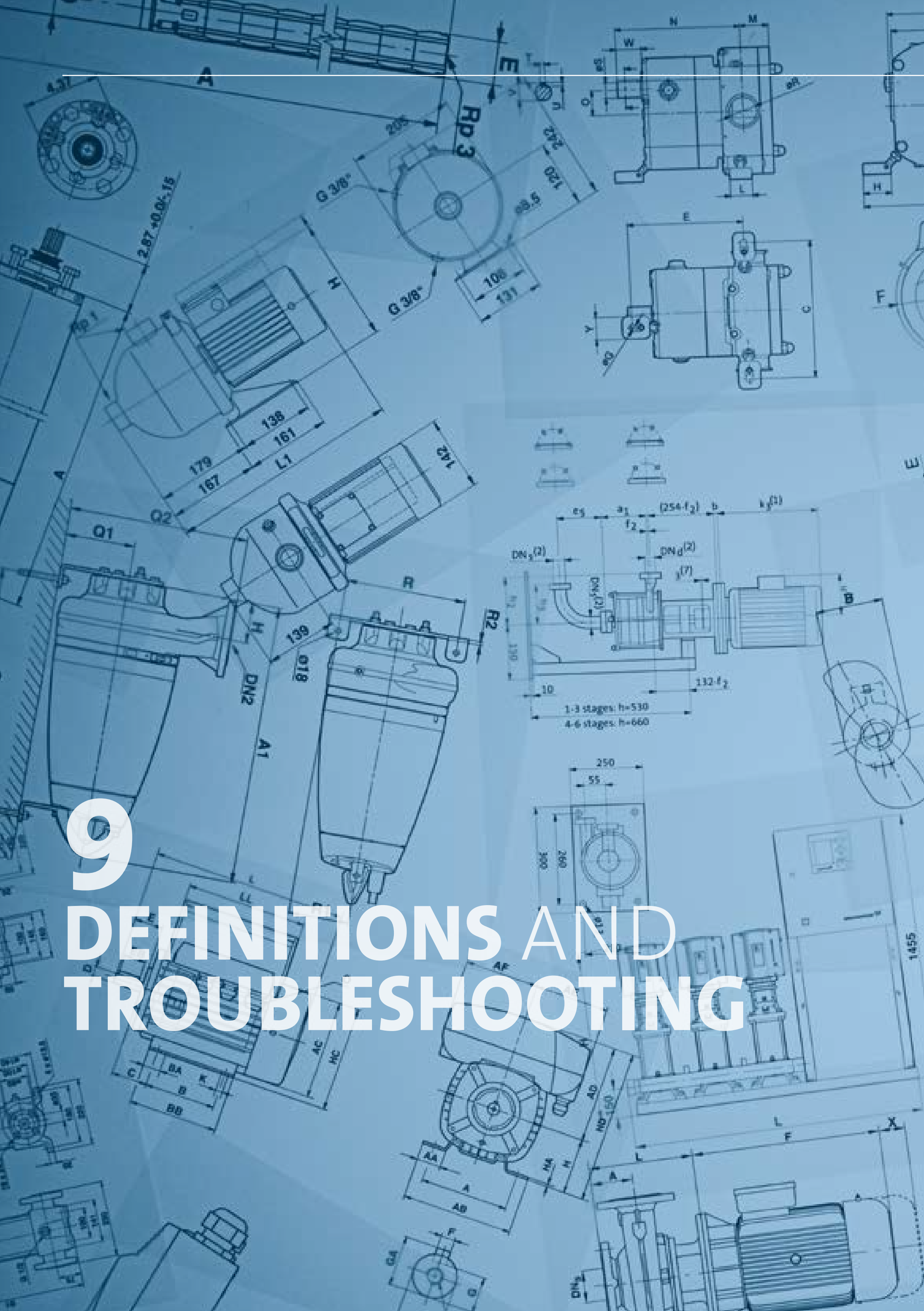
Run at power limit
Get full load power output, but optimal overload protection. Allows for operation with undersized motors or to get more pressure out of the same pump

PC tools at your disposal
If you wish to carry out adjustments yourself, we provide a dedicated PC based programming and monitoring tool. This gives you full access to optimizing your software in any way you want. We are also more than happy to provide customized code if you prefer to leave the programming to us. Backed by decades of experience we know the challenges you face and are able to provide you with solutions that will meet them.



Run at power limit

- Makes it possible to boost the pressure at lower flows by increasing the frequency
- Makes it possible to use the motor 100% over the full pump curve
- Smaller and more compact pump



9 DEFINITIONS AND TROUBLESHOOTING

9. Definitions and troubleshooting

A) METAL CHIPS

In general we don't have any problems with chips as long as the filters in the system are working. Furthermore we have a strainer in the inlet of our pumps that takes care of whatever must slip through the filters.
When it comes to smaller particles then particles from aluminium and rests from the grinding wheel are bad and results in wear in the pump. Especially the bearings and shaft seal in the pumps are sensitive to these small particles. With aluminium we have over the last years seen an increase in the amount of hard particles, simply because new aluminium types are being developed.
When it comes to how big a concentration of aluminium particles we can allow in our pumps then you cannot say anything about that.

B) AIR BUBBLES

Emulsion:
Normally air bubbles is not a problem in emulsions simply because the bubbles turns into a foam layer at the top of the liquid, and the pump has suction in bottom of the tank.

Oil:
Bubbles in oil are a problem because it is very difficult to get them out of the oil meaning they will be floating around in the oil for a long time. And because of this there will be a risk that we will have to deal whit them in the pump.

Furthermore will the bubbles stick to any chips in the oil meaning they will drop to the bottom of the tank and here is the suction from the pump creating even more problems. Basically clean bubbles will not harm the pump but only bring the performance down and create noise.

C) VISCOSITY

The viscosity is normally not an issue when you talk emulsions and oil at operation temperature which is normally around 25 °C. However be careful with the oil because where is the oil tank installed could for example be in a cold basement meaning also the oil will be cold and have a higher viscosity.
This will often result in a demand for an oversized motor, but often it would be more beneficial to install a heating element in the tank.

D) DENSITY

The density is never an issue regarding pumping or oversized motors. The only situation where it give problems is when sizing and you have to remember to convert the wished pressure in bar from the customer to some meter head to size the pump after.

$$H = \frac{p}{\rho \cdot g}$$

where:
H is the head in [m]
p is the pressure in [Pa = N/m^2]
ρ is the liquid density in [kg/m^3]
g is the acceleration of gravity in [m/s^2]

E) NOISE FROM PUMPS

Normally pumps doesn't make any noise, the only thing you should hear from a operating pump should be air noise from the ventilator fan on the motor. However if there is noise from the pump part it is very often because the liquid is aerated. If it is a centrifugal pump you have you can test if it is air by running a short while against closed valve. Because as soon you close the discharge and the flow through the pumps stop the noise should stop. If the noise continues it could be the bearings in the pump or the shaft seal (see more about the shaft seal under that topic).

Remember closing the discharge valve is never allowed on a positive displacement pump like our MTS or BMP pump.
Where air is the issue look for examples under construction of tanks.

F) FLOW IN SMALL TANKS

Flow in small tanks is always an issue, because of the risk of turbulence in the water resulting in bad inlet conditions for the pump. Too big a flow in small tanks also has a high risk of creating air bubbles in the water, resulting in noise from the pump and reduction in flow and head.

In the machine tool business, there is an extra risk from the amount of metal or other particles in the water. Design of the tank is an important part of ensuring perfect operation of the pump with a long lifetime.

G) WATER HAMMER:

Water hammer (or, more generally, fluid hammer) is a pressure surge or wave resulting when a fluid (usually a liquid but sometimes also a gas) in motion is forced to stop or change direction suddenly (momentum change). Water hammer commonly occurs when a valve is closed suddenly at the end of a pipeline system, and a pressure wave propagates in the pipe. It may also be known as hydraulic shock. This pressure wave can cause major problems, from noise and vibration to pipe collapse. It is possible to reduce the effects of the water hammer pulses with accumulators and other features. Water hammer in machine tool applications normally happens when magnetic valves are closed.

When water hammer enters multistage centrifugal pumps, or basically any pump then it often results in broken bearings and destroyed chamber and impellers. So it is crusiual not only for the system but for sure also for the pump to avoid water hammer if possible.

H) SHAFT SEALS

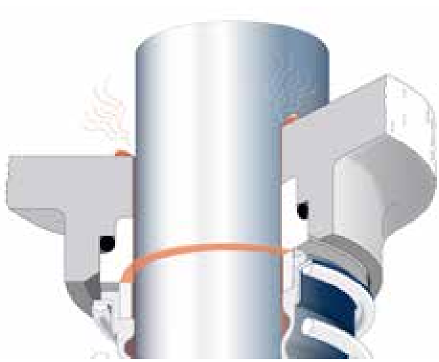
Failures on shaft seals are the most common failure issue in centrifugal pumps and it is also the case in machining industry.
The most common failure with seals in machining pumps are the following.

- Sticiking of seals
- Noise from seals
- Hang-up of seals

Sticking
Sticking occurs when the two seal rings are locked or partially welded together. The locked state results in a failure if the interconnection is higher than the starting torque of the motor. It may also result in mechanical damage of seal parts.

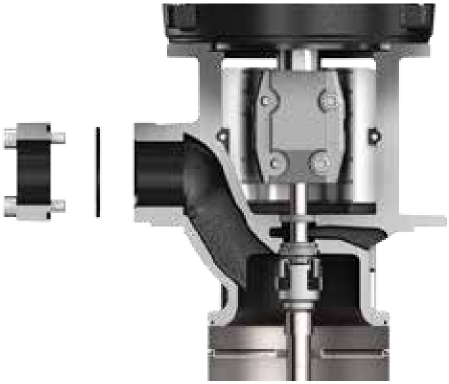
Sticking can have different causes. Mainly hard/ hard seal face pairings have a tendency to sticking. The main causes of sticking are precipitation of sticky materials from the pumped medium on the seal faces or corrosion of the seal faces.

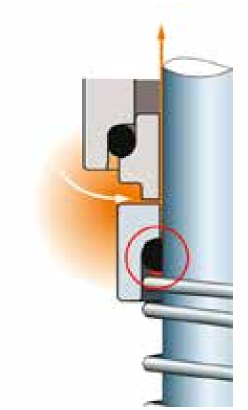
Sticking is only possible on shaft seals of pumps with start/stop operation. The period it takes for the seal rings to stick together ranging from a few hours and up, depending on the pumped medium. The process accellerates at elevated temperatures.



Noise
When lubrication is poor or totally absent, shaft seals with seal rings made of hard materials tend to generate a loud noise. Depending on the seal design, the hard materials used and the system, the noise can be at a constant level of intensity and frequency or be more random.

When noise is generated from the mechanical shaft seal, some parts of the seal vibrate. This may reduce the life of the seal. Metal bellows seals in particular have a tendency to fatigue on account of vibrations.





If there is continuously problems with shaft seal failures and the pump is the Grundfos MTR then solution could be the Drainage back to tank option.

MTR – Drainage back to tank
Leak-free pumps are a top priority in any industrial process. Leaking pumps may lead to costly downtime and in turn affect part cost. The MTR DBT (Drainage Back to Tank) pump effectively eliminates that risk, as the liquid remains in the tank where it is supposed to be – even if the shaft seal is worn out and starts to leak. In addition to being leak-free, the MTR DBT pump features an innovative frequency drive motor that reduces energy consumption to reduce further part costs.

- Downtime risk due to leakage is eliminated
- No risk of contamination
- Longer service intervals
- Reduction of part costs
- Non-sticking solution for the shaft seal on startup

Hang-up
Hang-up of a mechanical shaft seal means that the axial movement of the rotating part of the shaft seal is blocked.

Hang-up mainly occurs in connection with O-ring-type seals, but is also seen in connection with bellows seals, although the underlying mechanism is different.

In connection with O-ring-type shaft seals, settlements or precipitations may build up on the shaft beside the O-ring, preventing the O-ring from sliding freely.

When the temperature or pressure in the system change, the dimensions of pump parts change likewise. As a result, the O-ring must be able to slide freely on the shaft or sleeve to continue to function correctly.

Products for machine tool engineering

MTR multistage immersible pump with multiple variants

Specifications
- Flow: 0-1420 l/min
- Head: 0-25 bar
- Flexible installation length
- High efficiency

The most used pump for machine tool cooling in the Grundfos pump portfolio. Can be used more or less for all processes and adapted for specific requirements.

MTH multistage immersible pump

Specifications
- Flow: 0-170 l/min
- Head: 0-10 bar
- Flexible installation length
- High efficiency

Mostly used for smaller machines, where the required flow and pressure generally is lower.

MTA single stage immersible pump

Specifications
- Flow: 0-355 l/min
- Head: 0-13.5 m
- Semi open impeller
- No shaft seal

Typically used where there is not a separate filter pump, but uses the same pump both for cooling and filtration processes.

MTS screw spindle pump

Specifications
- Flow: 0-850 l/min
- Head: 0-150 bar
- High efficiency
- Low noise
- Compact design

Special high-pressure pump, used very much for drilling process where there is a need for inner cooling inside the drill bit. The MTS pump is a screw spindle pump, meaning there is higher demand for cleanliness of the cooling water. Please note that if the material is titanium or aluminium, the required pressure for inner cooling will be around 150 bar.

CR multistage inline centrifugal pump with multiple variants

Specifications
- Flow: 0-180 m^3/h
- Head: 0-50 bar
- Reliability
- Easy installation
- High efficiency

The CR pump is an alternative to the MTR pump mounted directly in the tank, whereas the CR is dry installed.

NB/NK end suction pump

Specifications
- Flow: 0-800 m3/h
- Head: 0-25 bar
- High efficiency

Typically used for parts washing.

be think innovate

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