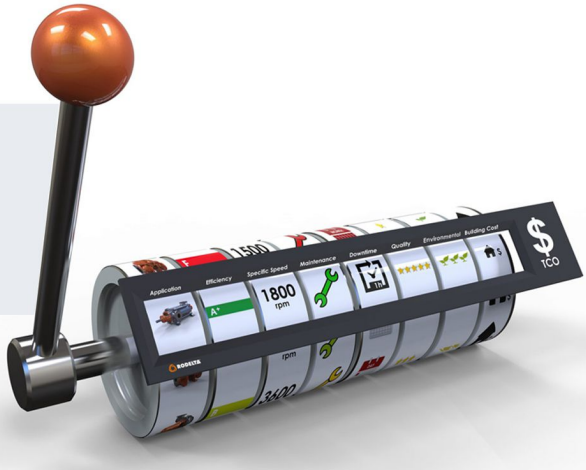
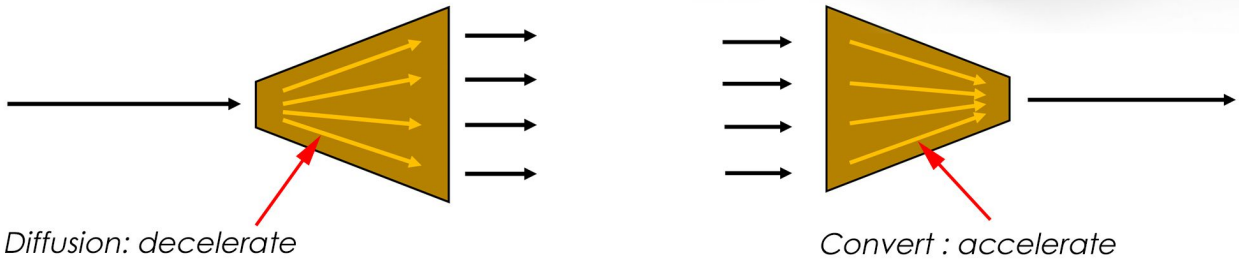
Loss of efficiency at pumps due to diffusion



Efficiency loss due to diffusion in pipe systems

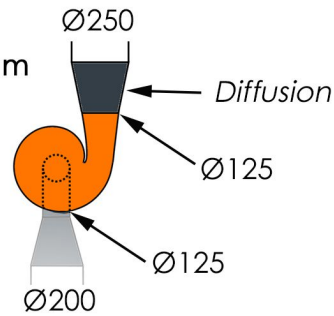


Diffusion is considered a highly inefficient process in fluid dynamics.

Pump selection example

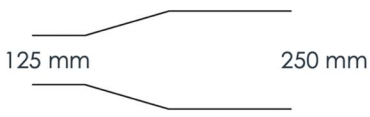
Q = 350 m3/u
H = 40 m
System pipe diameter 250 mm for 2 m/s flow rate

Pump selection 1
Flange diameter: 125 mm
Efficiency; 82%

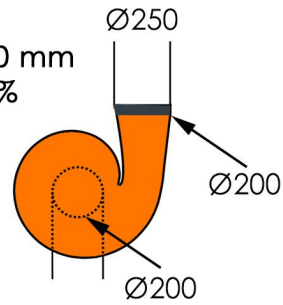


= PUMP EFFICIENCY
= NOT IN PUMP EFFICIENCY

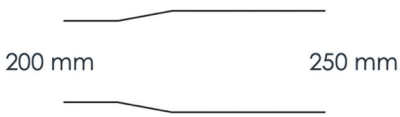
Pipe outlet required



Pump selection 2
Flange diameter.: 200 mm
Efficiency 80%



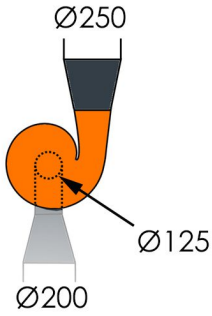
Pipe outlet required



Pump option 1

Flange diameter: 125 mm
Efficiency: **82%**

Exit speed: *7.9 m/s*
Velocity energy: *3.2 m*
Loss Factor K_D *0.52*
Pipe loss: *1,68m*
Fall acceleration: *9,81 m/s^2*



$$\Delta H = K_D \left(\frac{v^2}{2g}\right)$$

ΔH = 0.52 x (7.9² / (2 x 9.81)) = 1,68 m

1,68 m at 40 m = 4,2%

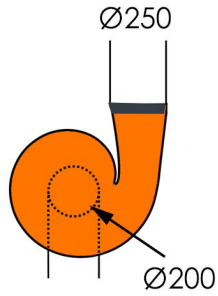
4,2% of the delivery head is lost in the path behind the pump!

The efficiency that remains is.:
82%x(40-1.68) / 40 = **78,6%**

Pump option 2

Flange diameter: 200 mm
Efficiency: **80%**

Exit speed: *3.1 m/s*
Velocity energy: *0.5 m*
Loss Factor K_D *0,08*
Pipe loss: *0.04 m*
Fall acceleration: *9,81 m/s^2*



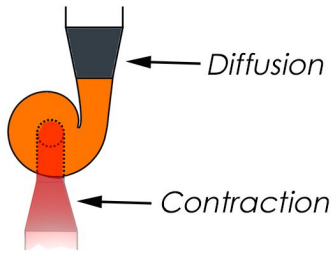
$$\Delta H = K_D \left(\frac{v^2}{2g}\right)$$

ΔH = 0.08 x (3.1² / (2 x 9.81)) = 0.04 m

0,04 m at 40 m = 0,1%

Only 0,1% of the delivery head is lost in the path behind the pump!

The efficiency that remains is.:
80%x(40-0.04) / 40 = **79,9%**



If the diffuser is mounted directly on the pump, there will be an interaction between the flow in the outlet of the pump and the diffuser. This interaction increases the losses.

* In the above comparison, only the diffusion is included and not the contraction (red) for the pump.
(Additional 0.5% loss) 78.1% pump 1 - 79,9% pump 2

Cost savings pump selection 1 versus pump selection 2								
Installation lifetime		25	Years					
Eff. choice 1		78,1	%					
Eff. choice 2		79,9	%					
Energy costs		0,09	€					
Operating hours		8600	hours					
Shaft power	pump selection 1	48,85	kW	420110	kWh		€ 37.810	
Shaft power	pump selection 2	47,75	kW	410650	kWh		€ 36.959	
				Annual consumption			Annual saving	€ 851
				Consumption 25 years				
				10502750	kWh		€ 945.248	
				10266250	kWh		€ 923.963	
							Saving	€ 21.285

With pump selection 2, you will save € 21,285 in 25 years with less problems and spare part costs

Advice
* Always choose 5 - 7 times the inlet diameter of the pipe as straight length in front and behind the pump.
* Constant diameter, equal to pump connection.

Pumps with small connection diameters can cause large system losses.
* Higher discharge velocity increases the velocity energy in the water quadratically..
* Larger surface area ratio increases loss factor.
* Combined effects increase pressure loss.

At high discharge rates, this loss can be several percent of the delivery head and several percent of the pump efficiency.

For a fair comparison of quotations on pump systems, it is very important to look properly at the variations in connection diameters (i.e. liquid velocity) from the pump selections. The example in this writing shows that this has a great influence on the final net pump efficiency.