Pump technology terms

为了更好的理解下列章节，我们首先要定义和解释在

此手册中与泵有关的术语，在索引中这些术语将按字母表顺序排列。单位和转换规则在简表中。

For better understanding of the following chapters, we firstly will define and explain the technical terms relating to pump technology used in this brochure. The reader will find these terms in alphabetical order in the index. Measures and conversion formulae are summarised in a table.

Flow rate [m≈/h]
流量

每单位时间内流过泵的管路的有效流量
The flow rate is the effective volume flowing per unit of time through the discharge connection of a pump.

为了选择最适宜的泵，流量必须被精确的算定
In order to optimize the pump design, the flow rate must be accurately determined.

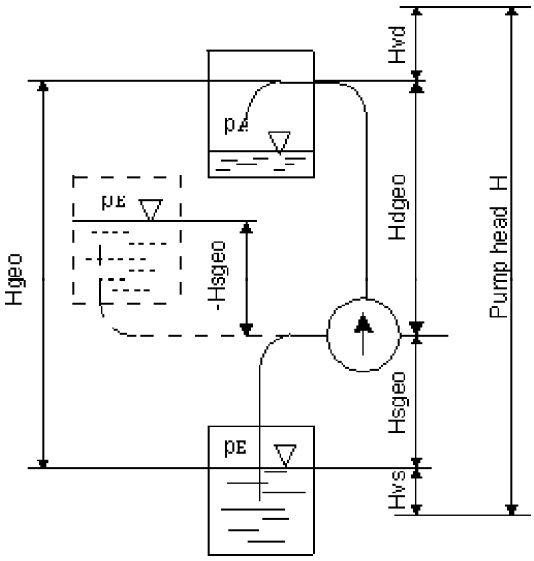
Total head [m]
总压头

The total head is the effective mechanical energy transferred by a pump to the fluid as a function of the weight force of the fluid. 泵对流体产生的有效压力

The total head results as follows: 总压头计算如下

$H = H_{geo} + H_V + p$

It consists of: 组成如下



- 吸入面高度与流出面高度的高度差 the difference in height to overcome between the suction side and the discharge side of an installation.
  $H_{geo} = H_{dgeo} \pm H_{sgeo}$
- 在装置中由于管壁，接头，阀损失的压力（高度差） the friction loss resulting from pipe walls, fittings and valves within the plant.
  $H_V = H_{VS} + H_{Vd}$
- 装置外压力差 the pressure difference
  $p = p_A \pm p_E$

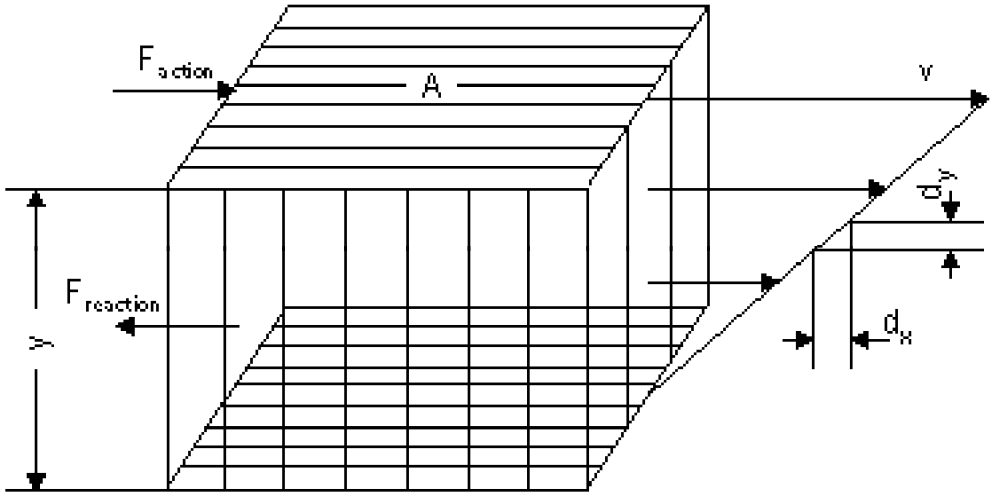
功耗 **Power consumption**

The power consumption is the total energy transferred by the pump to the discharge flow.
功耗是指至流出流体所消耗的总功耗

dynamic viscosity η
动态粘度

下图是流动面 A，与基准面的距离 Y，当力 F a 以 V 的速度移动时

Looking at two parallel plates with the surface A and the distance y, displaced against each other as a result of a force F_{action} with a velocity v, a force $F_{reaction}$ opposes to this displacement and increases with increasing dynamic viscosity of the medium between the two plates. 有一个反作用力 F r 在两个面间以动态粘度渐增的增加



The ratio of F to A is called shear stress τ. F 与 A 的比率叫剪切压力 τ

$$\tau = \frac{F}{A}$$

The shear stress τ increases in proportion to the shear velocity D and the dynamic viscosity η. 剪切压力 τ 与剪切率 D 和动态粘度 η 成正比

$$\tau = D \times \eta$$

The ratio of v to y is defined as shear velocity D. V 与 Y 之比被定义为剪切率 D

$$D = \frac{v}{y}$$

Thus the resulting dynamic viscosity η: 这样动态粘度 η 为：

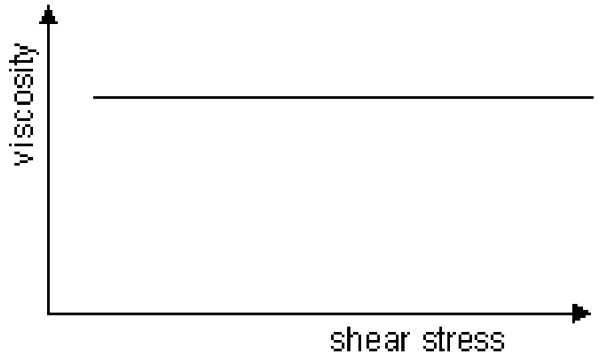
$$\eta = \frac{\tau}{D}$$

动态粘度 η 是与流体特性参数和温度相关的，因此粘度总是显示出相应的温度
Thus, the dynamic viscosity η is a characteristic parameter of the fluid concerned and depends on the temperature. Therefore the viscosity is always indicated together with the corresponding temperature.

Flow behaviour of fluids
流体流动性

Ideal viscous flow behaviour: 理想的粘性流动特性

Fluids with an ideal viscous flow behaviour are called Newtonian fluids. They are viscous fluids with linear molecules. They show a proportional flow behaviour.
有理想的粘流特性的流体叫牛顿流体，是线性的，成正比的流动性



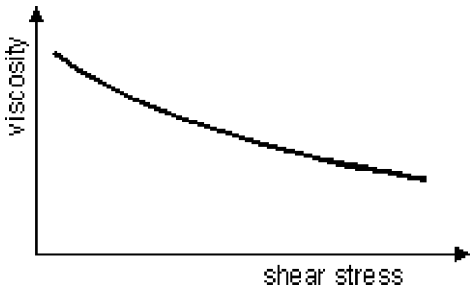
Typical Newtonian fluids are: water, salad oil, milk, sugar solutions, honey.
典型的牛顿流体：
水，色拉油，牛奶，糖液，蜂蜜

假塑性流动的特性
Pseudoplastic flow behaviour:

流体流动特性是由他们的物理化学性质决定的，加入溶解物，将增加粘度并改变流动特性
The flow behaviour of fluids depends on their physicochemical properties. Adding a filling agent to a pure solvent, will increase the viscosity and change the flow behaviour.

随着剪切压力的增加，通常溶液中高分子产品的粘度是降低的
With increasing shear stress, in general the viscosity of highly molecular products in solutions and melts tends to decrease.

这种流动特性叫假塑性
Such a flow behaviour is called pseudoplastic.

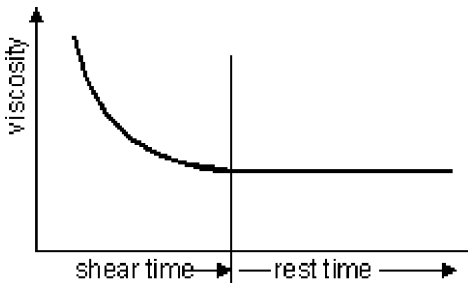


Examples of pseudoplastic flow behaviour: 假塑性流体有：
condensed milk, orange juice 炼乳，橘子汁

Irreversible flow behaviour: 不可逆流体特性

在剪切力破坏下（剪切时间），流体被不可逆的破坏
Fluids deformed under applied shear stress in a way that the structure after the destructive phase (shear time) can not be restored show an irreversible flow behaviour.

结果是持久的，剪切时间由粘度变化决定
The result is a permanent, shear time dependent change of viscosity.



Example for irreversible flow behaviour: 不可逆流体：
Yoghurt 酸乳酪

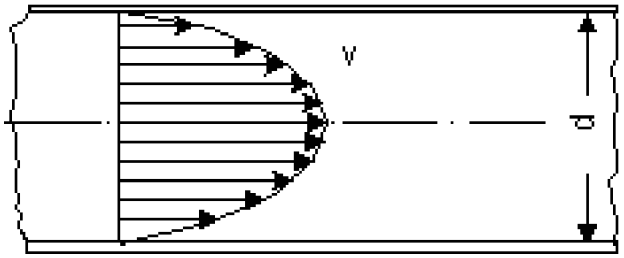
Types of flow
流动类型

根据ＲＥＹＮＯＤＳ定律，流体流过管道会显示出不同的物理特性
Depending on the Reynolds number, the flow passing through a pipe shows specific, typical flow patterns with different physical properties.

会有层流或湍流产生
In this context the generation of a laminar or turbulent flow is of particular concern.

Laminar flow
层流

In case of a laminar flow, the particles move in a streamline form and parallely to the pipe axis without being mixed.
举各例子，微粒在流线型管道内移动，都沿轴向方向移动并且不被混合



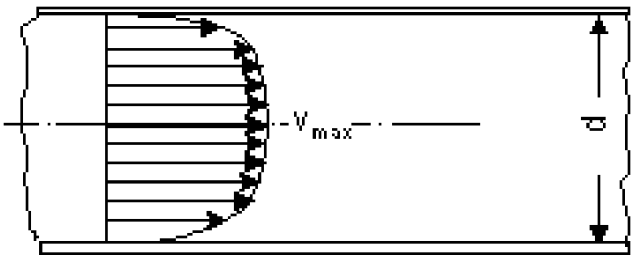
The roughness of the inside wall of pipes has no effect on the friction loss.
粗糙的管型不影响摩擦损失

You will find a laminar flow mainly with high viscous fluids.
你会发现层流主要出现在高粘度流体上

The loss of head changes linearly with the flow velocity.
损失的压力与流动速率成正比

Turbulent flow
湍流

In case of a turbulent or vortical flow the particles are mixed because of the movement along the pipe axis and an additional, transverse movement..
微粒在湍流或旋流中是混合的交错的，因为它除了轴向运动还有横向运动



The roughness of the pipe inside has great effect on the friction loss.
粗糙的管型对摩擦损失有很大的影响

Turbulent flows are mainly found with water or fluids similar to water.
湍流主要出现是水或水类似的流体

The loss on pump head varies by square of the flow velocity.
泵压力的损失与流速的平方相关

Reynolds number
R E Y N O L D S值

The Reynolds number describes the correlation between the flow velocity v, the viscosity η and the inner diameter of the pipe *d*.
R E Y N O L D S值主要描述流速V，粘度η以及管内径d之间的关系

The Reynolds number has no dimension.
R E Y N O L D S值设有单位

$$Re = \frac{v \times d_i \times \rho}{\eta}$$

Flow velocity	v	[m/s]	流速
Viscosity	η	[Pa s]	粘度
Inner pipe diameter	d_i	[mm]	管内径
Density	ρ	[kg/dm≈]	密度

With a Reynolds number of 2320 the laminar flow passes to a turbulent flow.
R E Y N O L D S数2 3 2 0是层流和湍流的分界点

Laminar flow < Re_{krit} = 2320 < turbulent flow
层流〈R e = 2 3 2 0 〈湍流

Example: 举例

In one second, 2 litres of acetic acid passes through a pipe with a nominal bore of 50 mm.
1秒内，2升乙酸流过一个5 0 mm孔的管子

The acetic acid has a kinematic viscosity of η = 1.21 mPa s = 0.00121 Pa s
乙酸动态粘度η = 1 . 2 1 m P a s = 0 . 0 0 1 2 1 P a s

and a density of 1.04 kg/dm≈.
密度1 . 0 4 K g / d m 3

Is the flow laminar or turbulent?
它是层流还是湍流？

The average flow velocity amounts to:
平均流速

$$v = \frac{Q}{A} = \frac{Q}{\frac{d^2 \times \pi}{4}} = \frac{2 \times 1000}{\frac{50^2 \times \pi}{4}} = 1.02 \text{ m/s}$$

Q [l/s]
d [mm]
v [m/s]

Thus the calculated Reynolds number is: ＲＥＹＮＯＬＤＳ值为：

$$Re = \frac{v \times d \times \rho}{\eta} = \frac{1.02 \times 50 \times 1.04}{0.00121} = 43634$$

此值超过临界值２３２０，为湍流
The Reynolds number exceeds the critical Reynolds number Re_{krit}=2320. The flow is turbulent.

NPSH value [m]
净正进口压力头

ＮＰＳＨ是Ｎｅｔ　Ｐｏｓｉｔｉｎｅ　Ｓｕｃｔｉｏｎ　Ｈｅａｄ的缩写
NPSH is the abbreviation for **N**et **P**ositive **S**uction **H**ead

除了流量Q，泵压头H，ＮＰＳＨ是离心泵的最主要的性能参数
Besides the flow rate Q and the pump head H, the NPSH value is one of the most important characteristic parameter of a centrifugal pump.

NPSH value of the pump
泵的净正进口压力头

泵的ＮＰＳＨ依赖于泵的设计和转速，泵转速越高，ＮＰＳＨ值越高
The NPSH value of the pump depends on the design and speed of the pump. The higher the speed of the pump, the higher the NPSH value will be.
The NPSH value is measured on a pump test stand and cannot be modified without supplementary means. ＮＰＳＨ值对于每个泵是固定的不能被其他的方法修改

设备的净正进口压力头
NPSH value of the plant

设备的ＮＰＳＨ值依赖于损失的压力，包过接头。设备内其他部分部件损失的压力，
The NPSH value of the plant depends on the loss of head including the losses in fittings and apparatus in the line of the plant, and should be always checked by **calculation**.
并且是永远计算在内的

p_E = pressure at the inlet cross section of the plant [bar] p_E 设备进口液面的压力

p_A = pressure at the outlet cross section of the plant [bar] p_A 设备出口液面压力

p_D = vapour pressure of the fluid at the middle of the suction connection of the pump [bar] p_D 泵的进口连接处的流体蒸气压力的中值

p_b = air pressure at the installation site of the pump [bar] p_b 泵安装位置的大气压力

进口管线损失的压力
设备的进口液面到泵的出口液面

H_{VS} = loss of head of the suction line, from the inlet cross section of the plant to the inlet cross section of the pump [m]

测量进口高度（负数，假设淹没进口）

H_{sgeo} = geodetic suction height (negative, in case of flooded suction) [m]

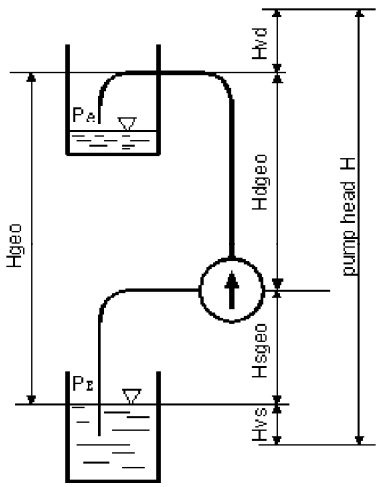
密度

ρ = density of the fluid [kg/m≈]

进口流量

v_E = inlet flow velocity [m/s]

$$NPSH = \frac{p_E + p_b - p_D}{\rho \times g} + \frac{v_E^{\leq}}{2g} + H_{sgeo} - H_{VS}$$



In order to ensure a correct operation of the pump the following condition must be given:
为了确保正常工作

$$\mathbf{NPSH_{plant} > NPSH_{pump}}$$

Boiling fluids with a velocity up to 0,3 m/s are a special case. 但流速为0．3m/s的沸腾流体是例外

In this case: $p_E = p_D$; as $\frac{v_E^2}{2g}$ and H_{VS} become negligible resulting in:
举例：当PE=PD，，那VE/2g和Hvs可以忽略不计

$$\mathbf{NPSH_{plant} = H_{sgeo}}$$