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INSTALLER'S MANUAL

DAB
PUMP PERFORMANCE

EDITION JANUARY 2010

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INSTALLER'S MANUAL
EDITION JANUARY 2010

DAB®
PUMP PERFORMANCE

Welcome!!!

This manual has been devised and produced to provide installers with an easy-access reference tool.

The subjects it covers have been selected according to the numerous enquiries the DAB PUMPS S.p.a. Customer Technical Service department has received and it has been developed in association with the service centres, installers,and the DAB PUMPS S.p.a. Engineering department.

PLEASE NOTE:

The suggestions made in this handbook are provided for illustrative purposes and are applicable in the majority of cases.
Nevertheless, we recommend that a careful analysis of the actual installation requirements and conditions be carried out by a technical design firm or a qualified professional who is specialised in this field.
Dab Pumps S.p.a. cannot be held in any way responsible for any injuries caused, including therein to consumers (as defined by Legislative Decree n. 206/2005), or damage to property, including therein systems, equipment, and products, as a direct or indirect result of events attributable to the choice of a product (based on the information contained herein) which is inappropriate for the actual installation requirements and conditions.

INDEX

Applications

✓Heating systems
✓Conditioning systems
✓Sanitary purposes
✓Anti-condensation applications
✓Closed circuits industrial applications




HEATING PUMP CALCULATION

Legislation stipulates that every building be assigned a “heat-loss factor” ; it has also established a maximum room temperature of 20°C.
To ensure the room temperature is kept at 20°C, a balance must be established between the “heat-loss factor” and the building overall heat-drop rate.
The heat-loss factor is the amount of heat lost by the building in an hour per cubic metre and per degree centigrade.
This coefficient is calculated by adding:
- the heating capacity per cubic metre and degree centigrade needed to offset the heat lost through transfer towards the outside via the opaque and transparent parts of a building (see fig. A).
- the heating capacity per cubic metre and degree centigrade needed to heat the fresh air inside the building (see fig. B).

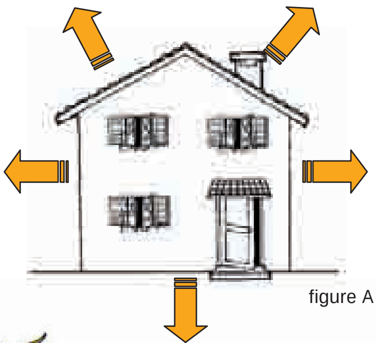


figure A

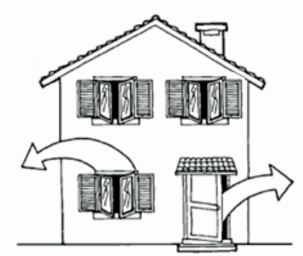
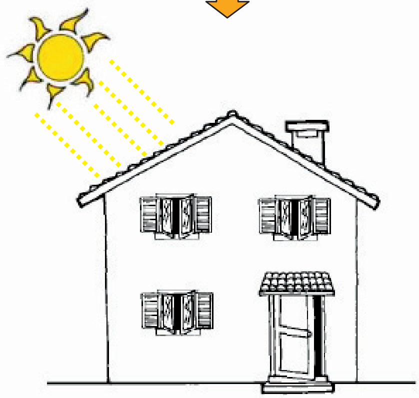
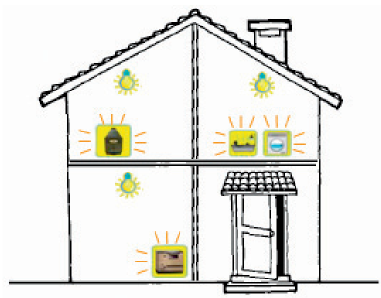


figure B

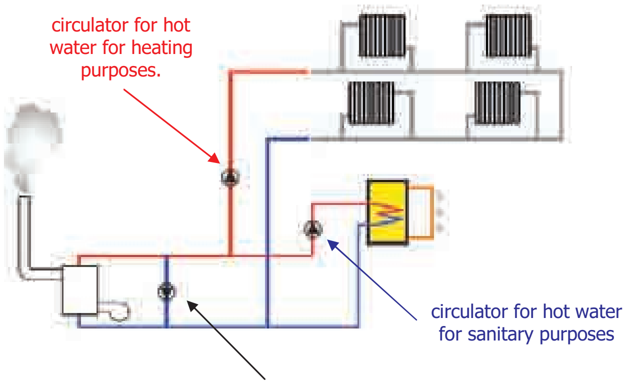


Free heat, such as solar radiation



Internal heat, such as computers, lighting, household appliances, etc...

SINGLE-PIPE HEATING SYSTEMS

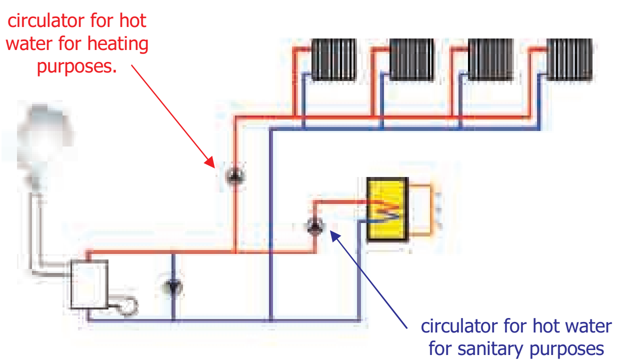


<u>Calculating the capacity of an anti-condensation circulator</u>

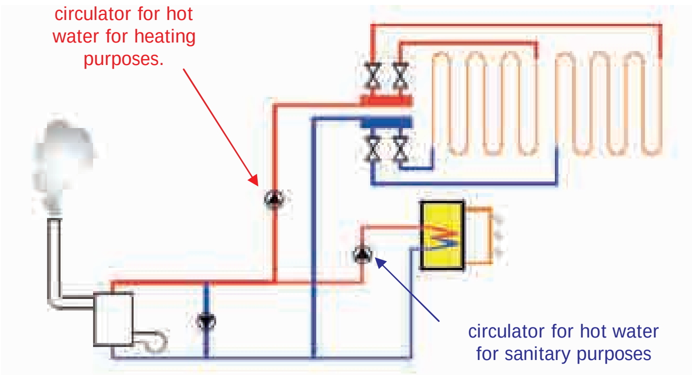
If:
P = power in kcal/h = 60,000 kcal/h
ΔT = Temperature delta between delivery and return = 20°C

Q = (0.33 x P)/ΔT
= (0.33x60,000 kcal/h)/20°C = 990 l/h = 0.9 m3/h

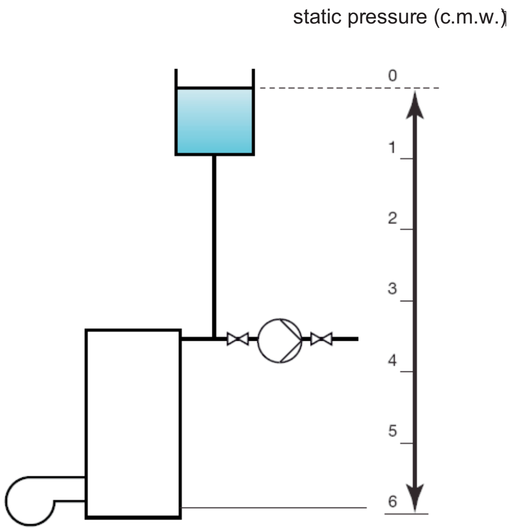
TWO-PIPE HEATING SYSTEMS



UNDERFLOOR HEATING SYSTEMS



OPEN TANK SYSTEM



In the case of open tank systems, the tank's position determines the system's static pressure.

In the case shown in the figure on the left, the circulator has a static pressure of 3.5 metres

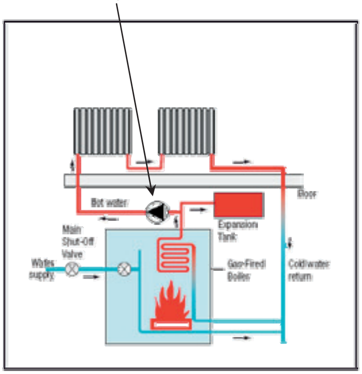
As a rule, the circulator should be installed downstream of the tank, to prevent cavitation problems and stop water from spilling out of the tank.

The next section looks at two ways of installing circulators; however, these installation arrangements are not essential to guarantee the motor-driven pump a long working life, and the fitter is free to choose whatever type of installation he prefers.

P1 (80°) > P2 (60°)

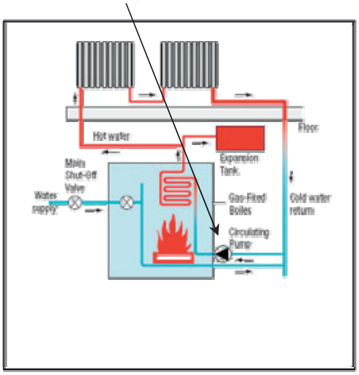
Installation with circulator on delivery side

P1
Operating temperature on return side of the system: 80°C



Installation with circulator on return side

P2
Operating temperature on return side of the system: 60°C



WHEN TO CHOOSE A ROTOR PUMP. A WET OR AIR-COOLED PUMP IN A HEATING SYSTEM?

The choice of pumps is usually left to the design engineer; the air-cooled rotor pump is the most common option when the flow rate required exceeds 70m^3/h and/or the head is over 15 metres. When performance ratings are lower, in the majority of cases wet rotor circulators are used, as they allow the user a choice of at least two curves, which can be selected using a switch fitted in the terminal box.

Advantages of air-cooled rotor pumps:
✓usable with water that contains lime;
✓installable with the motor axis in a vertical position;
✓wide range;

Advantages of the wet rotor circulator:
✓low noise levels;
✓2 to 3 speeds to choose from;

MAIN COMPONENTS OF A CONVENTIONAL HEATING SYSTEM

HEAT GENERATOR

The heat generator is usually a boiler, which may be powered either by gas, wood or any other solid fuel, and produces the amount of heat required to heat up the interior of the building via water recirculation.
Solar energy is one particular source of alternative energy which has become more popular recently, and solar panels are now being used to heat up water which is then recirculated for indoor heating.

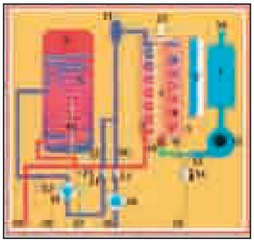
PIPING AND HEATING BODIES

The piping must be able to carry the heating liquid to the user devices, guaranteeing the maximum flow rate with minimum noise generated by the flow of water. What is more, if well insulated, it should also guarantee minimal drops in temperature between delivery and return, something which should not be underestimated as it affects running costs considerably.
These heating bodies may be radiators, fan coils, or wall-mounted or underfloor radiating panels.

PUMP

The pump is an essential component of water recirculation systems and to choose the right sized pump, you have to take into account two essential aspects:
• Maximum quantity of water, which is defined as the maximum flow rate;
• Head in metres, which must be sufficient to compensate the friction loss in the pipes and in the other parts of the system (e.g. radiators, air heaters, bends, elbows, gate valves etc..).

CALCULATING THE SYSTEM'S FLOW RATE



$$Q = \frac{Pw \times 0{,}86}{(\Delta T)} \left(\frac{m^3}{h}\right)$$

Q = Water flow rate (m3/h)
Pw = Heat demand in kW
0.86 = Factor for conversion from Kcal/h to kW
ΔT = Temperature delta between delivery and return in °C

Since the pump is a fundamental component, various considerations must be made concerning it, in terms of the major energy saving opportunities it offers and whether to use a fixed or variable speed pump.
• If the system loop is designed to work at a certain point of the curve, a fixed speed pump will be needed to meet the system's requirements.
• If the system allows the flow rate to be varied, we recommend the use of an inverter-controlled electronic circulator which regulates pump speed according to the system's requirements.

CHOOSING A CIRCULATOR FOR HEATING

Example:

CALCULATING THE FLOW RATE

1 - *Q = P / ΔT = 60,000 kcal/h / 10°C = 6,000 l/h = 6 m^3/h* **= Q1**

P = Power in kcal/h = 60,000 kcal/h

ΔT = Temperature delta between delivery and return = 10°C

CALCULATING THE FLOW RATE

2 - *Q = P / ΔT = 60,000 kcal/h / 20°C = 3,000 l/h = 3 m^3/h* **= Q2**

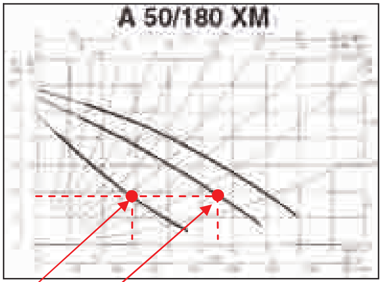
P = Power in kcal/h = 60,000 kcal/h

ΔT = Temperature delta between delivery and return = 20°C

HEAD

This is the pressure required to overcome the friction loss, so if:

H = 1.8 m = H



Q2 = 3 m3/h – H= 1.8 m.c.w. – ΔT 20°C

Q1 = 6 m3/h – H= 1.8 m.c.w. – ΔT 10°C

CALCULATING THE SYSTEM HEAD

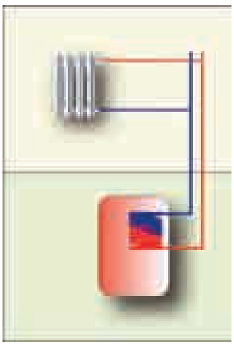
The system head is calculated by adding together the localised friction loss in the heating system.

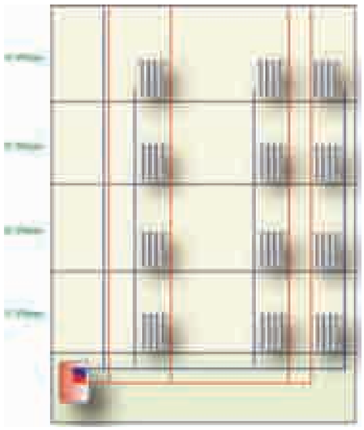
As a very rough example, to speed up the calculation for closed-loop systems, let's assume each floor has a head of 0.8-1 metre; so, for example, a building with 4 floors will have a head of 3.2 – 4 metres.

Calculation example:

H = Hed x K
Hed = building height of 9m
K = let's assume this is 25% - 30% of the building's height

➢ *H= 9 x 0.30 = 2.7 metres*
➢ *H= 9 x 0.25 = 2.25 metres*





Generally speaking, by installing an electronic pump, head selection mistakes can be averted by setting the head value for the system during installation.

CALCULATING THE SYSTEM HEAD

We recommend you set aside a few minutes to do this calculation. To help you, we have provided a table (below) indicating the friction loss in each component found in the heating system.
What is more, as far as the friction loss in the piping alone is concerned, we recommend you refer to the slide rule enclosed with this handbook or to the tables at pages 30-31.

If necessary, to obtain a more accurate calculation, we recommend you use the tables supplied by all the major manufacturers of distribution system components.

LOCALIZED FLOW RESISTANCE AT A TEMPERATURE OF 80°C AND WATER SPEED OF 1 m/sec

Type of resistance size	*3/8" - 1/2"*	*3/4" - 1"*	*1 1/4" - 2"*	*> 2"*
Fan coil	1500			
Radiator	149			
Boiler	149			
Three-way valve	495	495	396	396
Four-way valve	297	297	198	198
Heating body angle valve	198	198	149	-
Heating body straight valve	421	347	297	-
Check valve	149	99	50	50
Butterfly valve	173	99	74	50
Reduced bore ball valve	10	10	5	5
Full bore ball valve	80	50	40	30
Full bore gate valve	10	10	5	5
Reduced bore gate valve	60	50	40	30
90° bend	75	50	25	20
U bend	99	75	40	25
Bottleneck	50			
Expansion joint	25			

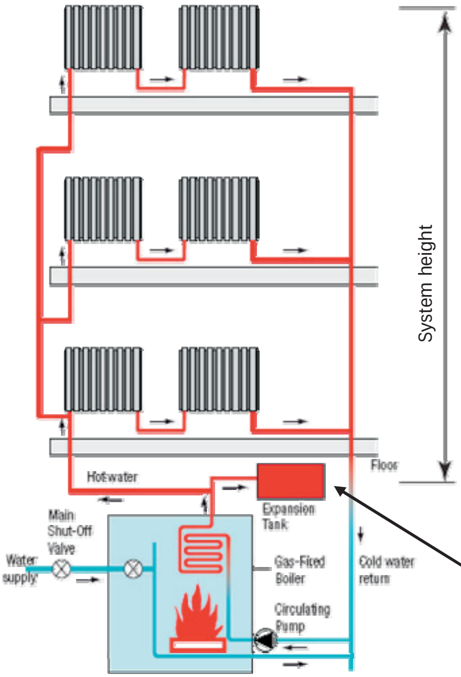
The numbers in the table in red refer to the localised pressure losses in mm. of column of water

SOME USEFUL HINTS ON EXPANSION TANKS:

The membrane expansion tank is an essential component which is found in all heating systems, and its task is to compensate for the changes in the volume of the heating water, and therefore the changes in temperature.

Experience has taught us that one thing that causes problems in heating systems is the presence of air inside them. To stop air getting in, you have to make sure the system's static pressure is always higher than the atmospheric pressure.

As a rule, you should check the pressure at least once a year, checking both the tank pre-charge pressure and the pressure of the system itself.
Generally speaking, the tank pressure should be set by taking the system's static pressure and dividing it by 10, (e.g. 30 m = 3 bar), while when the system is cold, the tank pressure must be increased by 0.5 bar.

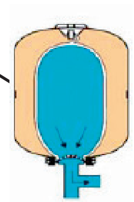


Example:

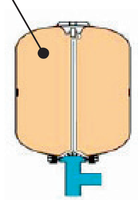
If the system height is 30 m,
the pre-charge pressure of the expansion tank must be:

30 m/10 = 3 bar

Example:
Precharge pressure with tank empty 3 bar



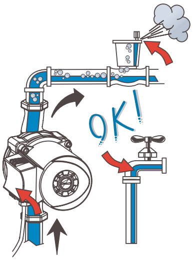
Status of tank during normal operation



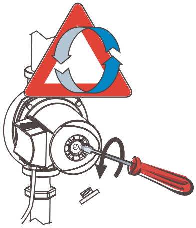
Status of tank in precharge phase, without water inside diaphragm

SOME HINTS ON HOW TO INSTALL THE CIRCULATOR

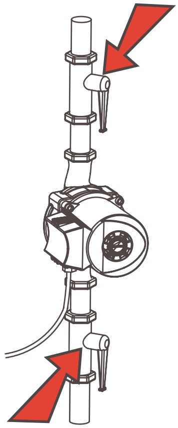
When starting up the system for the first time, it is always advisable to bleed the air from the motor; to do so loosen the breather cap slowly and let the liquid flow out for a few seconds.



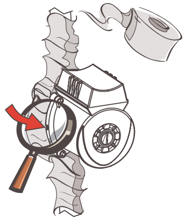
After installation, fill the system and bleed it before switching on the circulator.
Start the circulator up at top speed.



Generally speaking, circulators do not need maintenance. At the beginning of winter though, make sure the drive shaft is not jammed.



Fit an on/off valve on both the suction and delivery lines



If the unit is fitted with thermal insulation, make sure the condensation drainage holes in the motor housing are not closed up or obstructed in any way.

INSTALLATION ADVICE

The first time the system is switched on and at certain times during the year (when the heating system is in use), the heating body may not heat up. If this happens, the radiator must be bled (when the system is cold) to vent all the air that has built up inside it.
To stop air building up, we recommend the static pressure of the highest body be kept above 0.5 bar.

Suction pressure

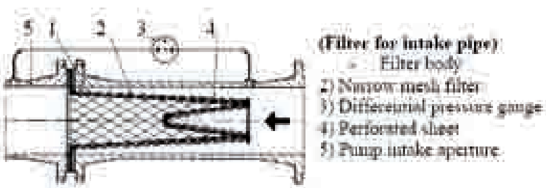
To prevent the effects of cavitation and noisy system operation, we recommend you respect the following pressure minimum values on suction inlet (depending on temperature). This way you will avert damage to the pump's bearings and/or bushings.

EXAMPLE OF THE INFORMATION CONTAINED IN THE DAB TECHNICAL CATALOGUE

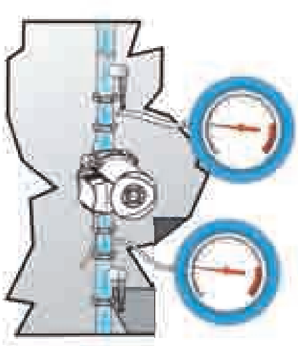
MINIMUM HEAD PRESSURE				
t°	75°	90°	110°	120°
m.c.a.	1.0	4	14	–

Installation tips for DAB circulators

- do not install a more powerful circulator than required as it may create noise problems in the heating system causing recirculation and turbulence in the piping;
- as a rule, you should always wash out the system before fitting and starting up the circulator; this is to ensure there are no welding deposits in the liquid which could damage the hydraulic circuit and stop the pump running;
- to prevent water seeping into the terminal board via the power cable, we recommend you position the cable guide so that it is facing downwards;
- the expansion tank is usually fitted on the suction side of the pump to prevent cavitation, which is damaging for the pump;
- before switching on the water supply to the circulator, it is advisable to de-gas and bleed it, as dry-running – even only for a short spell - can damage the pump;
- in case of new plants, valves, piping, tanks and connections must be cleaned thoroughly. To prevent welding residues or other impurities from entering the pump, it is advisable to use truncated-conical filters. These filters, made of corrosion-resistant material, have a free filter surface with cross-section 3 times that of the piping on which they are fitted to avoid creating excessive load loss.



HEATING SYSTEMS



Let's take a closed-loop system:

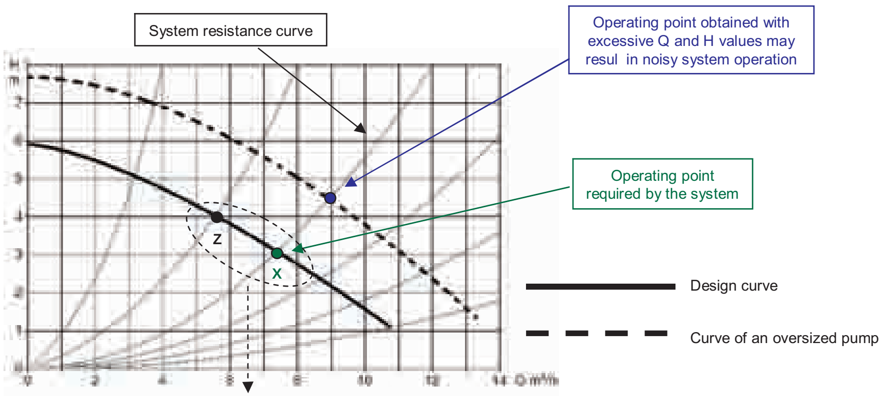
- recirculation of hot water for sanitary purposes;
- space heating;
- air conditioning.

The overall manometric head is calculated by adding together the friction losses in the distribution network; the building height does not affect this.

In the figure on the left, the two pressure gauges (one on the delivery pipeline and the other on the return line) measure the pressure, the difference being the manometric head.

FIRST CHECKS
TO CARRY OUT IF OPERATION IS NOISY

- Reduce speed;
- Close the delivery valve slightly;
- Check the static pressure;
- De-gas the circulator.



The resistance curve changes depending on the system's needs. If the zone valves close, the flow rate decreases and the system's characteristics change, resulting in a higher dynamic pressure. In this case, the operating point switches from point X to point Z.

Fitting an oversized circulator in a system will create noise problems caused by high water speed due to the greater flow rate, thereby jeopardising operation and working life. In some cases, cavitation problems may occur.

CIRCULATORS WITH DIALOGUE INVERTER

DIALOGUE is a built-in control device in wet rotor circulators (BPH-E, BMH-E, DPH-E, DMH-E type) which makes it possible to adjust the performance of pumps according to the actual requisites of the plant.

Inverter devices such as DIALOGUE have become very popular in the last few years, because the plants are increasingly aimed at cutting down on energy consumption, elimination of noise due to thermostatic valves and similar accessories and improvement of plant control.

BEST ADJUSTMENT

The use of frequency converters makes it possible to control the flow rate and/or the system pressure, obtaining accurate adjustment.

The inverter is capable of changing the pump impeller speed, ensuring continuous control and adapting the hydraulic performance to the new system conditions.

Traditional regulation systems, on the other hand, allow slow and inaccurate regulation as compared to a frequency converter.

EASY INSTALLATION

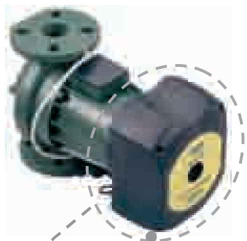
By installing an electric pump, errors in the choice of head can be avoided by setting the value in the installation phase.

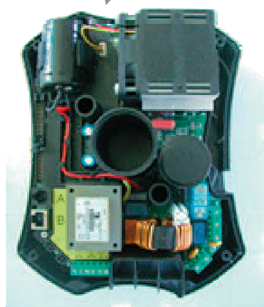
Moreover, the inverter makes it possible to simplify the plant, making overpressure valves by-pass, etc, superfluous...

REDUCED NOISE

The noise level changes with change in impeller speed. In fact, by reducing the rotation speed by 70% as compared to the nominal level, the noise level is lowered considerably, thereby improving comfort.

DIALOGUE single circulator

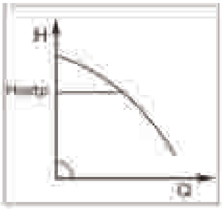




Internal view of inverter device

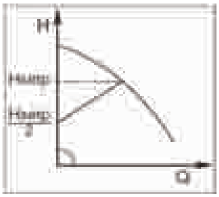
Differential pressure transducer

DIALOGUE OPERATING MODES



Constant differential pressure regulation mode ΔP-c

The ΔP-c regulation mode maintains the system's differential pressure constant at the set value Hsetp based on the varying flow rate. This setting is suggested particulary in those systems with pumps providing a low friction loss.

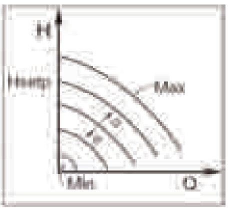


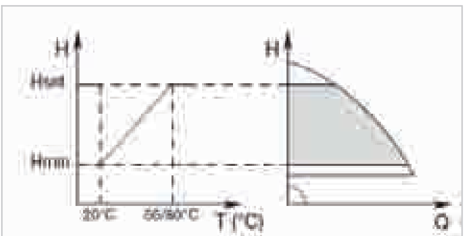
Proportional differential pressure regulation mode ΔP-v

The ΔP-v regulation mode, based on the changing flow rate, linearly varies the delivery value of the head from Hsetp to Hsetp/2. This setting is suggested particulary in those systems with pumps providing a high friction loss.

Constant curve regulation mode

The regulation at constant speed deactivates the regulation of the electronic module. The speed of the pump can be manually regulated at a constant value through the control panel, remote control or by a 0-10V signal. This setting is highly suggested in those systems where circulators already existed.





Proportional and constant differential pressure regulation mode based on the water temperature

The Setpoint related to the head of the circulator is reduced and increased base on the water temperature.

The temperature of the liquid can be set at 80°C or 50°C.

Hmin = 30% Hset

EXAMPLE OF SETTING THE SET POINT WITH ΔP-v

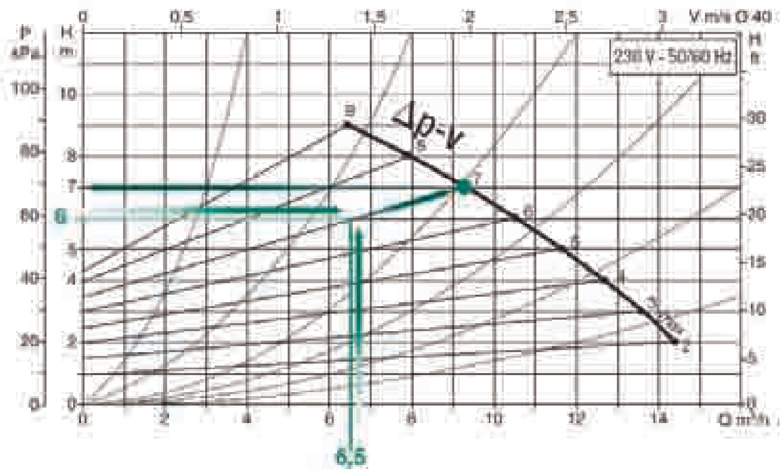
The following working point is needed:

Q = 6,5 m3/h

H = 6 m

PROCEDURE:

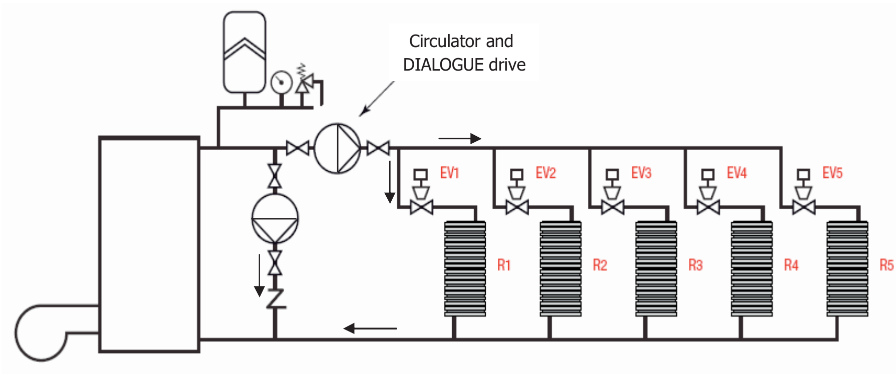
1. Put the desired working point in the graph and look for the DIALOGUE curve closest to it (in this case the point is right on the curve)
2. Go up the curve until you cross the extreme curve of the circulator.
3. The reading of the head next to this cluster point will be the set point head to set to get the desired working point.



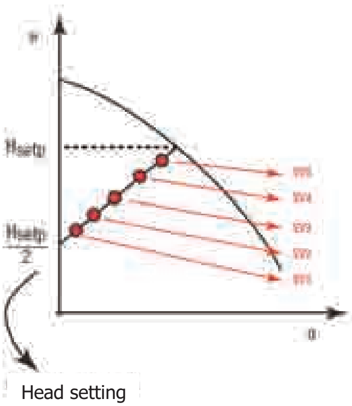
DIALOGUE INVERTER CONTROLLED CIRCULATOR

In the situation shown below, EV denotes the solenoid valve and R the user device to serve.

In the case in hand, as the water demand increases (EV... permissive), the recirculation water needs increase proportionally and the friction loss, which the pump has to make up for, also increases.



REGULATION BASED ON PROPORTIONAL DIFFERENTIAL PRESSURE



This kind of regulation is set using the control panel on the motor.

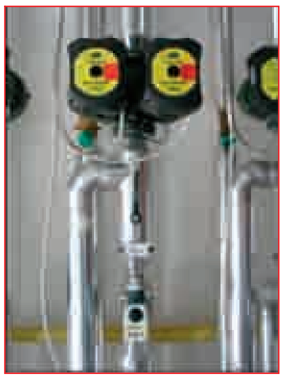
The pressure and flow rate increase or decrease in proportion to the variations in the demand of the system to serve.

In our case, where the Hsetp pressure is 4 metres column of water, the value of Hsetp/2 is automatically set at 2 metres column of water, which is the starting value.

DIALOGUE INVERTER-CONTROLLED CIRCULATOR

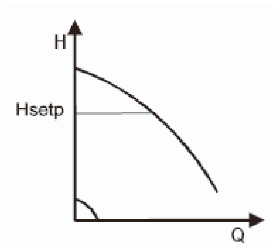
INSTALLATION EXAMPLE FOR DIALOGUE CIRCULATORS

The twin inverter-controlled circulators shown in the photo on the left manage a school's heating system.
Since they are in a twin set-up, they can be set to operate alternately every 24 hours (setting featured in the standard version) and the operating mode, in this system, guarantees a constant differential pressure between the delivery and return lines.
This setting allows friction loss due to the following components to be made up: manifold, heat generator, distribution pipes, valves, heating bodies, etc....
In the case in hand, the installation of circulators set up in parallel requires non-return valves which can guarantee and ensure correct system operation.



REGULATION BASED ON CONSTANT DIFFERENTIAL PRESSURE

This is set via the control panel on the motor.
In this case, the differential pressure remains constant regardless of the water demand



CALCULATING THE RECIRCULATION NETWORK

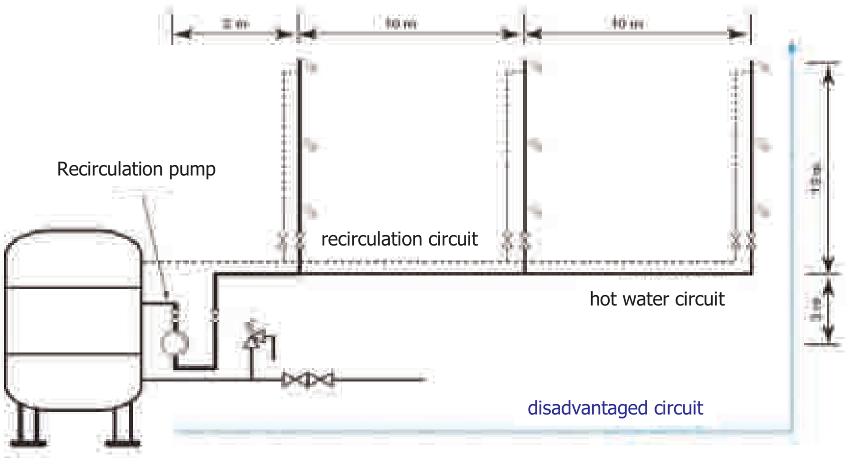
As well as guaranteeing maximum comfort, the creation of a recirculation system means less hot water wasted for sanitary purposes.

Establishing exactly which recirculation pump to use means making up the heat lost in the pipes when the users are not drawing on the hot water supply.

The head must be calculated according to the friction loss in the pipes, taking into account the most disadvantaged circuit.

For a rough calculation, we recommend the following:

Flow rate: 6 l/h per metre of the recirculation system's length
Head: 30 mm. per metre of the most disadvantaged circuit's recirculation system length



Length of the recirculation network = mt. (3+2+13)+(3+2+10+13)+(3+2+10+10+13)= mt 80

Flow rate = 6lt/h mt x 80 mt = 480 lt/h

Length of the most disadvantaged recirculation circuit (in m= = mt 2+3+10+10+13= mt 38

Head = 30 mm.w.c./mt x 38 mt = 1.140 mm.w.c.

Applications

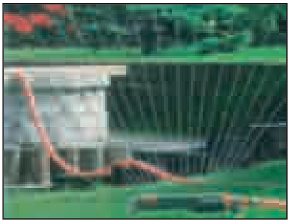
✓Pressurization systems
✓Industrial applications
✓Irrigations
✓Fire fighting systems
✓Agriculture




HOW TO CALCULATE THE FLOW RATE

General information:

The calculation of the correct flow rate for a residential building depends on the number of user devices the system must serve; usually, to supply a building for 5 to 8 people, the water flow rate required varies from 1.6m3/h to 2.8m3/h, while for irrigation of a garden measuring from 800 m2 to 1000 m2 the flow rate required varies from 1-2 m3/h.



To establish which unit it most suitable, you need to know how much water is required and to what height it must be carried.

The table below highlights the consumption (in l/min) needed for each user device.

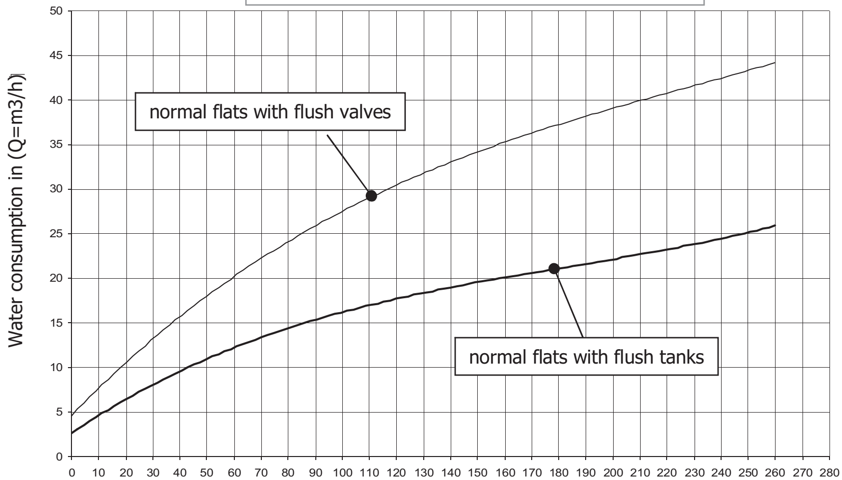
TOILET WITH RAPID FLOW VALVE	90 l/min
BATH	15 l/min
SHOWER	12 l/min
WASHING MACHINE	12 l/min
DISHWASHER	10 l/min
SINK	9 l/min
WASHBASIN	6 l/min
BIDET	6 l/min
TOILET WITH FLUSH TANK	6 l/min
TOTAL	166 l/min

Of course, you do not need 166 l/min per flat because the user devices will never get used all at once. To calculate the amount of water needed, we use mathematic formulas which supply the necessary flow rate per number of flats. The result of the calculations are shown in the two tables below:

FLOW RATE

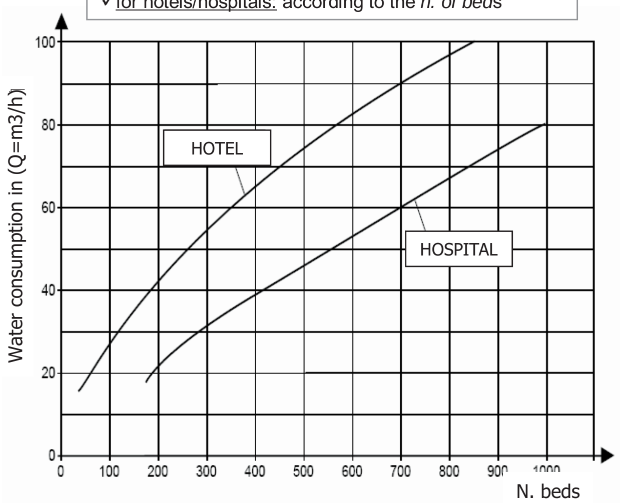
The tables below must be used to calculate the flow rate *(in m^3/h)*:

✓<u>for residential buildings:</u> according to the *n. of flats*



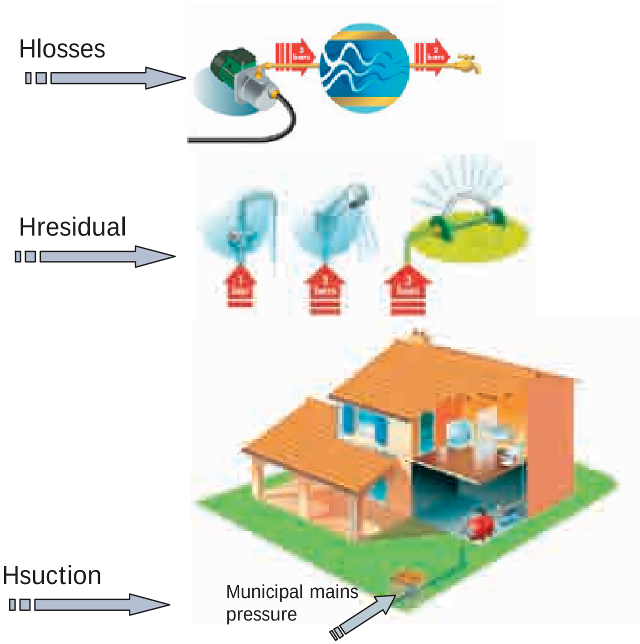
(flats with 2 **bathrooms ➔+30**% Q – flats with 3 **bathrooms ➔+25% Q**) N. flats

✓<u>for hotels/hospitals:</u> according to the *n. of beds*



CALCULATION OF HEAD

Once the necessary flow rate is defined, the head must be determined correctly.
The pumps unit must carry the water to the highest floor of the building and must have at the farthest point a pressure of at least 2 bar (approx. 20 m). However, the unit must overcome the load losses in the plant, while aided by a suction pressure; the value of the head of the unit is:
H= (Hbuilding + Hlosses + Hresidual) – **Hsuction (m))**



Considering that the losses are approx. 20% of Hbuilding and that the Hresidual required is equal to 2 bar (approx. 20 m):

$$H = (1,2 \times H_{building} + 20) - H_{suction}\ (m)$$

Summarizing: 1) From the number of apartments, we obtain flow rate Q.
2) From the height of the building and pressure in present in suction, we obtain H
3) Select the unit which has as intermediate point of the hydraulic curve the calculated values of Q and H

EXAMPLE OF CALCULATION OF HEAD

Building:
Height 42 *metres* with 50 apartments with tanks *(12 m3/h total)*
Inlet pressure 1 bar *(= 10 m.w.c.)*
Head required at most unfavourable point 20 *m.w.c.*

The pumps of the unit must have a Head like: (42 metres x 1,2) + 20 m.w.c. - 10 m.w.c. = 60 m.w.c.

If there are no specific customer requirements regarding the number of pumps of the unit, it is possible to select the version with *one, two or three* pumps taking into account that:

- The total flow rate is divided
- The head remains unchanged

FRICTION LOSSES AND SPEED

Use the table below to calculate the **friction losses** accurately and the ***speed***.

FLOW			Galvanized new pipes									
			Nominal diameter									
l / s	l / min	m^3 / h	1/2"	3/4"	1"	1" 1/4	1" 1/2	2"	2" 1/2	3"	3" 1/2	4"
			15,75	21,25	27	35,75	41,25	52,5	68	80,25	92,5	105
0,17	10	0,6	0,856 9,01	0,470 2,09	0,291 0,65							
0,25	15	0,9	1,284 19,07	0,705 4,43	0,437 1,38	0,249 0,35						
0,33	20	1,2	1,712 32,47	0,940 7,55	0,582 2,35	0,332 0,60	0,250 0,30					
0,42	25	1,5	2,140 49,06	1,175 11,41	0,728 3,55	0,415 0,91	0,310 0,45					
0,5	30	1,8	2,568 68,74	1,411 15,98	0,874 4,98	0,498 1,27	0,370 0,63	0,230 0,20				
0,58	35	2,1	2,996 91,42	1,646 21,26	1,019 6,62	0,581 1,69	0,440 0,84	0,270 0,26				
0,67	40	2,4		1,881 27,22	1,165 8,48	0,664 2,16	0,500 1,08	0,310 0,33				
0,83	50	3,0		2,351 41,13	1,456 12,81	0,831 3,27	0,620 1,63	0,390 0,50	0,230 0,14			
1	60	3,6		2,821 57,63	1,747 17,95	0,997 4,58	0,750 2,28	0,460 0,70	0,280 0,20			
1,17	70	4,2		3,291 76,64	2,039 23,88	1,163 6,08	0,870 3,03	0,540 0,94	0,320 0,27	0,230 0,12		
1,33	80	4,8			2,330 30,57	1,329 7,79	1,000 3,88	0,620 1,20	0,370 0,34	0,260 0,15		
1,5	90	5,4			2,621 38,01	1,495 9,69	1,120 4,83	0,690 1,49	0,410 0,42	0,300 0,19		
1,67	100	6,0			2,912 46,19	1,661 11,77	1,250 5,86	0,770 1,81	0,460 0,51	0,330 0,23	0,250 0,11	
2,08	125	7,5			3,641 69,79	2,077 17,79	1,560 8,86	0,960 2,74	0,570 0,78	0,410 0,35	0,310 0,17	0,240 0,09
2,5	150	9,0				2,492 24,92	1,870 12,41	1,160 3,84	0,690 1,09	0,490 0,49	0,370 0,24	0,290 0,13
2,92	175	10,5				2,907 33,15	2,180 16,51	1,350 5,10	0,800 1,45	0,580 0,65	0,430 0,32	0,340 0,17

The calculation formula used here is the Hazen Williams formula (UNI 9489 13.3.3.6)

Numbers written in white:
friction losses (in m) per 100 m of piping

Numbers written in green:
Water speed (in m/sec)

The table refers to galvanised piping.

For other materials, multiply by the respective amount:
- 0.6 for PVC pipes
- 0.7 for aluminium pipes
- 0.8 for rolled steel and stainless steel pipes

FRICTION LOSSES AND SPEED

Use the table below to calculate the ***friction losses*** accurately and the ***speed***:

FLOW			Galvanized new pipes – Nominal diameter									
			1" 1/4	1" 1/2	2"	2" 1/2	3"	3" 1/2	4"	5"	6"	8"
l/s	l/min	m^3/h	35,75	41,25	52,5	68	80,25	92,5	105	130	155	206
3,33	200	12,0	3,322 42,43	2,500 21,14	1,540 6,53	0,920 1,85	0,660 0,83	0,500 0,41	0,390 0,22	0,250 0,08		
4,17	250	15,0	4,153 64,12	3,120 31,94	1,930 9,87	1,150 2,80	0,820 1,25	0,620 0,63	0,480 0,34	0,310 0,12		
5	300	18,0		3,740 44,75	2,310 13,83	1,380 3,92	0,990 1,75	0,740 0,88	0,580 0,47	0,380 0,17	0,270 0,07	
6,67	400	24,0		4,990 76,20	3,080 23,55	1,840 6,68	1,320 2,98	0,990 1,49	0,770 0,80	0,500 0,28	0,350 0,12	
8,33	500	30,0			3,850 35,58	2,300 10,09	1,650 4,51	1,240 2,26	0,960 1,22	0,630 0,43	0,440 0,18	
10	600	36,0			4,620 49,85	2,750 14,14	1,980 6,31	1,490 3,16	1,160 1,70	0,750 0,60	0,530 0,26	0,300 0,06
11,67	700	42,0				3,210 18,81	2,310 8,40	1,740 4,20	1,350 2,27	0,880 0,80	0,620 0,34	0,350 0,09
13,33	800	48,0				3,670 24,08	2,640 10,75	1,990 5,38	1,540 2,90	1,010 1,03	0,710 0,44	0,400 0,11
15	900	54,0				4,130 29,94	2,970 13,37	2,230 6,69	1,730 3,61	1,130 1,28	0,800 0,54	0,450 0,14
16,67	1000	60,0				4,590 36,39	3,300 16,24	2,480 8,13	1,930 4,39	1,260 1,55	0,880 0,66	0,500 0,16
20,83	1250	75,0					4,120 24,54	3,100 12,29	2,410 6,63	1,570 2,34	1,100 0,99	0,630 0,25
25	1500	90,0					4,950 34,39	3,720 17,22	2,890 9,29	1,880 3,28	1,330 1,39	0,750 0,35
29,17	1750	105,0						4,340 22,90	3,370 12,35	2,200 4,37	1,550 1,85	0,880 0,46
33,33	2000	120,0						4,960 29,31	3,850 15,81	2,510 5,59	1,770 2,37	1,000 0,59
41,67	2500	150,0							4,810 23,89	3,140 8,44	2,210 3,59	1,250 0,90
50	3000	180,0								3,770 11,83	2,650 5,02	1,500 1,26
66,67	4000	240,0								5,030 20,15	3,530 8,55	2,000 2,14
83,33	5000	300,0									4,420 12,93	2,500 3,23

The calculation formula used here is the Hazen Williams formula (UNI 9489 13.3.3.6)

Numbers written in white:
friction losses (in m) per 100 m of piping

Numbers written in green:
Water speed (in m/sec)

The table refers to galvanised piping.

For other materials, multiply by the respective amount:
- 0.6 for PVC pipes
- 0.7 for aluminium pipes
- 0.8 for rolled steel and stainless steel pipes

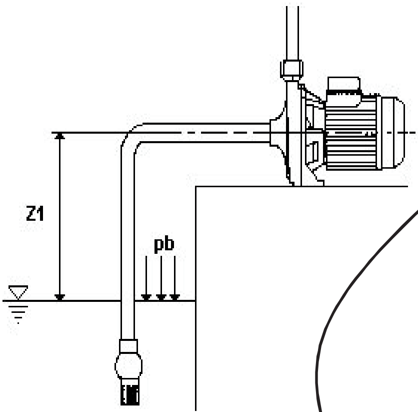
How calculate the max pump suction

✓*How to calculate the suction capacity*
✓*Cavitations*
✓*Suggestion for a right installation*

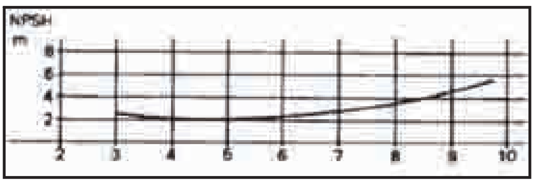
HOW CALCULATE THE MAXIMUM SUCTION

To calculate the maximum suction height **Z1** (in order to prevent cavitation), the following formula is used:

Z1 = pb – NPSHrequired - Hr – pV

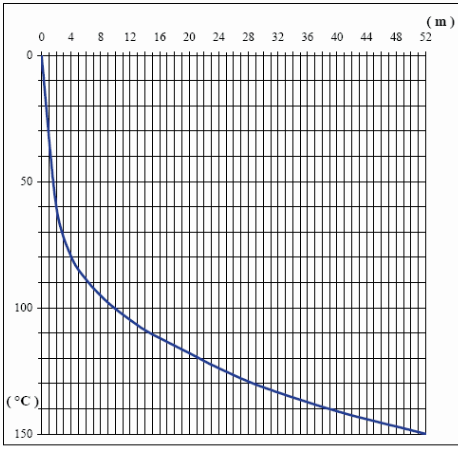


- ✓pb = barometric pressure (in metres column of water), this depends on the height above sea level (see table 2 on the next page)
- ✓**NPSH** = NPSH of the pump at the operating point, specified in the DAB PUMPS S.P.A. catalogue
- ✓Hr = friction losses (in metres column of water) from the suction side
- ✓pV = vapour pressure, i.e. the liquids' tendency to evaporate, (in metres column of water) depending on its temperature (see table 1 on the next page)



HOW CALCULATE THE MAXIMUM SUCTION

Vapour Tension



°C	m
10	0,121
20	0,22
30	0,387
40	0,675
50	1,147
60	1,888
70	3,014
80	4,67
90	7,035
100	10,33
110	14,83
120	20,85
130	28,744
140	38,97
150	52

$$\frac{Pb}{Y4°} - \frac{(Pb-Pv)}{Yt}$$

Pb e Pv in mCA

Table 1

Barometric Pressure (pb)

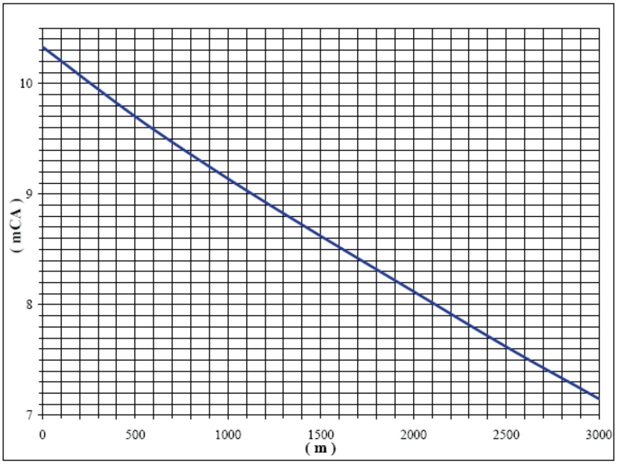


Table 2

EXAMPLE OF AN N.P.S.H. CALCULATION

Formula to apply: $Z1 = pb - NPSH_{required} - Hr - pV$

Example:

✓**If we take pump model K 90/100**

✓$Q = 7.4\ m^3/h$

✓**NPSH = 3.25 m**

✓**Pb = 10.33 m.w.c.**

✓H_r = **for the sake of simplicity, let's say 2 m**

If you want the system to work at three different temperatures:

T=20°C - pV=0.22 m	T=90°C - pV=7.035 m
Z1=10.33 - 3.25 - 2- 0.22= **4.86 m**	**Z1**=10.33 -3.25 – 2 - 7.035= **-1.95 m**

T=95°C - pV=8.55 m
Z1=10.33 - 3.25 – 2 - 8.55 = **-3.47 m**

NB: it is advisable to apply the safety factor (- 0.5 m) to the NPSH

If there is gas present in the water, apply the relative factor (-0.5 m).

CAVITATION

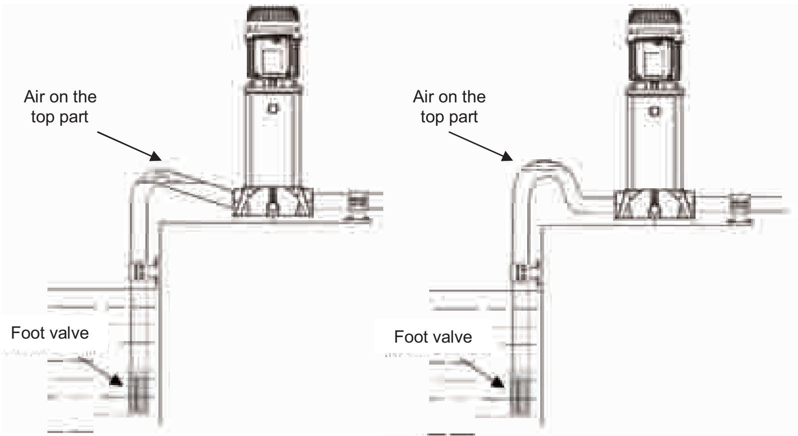
Calculation of Z1 is important for correct working of the pump without the occurrence of cavitation phenomena.

Working in CAVITATION conditions occurs when the absolute pressure at the impeller inlet drops to such values as to allow the formation of bubbles of steam inside the fluid, so the pump works irregularly with a reduced head. The pump must not operate in cavitation because, apart from generating a noise similar to a metal hammering (due to implosion of the vapour bubbles), it can cause irreparable damage to the impeller.

Shown below is an image of a cast iron impeller which operated in cavitation. The beginning of erosion near the blades of the suction port is clearly visible

INSTALLER'S MANUAL

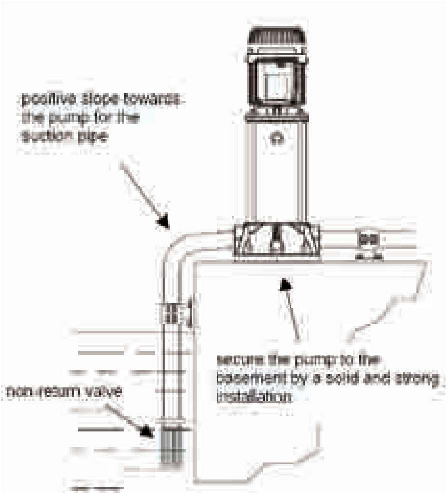
WHY WE ADVISE AGAINST THE SIPHON EFFECT



In some systems the suction goes against the gradient or works by siphon, which we absolutely recommend against because these methods can cause the pump to deprime.

The photos above show air that has formed in the highest point, and in this case the air is between the priming pipe and the line that runs to the pump suction inlet.
This situation leads to dry-running, which damages the pump's mechanical seal, the hydraulic components and therefore the pump itself, due to misuse.

SUGGESTIONS FOR CORRECT INSTALLATION



1. It is always good practice to position the pump as close as possible to the liquid to be pumped.
2. A solid anchoring of the pump legs to the base facilitates absorption of vibrations, if any, created during operation.
3. The pump must be installed horizontally or vertically, as long as the motor is always above the pump.
4. Prevent metal piping from transmitting excessive stresses to the pump ports, to avoid deformation or breakage.
5. If the suction head is negative, it is indispensable to install a foot valve having adequate features at the suction.
6. Passage from a tube having smaller diameter to one having a larger diameter must be gradual. The length of the passage cone must be 5 - 7 the difference of the diameters.
7. Carefully check the suction tube joints to make sure they do not allow infiltration of air.
8. To prevent the formation of air pockets in the suction tube, provide a slight positive sloping of the suction tube towards the electric pump, as shown in the Figure.

NOTE: Make sure the features of the water supply source are proportional to those of the unit installed.

SUCTION FROM WELL (OVERHEAD PUMP): it is advisable to use a protection against dry running to avoid working of the unit in faulty conditions.

• SUCTION FROM TANK (OVERHEAD OR UNDERHEAD PUMP): it is advisable to protect the pump from dry running using float switches, for example.

• DIRECT CONNECTION TO AQUEDUCT: if there is a possibility of the pressure dropping to very low values, it is advisable to install a minimum pressure switch at the suction for protection of the unit .

DRY RUNNING WILL DAMAGE THE ELECTRIC PUMPS!!

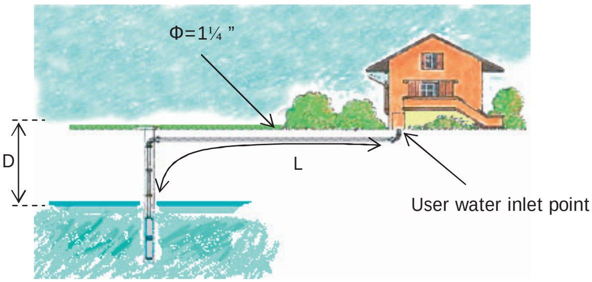
Installation of submerged pump

✓*Choosing a submerged pump*
✓*Installation examples*

CHOOSING A SUBMERGED PUMP

In order to choose the most suitable pump, you have to establish duty type, taking into account the following aspects:

✓Liquid type (salt water, hot spring water, well water etc …)
✓Sand content per m^3 (for 4” pumps: max 120g/m^3, for 6” pumps: max 40g/m^3);
✓Water temperature (in °C);
✓Acidity level (advised pH range from 6 to 9);
✓Well depth and diameter;
✓User type (whether supplying to residential or industrial users, for tank drainage, watering or other unspecified uses);
✓Flow rate required;
✓Pressure required at user devices;
✓Static level of water in well;
✓Dynamic level of water in well;
✓Characteristics of the supply piping;
✓Characteristics of the power supply (whether single-phase or three-phase);
✓Characteristics of the control device (whether conventional or with frequency regulator);
✓Distance required to ensure correct section of power cable between motor-driven pump and control device



D = difference in level between the groundwater surface and the level of the ground

L = total length of the piping up to the groundwater surface

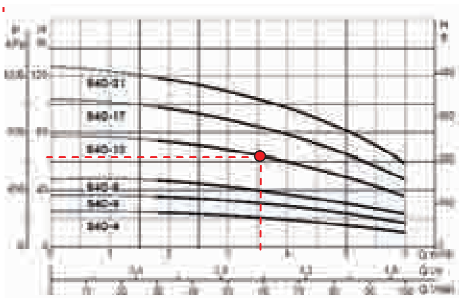
Pump calculation example:

<u>If the user demand is Q=60 l/min H=2.5 bar</u>

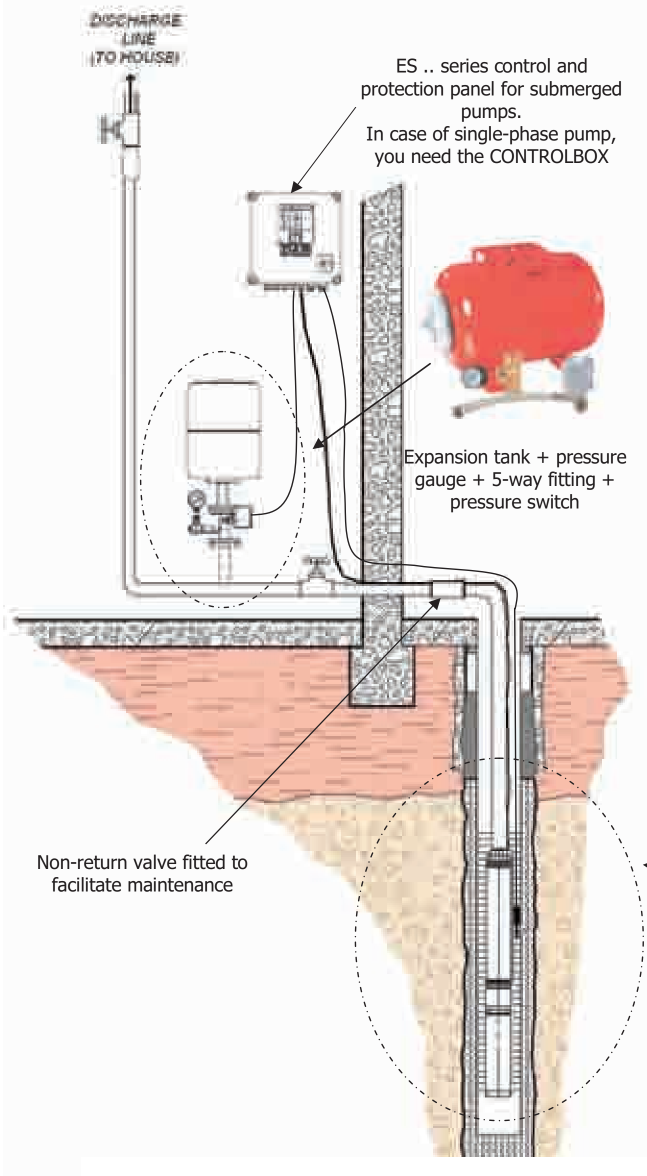
and the piping is L= 120 m - D= 30 m

H_{pump} = Friction loss along pipeline + Difference in level + Pressure required at user device inlet
= 5.7 + 30 + 25 = **60.7 m.c.w.**

Q_{pump} = **60 l/min**



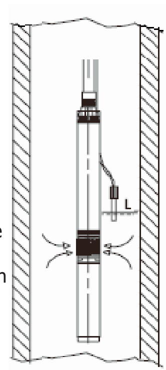
EXAMPLE OF A CONVENTIONAL SYSTEM WITH PRESSURE SWITCH, EXPANSION TANK AND CONTROL PANEL



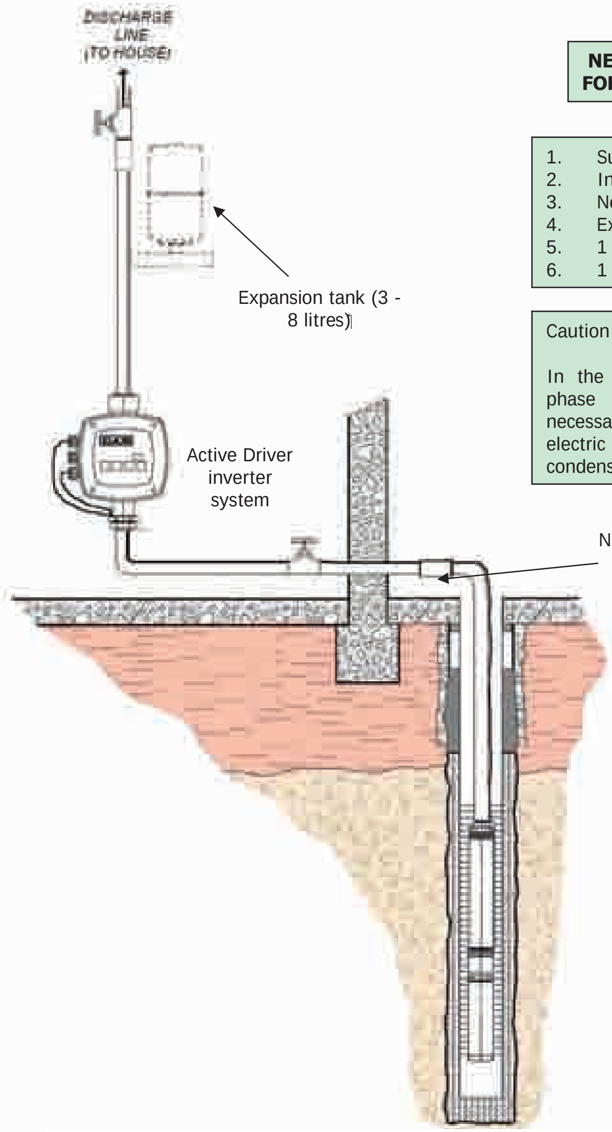
NECESSARY COMPONENTS FOR SYSTEM INSTALLATION

1. Submerged pump
2. Non-return valve
3. 5-way fitting
4. Pressure switch
5. Pressure gauge
6. Expansion tank
7. Hosing
8. Control electric panel
9. Level sensor for dry-running protection feature
10. 1 power cable
11. 1 pressure switch signal cable
12. 1 level sensor cable

Level sensor for dry-running monitoring, must be fitted at least 30-50 cm above the suction grille



CALCULATION EXAMPLE FOR A SUBMERGED PUMP AND FREQUENCY CONVERTER



NECESSARY COMPONENTS FOR SYSTEM INSTALLATION

1. Submerged pump
2. Inverter
3. Non-return valve
4. Expansion tank
5. 1 inverter power cable
6. 1 cable between inverter and pump

Caution:

In the version with single phase/single phase inverter (AD M/M 1,1) it is necessary to install the control box model electric panel, containing the starter condenser.

SUGGESTION:

In some plants, we recommend the installation of a filter upline of the AD so as to prevent damage to the pressure sensor inside the inverter.

Active Driver Device

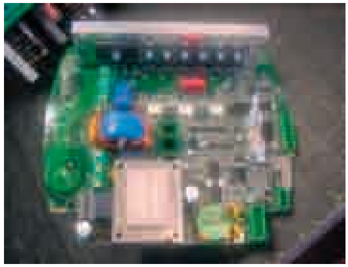
- ✓*What is the Active Driver*
- ✓*Available product range*
- ✓*Energy savings*



WHAT IS THE ACTIVE DRIVER

The ACTIVE DRIVER device is an innovative built-in control system for variable-speed electric pumps, capable of keeping the pressure constant with variation in flow rate.

The ACTIVE DRIVER consists of:
- an inverter
- a flow sensor
- a pressure sensor

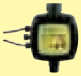
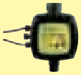
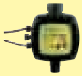
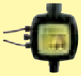
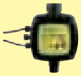
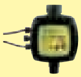
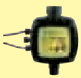


The water flows through the device, carrying out the function of cooling the components (Maximum temperature of pumped liquid 50°C).

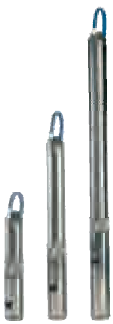
Some advantages of application of the ACTIVE DRIVER:
- *greater comfort* due to constant pressure,
- *energy saving* due to a more efficient use of the motor,
- *more silent* due to reduction of the motor rpm in function of reduction of the required flow rate,
- *elimination of overpressures*,
- *greater duration of electric pump ,*
- *easy installation.*

The ACTIVE DRIVER is provided with a system for protection against malfunctioning:
- Protection against dry-running
- Electric pump overheating protection
- Protection against abnormal power supply voltages
- Amperometric protection
- Protection against direct short circuit between the output phases

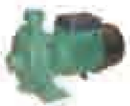
ACTIVE DRIVER CHARACTERISTICS

	Model	Nominal motor current (A)	Max. motor power (kW)	ACTIVE DRIVER power input (V)	Electric pump power input (V)	Pressure regulation range (bar)	Max. pressure (bar)
	Active Driver M/M 1.1	8.5 A	1.1 Kw	1x230V~	1x230V~	1-6	16
	Active Driver M/M 1.5	11 A	1.5 Kw	1x230V~	1x230V~	1-9	16
	Active Driver M/M 1.8	14 A	1.8 Kw	1x230V~	1x230V~	1-9	16
	Active Driver M/T 1.0	4.7 A	1.0 Kw	1x230V~	3x230V~	1-9	16
	Active Driver M/T 2.2	10.5 A	2.2 Kw	1x230V~	3x230V~	1-15	16
	Active Driver T/T 3.0	7.5 A	3.0 Kw	3x400V~	3x400V~	1-15	16
	Active Driver T/ T 5.5	13.3 A	5.5 Kw	3x400V~	3x400V~	1-15	16

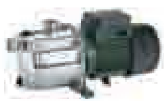
The ACTIVE DRIVER is available in different models, single-phase and three-phase, to be used with all DAB pumps for pressurization. Some examples of pumps compatible with the ACTIVE DRIVER device are shown below.



Serie CS4, AS4, S4

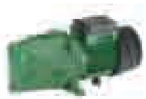


Serie K



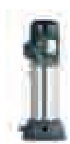
Serie EURO, EUROINOX, EUROCOM

Serie K



Serie JET, JETINOX, JETCOM

Serie PULSAR, PULSAR DRY



Serie KVC, KVCX

Serie KV3-6-10

Serie KV 32

N.B. Maximum recommended flow rate of pump Qmax < 300 lt/min

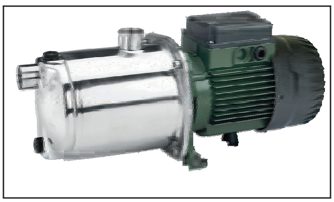
ENERGY SAVING FOR PUMP MODEL EURO 40-80 AND ACTIVE DRIVER INVERTER

As well as being easy to install and simplifying calibration later on, the pressure units featuring the Active Driver frequency converters offer noticeable comfort in terms of pressure stability and energy saving.

The next two pages show the power curves at different calibration pressures, and the respective efficiency rates. As you can see, a considerable decrease in the absorbed power is clear, while the efficiency is kept almost constant.

The tests, which were performed using a EURO 40/80T 2x230V pump and an AD 2.2 M/T inverter, demonstrated a considerable energy saving in terms of “WATT”.
The practical example given below (at the same flow rate of 60 l/min) shows the absorbed power rates:

- ❖Q = 60 l/min H =42 c.m.y. P= 1300 W
- ❖Q = 60 l/min H = 35 c.m.y. P= 1100 W
- ❖Q = 60 l/min H = 25 c.m.y. P= 820 W



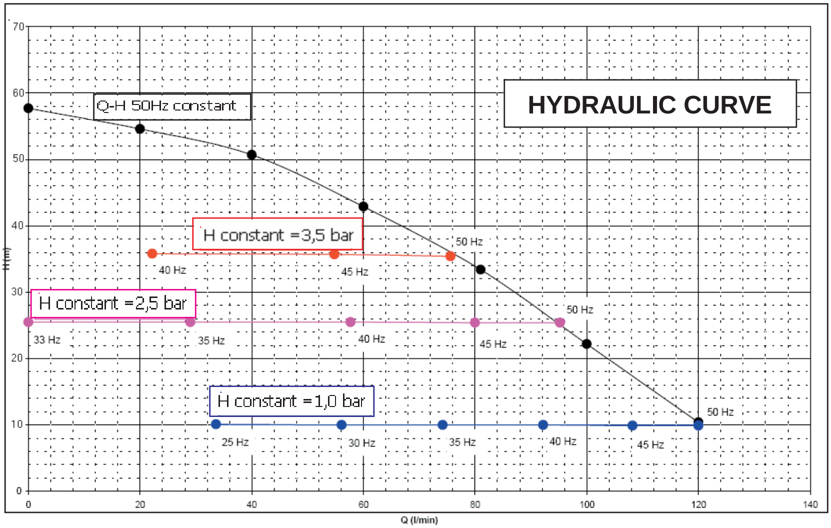
ENERGY SAVING WITH Euro 40-80 ACTIVE DRIVER

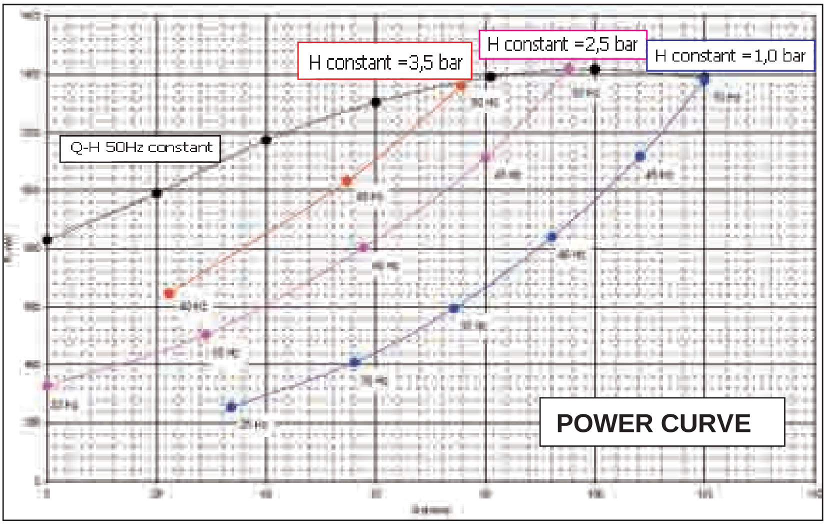
Q-H 50Hz constant

H constant =3,5 bar

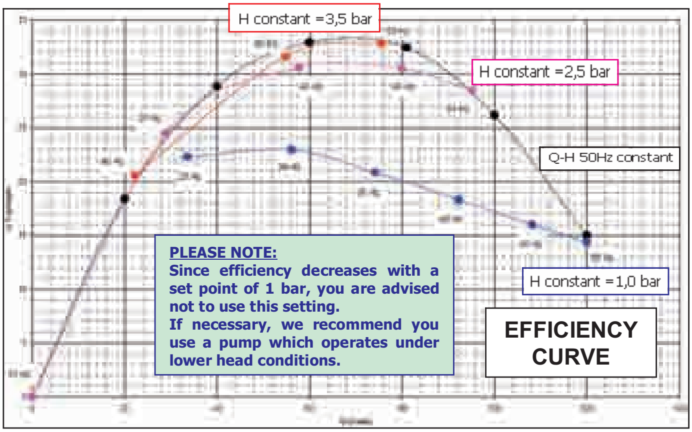
H constant =2,5 bar

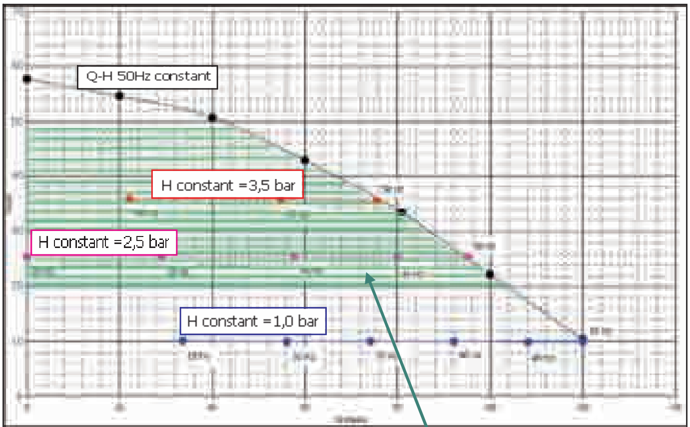
H constant =1,0 bar





ENERGY SAVING WITH Euro 40-80 ACTIVE DRIVER





CONCLUSIONS:

1 – Lowering the constant head value reduces the absorbed power, which results in an energy saving of approximately 30%, depending on the head value set.

2 – We recommend a head set point in the centre of the curve (no higher than 2/3 and no lower than 1/3), see the range shown in green.

INVERTER-CONTROLLED PRESSURE UNITS WITH ACTIVE DRIVER DEVICE

1 KVCX AD...

Multistage vertical pump

2 JET .... AD

Self-priming pumps

2 EUROINOX .... AD

Multistage horizontal pumps

2 PULSARDRY .... AD

PULSARDRY multistage pumps

3 KVCX AD...

Multistage vertical pumps

WHICH DAB PUMP UNIT?

To guide you through your choice of pump, we have provided a table (below) showing the most appropriate pump for the number of flats, floors and bathrooms in question.

<table>
<tr><th colspan="3">n° appart.</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>8</th><th>10</th><th>15</th><th>20</th><th>25</th><th>30</th><th>35</th><th>40</th><th>45</th><th>50</th></tr>
<tr><th>n° piani</th><th>h (mt)</th><th>tipologia</th><td colspan="15"></td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">27</td><td>1wc</td><td colspan="4">1AD. 40/80M</td><td colspan="5">2AD. 40/80M</td><td colspan="6">2AD 35/120M</td></tr>
<tr><td>2wc</td><td colspan="2">1AD. 40/80M</td><td colspan="6">2AD. 40/80M</td><td colspan="7">2AD 35/120M</td></tr>
<tr><td>3wc</td><td colspan="2">1AD. 40/80M</td><td colspan="5">2AD. 40/80M</td><td colspan="4">2AD 35/120M</td><td colspan="4">3AD 35/120M</td></tr>
<tr><td rowspan="3">3</td><td rowspan="3">32</td><td>1wc</td><td colspan="4">1AD. 40/80M</td><td colspan="5">2AD. 40/80M</td><td colspan="6">2AD 35/120M</td></tr>
<tr><td>2wc</td><td colspan="2">1AD. 40/80M</td><td colspan="6">2AD. 40/80M</td><td colspan="6">2AD 35/120M</td><td>3AD 35/120M</td></tr>
<tr><td>3wc</td><td colspan="2">1AD. 40/80M</td><td colspan="5">2AD. 40/80M</td><td colspan="4">2AD 35/120M</td><td colspan="4">3AD 35/120M</td></tr>
<tr><td rowspan="3">4</td><td rowspan="3">36</td><td>1wc</td><td colspan="5">1AD. 40/80M</td><td colspan="4">2AD. 40/80M</td><td colspan="6">2AD 45/120M</td></tr>
<tr><td>2wc</td><td colspan="2">1AD. 40/80M</td><td colspan="6">2AD. 40/80M</td><td colspan="7">2AD 45/120M</td></tr>
<tr><td>3wc</td><td colspan="2">1AD. 40/80M</td><td colspan="5">2AD. 40/80M</td><td colspan="4">2AD 45/120M</td><td colspan="4">3AD 45/120M</td></tr>
<tr><td rowspan="3">5</td><td rowspan="3">41</td><td>1wc</td><td colspan="7">2AD. 55/50M</td><td colspan="8">2AD 45/120M</td></tr>
<tr><td>2wc</td><td colspan="5">2AD. 55/50M</td><td colspan="10">2AD 45/120M</td></tr>
<tr><td>3wc</td><td colspan="3">2AD. 55/50M</td><td colspan="8">2AD 45/120M</td><td colspan="4">3AD 45/120M</td></tr>
<tr><td rowspan="3">6</td><td rowspan="3">45</td><td>1wc</td><td colspan="7">2AD. 55/50M</td><td colspan="6">2AD. 65/80M</td><td colspan="2">2AD 60/120</td></tr>
<tr><td>2wc</td><td colspan="5">2AD. 55/50M</td><td colspan="5">2AD. 65/80M</td><td colspan="5">2AD 60/120</td></tr>
<tr><td>3wc</td><td colspan="3">2AD. 55/50M</td><td colspan="5">2AD. 65/80M</td><td colspan="3">2AD 60/120</td><td colspan="4">3AD 60/120</td></tr>
<tr><td rowspan="3">7</td><td rowspan="3">50</td><td>1wc</td><td colspan="7">2AD. 55/50M</td><td colspan="6">2AD. 65/80M</td><td colspan="2">2AD 60/120</td></tr>
<tr><td>2wc</td><td colspan="5">2AD. 55/50M</td><td colspan="5">2AD. 65/80M</td><td colspan="5">2AD 60/120</td></tr>
<tr><td>3wc</td><td colspan="3">2AD. 55/50M</td><td colspan="5">2AD. 65/80M</td><td colspan="3">2AD 60/120</td><td colspan="4">3AD 60/120</td></tr>
<tr><td rowspan="3">8</td><td rowspan="3">54</td><td>1wc</td><td colspan="7">2AD. 55/50M</td><td colspan="4">2AD. 65/80M</td><td colspan="4">2AD 60/120</td></tr>
<tr><td>2wc</td><td colspan="5">2AD. 55/50M</td><td colspan="4">2AD. 65/80M</td><td colspan="3">2AD 60/120</td><td colspan="3">3AD 60/120</td></tr>
<tr><td>3wc</td><td colspan="3">2AD. 55/50M</td><td colspan="4">2AD. 65/80M</td><td colspan="3">2AD 60/120</td><td colspan="5">3AD 60/120</td></tr>
<tr><td rowspan="3">9</td><td rowspan="3">59</td><td>1wc</td><td colspan="10">2AD. 65/80M</td><td colspan="5">2AD 60/120</td></tr>
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<tr><td>3wc</td><td colspan="7">2AD. 65/80M</td><td colspan="3">2AD 60/120</td><td colspan="5">3AD 60/120</td></tr>
<tr><td rowspan="3">10</td><td rowspan="3">63</td><td>1wc</td><td colspan="10">2AD. 65/80M</td><td colspan="5">2AD 70/120</td></tr>
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<tr><td>3wc</td><td colspan="7">2AD. 65/80M</td><td colspan="3">2AD 70/120</td><td colspan="5">3AD 70/120</td></tr>
</table>

LEGEND:
h = total necessary pressure considering the n° floors (in m)
Typology = n. of toilets per flat

Example:

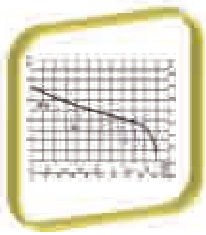
If you have a 7-floor building containing 28 flats, 1 WC per flat, and no suction pressure, you would choose **2 A.D. 65/80 M**

Let's take the case of a system with positive head, and assume:
H_suction = 1.5 bar = 15 m
H_floor = 3 m per floor

For a 7-floor building containing 28 flats, 1 WC per flat and suction pressure of 15 m, you would choose **2 A.D. 35/120 M,** because you would detract 15 m (of positive pressure on the suction side) and the result would be the same as for a 2-floor building.

Suggestion how to set and choose the pressure switch and vessel

✓*Choosing a vessel*
✓*Example of installation and settings*
✓*How to read the hydraulic performance of a jet pump*
✓*How to set the pressure switch*



CHOICE OF EXPANSION TANK

The choice of the volume of the expansion tank is determined on the basis of the work point (required flow rate) of the pump: the capacity is usually 1/3 of the flow rate expressed in l/min.

Example:

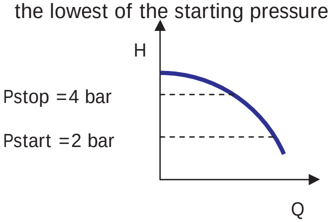
Flow rate Q=120 l/min ➔ expansion tank volume = 120/3 = 40 litres

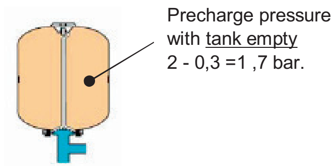
----

The presence of an expansion tank on traditional plants with pressure switches prevents continuous intermittent start/stop cycles due to the absence of compensation, ensuring stability of pressure.

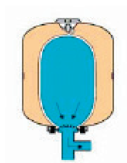
CHOICE OF EXPANSION TANK PRECHARGE

The precharge pressure of expansion tanks must be equal to 0.3 bar less than the lowest of the starting pressure of the plants electric pumps.





Situation tank without water, in precharge phase



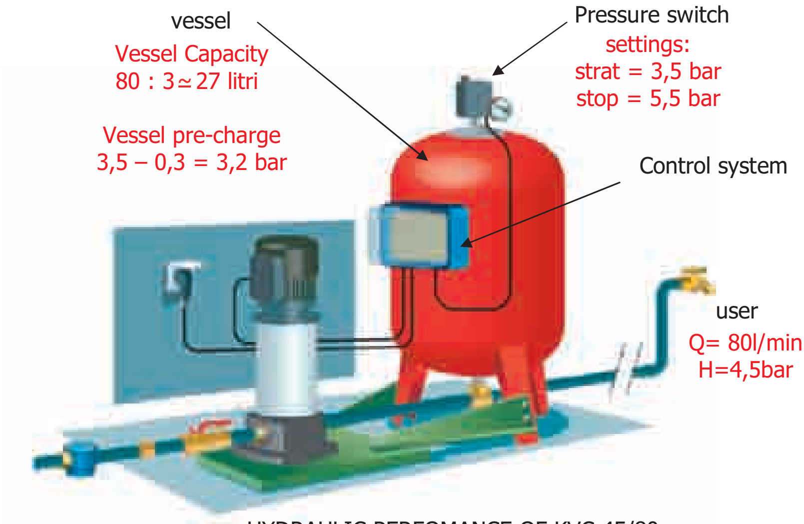
Situation tank containing water, in normal operation

FOR CORRECT MAINTENANCE .....

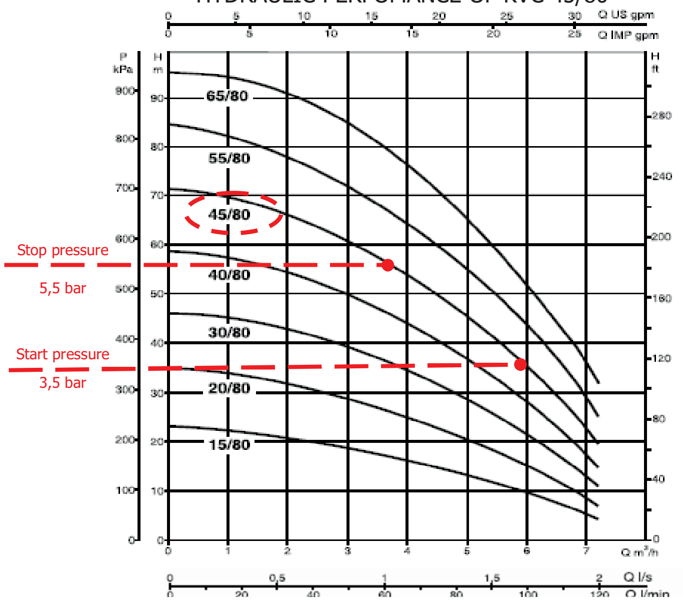
Check the precharging of the expansion tanks at least every 4 – 6 months, with the plant drained, to ensure it is maintained at 0.3 bar below the lowest of the starting pressures of the plant electric pumps. The checking frequency must, however, be increased according to the increased frequency of start-ups and the maximum operating pressure of the unit

EXAMPLE OF INSTALLATION AND SETTINGS

Requested duty point: Q=80l/min – H=4,5bar

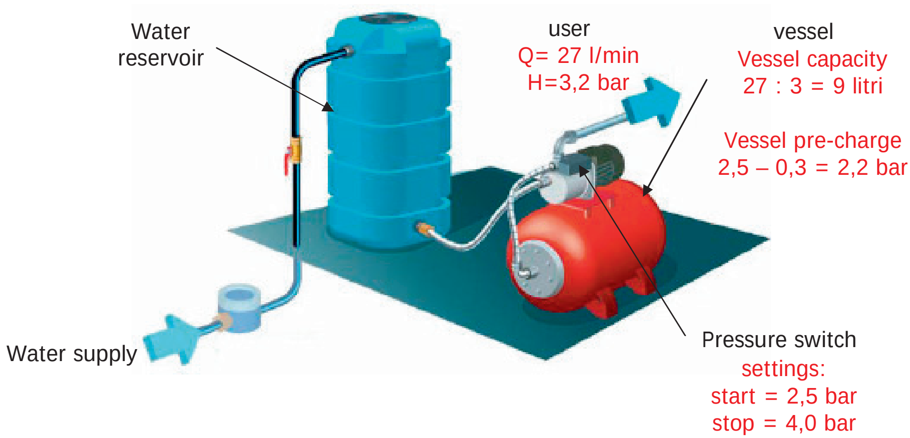


HYDRAULIC PERFOMANCE OF KVC 45/80

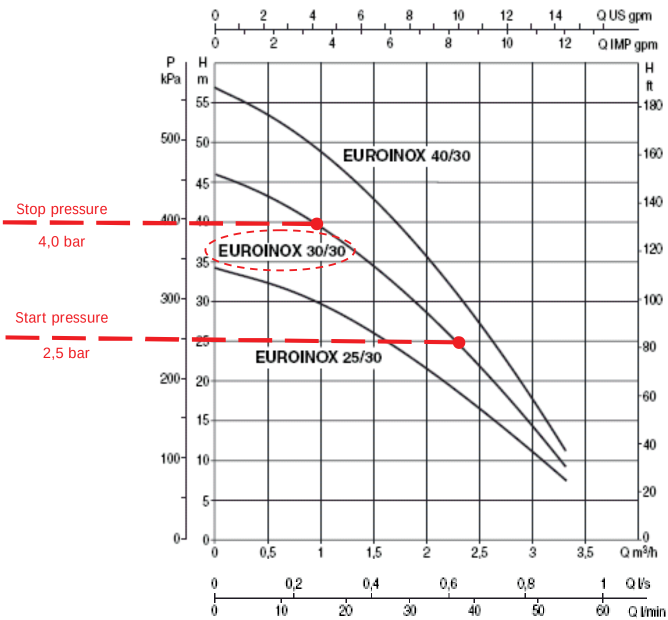


EXAMPLE OF INSTALLATION AND SETTINGS

Requested duty point: Q=27 l/min – H=3,2 bar



HYDRAULIC PERFOMANCE OF EUROINOX 30/30

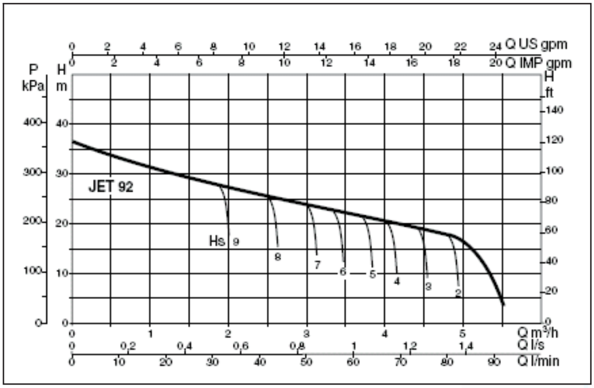


GUIDE TO READING A HYDRAULIC CURVE

SELF-PRIMING DAB PUMP

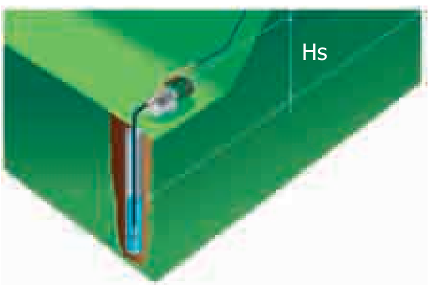
The self-priming pumps are capable of generating a depression in the empty piping on start-up, owing to the nozzle and the "venturi tube", sufficient to allow the liquid to rise and fill the suction piping, as in the case of suction from wells using pumps situated above the groundwater surface. The suction must, however, not be more than 9 metres. These pumps are characterized by relatively low flow rates and powers.

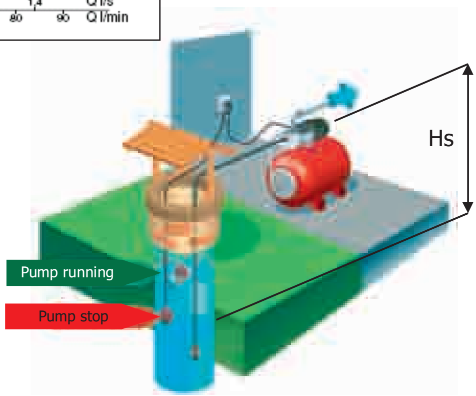
A hydraulic curve of a DAB PUMPS SPA self-priming jet pump is shown below. This performance highlights the hydraulic features at different suction heights, indicated by means of Hs. An increase in level difference will reduce the flow rate.



Example:

In case of suction heights of 8 m the pump's maximum flow rate will be 2.5 m3/h, with a head of 25 mwc.



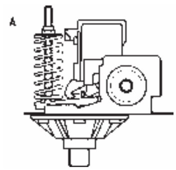


Suction from well

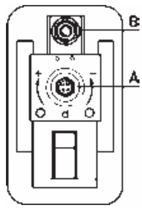
Suction from Roman well, with safety float for protection against dry running.

PRESSURE SWITCHES USED ON BOOSTER SETES

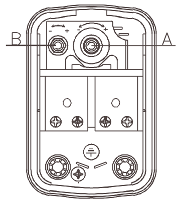
Square D



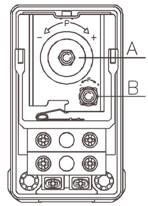
Telemecanique



Square D & Telemecanique



Italtecnica



INSTRUCTIONS FOR ADJUSTING THE PRESSURE SWITCH

The automatic pressurization groups are provided with a factory setting that is sufficient for most plants and requirements. However, the setting of the pressure switch may be adjusted to adapt the group to meet different requirements.

ADJUSTMENT OF THE CONTROL MECHANISM

Establish the minimun desired pressure value (leaving the pump).

Set the storage tank preloading pressure 0,2 bar less than the minimun pressure level. This operation must be carried out only after having grained all the out the tank.

After having identified the model of pressure switch supplied with supplied with the pump, calibrate it following the indications given lelow and checking the established values with a pressure gauge.

Square D:

tighten the nut A to vary the starting pressure value. This will automatically change the stopping pressure value; as the differential cannot be varied;

loosen the nut A to perform the opposite operation.

Telemecanique / Square D – Telemecanique / Italtecnica:

tighteen the nut B to decrease the starting pressure value, Thus varving the differential;

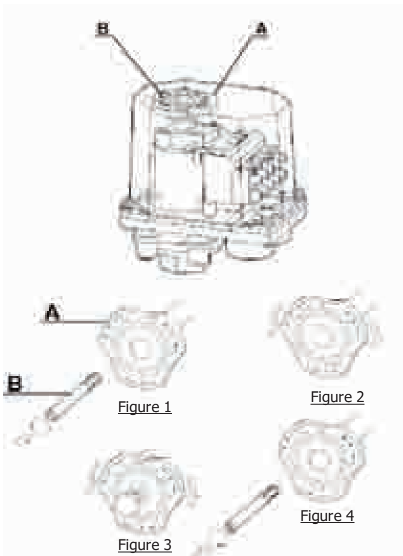
tighteen the nut A to increase the stopping pressure value;

loosen nuts A and B to perform the opposite operation.

FAULT FINDING CHART

FAULT	CHECK (possible cause)	REMEDY
1.The motor does not star.	A.Check that the pressure switch is live. B.Ensure that the tank preloading pressure is not higher than the minimun value of the pressure switch.	A.Set the preloading pressure 0,2 bar below the minimun value of the pressure switch.
1.The motor does noy stop when the demand for water has ceased.	A.Ensure that the value at which the pressure switch is set to stop the motor is not higher than the pressure than the pump can generate (suction + delivery) B.Check that the pressure switch contacts move freely.	A.Set the pressure switch at a lower pressure. B.Otherwise change the pressure switch.
1.The pressure switch, starting and stopping frequently during normal water delivery.	A.Check the setting of the pressure switch which witt certainly be too low. B.Check thet the diaphragm of the expansion chamber (if used) is unbroken.	A.Increase the setting values of the pressure switch until the problem is overcome. Do not forget to reset the minimun intervention pressure. B.Otherwise remove the fault.

KLOCKNER MOELLER PRESSURE SWITCH TYPE MCS



- Slacken the 4 screws and remove the transparent cover.

- Slacken and remove the locking screw “B” positioned in one of the 12 holes in the regulating knob “A”. (figure 1)

- When the regulating knob “A” is turned clockwise, the pump starting and stopping pressures are increased at the same time. When it is turned counter-clockwise they are decreased. (figure 2)

- When the regulating knob “A” is pressed and turned counterclockwise,the differential between the starting and the stopping pressure of the pump is increased (the starting pressure decreases while the stopping pressure remains fixed).
When the regulating knob “A” is pressed and turned clockwise, the differential is decreased. (figure 3)

- Replace and tighten the locking screw “B” in the hole in the regulating knob “A” that is most aligned with one of the two threads under the knob. (figure 4)

- Replace the transparent cover and tighten the 4 screws.

How calculate a submersible pump

Applications

✓Rainfall water drainage
✓Condensation water drainage
(conditioning systems, heating systems, etc..)
✓Laundries located under municipal sewerage
✓Reservoirs and/or swimming-pools drainage
✓Wastewater handling
✓Industrial installations for machine tools




SUBMERSIBLE PUMPS

The way to choose a electric pump required for draining purposes is the same as outlined above for choosing a normal centrifugal electric pump; you have to calculate the flow rate and the head required by the system and then select the pump that can deliver these results.

Submersible pumps can be installed in two ways: fixed or portable.

In the case of a portable installation, DAB submersible pumps feature handles with an ergonomic grip which allow effortless handling and easy installation; the latter is particularly important to prevent difficulties arising from potential problems linked to misuse.

In the case of a fixed installation, DAB offers an extremely handy tool which facilitates the pump's removal from the well, a fast-acting lifting device called the DSD2. This device, as well as being simple and intuitive, offers the various DAB models great flexibility and scope for adaptation (see Technical catalogue).

An essential and recommended accessory, it allows reflux to be averted, and the installation of a full-bore non-return valve (of either the ball or clapet variety) prevents air forming in the pump body. This is important as the build-up of air is dangerous for two reasons: 1) it can lead to the pump depriming;2) it can lead to water seeping into the motor as a result of dry-running in the area where the mechanical seal is located.
What is more, if the non-return valve is not fitted (in cases where the basin is relatively small), water column return is allowed, making the level rise and the pump run continuously.

Finally, care should be taken when choosing the delivery pipeline to prevent unnecessary friction losses, since greater losses make a more powerful pump preferable (higher energy consumption).

CALCULATING THE FLOW RATE

Pump sizing

WASTEWATER LINE

USER TYPE	**Unit of meas.**	**Quantity (in litres/hour)**
Office	Toilets	120
Flat/house	Inhabitants	65/80
Catering/canteen	Persons present	60/70
Hotels	Persons present	55/65
Sundry buildings for collective use	Persons present	65/75

CALCULATING THE PUMP'S FLOW RATE

Multiply the number of users by the estimated average quantity.
e.g. 20 offices in a building also used for civil purposes and containing 30 flats (each flat with 3 habitants);
(20x120) + (30x3x80) = 2.400 + 7.200 =9.600 l/h in total to provide

CALCULATING THE PUMP'S FLOW RATE FOR RAINWATER DISPOSAL PURPOSES

K x SURFACE AREA EXPOSED TO RAINFALL divided by NUMBER OF PUMPS INSTALLED

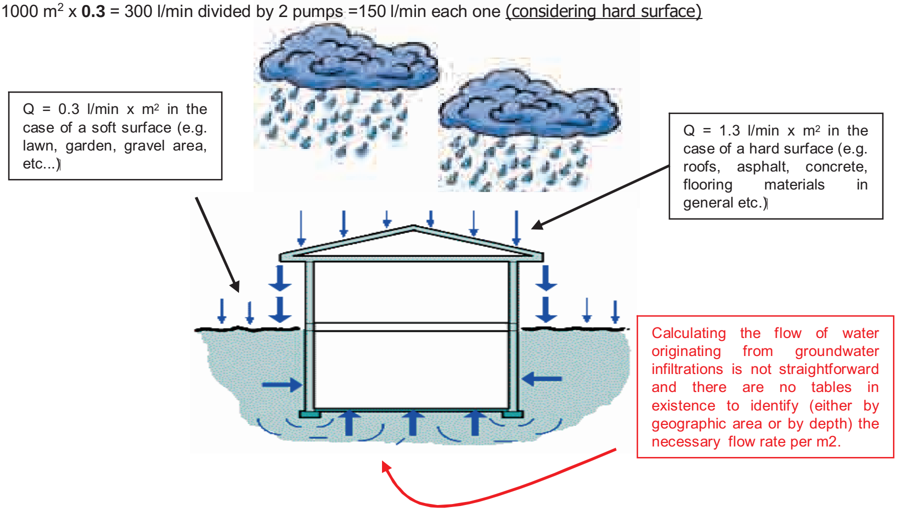
In case of a hard surface (e.g. asphalt, concrete, flooring materials in general etc..)
K = 1.3 l/min x m^2 (considering the southern part of Europe)
K = 1.7 l/min x m^2 (considering the northern part of Europe)

In case of a soft surface (e.g. lawn, garden, gravel area, etc...)
K = 0.3 l/min x m^2 (considering the southern part of Europe)
K = 0.4 l/min x m^2 (considering the northern part of Europe)

e.g. 1000 m^2 of exposed surface area for a system comprising 2 pumps and the southern part of Europe:

1000 m^2 x **1.3** = 1300 l/min divided by 2 pumps =650 l/min each one (considering hard surface)

1000 m^2 x **0.3** = 300 l/min divided by 2 pumps =150 l/min each one (considering hard surface)



CALCULATING THE HEAD

"Pumping head" is the term given to the total difference in level, vertically, between the pump and the piping outlet level.
It is extremely important for the system that you choose the most suitable piping.
To prevent saturation in the piping and noisy unit operation, it is advisable to size the piping so that the liquid speed range is kept at between 0.7 m/sec and 1.7 m/sec.
The section below contains a series of tables for calculating the friction losses according to the water flow rate and the piping sizing.

Friction losses in any accessories featured in the system usually have to be calculated by applying a formula which depends on a coefficient supplied by the manufacturer of the distribution system components .

To give you a rough idea, the table below refers to the friction losses attributable to bends, unions, gate valves and non-return valves.
The values shown refer to the drops in terms of metres in length of equivalent piping.

DN	Elbow			Connection	
	45°	90°	90° large curve	Ball valve	No returned valve
	Equivalent lenght (metres)				
25	0,3	0,6	0,6	_	1,5
32	0,3	0,9	0,6	_	2,1
40	0,6	1,2	0,6	_	2,7
50	0,6	1,5	0,9	0,3	3,3
65	0,9	1,8	1,2	0,3	4,2
80	0,9	2,1	1,5	0,3	4,8
100	1,2	3,0	1,8	0,6	6,6
125	1,5	3,6	2,4	0,6	8,3
150	2,1	4,2	2,7	0,9	10,4
200	2,7	5,4	3,9	1,2	13,5
250	3,3	6,6	4,8	1,5	16,5
300	3,9	8,1	5,4	1,8	19,5

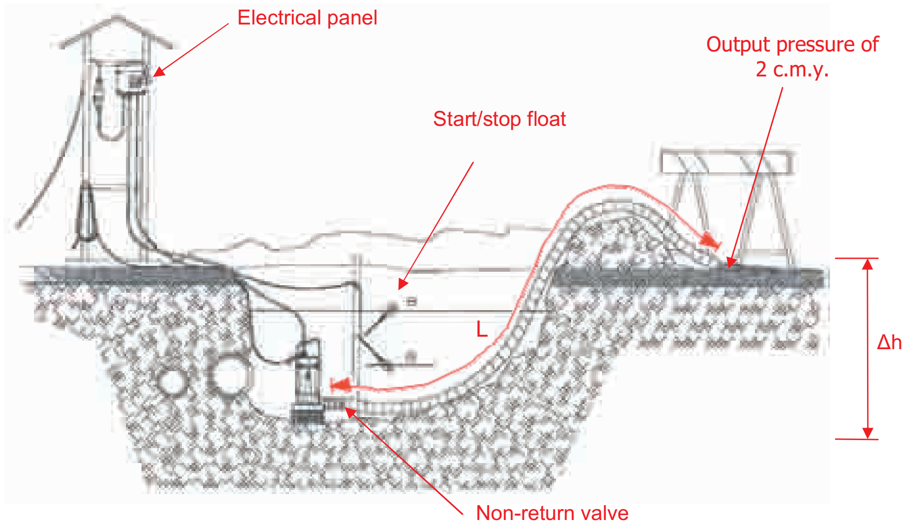
CALCULATING TANK CAPACITY

WASTE WATER TANK CAPACITY

Total quantity to be disposed off divided by 4 (multiply by 0.6 in case of a 2-pump installation).
Example:
10 m3/h / 4 = 2.5 m3 (for 1 pump)
10 m3/h / 4 x 0.6 = 1.5 m3 (for 2 pumps)

RAIN WATER TANK CAPACITY

0.035 x EXPOSED SURFACE = m3 capacity
Eg.: 1000 m2 x 0.035 = 35 m3
The tank capacity must provide for up to 25-30 minutes of power failure.



Pump calculation example:

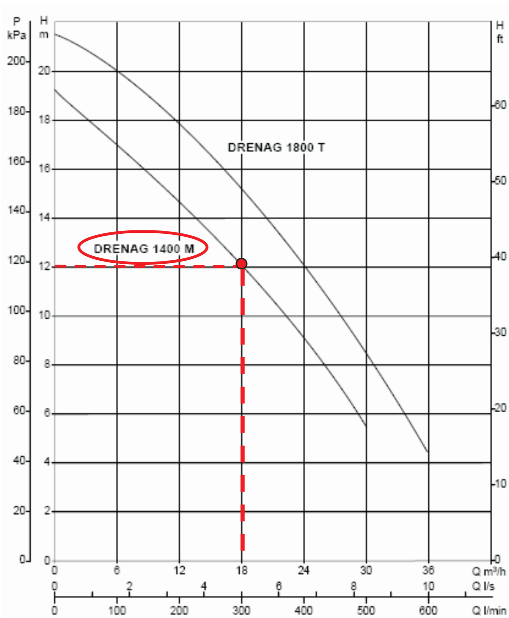
<u>If the demand is Q=300 l/min,</u>

and the piping is: L= 30 m - Δh= 4 m

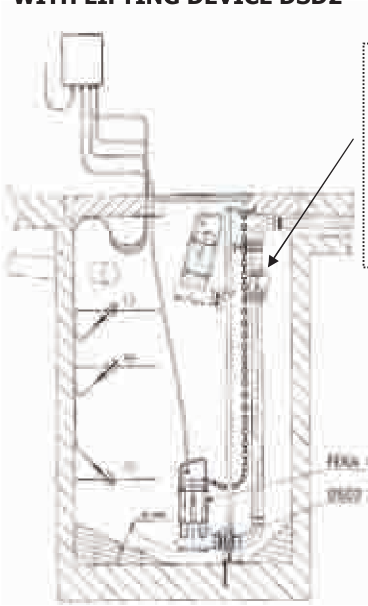
Hpump = PCL + Δh + output pressure
= 4.2 + 4 + 3 = **11.20 metres columns of water**

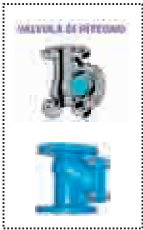
Qpump = 300 l/min

PCL = friction losses due to piping
Δh = total difference in level
L = total length of the piping

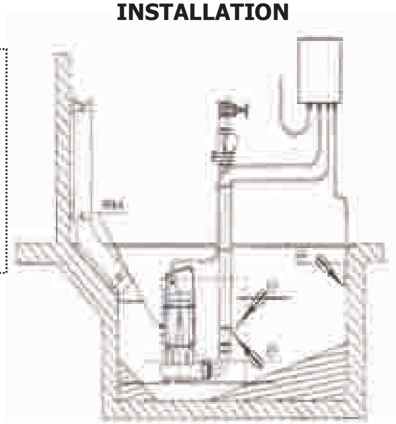


EXAMPLE OF AN INSTALLATION WITH LIFTING DEVICE DSD2

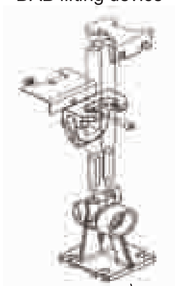




EXAMPLE OF A FIXED INSTALLATION

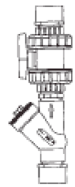


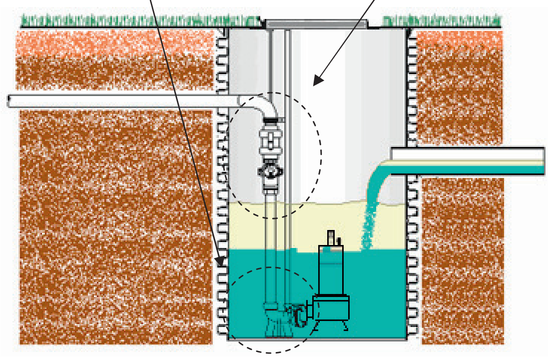
DAB lifting device



Stepping valve

Full bore non-return valve





Suggestions for careful maintenance

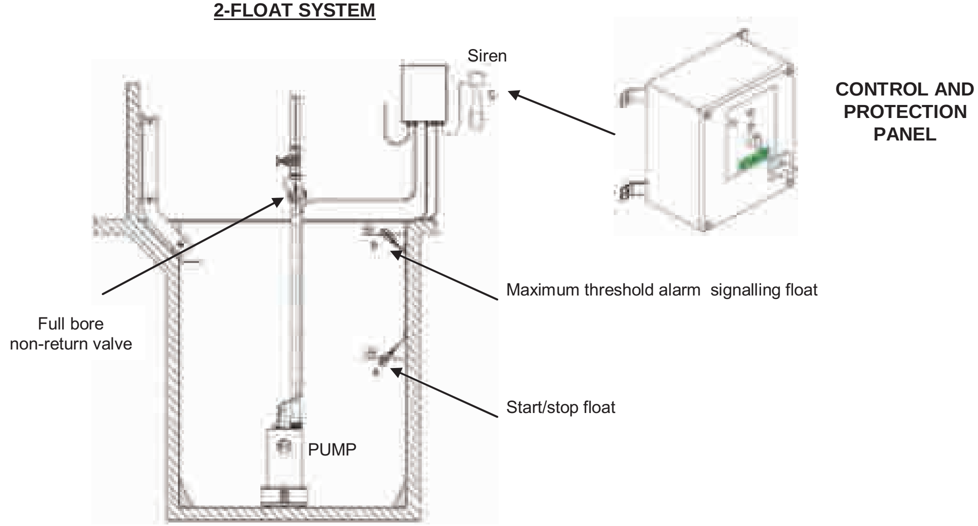
• After plant start-up, it is advisable to carry out inspection and cleaning every three months, in particular, of the non-return valve. This interval can be increased if the outcome of the initial inspections is positive.

• Clean the pump thoroughly to remove all foreign bodies adhering to the suction grille and check to ensure free movement of the float. Remove the pump from the tank, if necessary.

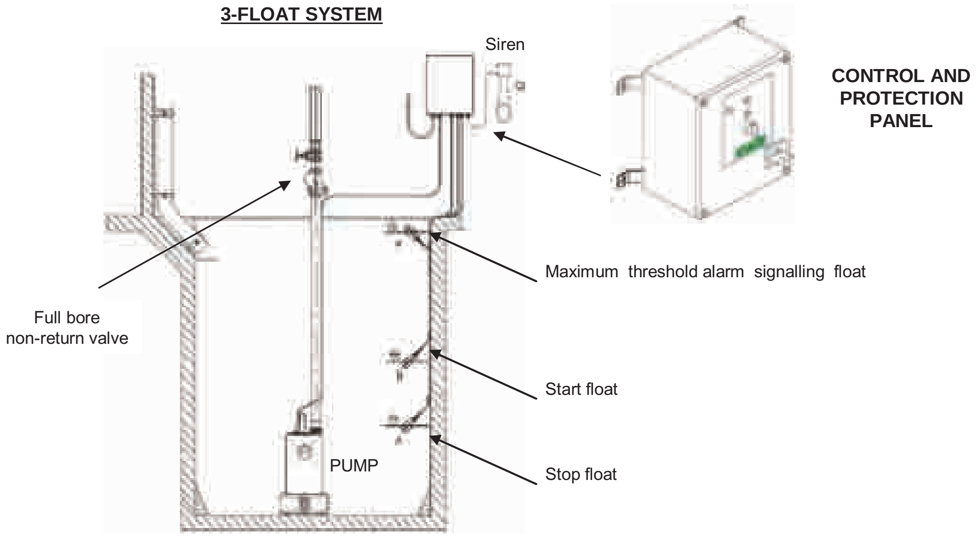
• It is advisable to clean the plant with running water at least once a year, by operating the pump repeatedly.

EXAMPLE OF FLOAT CONNECTIONS ON A 1-PUMP STATION

<u>2-FLOAT SYSTEM</u>

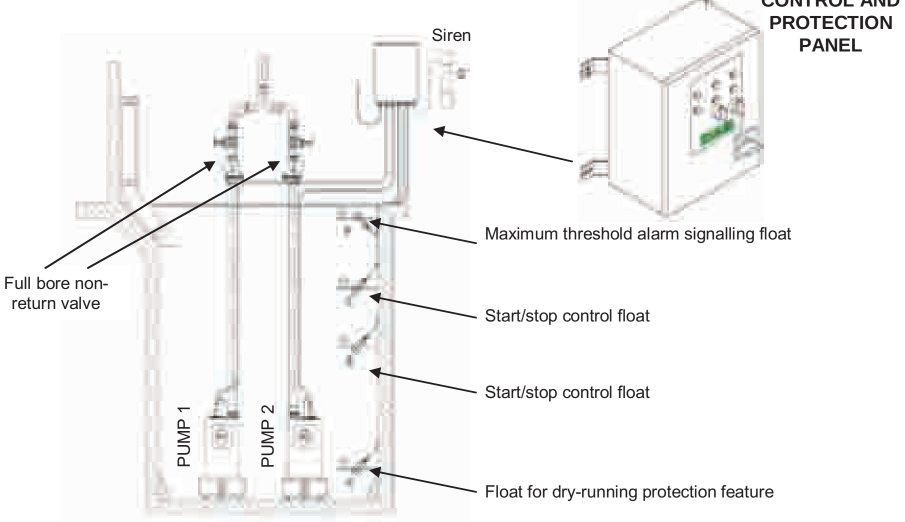


<u>3-FLOAT SYSTEM</u>

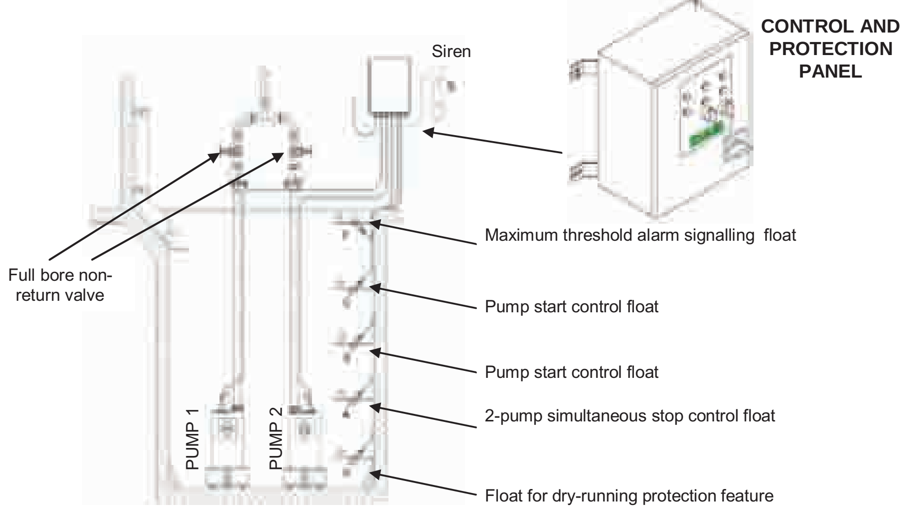


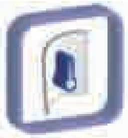
EXAMPLE OF FLOAT CONNECTIONS ON A 2-PUMP STATION

4-FLOAT SYSTEM



5-FLOAT SYSTEM



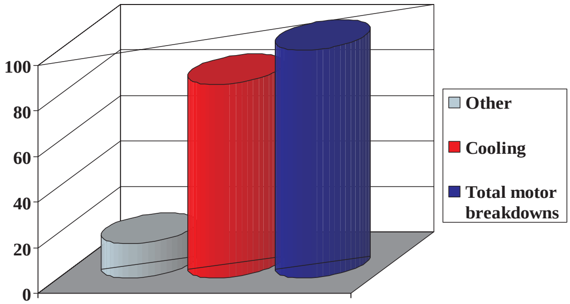


How to size a cooling jacket

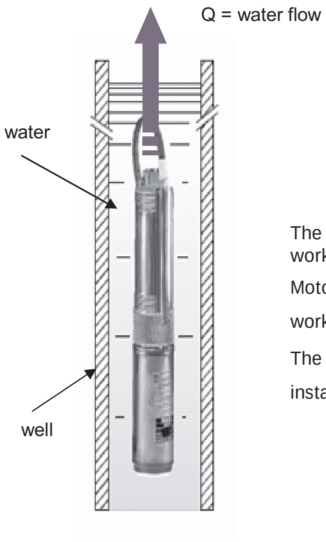
✓*Sizing the cooling jacket*

HOW TO SIZE A COOLING JACKET

One rule that not everyone applies when installing a submerged pump is the creation of a flow of water designed to guarantee motor cooling when the pump is operating



An estimate has shown that over **80 %** of problems are caused by: **over-temperature**



The motors used in DAB submerged pumps are designed to work in an ambient temperature of 40°C.

Motor cooling must be assured to guarantee the motor a long working life.

The cooling speed is stated on the motor rating plate and in the installation handbook supplied with the motor.

HOW TO SIZE A COOLING JACKET

(these considerations are valid for water temperatures below 40°C)

1. *Check proper motor cooling*

- Calculate the flow speed according to the following formula:

$$v_{[m/s]} = \frac{Q_{[m^3/h]} \times 353,7}{\left(D_{[mm]}\right)^2 - \left(d_{[mm]}\right)^2}$$

where:

Q = flow rate

D = well diameter

d = motor diameter

- If v > 0.3 m/s

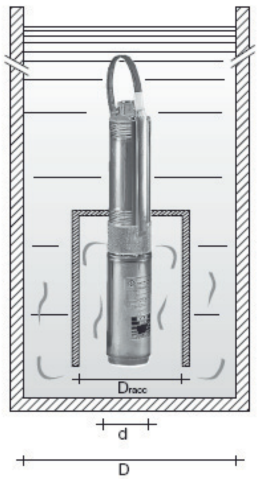
(0.08 m/s for 4" Franklin and 0.15 m/s for 6" Franklin)

No cooling jacket is required, the motor is adequately cooled.

- If v < 0.3 m/s

(0.08 m/s for 4" Franklin and 0.15 m/s for 6" Franklin)

go to next page

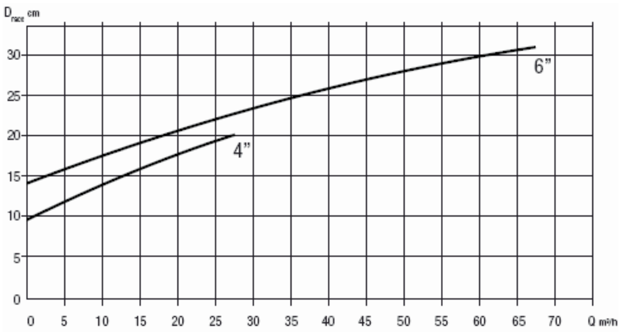


HOW TO SIZE A COOLING JACKET

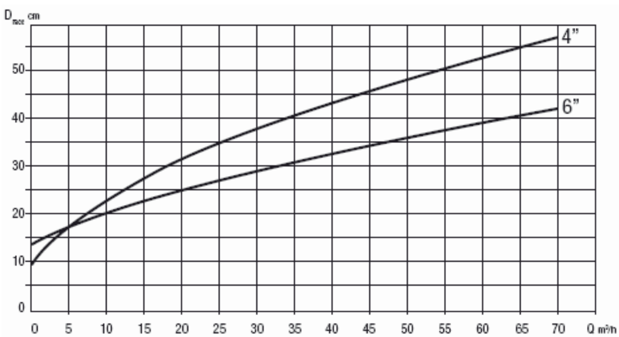
(these considerations are valid for water temperatures below 40°C)

2. *Calculate the recommended diameter of the jacket*

- Given the system flow rate (Q), use the graph to interpolate the maximum diameter recommended for the jacket



Maximum diameter recommended - Motors DAB



Maximum diameter recommended - Motors FRANKLIN

Compatibility between materials and liquids other then water

CONTENTS

WHAT KIND OF WATER ARE WE WORKING WITH?

Drinking water:

Clear, colourless, odourless, bacteriologically pure, pH ~6,4÷8 and temperature 8÷15°C

Natural waters

Water may be of surface, deep or, much more rarely, of atmospheric origin.

Surface waters:
(Source of surface waters: rivers, lakes, ponds or sea)

The water found in rivers and lakes is generally sweet, i.e. its salt content is not very high. The waters in certain salt lakes are an exception, as well as the lower courses of rivers that flow into the sea through an estuary, at high tide or in dry periods.
The total hardness of European river waters ranges in most cases from 10 to 35°F, with a few exceptions above or below the range.
The chemical composition of surface waters, as well as deep waters, often reflects the nature of the soil with which they come in contact.
Hard waters come from areas where soils are rich in calcite and argonite ($CaCO_3$), chalk ($CaSO_4$ $2H_2O$) and dolomite ($CaCO_3$ $MgCO_3$).
Alkaline waters are found in areas where carbonates prevail over neutral salts.
Siliceous waters flow mainly on quartz rocks.

Deep waters
Unlike surface waters, deep waters do not contain suspended substances such as mud, clay or various wastes from industrial and domestic sources. This waste in deep water is filtered by the geological layers it passes through.

Rainwater

Rainwater is not pure: as it passes through the atmosphere it washes it, incorporating many of the impurities it contains. It is also highly corrosive due to its high content of dissolved gases (oxygen, carbon dioxide and, in industrial areas, sulphur dioxide and hydrogen sulphide).

Seawater

Seawater (or, more generally, salt water) is over-saturated with calcium carbonate ($CaCO_3$). However, it does not tend to form scaling though it is a highly corrosive medium.

The salt content may range from 32 to 38 g/Kg depending on the sea.

The salts found in greater quantities are sodium chloride and magnesium chloride.

As a first approximation, the percentage composition can be considered almost constant, at least as regards its main constituents and samples taken in deep seas. Therefore, if we know the content of one of these constituents we can calculate all the others. Chlorinity, i.e. the concentration of halides in one kilogram of seawater, expressed as "Cl", has been chosen as the basic factor.

The relation between chlorinity and total salinity is expressed by the following formula:

$$S\% = 0.03 + 1.805\ Cl.\%$$

The dissolved gas content is mostly affected by temperature, although cases of oversaturation or undersaturation may sometimes occur as a result of local conditions or biological activity.

Cooling waters:

(Employed in all types of cooling systems)

Ideal characteristics

- Mean calcium hardness 10÷20°Fr;
- Slight calcium carbonate oversaturation;
- High buffer capacity (difficult to alter the pH);

- Total salinity and content of chlorides and dissolved gases not too high;
- Absence of spores and animal or vegetal micro-organisms (bacteria, fungi and algae);
- Absence of suspended solids as well as putrescible or corrosive substances originating from domestic or industrial waste;
- Constant, not too high temperature;
- Long-lasting constant flow;

Steam boiler waters:

- Free from scaling (hardening) salts;
- Non-corrosive for the materials used to build the system;
- Must not cause foaming or contaminate the steam produced

Condensate water:

(water that has warmed up as a result of condensation)

Condensate water can be considered a diluted solution of carbon dioxide and oxygen.
The dissolved carbon dioxide causes an acid reaction in the water, whose strength increases as the partial pressure exerted by the carbon dioxide in the overlying gaseous phase increases.

Condensate water is an acid solution, therefore iron dissolves in it according to the reaction $Fe \leftrightarrow Fe^{++} + H_2$ (1), which represents a cell in which there is iron solution in the anodic areas and hydrogen development in the cathodic areas.
If oxygen is absent, the reaction (1) can only take place with great difficulty (because hydrogen development is inhibited by phenomena that take place at the atomic level and have yet to be clarified). Consequently, also the anodic reaction stops or slows down drastically.

If the solution is highly acid, the very high concentration of hydrogen ions is able to overcome this condition of inertia, thus enabling the reaction to take place.

In practice, the effect of PH on the corrosion rate of iron in condensate water is shown in the table below.

Table (R.Rath)

pH	Corrosion rate of iron in condensate water
7	Nil
6	Slow
5	High
<5	Very high

The situation changes completely when oxygen is present. Oxygen combines with the gaseous hydrogen according to the reaction $H_2 + \frac{1}{2}O_2 \leftrightarrow H_2O$, releasing the reaction (1), which reactivates the corrosion process.

It has been demonstrated that the reaction $Fe \leftrightarrow Fe^{++} + H_2$ is thermodynamically possible up to a pH of 9.7. This value has been defined as <<nil corrosion of iron in water pH >>. R. Rath has calculated that this value is valid also within the 25 to 250°C temperature range.

To sum up: in order to ensure proper protection against corrosion it is sufficient to alkalize[1] the condensate water and to bring the pH to a value of 9.

As regards the oxygen, provided its content does not exceed 0.07 ppm there is no need to fear the occurrence of any corrosion phenomena.

---

[1] The alkalizing substances are: ammonia and liquid amines (morpholine, benzylamine and cyclohexylamine)
These have a dual task: first, they must neutralize the acidity due to the dissolved carbon dioxide, second, they must alkalize the solution up to a set pH.
The oxygen may be eliminated from the boiler water, and consequently from the condensate water, by adding to the feed water, at a point immediately upstream from the pump, special chemical substances that combine with it and render it harmless.

Water for hygienic and safety applications:

The waters for hygienic applications (bathrooms, showers, etc..) must not contain any substances that are irritating to the skin and eyes, and must not be bacteriologically polluted.
These waters undergo a heating process, therefore they can cause scaling or corrosion. In these cases the chemical treatment must be carried out using completely harmless substances.
Although bathroom waters are not intended for drinking, factory doctors often demand that they have the characteristics of potable water, to guard against mistakes by the labour force.
The water used in safety systems for firefighting applications need not have any special physical-chemical characteristics; however, it must always be available in sufficient quantities to meet any accident at any time.

This need is most strongly felt in factories that produce explosives and flammable materials, and in oil refineries. This is one of the reasons why refineries are often built on the seashore.

***Residual waters* (wastewater, sewage, dirty waters)**

The pollution of natural waters can be of different origins:

- Domestic
- Industrial
- Agricultural

Domestic pollution is due to urban sewage containing products resulting from human metabolism, food residues, cleaning products and various wastes. The problem is

especially prominent in highly industrialized areas with a large density of population and high living standards.
These sewage waters, which receive effluents of domestic origin, have a quality composition that does not greatly differ from town to town; the only thing that changes is the concentration of the suspended and dissolved substances.

Industrial pollution is due to the discharge of residual waters from factories. These waters contain considerable amounts of raw materials, finished products and by-products, which are often very harmful substances.
Moreover, the temperature variations commonly caused by industrial cooling waters or water discharged from thermoelectric plants cause serious biological imbalances among living organisms in watercourses.

Agricultural pollution is due to chemical fertilizers, and above all to fungicides and insecticides.
Although pollution originates from a large variety of causes, it can always be ascribed to three major factors, i.e.:

- Lack of oxygen
- Presence of toxic or harmful substances
- Temperature variations

WE TALK ABOUT CORROSION, BUT WHAT SHOULD WE DEFEND OURSELVES AGAINST?

The main factors of corrosion

High chloride content, that causes a process of depolarisation, enables Cl ions to penetrate underneath the passivated layers of the material causing their breakdown.

Low resistivity of the liquid, which causes the corrosive processes to intensify.

High oxygen concentration, often approaching or even exceeding the saturation level.

However, where oxygen is absent (deep waters, port and lagoon waters), the anaerobic environment promotes the activity of the sulphate-reducing bacteria, which results in cathodic depolarisation.

The presence of living organisms, whose biological activity can directly contribute to the etching of metal surfaces.
In other cases, molluscs attached to the metal can form differential aeration cells.
Seawater is known to be aggressive to metals.
The most suitable alloys for plant and machine construction are:

- Phosphorous bronzes (phosphorus content ≈ 0.1 ÷ 0.3 %);
- Bronzes alloyed to zinc and nickel;
- Copper-aluminium alloys, and, in some cases,
- stainless steel.

But, TECHNICALLY SPEAKING?

Temperature

Based on certain chemical kinetic considerations, as the temperature increases the corrosion rate should also be expected to increase according to an exponential law. Actually this is not always so, as the figure below shows.

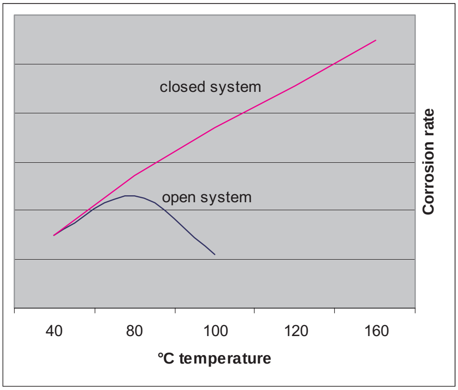


Figure 1 – Corrosion rate

If steel is in contact with the water in a closed system, the corrosion rate will increase steadily along with the temperature; however, if the system is open, after touching the maximum corrosion point the curve turns down. This phenomenon is explained by the fact that the oxygen, whose solubility decreases with rising temperature, can abandon the solution if the system is an open one.

Temperature of the waters

Surface waters are subject to wide seasonal oscillations connected with atmospheric temperature variations.
It should be noted that water in lakes can have a somewhat constant temperature provided the water is drawn from the depths.
Subterranean waters maintain a somewhat constant temperature throughout the year.
The temperature of seawater is subject to seasonal variations; however, these are less marked than the corresponding changes in the temperature of the air above it. In temperate regions and in the high seas they usually range from 5 to 10°C.

Saline concentration

The same can be said as regards the effect of the salinity of the solution. In other words, the resistivity of the solution diminishes as the salinity increases, therefore the corrosion rate increases.
However, the solubility of oxygen diminishes as the salinity increases, therefore there comes a point when the latter factor prevails on the former one and, due to the new increase in concentration, the corrosion rate decreases.

Circulation rate of the solution

This is an extremely important factor, though its complex mechanism is not yet well known.
As regards iron, it has been demonstrated that whereas in an acid solution the increase in the circulation rate causes a negligible increase in the corrosion rate, in a neutral solution the progress of the phenomenon is much more complex. This strange behaviour can be explained by surmising that the circulation of the liquid promotes the access of oxygen; as this has a double effect, both of stimulating and inhibiting corrosion, the slope of the curve in the first two branches reflects the predominance of each of these two trends.
The last ascending branch of the curve can be explained by the mechanical action of the solution, which, as a result of the turbulence, tears away the protective films that cover the metal.

Stimulating substances

Foremost among the substances that cause an acceleration of the corrosion processes when they are dissolved in the solution are the depolarising agents. Generally speaking, these are substances that are capable of yielding oxygen.

Another group of corrosion stimulators consists of the complexing substances. With the ions of dissolved metals these form soluble complexes, i.e. substances that are capable of substantially lowering the concentration of the ions themselves and therefore of ennobling the metal. If the metal is covered by a protective film which makes its potential more electropositive, a strong denobilization can be caused by the presence of appreciable quantities of chloride ions. This appears to be due to the small size of the ions, which enables them to penetrate through the pores of the oxide film and come into direct contact with the metal.

The actual mechanism of activity of the chlorides has not been made quite clear yet. In any case, it is certain that they are responsible for numerous instances of corrosion process acceleration, with occasionally destructive results.

Mechanical stress of the material

Many plants are subject to various types of stress during their operation. Moreover, many parts are obtained by a deformation of the metal that is not followed by a corresponding tempering treatment.

Experience teaches us that the corrosion rate of metals is accelerated by stress and deformation processes. Moreover, these processes tend to significantly aggravate the situation by transforming uniform corrosion into intercrystalline corrosion. The exact mechanism of these phenomena is not yet known; it appears that an important role is to be ascribed to potential variations in the intercrystalline regions, caused by elastic deformation of the metal.

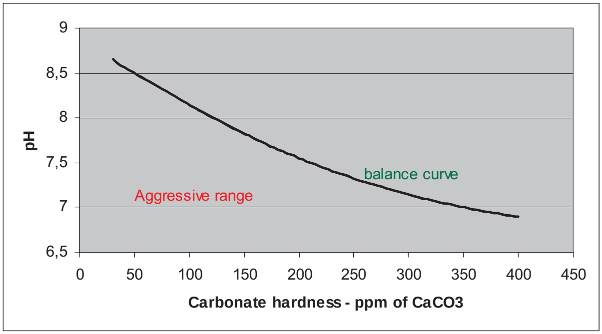
Aggressiveness of water

The free oxygen dissolved in water in the form of gas is a very important factor of corrosion.

The pH value is decisive for the corrosion rate generated by oxygen-poor water. When the pH value drops below 7, the rate of corrosion increases proportionally and is even perceptible with a pH value of 7.

In oxygen-rich water the nascent hydrogen is converted into water and the dissolved iron is oxidized (rust).

In this case the corrosion rate does not depend on pH but on the oxygen content or addition. The oxygen content facilitates the formation of a protective layer on the ferrous surface which inhibits the progress of corrosion, but only provided that the pH value is above the balance curve.



N.B. The dry residue remaining after evaporation of 1 litre of water indicates the approximate quantity of salts dissolved in it.

This salt residue gives rise to electrolytic conductivity: the use of different metals generates electrolytic corrosion.

The table below provides an approximate evaluation based on analysis surveys; starting from the top, the characteristics that do not correspond to the case being examined are progressively eliminated, until the corresponding indication is found.

	ANALYSES-SURVEYS				Evaluation
	Hardness ppm of $CaCO_3$	FREE OXYGEN (mg/L)	Carbon dioxide CO_2, Free(mg/L)	pH	
Aggressive behaviour	< 107.4	< 4		= balance value	harmless
				<balance value	attacks iron; the attack increases as pH diminishes
		> 4			attacks iron; the attack increases as the O_2 content increases
	= 107.4	˜ 0		=balance value	harmless
				<balance value	attacks iron; the attack increases as pH diminishes
		> 0	=CO_2 Free necessary	=balance value	harmless
			>CO_2 Free necessary	<balance value	attacks iron; the attack increases as the O_2 content increases
	Evaporation residues		< 500 mg/l		harmless
			> 500 mg/l		avoid use of different metals - electrolytic corrosion-
	Chlorides		< 150 mg/l		harmless
			> 151 mg/l		avoid use of different metals - possible perforation-
	Hydrogen sulfide		(marsh gas)		attacks iron
Deposits	limestones		CO_2 libera > CO_2 necessaria		no deposits
			CO_2 libera < CO_2 necessaria		deposits increase as CO_2 diminishes : free CO_2 = 0: in the form of sludge; free CO_2 > 0 : in the form of scaling
	iron		< 0.2 mg Fe/l		no precipitation
			= 0.2 mg Fe/l		Sludge deposit; increasing as the iron and O_2 content increase
	manganese		< 0.1 mg Mn/l		no precipitation
			= 0.1 mg Mn/l		manganese deposit; increasing as the CO_2 content increases
Sand abrasion	sand content = 0.1%				use machines not affacted by sand
	sand content > 0.1%				harmful

WATER IS A LIQUID! WHY IS IT CALLED "HARD"?

The water we normally use contains substances whose presence is far from desirable. These substances are salts that the water dissolves and accumulates while it passes through the different layers of the ground; their presence determines the total Salinity of the water (measured in ppm – parts per million – per litre of water).

Among the different Salts dissolved in the water are Calcium (Ca) and Magnesium (Mg) salts, and that's why we talk about "calcium hardness" and "magnesium hardness".

The use of "hard" water causes a number of drawbacks, including calcium deposits in pipes, radiators, kettles and boilers; this results in poor heat transmission and problems to valves, gates, taps... and therefore energy waste.

Moreover, the simplest example and the easiest to demonstrate, is the fact that laundry washed in "hard" water comes out raw (this is the reason why softeners are so commonly used).

Hardness can be expressed using different units of measurements; the most commonly used are ppm of CaCO3 (calcium carbonate) and French degrees.

Hardness is usually indicated by the symbol H. The symbols TH (titre hycrotimétrique) and Tca (titre calcique) are used in French-speaking countries.

	Degrees of hardness				ppm of CaCO3
	French	English	American	German	
	10 mg CaCO3 per litre	1 grain of CaCO3 per UK gal	1 grain of CaCO3 per US gal	10 mg CaCO3 per Litre	1mg CaCO3 per Litre
1°French	1,00	0,70	0,59	0,56	10,00
1° English	1,43	1,00	0,83	0,80	14,30
1° America	1,71	1,20	1,00	0,95	17,10
1° German	1,79	1,25	1,05	1,00	17,90
1 ppm	0,10	0,07	0,06	0,06	1,00

Aggressiveness of natural water

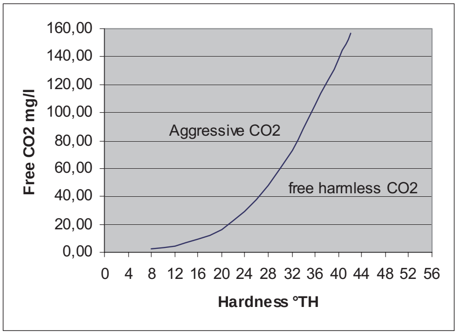
Total hardness is not sufficient by itself for determining aggressiveness.

The determining factor for establishing the aggressiveness of natural water based on chemical analysis is the hardness of the bicarbonates, i.e. the total hardness of water that is caused by calcium bicarbonate $Ca(HCO_3)_2$.

This highly soluble salt can exist only in the presence of a certain amount of free carbon dioxide (CO_2). If this balance is disturbed, a part of the bicarbonate is transformed into insoluble monocarbonate (limestone) and precipitates.

Carbon dioxide is dissolved in water in the form of gas. Part of it is harmless, as it is needed to maintain the bicarbonates, i.e. the Salts that give temporary hardness, while the extra amount that is not needed for this purpose is aggressive and attacks iron and concrete.

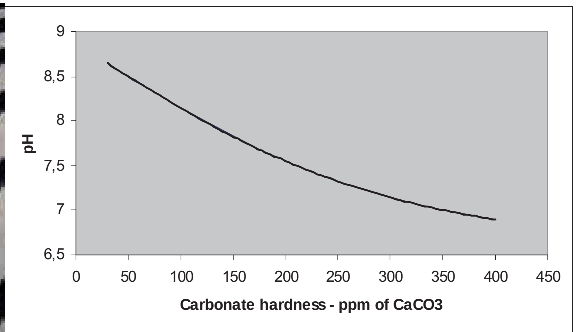
The table below divides natural water into two types, “aggressive” and “harmless”.



Water resembles us… it might be ACID!

(Alkaline or Acid)

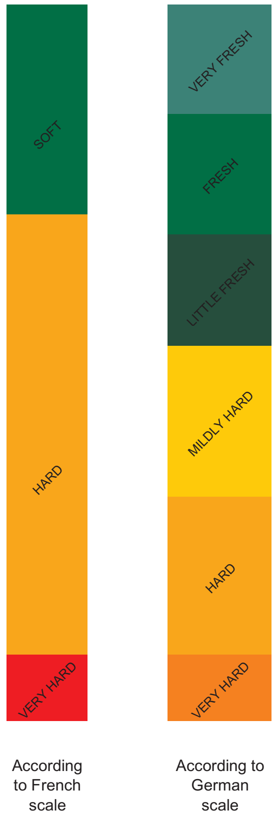
The acidity of water depends on the acids it contains (carbonic acid, hydrogen sulphide, hydrochloric acid, boric acid... etc.)
The alkalinity depends on the presence in the water of basic substances.
The pH represents the cologarithm of the concentration of hydrogen ions in solution, and expresses the reaction of the water, whether it is acid or alkaline.



DIFFERENT MEASUREMENTS OF HARDNESS

ppm	French °Th or Tca	English °H	American °H	German °dH
0,0	0,0	0,0	0,0	0,0
40,0	4,0	2,8	2,4	2,2
71,2	7,1	5,0	4,2	4,0
80,0	8,0	5,6	4,7	4,5
120,0	12,0	8,4	7,1	6,7
140,0	14,0	9,8	8,3	7,8
143,2	14,3	10,0	8,4	8,0
160,0	16,0	11,2	9,4	9,0
200,0	20,0	14,0	11,8	11,2
214,8	21,5	15,0	12,7	12,0
240,0	24,0	16,8	14,2	13,4
280,0	28,0	19,6	16,5	15,7
320,0	32,0	22,4	18,9	17,9
322,2	32,2	22,6	19,0	18,0
360,0	36,0	25,2	21,2	20,2
400,0	40,0	28,0	23,6	22,4
440,0	44,0	30,8	26,0	24,6
480,0	48,0	33,6	28,3	26,9
520,0	52,0	36,4	30,7	29,1
537,0	53,7	37,6	31,7	30,1
540,0	54,0	37,8	31,9	30,2
560,0	56,0	39,2	33,0	31,4

WATER DISTINCTION



GENERAL CHARACTERISTICS OF THE PRINCIPAL MATERIALS USED IN THE MANUFACTURE OF DAB PUMPS

CAST IRONS

- These are Fe-C (Iron-Carbon) alloys with C>2.06% ;
- High castability (castings with complex geometry, such as automobile engines, pump casings, etc…);
- Mechanical properties not as high as those of steel, but good resistance to vibrations and impacts thanks to the dissipation of energy between the graphite fins, which act as dampeners.

Microstructure of various types of cast iron:

a) grey iron: dark graphite fins in ferritic matrix (500x)
b) spheroidal graphite cast iron: dark graphite spheroids in ferritic matrix (200x)
c) white cast iron: large white cementite crystals immersed in pearlite (thin ferrite and cementite fins placed side by side)
d) malleable cast iron: black graphite "flakes" (annealed carbon) in ferritic matrix.

STEELS

- Low carbon content (C < 2%) and wide variety
- **Common steel** (without alloying elements, for steel structural work, Fe 360, Fe410,...):
  - o Low C content (max 0.25%) to ensure weldability (a very important characteristic!);
  - o Moderate mechanical resistance;
  - o Excellent ductility and toughness and fair machine tool machinability;
  - o Low corrosion resistance;
  - o Very moderate cost.
- **Special structural steels capable of being hardened and tempered**: very important for the construction of dynamically stressed machine parts (pinions, gears,..)
- **Casehardening steels**: suitable for thermal treatment whereby the surface of the metal is modified to give it wear resistance characteristics.
- **Tool steels**: these are highly alloyed with other elements to obtain high mechanical, abrasion and wear resistance. Used in the manufacture of dies, punches and bottom dies, shears, gauges, etc.
- **Stainless steels**: (*e.g. 18-8 in cutlery and pans...Italian nomenclature only*)
  - o Excellent corrosion resistance due to high content of chromium, which is passivated, forming a thin surface layer that protects the underlying metal;
  - o Low C content C<0.1% ;
  - o Excellent cold forming characteristics;
  - o Excellent resilience;
  - o malleability;
  - o high temperature resistance.
  - o AISI 316 contains 2-3% of Molibdenum for resistance in marine environments and to sulphuric acid.
- **Nickel superalloys**: high nickel content, excellent resistance to mechanical stress, oxidation and aggressive environments. Used in the construction of turbine blades.

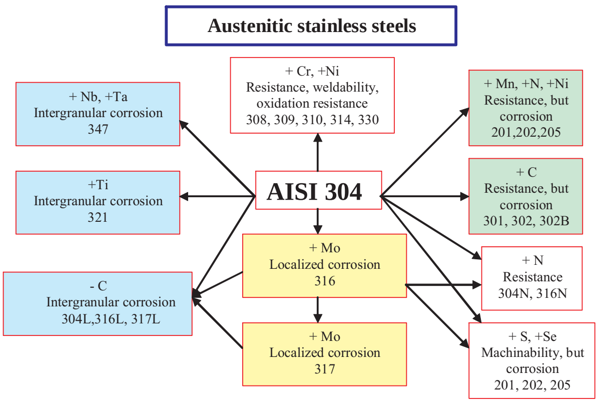


Figure 2- AISI 304 steels

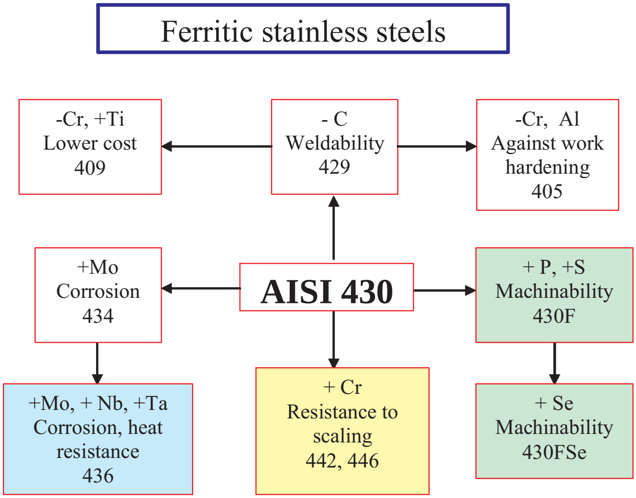


Figure 3 AISI 430 steels

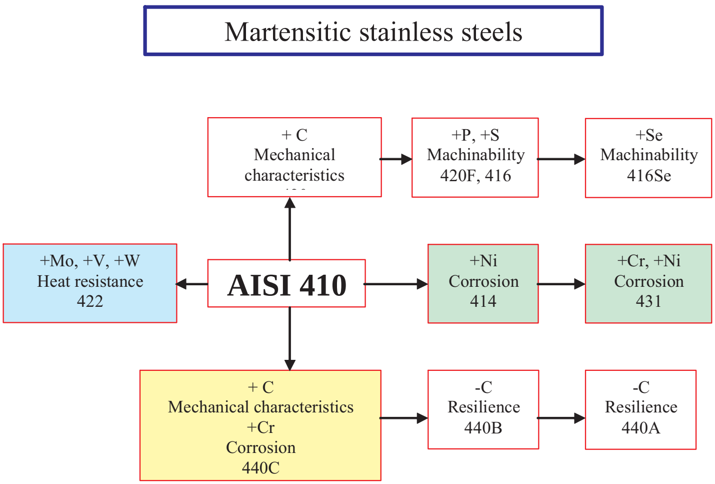


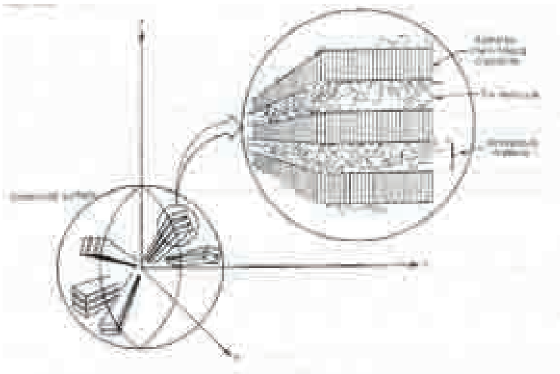
Figure 4 AISI 410 steels

PLASTIC MATERIALS

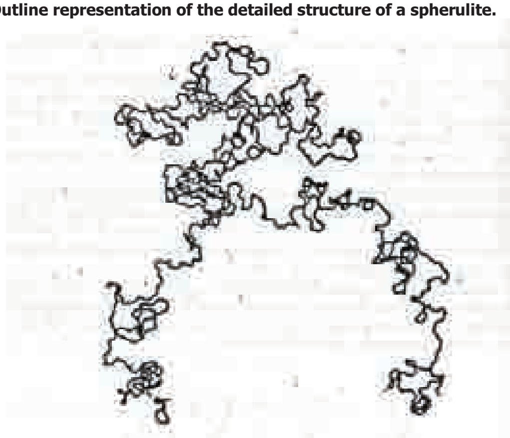
- Plastic materials are macromolecular **organic substances** (made from oil and its various derivatives) formed by a fundamental unit repeated a number of times (polymer), like a bunch of magnetic balls attached to each other. These very long and flexible chains twist upon themselves to form entanglements that resemble a plate of noodles.
- The plastic can be softer or harder, more flexible and malleable or more rigid and fragile depending on the number of links between the various chains.
- In thermosetting compositions, the links between the different molecules are so thick as to form a single large three-dimensional lattice (resins, such as those used in the production of boots, car body parts, etc.);
- Some amorphous (shapeless) plastics are perfectly transparent, like Plexiglas or the polycarbonate used in the manufacture of motorcycle helmet visors.
- It has **excellent electrical and thermal insulating properties** and is used to make electrical cables and insulating elements in the building industry (polyurethane foam, polystyrene, etc...);
- **Good chemical resistance**, although certain plastics and rubbers require special care (for rubbers, see relevant section) when in contact with solvents derived from oil.

RUBBERS

- Rubbers are special materials characterized by high elasticity, flexibility and strength.
- Natural rubber has long been used to manufacture car tyres.
- Artificial rubbers, such as SBR, NBR, EPDM, are used nowadays to produce gaskets and O-rings.



- Outline representation of the detailed structure of a spherulite.



CERAMIC MATERIALS

- Ceramic materials have a very compact and rigid crystalline structure which gives them special properties;
- Mechanical properties:
  - Very high mechanical resistance combined with high fragility: even the smallest impacts will cause them to chip or break;
  - Ceramic has excellent anti-abrasive properties and is used on sliding parts (bushings, seals, etc..).
- Fair electrical and thermal properties: ceramic materials are used for insulation in the electronic industry and in power towers.

SINTERED MATERIALS

- **Sintering** is a special production process that uses powders to obtain products of various shapes intended for a variety of purposes. The powder grains are pressed in a die at high temperatures and high pressure and are almost melted together to form a resistant piece;
- **The carbon bushings in DAB circulation pumps** are an example: the carbon leaves a powdery deposit when touched, but it has excellent abrasion and wear resistance;
- Another example is **WIDIA**, which is also used to make cutting blades.

STANDARD MECHANICAL SEALS IN DAB PUMPS

Carbon – Graphite

The term “carbon -graphite”, or more simply “carbon”, is used for a wide range of carbonaceous materials that are generally used for one of the two retainers.

Advantages:

1) good lubricating capacity even under conditions of boundary friction or dry friction
2) tendency to mitigate and fill in small imperfections in the sliding surface
3) good chemical resistance
4) good resistance to temperature, going from cryogenic temperatures to 250 °C. This upper limit can be raised to 350 °C through the use of several metallic carbons, and up to 450 °C with electrographite-type carbons
5) adequate resistance to compression
6) moderate production cost.

Disadvantages:

1) low tolerance in the presence of abrasives
2) strong oxidizing agents (nitrates, chlorates, etc.) can chemically attack the carbon and/or impregnator
3) lower rigidity and greater tendency to warp at high temperatures as compared to metals and ceramics
4) several industrial applications cannot tolerate the presence of carbon powder
5) low resistance to tensile stress
6) the finished product must be handled with care
7) low thermal conductivity (for several types)

Counterfaces

Carbon's ready tendency to be coupled with a wide variety of counterfaces justifies its widespread use as a seal component.

Tungsten carbide

This material is composed of very hard carbon particles alloyed with a ductile metal. It is used in particularly harsh conditions (in terms of PV). Despite the fact that it is the most costly of all the materials examined so far, it is often used because of the advantages it offers in terms of seal performance and life.

Advantages:

1) highly wear resistant even under particularly demanding working conditions
2) excellent thermal conductivity
3) high tensile modulus and thus less tendency to warp under pressure as compared with other metals
4) greater resistance to mechanical shock than other hard non-metallic materials.

Disadvantages:

1) limited chemical resistance, especially in acid environments
2) high density, which can compromise the performance of this material at high rotational speeds
3) limited resistance capacity in dry operating conditions or with boundary lubrication in carbide-carbide coupling
4) high cost of raw material

Counterfaces

Since it is used in the presence of abrasive liquids, it is generally coupled either with itself or with alumina. Given the fact that in these cases it has a very low dry-operation tolerance, it is increasingly being replaced with silicon carbide.

Aluminium oxide

Commonly referred to as “alumina”, it was the first of the “hard” non-metallic materials to be used for mechanical seals.

Advantages:

1) it is one of the most economical hard materials and offers excellent resistance to wear
2) it has excellent chemical resistance properties that depend on the degree of purity
3) in water or aqueous solutions, it has excellent properties when carbon is used as a counterface. Good resistance in the presence of abrasive solutions.

Disadvantages:

1) low thermal conductivity; it dissipates very little heat under critical conditions

2) adequate resistance to thermal shock only with particular types of carbon. This may cause problems under transient operating conditions. Resistance to thermal shock can be increased by using suitable additives
3) It is a fragile material that is subject to mechanical damage under certain conditions.

Counterfaces

Alumina is generally coupled with different types of carbon or with PTFE; the latter coupling is used in highly corrosive conditions.

Silicon carbide

The use of silicon carbide (particularly the sintered type) is becoming increasingly widespread, non only for critical applications, but also because in more normal cases its good price/performance ratio has helped make it the preferred material.

Advantages:

1) good wear resistance characteristics even under particularly harsh conditions
2) high thermal conductivity as compared with other ceramic materials
3) good resistance to thermal shock
4) high tensile modulus
5) good chemical inertia
6) lower density than tungsten carbide
7) less expensive than tungsten carbide
8) easily obtainable raw material

Disadvantages:

1) less tough than tungsten carbide
2) low resistance to tensile stress
3) requires special attention in selecting couplings; a wrong choice can lead to great generation of heat and thus to possible vaporization of the fluid interface film, thus inevitably damaging the seal. Silicon carbides with suitable additives are being studied to improve behaviour under reduced lubrication conditions.

Counterfaces

Silicon carbide with carbon is a combination that can ensure long seal life under a wide variety of conditions, since it offers excellent resistance to thermal shock, transients and to boundary conditions. Instead, the silicon carbide - silicon carbide combination is generally used when high wear resistance characteristics are required.

COMPATIBILITY OF MATERIALS and LIQUIDS

INTRODUCTORY STATEMENT

The information provided in this manual regarding the compatibility of liquids may only be used for confirmation of the pump construction materials.

This information has been collected from a variety of sources that are considered reliable, whereas DAB PUMPS s.p.a. has not conducted any verification tests and shall assume no responsibility regarding the correctness of this information.

Each application requires a specific set of stresses, exposure time, concentration of the chemical substance and specific temperature for use. Therefore DAB PUMPS s.p.a. strongly recommends that the materials that are to come into contact with liquids other than those for which they have been studied and designed be subjected to practical tests.

			CORPO POMPA-IDRAULICA-ALBERO MOTORE / PUMP BODY-HYDRAULICS-SHAFT MOTOR								TENUTA MECCANICA - MECH. SEAL			
LIQUIDO	LIQUID	CONC.%	Serie 400	AISI 304	AISI316	ACCIAIO AL CARBONIO	GHISA	BRONZO	OTTONE	PP	NBR	EPDM	GRAFITE	VITON
			Series 400	AISI 304	AISI316	CARBON STEEL	CAST IRON	BRONZE	BRASS	POLYPROPILENE	NBR	EPDM	GRAPHITE	VITON
Acetato di Etile	Acetato di etile			▶	▲		!!		▶			▶		
Aceto	Vinegar	100	▲	▲	▲			▶			▶	▲		▲
Acido Acetico	Acetic Acid	25	▲		▲		!!	!!	!!	▲	!!	▲	▲	!!
Acido Acetico	Acetic Acid	50	▲		▲		!!	!!	!!	▲	!!	▲	▲	!!
Acido Acetico	Acetic Acid	85	▲		▲		!!	!!	!!	▲	!!	▲	▲	!!
Acido Acetico	Acetic Acid	90	▲	▲	▲		▼	!!				▲		
Acido Acetico Glaciale	Acetic Acid, Glacial		▶	!!	▲			▼						!!
Acido Citrico	Citric Acid C6H8O7	10		▶	▲		!!	!!			▲	▲		▲
Acido Citrico	Citric Acid C6H8O7	SAT'D.	▶		▲		!!	!!	!!	▲	▲	▲	▲	▲
Acido Cloridrico	Hydrochloric Acid	2 MAX		▲	▲		▶							▲
Acido Cloridrico	Hydrochloric Acid	< 25	!!		▶		!!	!!	!!	▲	!!	▲	▲	▲
Acido Cloridrico	Hydrochloric Acid	37	!!		▶		!!	!!	!!	▲	!!	▲		▲
Acido Cloridrico	Hydrochloric Acid	100		▼	▼									▲
Acido Fluoridrico	Hydrofluoric Acid	< 3	!!			!!	!!	!!	!!	▲	!!	!!	▲	▲
Acido Fluoridrico	Hydrofluoric Acid	30	!!		!!		!!	!!	!!	▲	!!	!!	▲	▲
Acido Fluoridrico	Hydrofluoric Acid	40	!!	▼	!!		!!	!!	!!	▲	!!	!!	▲	▲
Acido Fluoridrico	Hydrofluoric Acid	50	!!		!!		!!	!!	!!	▲	!!	!!	▲	▲
Acido Formico	Formic Acid		▲	▼	▲		!!	!!		▲	!!	▲	▲	!!
Acido Fosforico	Phosphoric Acid	10	▶		▲		!!	!!	!!	▲	▲		▲	▲
Acido Fosforico	Phosphoric Acid	25	▶	▲	▲			!!				▲		▲
Acido Fosforico	Phosphoric Acid	50	▶		▲		!!	▶	!!	▲	!!		▲	▲
Acido Fosforico	Phosphoric Acid	60	▲	▲	▲		▼	▶				▲		▲
Acido Fosforico	Phosphoric Acid	85	▶	▶	▲		!!	▶	!!	▲	!!		▲	▲
Acido Nitrico	Nitric Acid	<10	▶		▲		!!	!!	!!	▲	!!	▲	▲	▲
Acido Nitrico	Nitric Acid	30	▲				!!	!!	!!	▲	!!	▲	!!	▲
Acido Nitrico	Nitric Acid	40	▲				!!	!!	!!	!!	!!	!!	!!	▲
Acido Nitrico	Nitric Acid	50	▶		▲		!!	!!	!!	!!	!!	!!	!!	▲
Acido Nitrico	Nitric Acid	70	!!		▲		!!	!!	!!	!!	!!	!!	!!	▲
Acido Nitrico	Nitric Acid	puro		▲	▲		▼	▼				!!		▲
Acido Nitrico	Nitric Acid	Fuming	!!		▲		!!	!!	!!	!!	!!	!!	!!	!!
Acido Ossalico	Oxalic Acid	10		▶	▶		▼	▶			!!	▲		▲

▲	Buona resistenza Good resistence	!!	Caratteristiche di resistenza insufficenti Insufficient resistence		informazioni mancanti information incomplete
▶	Moderata resistenza Moderately resistence	▼	assolutamente sconsigliato heedless		

Considerare temp. max di 24°C - Consider max temp.24°C

			CORPO POMPA-IDRAULICA-ALBERO MOTORE / PUMP BODY-HYDRAULICS-SHAFT MOTOR								TENUTA MECCANICA - MECH. SEAL			
LIQUIDO	LIQUID	CONC.%	Serie 400	AISI 304	AISI316	ACCIAIO AL CARBONIO	GHISA	BRONZO	OTTONE	PP	NBR	EPDM	GRAFITE	VITON
			Series 400	AISI 304	AISI316	CARBON STEEL	CAST IRON	BRONZE	BRASS	POLYPROPILENE	NBR	EPDM	GRAPHITE	VITON
Acido Ossalico	Oxalic Acid	50	►		▲		!!	!!		▲	!!	▲	▲	▲
Acido Solforico	Sulfuric Acid	3										►		▲
Acido Solforico	Sulfuric Acid	UP TO 30	!!		▲		!!	!!	!!	▲	!!	▲	▲	▲
Acido Solforico	Sulfuric Acid	30		▼	▲		▼	!!						
Acido Solforico	Sulfuric Acid	50	!!		▲		!!	!!	!!	▲	▲	▲	▲	▲
Acido Solforico	Sulfuric Acid	60	!!		►		!!	!!	!!	▲	!!	!!	▲	▲
Acido Solforico	Sulfuric Acid	70	!!		►		!!	!!	!!	▲	!!	!!	▲	▲
Acido Solforico	Sulfuric Acid	80	!!		!!		!!	!!	!!	▲	!!	!!	▲	▲
Acido Solforico	Sulfuric Acid	90	!!		!!		!!	!!	!!	!!	!!	!!	▲	▲
Acido Solforico	Sulfuric Acid	93	!!		!!		!!	!!	!!	!!	!!	!!	▲	▲
Acido Solforico	Sulfuric Acid	94	!!		!!		!!	!!	!!	!!	!!	!!	▲	▲
Acido Solforico	Sulfuric Acid	95	!!		!!		!!	!!	!!	!!	!!	!!	►	▲
Acido Solforico	Sulfuric Acid	96	!!		!!		!!	!!	!!	!!	!!	!!	!!	▲
Acido Solforico	Sulfuric Acid	98	!!		!!		!!	!!	!!	!!	!!	!!	!!	▲
Acido Solforico	Sulfuric Acid	FUMING	!!		►		!!	!!	!!	!!	!!	!!	!!	!!
Acido Solforoso	Sulfurous Acid	5												
Acido Solforoso	Sulfurous Acid	SAT'D.	►		▲		!!	!!	!!	▲		▲	▲	▲
Acido Tartarico	Tartaric Acid	circa 30		►	▲						▲	►		▲
Acido Tartarico	Tartaric Acid		▲		▲		!!	▲	!!	▲	▲	!!	▲	▲
Acqua Deionizzata	Water, Deionized											▲		
Acqua Deionizzata	Water, Deionized		►		▲		!!	►	!!	▲	▲	▲	▲	
Acqua Demineralizzata	demineralized water			►	▲		!!	▼	▼			▲		▲
Acqua Dissalata	desalinated water	100		▲	▲		!!				▲	▲		▲
Acqua distillata	Water, Distilled		▲		▲		►	▲	►	▲	▲	▲	▲	
Acqua Ionizzata	ionized water	100		▲	▲		!!	!!	!!		▲	▲		
Acqua Ossigenata	hydrogen peroxide			▲	▲						!!	!!		▲
Acqua Ragia Salata	White Spirit / Calcium Chloride	70/30		►	►		!!				▲	▲		▲
Acqua Salata	Water, Salt	30		►	►		▼							▲
Acqua Salata	Water, Salt		►		▲		!!	►	!!	▲	▲	▲	▲	

▲	Buona resistenza Good resistence	!!	Caratteristiche di resistenza insufficenti Insufficient resistence		informazioni mancanti information incomplete
►	Moderata resistenza Moderately resistence	▼	assolutamente sconsigliato heedless		

Considerare temp. max di 24°C - Consider max temp.24°C

			CORPO POMPA-IDRAULICA-ALBERO MOTORE / PUMP BODY-HYDRAULICS-SHAFT MOTOR								TENUTA MECCANICA - MECH. SEAL			
LIQUIDO	LIQUID	CONC.%	Serie 400	AISI 304	AISI316	ACCIAIO AL CARBONIO	GHISA	BRONZO	OTTONE	PP	NBR	EPDM	GRAFITE	VITON
			Series 400	AISI 304	AISI316	CARBON STEEL	CAST IRON	BRONZE	BRASS	POLYPROPILENE	NBR	EPDM	GRAPHITE	VITON
Acqua di Mare	Sea Water		▶		▶		‼	▶	‼	▲	▲	▲	▲	
Acqua + abrasivi	water + abrasives	sale marino		▲	▲		▶	▶			▲	▲		▲
Alcool Etilico	Ethyl Alcohol (Ethenol)	100		▲	▲						▶	▲		‼
Alcool Etilico	Ethyl Alcohol (Ethenol)		▲		▲	▲	▲	▲	▲	▲	▲	▲	▲	
Alcool Isopropilico	Alcohols:Isopropyl	100		▲	▲		▲	▲			▶	▲		▲
Alcool Isopropilico	Alcohols:Isopropyl		▲		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Amido	Starch		▲		▲	▶	▶	▶	▶		▲	▲		▲
Ammoniaca	AMMONIA, AQUEOUS	10	▶		▲	‼		‼	‼	▲	▶	▲	▲	▲
Ammoniaca	Ammonia	30		▶	▶		▶				▲	▲		▲
Ammoniaca	Ammonia	100		▶	▶		▶					▲		
AMMONIACA, GAS	AMMONIA, GAS	100			▲	▲	▲	▶	‼	▲	▲	▲	▲	‼
AMMONIACA, LIQUIDO	AMMONIA, LIQUID	100	▲		▲	▲		‼	‼	▲	▶	▲	▲	‼
Anidride Carbonica liq.	liquid carbon dioxide			▲	▲		‼				▲	▶		▶
Benzina + Acqua	Gasoline + Water	50	▲	▲	▲			▲			▲			▲
Benzina al piombo	Gasoline Leaded		▲		▲	▲	▲	▲	▲	‼	▲	‼	▲	▲
Benzina senza Piombo	Gasoline UnLeaded		▲		▲	▲	▲	▲	▲	‼	▲	‼	▲	▲
Bicarbonato Ammonio	ammonium bicarbonate											▲		
Ammonio Acetato	Ammonium Acetate	SAT'D			▶			‼	‼	▲		▲		
Ammonio Bifloruro	Ammonium Bifluoride	SAT'D	‼		▶	‼	‼	‼	‼		▲	▲	▲	▲
Ammonio Bisulfito	Ammonium Bisulfide										▲			
Ammonio Carbonato	Ammonium Carbonate	SAT'D	▶		▶	▲		‼	‼	▲		▲		▲

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Considerare temp. max di 24°C - Consider max temp.24°C

			CORPO POMPA-IDRAULICA-ALBERO MOTORE / PUMP BODY-HYDRAULICS-SHAFT MOTOR								TENUTA MECCANICA - MECH. SEAL			
LIQUIDO	LIQUID	CONC.%	Serie 400	AISI 304	AISI316	ACCIAIO AL CARBONIO	GHISA	BRONZO	OTTONE	PP	NBR	EPDM	GRAFITE	VITON
			Series 400	AISI 304	AISI316	CARBON STEEL	CAST IRON	BRONZE	BRASS	POLYPROPILENE	NBR	EPDM	GRAPHITE	VITON
Ammonio Cloruro	Ammonium Chloride	SAT'D	‼		►	‼	‼	‼	‼	▲	▲	▲	▲	▲
Ammonio Dicromato	Ammonium Dichromate										▲	▲	▲	
Ammonio Floruro	Ammonium Fluoride	10	‼		‼	‼		‼	‼		▲	▲	▲	
Ammonio Floruro	Ammonium Fluoride	25	‼		‼	‼		‼	‼			▲	▲	
Ammonio Idrossido	Ammonium Hydroxide	10	►		▲	‼		‼	‼	▲	►	▲	▲	▲
Ammoniaca Idrossido	Ammonia Hydroxide	SAT'D	►		▲	‼		‼		▲	‼	▲	▲	‼
Ammonio Nitrato	Ammonium Nitrate	SAT'D						‼	‼	▲	▲	▲	▲	▲
Ammonio Persolfato	Ammonium Persulphate		►		▲	‼	‼	‼	‼	▲		▲		
Ammonio fosfato Monobasico	Ammonium Phospate (monobasic)	ALL	▲		▲	‼	►	‼	‼		▲	▲	▲	▲
Ammonio Solfato	Ammonium Sulfate		►		►	‼	►	‼	‼	▲	▲	▲	▲	▲
Ammonio Solfito	Ammonium Sulfide	DILUTE			►	‼	‼	‼	‼		▲	▲		
Tiocianato di ammonio	Ammonium Thiocyanate	50-60			▲	‼	‼	‼	‼		▲			▲
Birra	Beer		▲		▲	‼	‼	▲	▲	▲	▲	▲		▲
Allume potassico	Potassium Alum										▲	▲		▲
Solfato di alluminio e potassio	Potassium Alluminum Sulphate		►		▲	‼			‼		▲	▲		▲
Amilxantato di potassio	Potassium Amyl Xanthale													
Potassio bicarbonato	Potassium Bicarbonate	SAT'D			▲	▲				▲	▲	▲		▲
Potassio bicromato	Potassium Bichromate	SAT'D	►		▲	►			►		▲	▲	▲	▲

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Considerare temp. max di 24°C - Consider max temp.24°C

			CORPO POMPA-IDRAULICA-ALBERO MOTORE / PUMP BODY-HYDRAULICS-SHAFT MOTOR								TENUTA MECCANICA - MECH. SEAL			
LIQUIDO	LIQUID	CONC.%	Serie 400	AISI 304	AISI316	ACCIAIO AL CARBONIO	GHISA	BRONZO	OTTONE	PP	NBR	EPDM	GRAFITE	VITON
			Series 400	AISI 304	AISI316	CARBON STEEL	CAST IRON	BRONZE	BRASS	POLYPROPILENE	NBR	EPDM	GRAPHITE	VITON
Bisolfato di potassio	Potassium Bisulfate				▲	!!	!!	►			▲	▲	▲	▲
Bromato di potassio	Potassium Bromate				▲	▲	!!			▲	▲			▲
Bromuro di Potassio	Potassium Bromide				▲	!!	!!	►		▲	▲	▲	▲	▲
Carbonato di Potassio	Potassium Carbonate		▲		▲	▲	▲	►	►	▲	▲	▲	▲	▲
Potassio clorato (acquoso)	Potassium Chlorate (Aqueous)		▲		▲	▲	▲	►		▲	►	▲	!!	▲
Cloruro di Potassio	Potassium Chloride		►		►	►	►		▲	▲	▲	▲		▲
Potassio cromato	Potassium Chromate				▲	►	►	▲			▲	▲	!!	▲
Potassio Cianato	Potassium Cyanide		▲		▲	►	►	!!	!!		▲	▲		▲
Dicromato di potassio	PotassiumDichromate	SAT'D	▲		▲	!!	►	►			▲	▲	!!	▲
Xantato di potassio	Potassium Ethyl Xanthate													
Potassio ferricianuro	Potassium Ferricyanide				▲	!!	►	!!			▲	▲		▲
Potassio ferrocianuro	Potassium Ferrocyananide		►		▲	!!	!!	►	!!		▲	▲		▲
Fluoruro di potassio	Potassium Fluoride				▲						▲	▲	▲	▲
Idrossido di potassio	Potassium Hydroxide	25	▲		▲	►	►	!!		▲	►	▲	▲	!!
Potassio ipoclorito	Potassium Hypochlorite				▲	!!		!!		!!	!!	!!		▲
Potassio ioduro	Potassium Iodide				▲	►		►		▲	▲	▲	▲	▲
Nitrato di potassio	Ptassium Nitrate		▲		▲	►	►	▲	►		▲	▲	!!	▲
Potassio di Nitrito	potassium nitrite													

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Considerare temp. max di 24°C - Consider max temp.24°C

LIQUIDO	LIQUID	CONC.%	CORPO POMPA-IDRAULICA-ALBERO MOTORE / PUMP BODY-HYDRAULICS-SHAFT MOTOR								TENUTA MECCANICA - MECH. SEAL			
			Serie 400	AISI 304	AISI316	ACCIAIO AL CARBONIO	GHISA	BRONZO	OTTONE	PP	NBR	EPDM	GRAFITE	VITON
			Series 400	AISI 304	AISI316	CARBON STEEL	CAST IRON	BRONZE	BRASS	POLYPROPILENE	NBR	EPDM	GRAPHITE	VITON
Potassio perborato	Potassium Perborate									▲	▲		▲	
Perclorato di potassio	Potassium Perchlorate										‼	▲		▲
Potassio permanganato	Potassium Permanganate	10	▲		▲	▲	▲	▶		▲	‼	▲		▲
Potassio permanganato	Potassium Permanganate	25	▲		▲	▲	▲	▶		▲	‼	▲		▲
Per solfato di potassio	Potassium Persulfate										‼	▲		▲
Potassio solfato	Potassium Sulfate		▲		▲	▲	▲	▲	▶	▲	▲	▲	▲	▲
Potassio solfuro	Potassium Sulfide		▶		▶	‼	‼	‼	‼		▲			▲
Solfito di potassio	Potassium Sulfite				▲	‼	‼	▶			▲	▲		▲
Tetraborato di potassio	Potassium Tetraborate				▲	▲					▲	▲	▲	▲
Potassio tripolifosfato	Potassium Tripolyphosphate				▲	▲	▲				▲		▲	▲
Carbonato di Sodio	sodium carbonate										▲	▲		
Sodio acetato	Sodium Acetate	SAT'D	▶		▲	‼	▶	▲		▲	‼	▲		‼
Solfato di alluminio e sodio	Sodium Alum					‼					▲	▲		▲
Sodio alluminato	Sodium Aluminate	SAT'D			▲	▲	▶	‼			▲	▲		▲
Sodio benzoato	Sodium Benzoate									▲	▲	▲		▲
Sodio bicarbonato	Sodium Bicarbonate		▲		▲	‼	▲	▲	▶	▲	▲	▲		▲
Bicromato di sodio	Sodium Bichromate	SAT'D	▲		▲			‼		▲	▲	▲	‼	▲
Sodio bisolfato	Sodium Bisulfate		▶		▲	‼	‼	‼	‼	▲	▲	▲		▲
Sodio bisolfito	Sodium Bisulfite				▲	‼	‼	▶		▲	▲	▲		▲
Sodio tetraborato	Sodium Borate (Borax)	SAT'D	▲		▲		▶	▲		▲	▲	▲	▲	▲
Sodio bromuro	Sodium Bromide	SAT'D			▲	‼	‼	▶		▲	▲	▲	▲	▲
Sodio carbonato	Sodium Carbonate				▲	▲	▲	▲	▶	▲	▲	▲		▲

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			CORPO POMPA-IDRAULICA-ALBERO MOTORE / PUMP BODY-HYDRAULICS-SHAFT MOTOR								TENUTA MECCANICA - MECH. SEAL			
LIQUIDO	LIQUID	CONC.%	Serie 400	AISI 304	AISI316	ACCIAIO AL CARBONIO	GHISA	BRONZO	OTTONE	PP	NBR	EPDM	GRAFITE	VITON
			Series 400	AISI 304	AISI316	CARBON STEEL	CAST IRON	BRONZE	BRASS	POLYPROPILENE	NBR	EPDM	GRAPHITE	VITON
Sodio clorato	Sodium Chlorate	SAT'D	►		▲	►	►	▲		▲	►	►		▲
Sodio cloruro	Sodium Chloride		▲	►	►	►	►	►	▲	▲	▲	▲		▲
Clorito di sodio	Sodium Chlorite	25									‼	‼	‼	‼
Sodio cromato	Sodium Chromate		▲		▲	►	►	▲			▲	▲	‼	▲
Sodio cianuro	Sodium Cyanide				▲	▲	‼	▲	‼	▲	▲	▲	▲	▲
Dicromato di sodio	Sodium Dichromate	20			▲	►	►	‼		▲	‼	▲	‼	▲
Ferricianuro di sodio	Sodium Ferricyanide	SAT'D			▲		‼	‼		▲	▲	▲		▲
Ferrocianuro di sodio	Sodium Ferrocyanide	SAT'D			▲						▲	▲		▲
Sodio fluoruro	Sodium Fluoride				▲	‼	‼	▲		▲	▲	▲	▲	▲
Sodio Idrossido	Sodium Hydroxide	<10	▲		▲	▲		▲		▲	▲	▲	▲	‼
Soda Caustica e H2O	Sodium Hydroxide (Caustic Soda) + H2O	<30		►	▲		►				▲	▲		►
Sodio Idrossido (soda caustica)	Sodium Hydroxide (Caustic Soda)	30	▲		▲	►		▲		▲	▲	▲	▲	►
Sodio Idrossido	Sodium Hydroxide	50	▲		▲	►	►	►	‼	▲	‼	▲	▲	‼
Sodio Idrossido	Sodium Hydroxide	70	▲		▲	►	►	‼	‼	▲	‼	▲	▲	‼
Sodio Ipoclorito	Sodium Hypochlorit	<20		‼	‼		▼				►	►		▲
Sodio Ipoclorito	Sodium Hypochlorite	5	‼		‼	‼	‼	‼	‼	►	‼	▲		▲
Sodio Ipoclorito	Sodium Hypochlorite	SAT'D	‼		‼	‼	‼	‼	‼	‼	‼	‼		▲
Ioduro di sodio	Sodium Iodide												▲	
Sodio metafosfato	Sodium Metaphosphate				▲	‼	‼	‼		▲	▲	▲	▲	▲
Sodio nitrato	Sodium Nitrate	SAT'D	▲		▲	▲	▲	▲	►	▲	▲	▲	▲	▲
Nitrito di sodio	Sodium Nitrite				▲	►	►	▲			‼	▲		▲
Palmitato di sodio	Sodium Palmitate	5												
Sodio perborato	Sodium Perborate		▲		▲	►	►	‼		▲	▲	▲	▲	▲
Perclorato di sodio	Sodium Perchlorate										►			

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			CORPO POMPA-IDRAULICA-ALBERO MOTORE / PUMP BODY-HYDRAULICS-SHAFT MOTOR								TENUTA MECCANICA - MECH. SEAL			
LIQUIDO	LIQUID	CONC.%	Serie 400	AISI 304	AISI316	ACCIAIO AL CARBONIO	GHISA	BRONZO	OTTONE	PP	NBR	EPDM	GRAFITE	VITON
			Series 400	AISI 304	AISI316	CARBON STEEL	CAST IRON	BRONZE	BRASS	POLYPROPILENE	NBR	EPDM	GRAPHITE	VITON
Sodio perossido	Sodium Peroxide		▲		▲	‼	‼	‼	‼		►	▲	‼	▲
Fosfato di sodio	Sodium Phosphate	ACID	▲		▲	►	►	►	►	▲	▲	▲	▲	▲
Fosfato di sodio	Sodium Phosphate	ALKALINE	▲		▲	►	►	►	►	▲	▲	▲	▲	▲
Fosfato di sodio	Sodium Phosphate	NEUTRAL	▲		▲	►	►	►	►	▲	▲	▲	▲	▲
Silicato di Sodio	Sodium Silicate		▲	▲	▲	▲	▲	►		▲	▲	▲		▲
Sodio solfato	Sodium Sulfate	SAT'D	▲		▲	▲	▲	▲	►	▲	▲	▲	▲	▲
Sodio solfuro	Sodium Sulfide		▲		▲	‼	►	‼	‼	▲	▲	▲		▲
Sodio Solfito	Sodium Sulfite		►	▲	▲	►	►	▲		▲	▲	▲		▲
Tiosolfato di sodio	Sodium Thiosulphate				▲	‼	‼	►		▲	▲	▲		▲
Acqua Clorinata	Chlorinated Water	Liquid	►		▲	‼		►	‼		‼	►	▲	▲
Acqua Clorinata	Chlorinated Water	<3500 PPM	‼		▲	‼		‼	‼	‼	‼	‼	▲	▲
Calcio cloruro	Calcium Chloride		►	►	▲	‼	▲	►	►	▲	▲	▲	▲	▲
Calcio bisolfuro	Calcium Bisulfide				▲						▲			▲
Calcio bisolfito	Calcium Bisulfite		►		▲	‼	‼	‼	‼	▲	▲	‼		▲
Calcio carbonato	Calcium Carbonate		▲		▲	►	►	‼	‼	▲	▲	▲		▲
Calcio clorato	Calcium Chlorate		►		▲	►	►	►	►		▲	▲	▲	▲
Calcio idrossido	Calcium Hydroxide		▲	▲	▲	‼	‼	►	‼	▲	▲	▲		▲
Calcio ipoclorito	Calcium Hypochlorite		►		►	‼	‼	‼	‼	▲	‼	▲	▲	▲
Calcio nitrato	Calcium Nitrate				▲		►	►	►	▲	▲	▲	‼	▲
Calcio ossido	Calcium Oxide				▲	►	▲				▲	▲		
Calcio solfato	Calcium Sulfate		▲	▲	▲	►	▲	▲	►		▲	▲	▲	▲
Magnesio cloruro	Magnesium Chloride		‼	►	‼	‼	‼	▲	►	▲	▲	▲	▲	▲
Magnesio carbonato	Magnesium Carbonate		▲		▲	►	►	►			▲	▲		▲
Citrato di magnesio	Magnesium Citrate										▲	▲		▲
Fluoruro di magnesio	Magnesium Fluoride				►							▲	▲	▲
Magnesio ossido	Magnesium Oxide							▲			▲	▲		
Magnesio solfato	Magnesium Sulfate		▲		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲

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			CORPO POMPA-IDRAULICA-ALBERO MOTORE / PUMP BODY-HYDRAULICS-SHAFT MOTOR								TENUTA MECCANICA - MECH. SEAL			
LIQUIDO	LIQUID	CONC.%	Serie 400	AISI 304	AISI316	ACCIAIO AL CARBONIO	GHISA	BRONZO	OTTONE	PP	NBR	EPDM	GRAFITE	VITON
			Series 400	AISI 304	AISI316	CARBON STEEL	CAST IRON	BRONZE	BRASS	POLYPROPILENE	NBR	EPDM	GRAPHITE	VITON
Etilcloruro	Ethyl Chloride		▲		▲	▲	▲	▲		▲	‼	►	▲	▲
Etilacetato	Ethyl Acetate		▲		▲	▲	▲	▲		▲	‼	▲		‼
Acetacetato di etile	Ethyl Acetoacetate										‼	▲		‼
Etilacrilato	Ethyl Acrylate		▲		▲	▲	▲	▲			‼	▲		‼
Etil benzene	Ethyl Benzyne				▲	►	►	►		‼	‼	‼		▲
Etilcloroacetato	Ethyl Chloroacetate													
Etilene bromuro	Ethylene Bromide				▲	▲		▲		‼	‼	‼		►
Etilene cloruro	Ethylene Chloride				▲					▲	‼			▲
Etilencloridrina	Ethylene Chlorohydrin									▲	‼	▲	▲	‼
Etilendiammina	Ethylene Diamine		▲			▲	▲	▲	▲	▲	▲	▲		
Etilene bicloruro	Ethylene Dichloride				▲	▲	▲	▲		▲	‼	‼	▲	▲
Etilenglicole	Ethylene Glycol		▲		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Etilene ossido	Ethylene Oxide				▲	▲	►	▲		‼	‼	‼		‼
Etil etere	Ethyl Ether									‼	‼	‼		‼
Etilformiato	Ethyl Formate				▲	▲	▲	▲			‼			‼
2-etilesanolo	2-Ethythexanol													
Etilmercaptano	Ethyl Mercaptan				▲	▲							▲	
Etilossalato	Ethyl Oxalate										‼	▲		
Detergenti	Detergents (Heavy Duty)		▲		▲	▲	▲	▲	▲	▲	▲	▲		▲
Esano	Hexane	100		▲	▲		▲	▲			▲	▼		▲
n-Esano	n-Hexane		▲		▲	▲	▲	▲		▲	▲	‼		▲
Esanolo	Hexanol		▲		▲	▲	▲	▲			▲	‼		▲
Fenolo	Phenol		▲		▲	‼	‼	▲		▲	‼	▲	▲	▲
Formaldeide	Formaldehyde			▲	►		▼		►			►		
Formaldeide	Formaldehyde	Dilute	▲		▲	►	‼	▲		‼	‼	▲	▲	‼
Formaldeide	Formaldehyde	35%	▲		▲	►	‼	▲		‼	‼	▲	▲	‼
Formaldeide	Formaldehyde	37%	▲		▲	►	‼	▲		‼	‼	▲	▲	‼
Formaldeide	Formaldehyde	50%	►		▲	►	‼	►		‼	‼	▲	▲	‼
Freon 111	Freon 111	100		▲	▲									►

▲	Buona resistenza Good resistence	‼	Caratteristiche di resistenza insufficenti Insufficient resistence		informazioni mancanti information incomplete
►	Moderata resistenza Moderately resistence	▼	assolutamente sconsigliato heedless		

Considerare temp. max di 24°C - Consider max temp.24°C

			CORPO POMPA-IDRAULICA-ALBERO MOTORE / PUMP BODY-HYDRAULICS-SHAFT MOTOR								TENUTA MECCANICA - MECH. SEAL			
LIQUIDO	LIQUID	CONC.%	Serie 400	AISI 304	AISI316	ACCIAIO AL CARBONIO	GHISA	BRONZO	OTTONE	PP	NBR	EPDM	GRAFITE	VITON
			Series 400	AISI 304	AISI316	CARBON STEEL	CAST IRON	BRONZE	BRASS	POLYPROPILENE	NBR	EPDM	GRAPHITE	VITON
Freon 113 (R113)	Freon 113		▲	▲	▲	►	►	▲	▲		▲	‼	▲	▲
Freon 12	Freon 12		▲	►	▲	►	►	▲	▲	▲	▲	►	▲	▲
Freon 11	Freon 11		▲		▲	►	►	▲	▲		▲	‼	▲	▲
Freon 21	Freon 21		▲		▲	►	►	▲	▲		‼	‼	▲	‼
Freon 22	Freon 22		▲		▲	►	►	▲	▲	▲	‼	‼	▲	‼
Freon 114	Freon 114		▲		▲	►	►	▲	▲		▲	‼	▲	‼
Diesel (Gasolio)	Diesel Fuels		▲		▲	▲	▲	▲	▲		▲	‼		▲
Glicerina	Glycerin		▲		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Glicole Dietilenico	Di-ethylene glycol	100		▲	▲						▲	▲		▲
Glicole Propilenico	Propylene Glycol	<25	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Glicole Propilenico	Propylene Glycol	>25	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Glicole Triet.(Paraflù)	triethylene glycol (Paraflu)	50	▲	▲	▲							▲		►
Glicolammina	Glycol Amine				▲	▲	▲	‼		▲	‼			▲
Acido glicolico	Glycolic Acid				▲	‼	‼	►			‼			
Etilenglicole	Ethylene Glycol		▲		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Kerosene	Kerosene			▲	▲	▲	▲	▲	▲	▲	▲	‼	▲	▲
Latte	Milk		‼	▲	▲	‼	‼	►	►	▲	▲	▲		▲
Siero di latte	Milk (Butter)			▲	▲		▼				▼	▼		▲
Latte di Calce		5 di Calce		►	▲		►					▲		
Olio di Lino	Linseed Oil		▲	▲	▲	▲	▲	▲	▲	▲	▲	►		▲
Olio Minerale	Mineral Oil		▲	▲	▲	▲	▲	▲	▲	▲	▲	‼		▲
Ozono	Ozone		▲		▲	▲	▲	▲	▲		‼	▲	‼	▲
Percloroetilene	Perchloroethylene		▲	►	▲	►	►	►			‼	‼		▲
Percolato														
Perossido Idrogeno	Hydrogen Peroxide	50	▲		▲	►	‼	‼	‼	▲	‼	▲	▲	▲
Idrogeno Perossido	Hydrogen Peroxide	90	▲		▲	►	‼	‼	‼		‼	‼	‼	▲
Profumo	perfume	100		▲	▲							▲		
Sapone liquido puro	Liquid soap pure	100		▲	▲		▼	▼			►	▲		►
Saponi liquidi	Liquid soap		▲	▲	▲	►	►	►		▲	▲	▲		▲

▲	Buona resistenza Good resistence	‼	Caratteristiche di resistenza insufficenti Insufficient resistence		informazioni mancanti information incomplete
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Considerare temp. max di 24°C - Consider max temp.24°C

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LIQUIDO	LIQUID	CONC.%	Serie 400	AISI 304	AISI316	ACCIAIO AL CARBONIO	GHISA	BRONZO	OTTONE	PP	NBR	EPDM	GRAFITE	VITON
			Series 400	AISI 304	AISI316	CARBON STEEL	CAST IRON	BRONZE	BRASS	POLYPROPILENE	NBR	EPDM	GRAPHITE	VITON
Solfato di Alluminio	Aluminum Sulfate (Alum)	30	▶	▲	▲		▼	▶			▲	▲		▲
Solfato di alluminio	Aluminum Sulfate (Alum)	SAT'D	‼			‼	‼	‼	‼	▲	▲	▲	▲	▲
Solfato di Ferro	Ferric Sulfate	5		▶	▲		▼					▲		
Solfato di Ferro	Ferric Sulfate		▶		▲	‼	‼	‼	‼	▲	▲	▲	▲	▲
Solfato di Rame	Copper Sulfate	SAT'D	▲	▶	▲	‼	‼	‼	‼	▲	▲	▲	▲	▲
Succo d'Arancia concent	Juice:										▲	▲		▲
Succo d'Arancia Tropica	Juice:										▲	▲		▲
Succo di Pomodoro	Tomato Juice				▲	▶	‼	▶		▲	‼	▲		▲
Succo di Pompelmo	grapefruit juice										▲	▲		▲
Toluene	Toluene (Toluol)		▲		▲	▲	▲	▲	▲	‼		‼		▲
Trielina/Acetone/Toluol	trichloroethylene/acetone/toluene	100		▶	▲		▶				▶	▲		‼
Acetone	Acetone		▲		▲	▲	▲	▲	▲	‼	▲	▲	▲	‼
Tricloroetilene	Trichloroethylene		▲	▲	▲	▶	▶	▲	▲	‼	‼	‼	▲	▲
Trietilammina	Triethylamine	100		▲	▲						▲	▼		‼
Urina	Urine		▲		▲	‼	‼			▲	▲	▲		▲
Vaselina	Vaseline (Petroleum Jelly)		▲		▲	▲	▲			▲	▲	‼		▲
Vino	Wine		▶		▲	‼	‼	‼		▲	▲	▲		▲
Vodka	Vodka	100		▲	▲						▶	▲		‼
Whiskey	Whiskey		▶	▲	▲	‼	‼	‼		▲	▲	▲		▲
Yoghurt	Yoghurt										▲			
Zucchero + Acqua 65° Brix	Sugar + Water	circa30		▲	▲						▲	▲		▲

▲	Buona resistenza Good resistence	‼	Caratteristiche di resistenza insufficenti Insufficient resistence		informazioni mancanti information incomplete
▶	Moderata resistenza Moderately resistence	▼	assolutamente sconsigliato heedless		

Considerare temp. max di 24°C - Consider max temp.24°C

IMPROPER USE
Troble snooting

- ✓ *Let's learn how to read the data from the pump plate*
- ✓ *Impurities from the heating system*
- ✓ *Overheating of the motor*
- ✓ *Too many cycles*
- ✓ *Knocking*
- ✓ *Excess pressure*
- ✓ *The mechanical seal: wear and thermic shock*
- ✓ *Pitting and stray currents*
- ✓ *Windings: possible malfunctions*
- ✓ *Submerged motors*



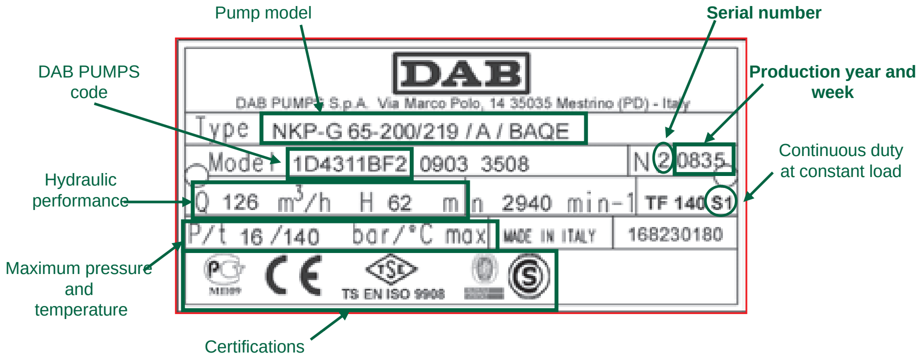

After purchasing a genuine original product, to avoid problems DAB PUMPS SPA recommends taking time to read the instructions and maintenance handbook supplied in the pack in order to gain familiarity with the product and its possible applications and to comply with any recommendations given.

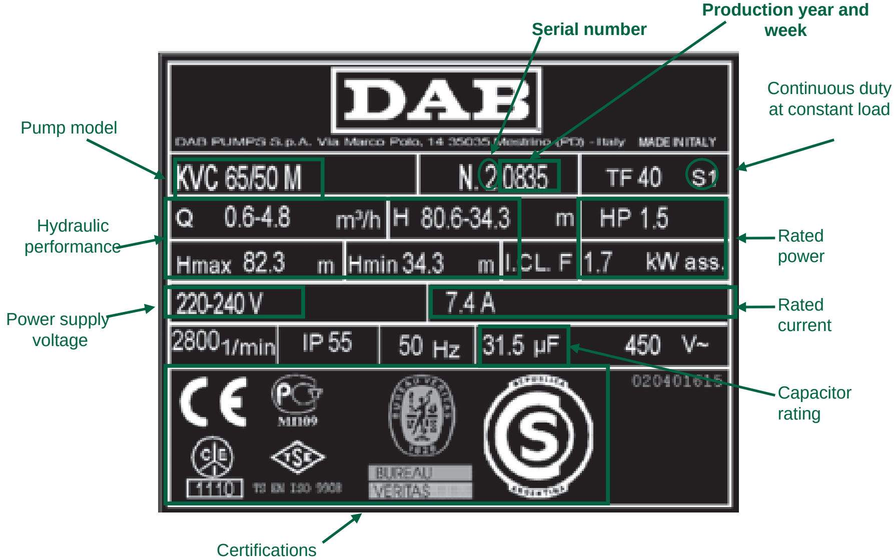
The following chapter describes some of the experiences of our technical service organisation over the years, with photos showing damaged products and explanations of the relative causes and the corrective actions to implement to prevent the recurrence of such situations.

It is not infrequent to find that replacing or repairing a pump fails to allow the user to achieve a definitive solution to his problems. That's why DAB PUMPS SPA offers a dedicated telephone helpline and an e-mail address for technical service queries, and that’s why we want to inform customers of our service experience by means of this manual, which offers a summary of classic measures to be adopted to solve or avoid the most common problems.

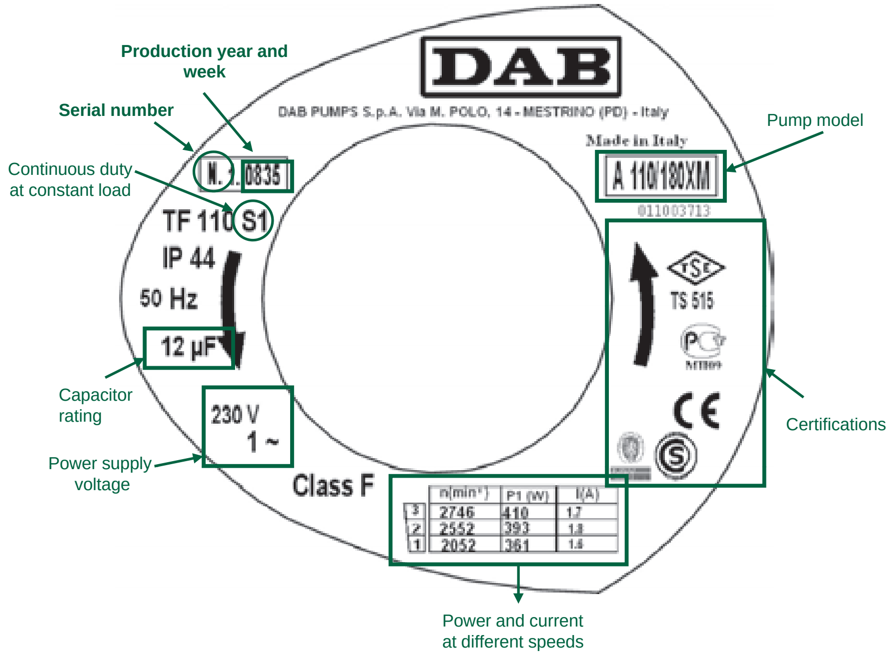
Customers often request the replacement or repair of products under warranty, but it must be remembered that our technical service organisation is unable to check whether the product is covered by the warranty unless we know exactly what happened to cause the problem.
First of all we recommend that customers read the general conditions of sale of DAB PUMPS given in the price lists, followed by careful consultation of this manual, which is designed to help users find the cause of the most frequently encountered problems on certain DAB products.

INTRODUCTION:
Learn how to read the nameplates and the production dates of various pump models





INTRODUCTION:
Learn how to read the nameplates and the production dates of various pump models



	n[min⁻¹]	P1 (W)	I(A)
3	2746	410	1.7
2	2552	393	1.8
1	2052	361	1.6

CIRCULATORS

Water is not always clean ...

Photo 1

Photo 2

- Most damage occurring to circulators is due to poor water quality (see page ...). Water quality actually plays a very important role in relation to the reliability and lifetime of circulator pumps. During its life, a heating system is topped up with fresh water with high contents of oxygen and calcium carbonates which can lead to calcium deposits **(limestone)** resulting in corrosion of steel and cast iron parts of the circulator.

- In order to guarantee the durability of a new circulator we recommend checking to ensure that the circuit piping is **clean.** Also this factor is critical in relation to the lifetime of the circulator: if the piping is fouled this may result in damage to certain parts of the pump. When installing a new circulator on an existing system it is advisable to perform a process of sanitation, protection, and descaling of the central heating circuits.

- We also recommend devoting particular attention to the choice of a circulator to replace an "old" circulator in a central heating system. In fact, when the original circulator is replaced it is important not to install a higher performance unit to avoid the risk of creating higher noise levels in the system.

- Photos 1 show erosion of the rotor assembly due to the fact that the circulator is conveying water containing abrasive solid residues.

- In photos 2 the material coating rotor indicates, here too, problems with the level of fouling in the piping and significant amounts of limescale in the circuit.

Water is not always clean ...

The above photos show the residues that deposit on the circulator when the pumped liquid is highly contaminated. Deposits of red-brown colour material are an indicator of significant levels of fouling.
The components of a circulator that can be irreparably damaged by fouled piping and contaminated water are: thrust box ceramics, rotor shaft, stator sleeve and bushings.

Water is not always clean ...

These photos provide further evidence of circulators subject to the deposit of red-brown coloured residues in the circuit in which they were installed.

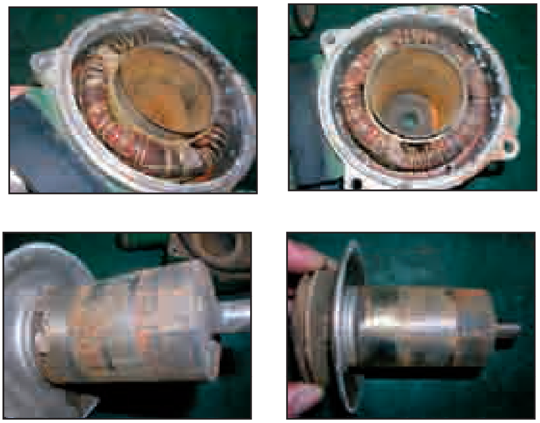


Photo 1

Photo 1 shows damage to the sleeve caused by continuous erosion between the rotor assembly and the steel sleeve, which leads initially to high noise levels and subsequently to leakage of water via the bushing.

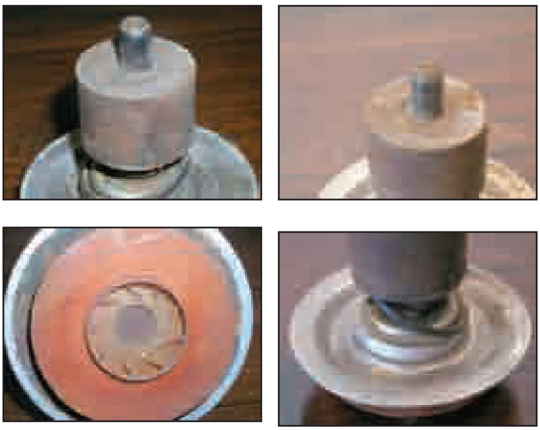


Photo 2

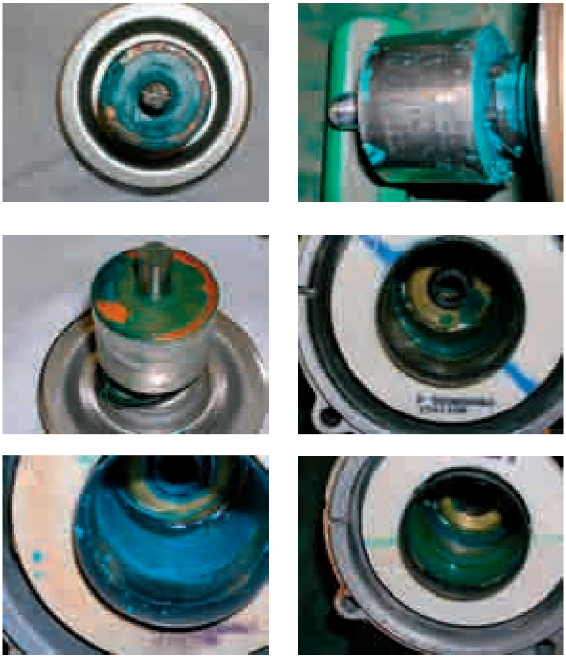
Photo 2 shows an anomalous coating of rotating parts indicating constant deposits which have eventually led to seizure of the circulator.

Note also that insufficiently clean piping can lead to pressure drops that are so considerable that the hydraulic performance of the circulator becomes insufficient in relation to the circuit in which has been installed.

CIRCULATOR SEIZED?
Hard water with high calcium contents

This circulator shows evident signs of limescale deposit on the rotor shaft.
Situations of this type inevitably lead to mechanical seizure resulting in the need to renew the circulator.
The increased diameter of the shaft, held in the front bushing, is one of the most commonly occurring phenomena due to limestone deposits.

CIRCULATOR SEIZED?
Solidified glycol



Circulators can sometimes seize because the pumped liquid is not in compliance with the operating specifications.
In the circulators shown in the photos the glycol contents of the fluid have solidified causing rotating parts of the pump to jam. This situation suggests that glycol was injected into the plant without mixing it properly with the water. The percentage of glycol used in circuits equipped with standard circulators can be as much as 30%, while with solar panel systems (equipped with special VSA type circulators) the contents can be up to 60%.

Damage due to overpressure




Breakages such as those of the circulator shown in the above photos are caused by overpressures that may occur while filling the circuit. This circulator was subjected to such a high pressure value that it caused the motor casing to rupture. By way of example, if we consider that a circulator specified as PN 10 is required to withstand a pressure that is higher by 10 bar, tests performed in our R&D laboratory show that this kind of breakage occurs at pressure values that are 2-3 times higher than the nominal pressure.

PRESSURE **bar**	**PRESSURE DURATION** **minutes**	**RESULT**
3	2	ok
6	2	ok
9	2	ok
13	120	ok
33	/	rupture

MORE EXAMPLES OF DAMAGE DUE TO IMPROPER USE

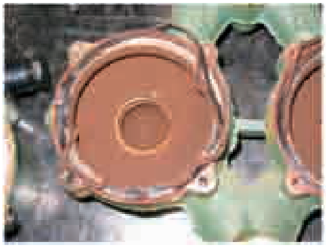
Pumping of oily liquids

During the analysis of circulator pumps in our Test Room we noticed a strong odour of fuel oil - especially after having removed the motor from the pump body, where we noted the presence of oily residues inside the volute and motor casing.
Moreover, since the the O-rings and clapet type valves of the circulators are made of EPDM (which tends to swell in contact with oil), these components showed signs of distortion and damage.

VD 55/220.32M

Condition of twin circulator

Leakage from condensate drain



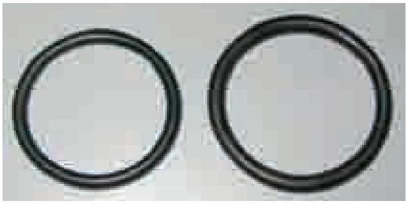
Cause for leak from condensate drain
Damaged body seal

Traces of oil and contamination on impeller

Pumping of oily liquids

Swollen flange and thrust box O-ring

Damaged motor casing sealing O-ring



new deformed

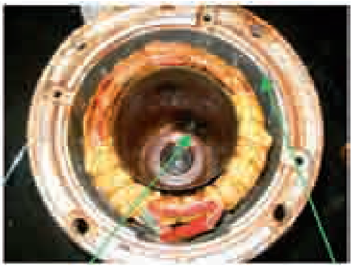
Dimensions:

new 32.92 x 3.53

deformed 36.5 x 4.2

BPH 120/280-50T

Leakage zone on BPH 120/280-50T



Damaged O-ring, traces of fuel oil in motor

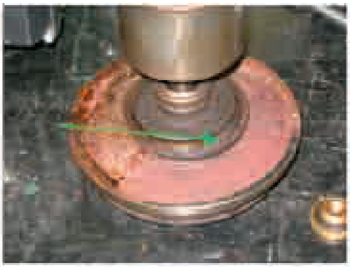
Pumping of oily liquids

DMH 60/280-50T

DMH 60/280-50T leakage zone

Clapet type valve jammed in mid position due to swelling

Traces of oil



Deformed flange – motor casing sealing O-ring

CONCLUSIONS:

The cause for leaks from condensate drains is attributable to pumping of water mixed with fuel oil, which degrades the seals and impairs their efficiency.

Pumping of liquids containing contaminants and solid debris

Photo 1

Photo 2

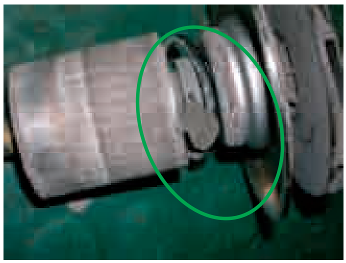


Photo 3

The solid debris shown in Photo 3 indicates that the circulator was installed in a system in which the piping is dirty and scaled up.
In this case scale build-up on the rotor shaft has resulting in a breakdown of the entire heating system.
We therefore stress the importance of checking the operating conditions of a circulator before being able to guarantee its reliability and lifetime.

MOTOR OVERHEATING?
incorrect electrical connection





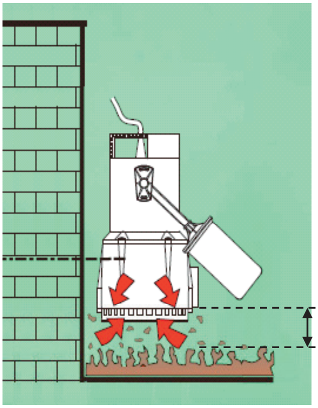
Before starting the circulator it is good practice to check the electrical connection, because up to motor power of 2.2 kW the windings connection can be either delta type (Δ for V=3x230V) or star type (Y for V=3x400V).
From the above photos we can see that the motor windings have overheated because the motor shaft and bearings display a purple coloration, which is a typical sign of the fact that temperatures above 160 °C have been reached. Power supplies with the incorrect voltage can lead to overheating of the shaft and bearings with consequent damage and also reduction of the speed of the pump and hence its hydraulic performance.

EXCESSIVE ELECTROPUMP NOISE LEVELS?

Excessively noisy operation of a pump is frequently due to oxidation of bearings. This situation may occur not only due to leaks from the mechanical seal, but also, for example, due to flooding of the installation site, as in the case of the photos below. Here we can see that the stator winding insulation is in good condition, but the bearings are damaged so the pump runs noisily. In the case of flooding of the pump room there may also be a film of rust on the stator pack and on the rotor.

DRAINAGE PUMPS

For correct installation



We always advise installers to avoid resting NOVA-FEKA-DRENAG-GRINDER series drainage pumps on the bottom of the sump to prevent sludge deposits from obstructing normal running of the impeller and causing motor damage due to operation under strain or with a seized rotor.
We also stress the importance of reading the booklet supplied in the pack thoroughly because it contains comprehensive installation and maintenance instructions.

Maintenance and checking

Maintenance, checking, and cleaning of drainage pumps are extremely important operations in order to ensure lasting efficient operation. The above photos show examples of heavy incrustations and deposits - also in the area of the float - caused by poor maintenance of the systems in which the pumps were installed. Scale build-up in the area of the float can cause the float to jam resulting in the risk of flooding of the protected premises.

DRAINAGE PUMPS

Pumping of water mixed with sand

A test was conducted in the laboratory to assess the impact on the microcast AISI 304 stainless steel rotor of a drainage pump working with water mixed with sand. The quantity of sand dissolved in the liquid was in the order of 1%, with a max. dimension of Ø 2 mm.

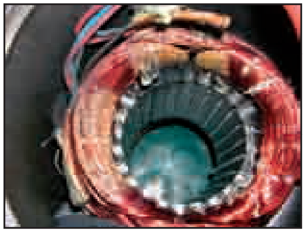
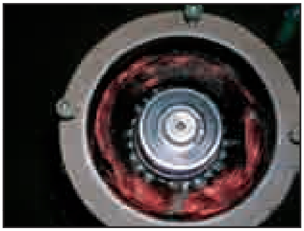
Rotor for FEKA VX 1000 which has worked with sand for 3500 hours (146 days continuous functioning)

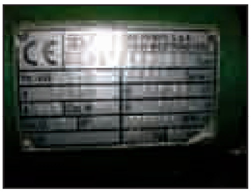
New rotor for FEKA VX 1000

Rotor for FEKA VX 1000 with blades worn by the sand

New rotor for FEKA VX 1000, blades show no signs of wear

Pay attention to the DIRECTION OF ROTATION of pumps driven by a three-phase motor!!!

These photos show an example of a winding of the motor coupled to a FEKA 2500.2T pump; the motor has burned out due to an overload.

In this case the overload is caused by the pump running in the wrong direction.

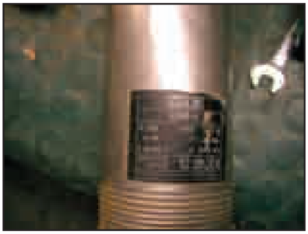
In this context, note that FEKA 2500-3000-4000-6000 series pumps provide the same hydraulic performance with both motor run directions. However, the motor current draw will be approximately 30% higher than the nominal value in the case of incorrect run direction.

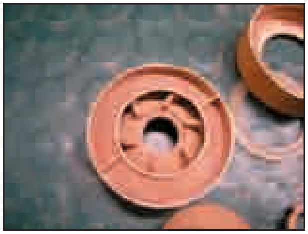
To check the correct run direction, prior to installation proceed as described below (as also indicated in the installation and maintenance manual of this series of electropumps):

•Incline the electropump on one side and keep it suspended in a safe position.

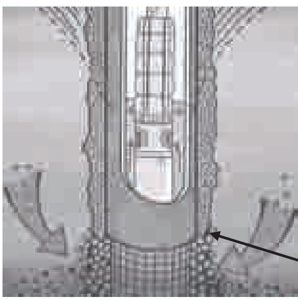
•Run the electropump momentarily and observe the direction of recoil when the motor starts. The correct direction of rotation corresponds to a counterclockwise recoil movement when observing the unit from the top.

4" SUBMERGED PUMPS





The reason for the impairment of performance of a submerged pump serving an irrigation system is to be sought in the presence of a high level of sand/mud (more than 120 g/m3 for DAB 4" pumps). The photos show an example of a 4" submerged pump with pronounced abrasion of the impeller that has caused a reduction in hydraulic performance values.
In this case we recommend checking the well and the check valve. The check valve may be faulty creating constant back pressure, resulting in destruction of the natural filter created by the gravel surrounding the well.



Natural filter composed of gravel, pebbles, etc....

Too many cycles!!!
For a submersible pump





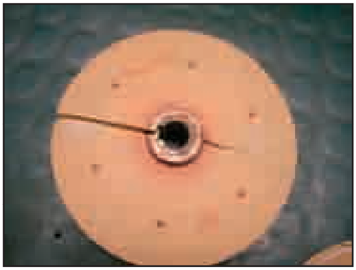

Too many starts in an excessively short time interval can damage the pump and stress the motor windings electrically and, in cases, also the capacitor. The causes of continuous start-stop cycles of a submersible pump can be:

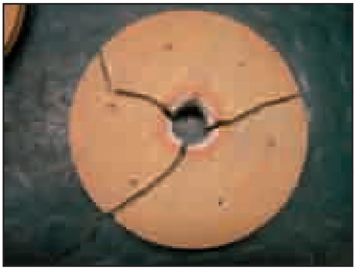
-excessively small sump, which tends to fill too fast. The pump starts each time the sump is full and stops when it has been emptied. The effective volume of the sump should be equivalent to one quarter of the quantity of water to be drained in one hour.

-absence of a check valve on the pump discharge line or damaged check valve. This results in back pressure which causes the pump to start repeatedly.

The photos show a pump with the run winding and capacitor burnt out due to an excessive number of repeated starts.

Too many cycles!!!
For a surface pump





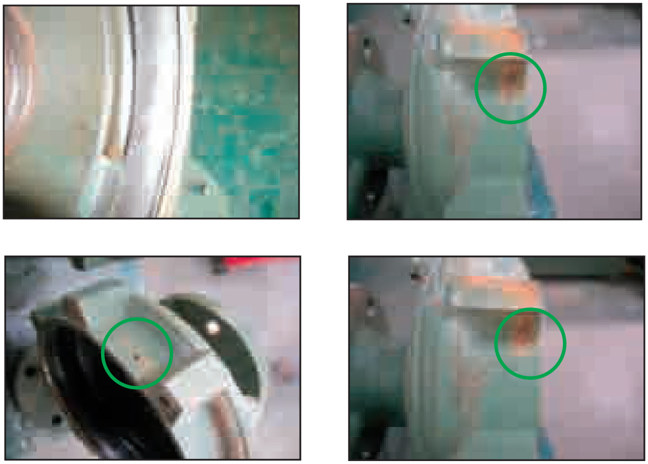
The type of breakage of impellers and failure of the insert, as shown in the above photos, may occur in the case of a pump operating in high mechanical stress conditions. The factors that can cause this **fatigue failure** in pressurisation plants may be as follows:

-Incorrect precharging of pressure vessels, usually too low (see page 54 to find the correct precharge pressure value);

-Excessively small delta pressure setting on pressure switch. In this case the pump performs a start-stop cycle whenever even a minimum amount of water is lifted.

Fatigue is a mechanical phenomenon whereby a material subjected to variable loads through time (in a regular or random manner) is damaged to the point of breakage even though the maximum intensity of the loads in question is significantly lower than the breaking strength or static yield strength of the material in question.

Pumping river water without a filter...



The pump body in the above photos displays eroded areas caused by solid particulate in the liquid drawn in by the pump (in this case the pump is drawing in river water directly without interposed filters).
A level of turbulence has been created in the pump body such that the particles in the liquid have caused localised erosion of the cast iron to the point that clearly visible holes have formed.

PULSAR



The above photos show several components of the hydraulic section of a PULSAR submerged pump that has clearly been employed to pump very dirty liquid.

The ferrous residues, which are present in the form of small dust particles (see above photos), but especially the soil and mud drawn in by the pump (as shown by the photos below) can damage the seals and the hydraulic part.
The direct consequence of this is the infiltration of water, which can result in irreversible damage to the motor casing.

Tip for correct installation: keep the electropump at least 1 m from the bottom in such a way that any deposits that form after installation are not drawn in (see Fig. 1)



example

Incorrect installation:
submerged pump located in contact with the soil.
Cause of damage:
pump is drawing a mixture of liquid, soil and mud.
Effect:
damage of the hydraulic part with consequent infiltration of water into the motor.

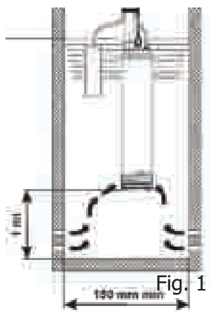


Fig. 1

WATER HAMMER

These photos show the case of a pump whose body has been damaged over the entire volute because of water hammering.

A **water hammer** is a phenomenon that occurs in a pipeline when the water flowing in it is stopped abruptly by the sudden closing of a valve.

This causes a pressure shock that starts at the valve because of the inertia of the moving column of water that impacts against the wall of the closed valve.

The pressure generated depends on the pipeline dimensions (length and diameter), the velocity of the fluid, and, above all, the closing time of the valve.

Practical recommendations to reduce or eliminate the problem of damage due water hammer pressure surges: fit a check valve on the pipeline, install an expansion vessel with adequate precharging pressure (see page 54).

WATER HAMMER and OVERPRESSURE

It may occur that the water hammer phenomenon occurs with such intensity, especially in plants with long large diameter pipes, as to damage also the expansion vessels.
The photo shows an example of expansion vessels damage caused by very high overpressure.

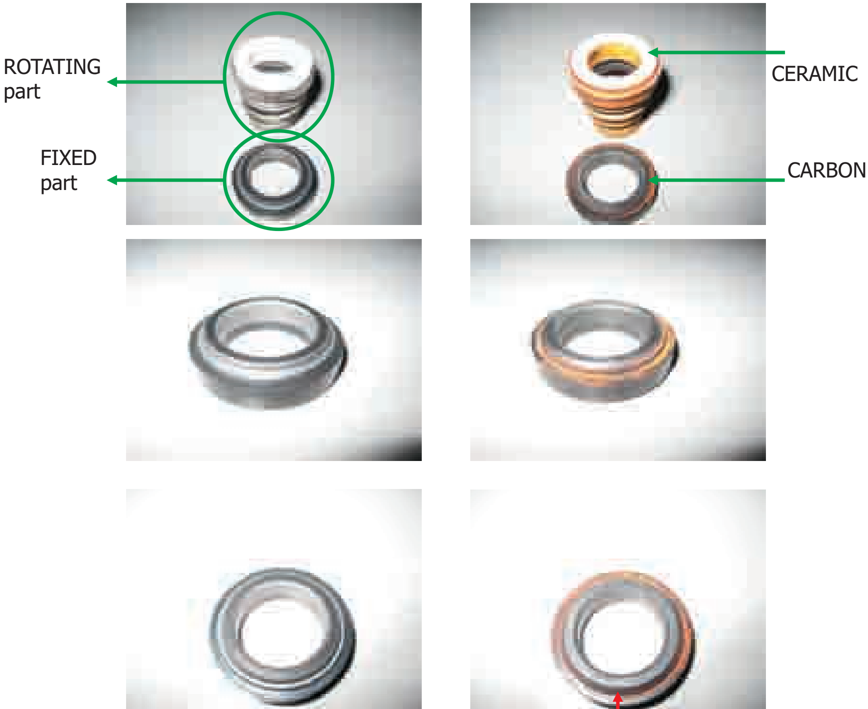
It is also advisable to select the PN of the expansion vessels of a system in relation to the overpressure values that may occur, taking account of the following factors:
-pipelines length
-pipelines diameter
-water velocity
-closing time of valves installed on the pipeline
-maximum pressure delivered by the pumps.

Other causes that may cause expansion vessels to fail are rupture of the internal diaphragm (which also leads to oxidation of the external sheet metal, making it more susceptible to damage) and low precharge pressure of the vessel.

MECHANICAL SEAL

Wear due to pumped liquid

OK **DAMAGED**



The formation of micro-imperfections of the contact surface between the fixed part and the rotating part of a mechanical seal will result in water leakage from the seal.

MECHANICAL SEAL

Leakage from the mechanical seal

This clearly visible scoring on the pump shaft was caused by mechanical action exerted by the metal box on the rotating part of the mechanical seal.
The problems that led to this situation were as follows:
1 - Sticking of the seal
2 - Wear and distortion of the O-ring on the rotating section of the seal.
3 - Slight inclination of the rotating section of the seal
4 - Wear/scoring of the shaft resulting in the formation of the groove clearly visible in the photo.

MECHANICAL SEAL

Thermal shock

It may occur that the user forgets to prime the pumps, causing them to run dry with resulting overheating of the mechanical seal. Usually in such cases users attempt to remedy the problem by rapidly filling the pump body with water at ambient temperature (approximately 20°C), wetting the faces of the mechanical seal which, after running dry can reach temperatures of up to 180°C. This results in a significant thermal shock which causes irreparable damage to the mechanical seal.

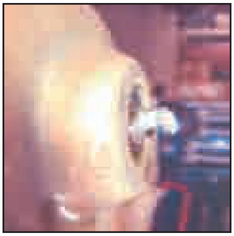
The evident cracks in the rotary part of the mechanical seal show in the photo were caused by thermal shock.

PITTING

PITTING is a form of highly localised corrosion in which tiny holes are formed in the metal surface. The corrosion mechanism is caused by a lack of oxygen in a microscopic point of the surface. The point in question functions as an anode, while the surrounding area with excess oxygen becomes a cathode, resulting in a phenomenon of localised corrosion. Pitting is the type of corrosion attack to which steel is subject in the presence of chlorides.

Pitting resistance depends on the composition of the steel. This gives the ***pitting resistance equivalent number (PREN),*** which is an empirical equation used to define the resistance of a steel to a corrosion phenomenon.
PREN = Cr + 3.3 (Mo + 0.5 W) + 16N.

STRAY CURRENTS



A metal structure in a medium having ionic conductivity, such as water, which is subject to an electrical field associated with the circulation of direct current, can be subject to corrosion due to interference.

example

Installation:
submerged pump connected to the power supply without an adequate protective earth connection.

Cause:
stray currents shorting on the rotor shaft.

Effect:
damage/corrosion of the AISI 416 steel rotor shaft

EXAMPLES of POSSIBLE WINDING FAULTS

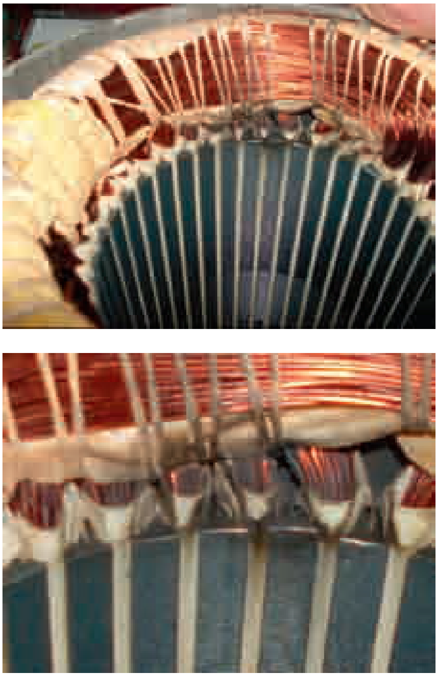
Stator of an A50/180XM circulator completely burnt out due to an overload or seized rotor.

JET 151 M stator: damaged start winding (internal) due to electrical discharge.

Winding of submersible pump model Feka VS 750 M: damaged run winding (external) due to excessive number of cycles.

EXAMPLES of POSSIBLE WINDING FAULTS

Motor of drainage pump model Feka 2500T: clearly one of the three phases of the winding has been damaged due to the missing third power feeding phase.



Three phase motor of an 11 kW industrial pump: after 3 months of operation the motor exhibits localised burning near the slot insulators due to poor insulation resulting from a manufacturing defect.

SUBMERSIBLE MOTORS

Damage due to overvoltage or atmospheric discharge

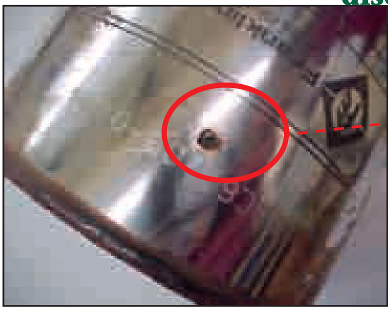


Photo 1

Photo 2

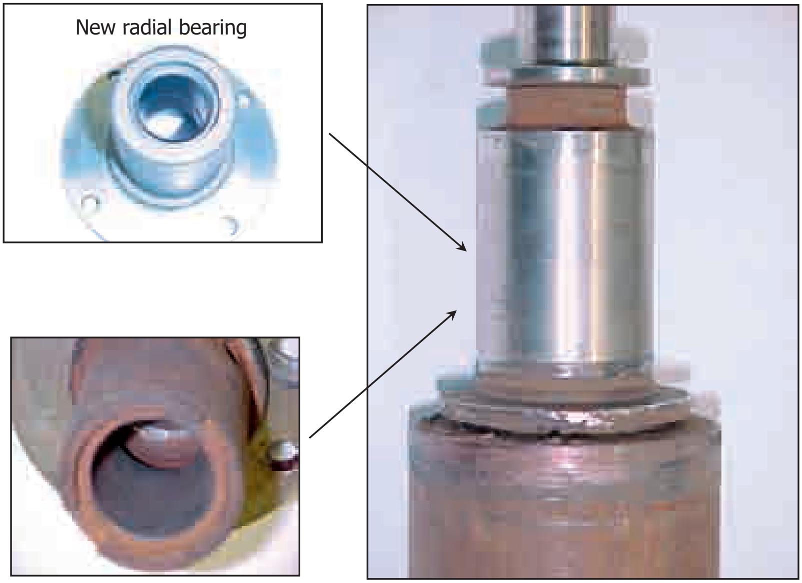
The hole shown in photo 1 was caused by overvoltage on the power feeding line or a lightning discharge. As can be seen in Photo 2, the damage is located near the power feeding cable inlet.

Abrasion of shaft or spline due to the presence of sand in the water

Once again sand is the cause of damage and infiltration of water into the motor.

The photo alongside shows diffused erosion just below the spline (area marked in red).
Grains of sand, or in certain cases marble dust particles, are deposited on the shaft, and due to shaft rotation (at approximately 2800 rpm) they cause erosion to the point that water is able to infiltrate into the motor, with resulting damage to the insulation.

Radial bearing wear


New radial bearing

The photos show excessive wear of the motor radial bearing caused by infiltration of abrasive material and excess vibration. Vibration may be the result of the motor having suffered violent impact during transport and handling procedures.

Counterthrust washer damaged due to motor running in counterthrust conditions

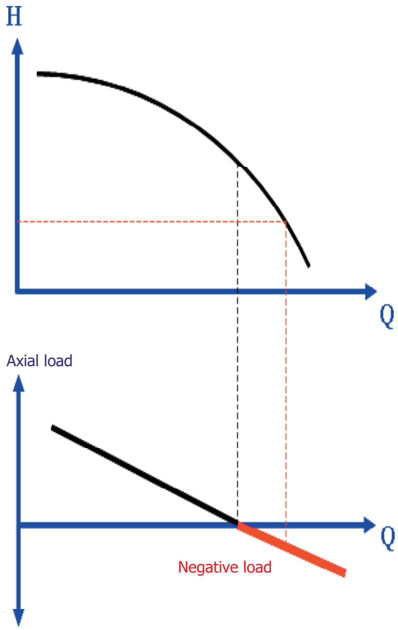
Counterthrust Conditions

If the quantity of pumped water is greater than the quantity for which the pump was designed, a condition of negative axial thrust results (loading in an upward direction).

Submersible motors are designed to support this type of load for a limited period of time. If the pump runs continuously in this condition the **counterthrust washer will suffer irreversible damage.**

The small plastic chips that would detach from the counterthrust washer could reduce lubrication of both the radial and thrust bearings, causing the motor to malfunction.

The photos at the top of the page show counterthrust washers displaying the typical wear caused by excessive negative axial loading.

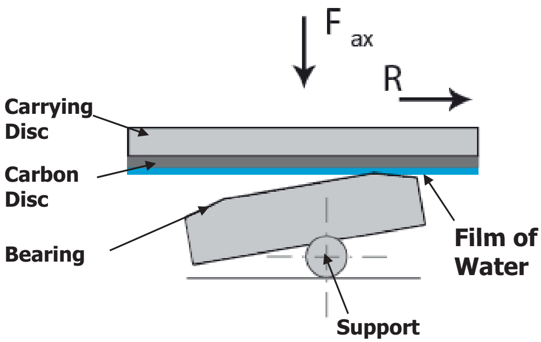


Damaged thrust bearings

Damage caused by overheating of the carbon disc is caused by unsuitable lubrication.
This type of damage is typical of installations with an inverter drive in which the motor can run constantly at speeds lower than 1800 rpm (corresponding to 30Hz)

Breakage of the carbon disc and damage to the bearings can be caused by pressure surges (water hammer) or violent impact on the base of the motor.

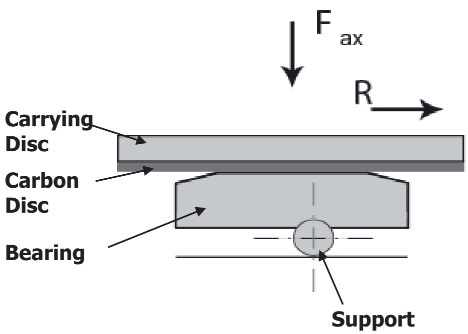
Functional analysis of thrust bearings



Normal RPM

30-50/60 Hz

During normal operation of the motor a film of water is created between the carbon disc and the bearings: this condition ensures correct operation of the thrust bearings.

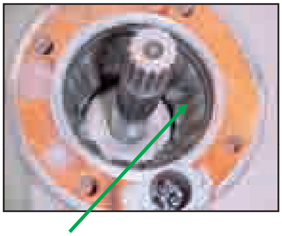
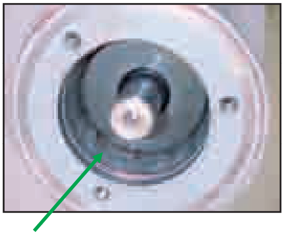


Low RPM

0-30 Hz

During low speed operation the absence of the film of water will lead to accelerated wear of thrust bearings.

Effect of overheating

Overheating of the motor has led to seizure in this case.
The swelling visible in the upper photos occurs when the maximum liquid temperature is exceeded and/or minimal flow rate of the liquid pumped around the jacket is not guarantee.
In order to size the cooling jacket correctly refer to the recommendations given on page ... of this manual. Note that it has been estimated that the cause of more than 80% of all faults is due to **overheating.**

Rewindable Motor

internal short circuit and fused insulating material


The above photos show an example of a short circuited rewindable motor.
Note that the insulating material, which is normally white in colour, has blackened due to overheating. The damage to the insulation and the windings has caused the motor to short circuit.

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