POMPA TIPO "V"

Manuale d'uso

User Manual

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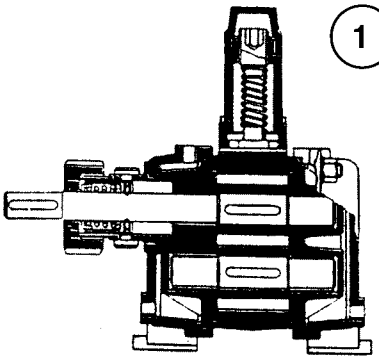
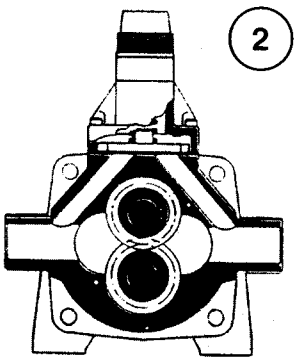
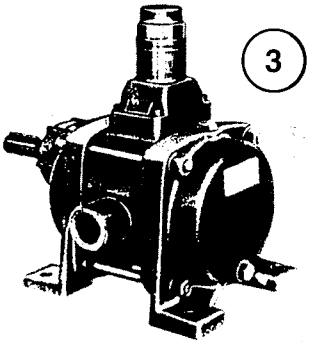
OFFICINE MECCANICHE
COSTRUZIONE POMPE AD INGRANAGGI

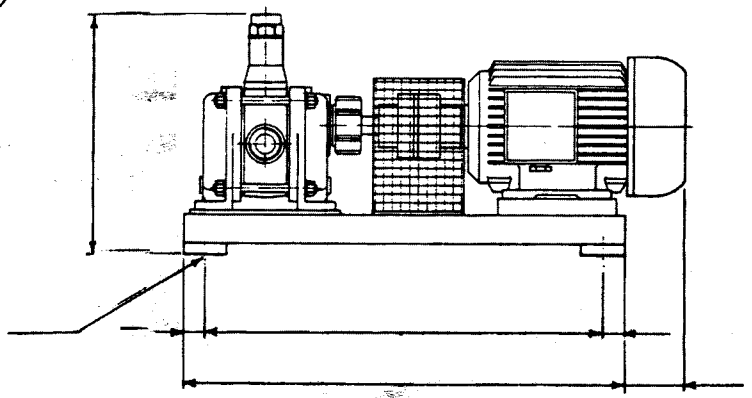
POMPA SEZIONATA

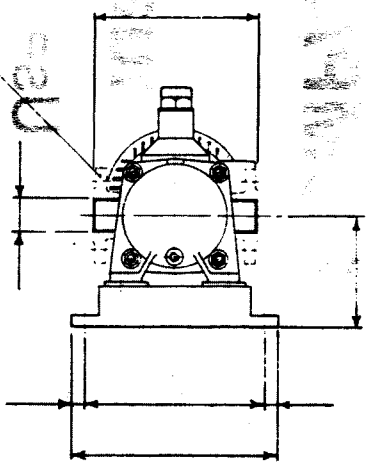






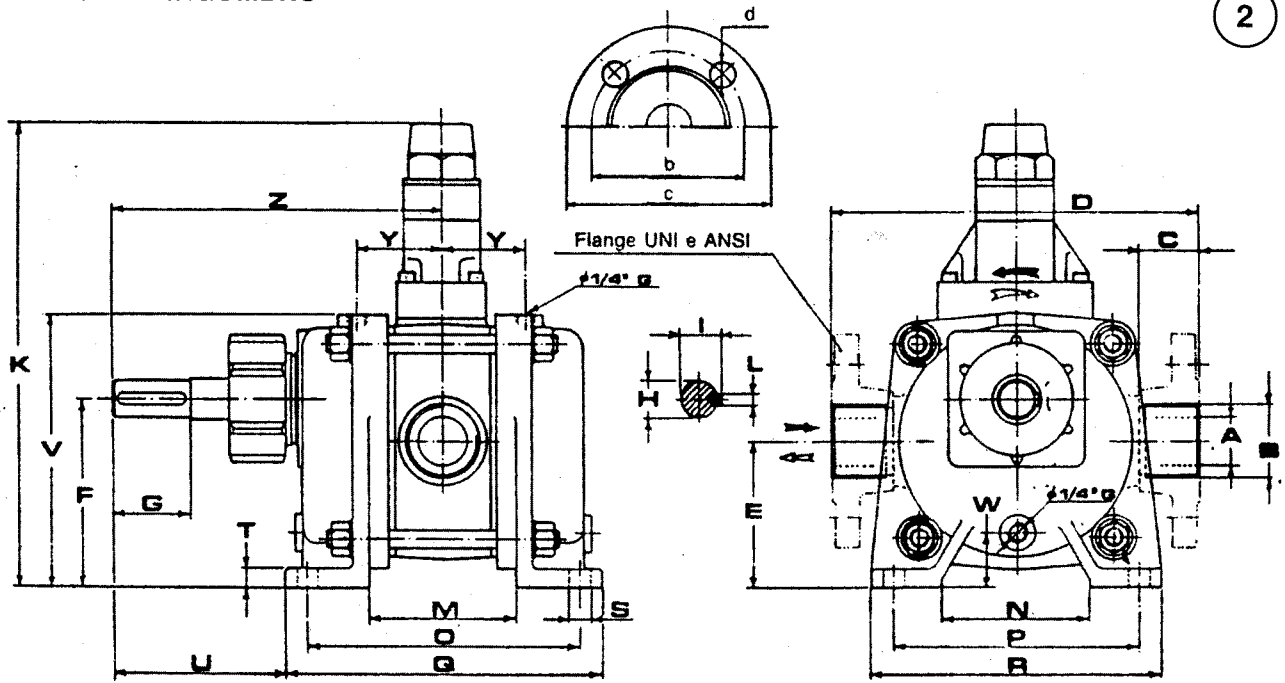
TA-3 ACCOPPIAMENTO A MOTORE ELETTRICO





DIMENSIONI DI INGOMBRO

2



Pompa Mod	A	B	C	D	E	F	G	H	I	L	M	N	O	P	Q	R	S	T	U	V	Z	Y	W	K	Flange DN	b	c	d	N fori	Peso kg
V. 15	15	3/4" G	25	150	62	78	30	12	15	5	60	60	121	92	141	112	10	10	75	115	145,5	36,5	30	233	20	75	105	14	4	7
V. 29	20	1" G	30	180	70	89,5	30	14	17	5	72	68	134	120	154	140	10	10	78	132	155	42	29	255	25	85	115	14	4	10
V. 52	25	1"1/4 G	32	200	80	103	40	16	21,5	6	90	78	157	124	182	150	12	12	115	150	206	48,5	32	299	32	100	140	18	4	16
V. 92	32	1"1/2 G	40	240	96	123,5	50	24	27	8	96	96	181	160	210	190	14	14	135	180	240	55,5	36	330	40	110	150	18	4	26
V. 138	40	2" G	40	260	106	138,5	60	28	31	8	122	106	212	170	244	202	16	16	151,5	200	273,5	60	36	370	50	125	165	18	4	45
V. 230	50	2"1/2 G	49	310	128	167	80	38	41	10	140	130	247	200	284	240	18	18	194	238	336	66,5	42	413	65	145	185	18	8	64
V. 345	65	3" G	55	350	142	186	110	42	45	12	160	146	277	230	318	270	20	20	223	265	382	75,5	44	467	80	160	200	18	8	83
V. 460	80	3"1/2 G	60	380	154	203	110	48	51,5	14	172	160	303	246	348	290	22	22	226	288	400	79,5	46	494	100	190	235	22	8	103

N.B. - Normalmente le pompe vengono fornite con bocche filettate esternamente (quota B). A richiesta si possono fornire flange UNI 2223/29 - PN 25 e/o ANSI B. 16.5

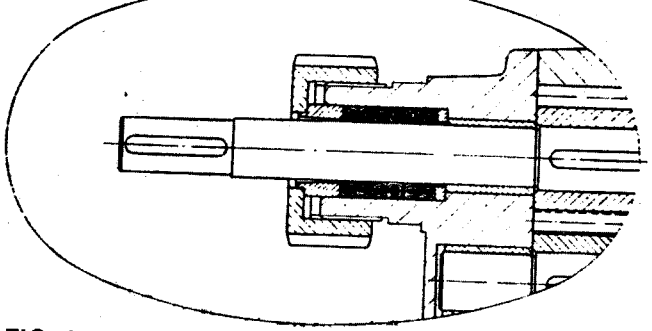


FIG. 1 - TENUTA A BADERNA

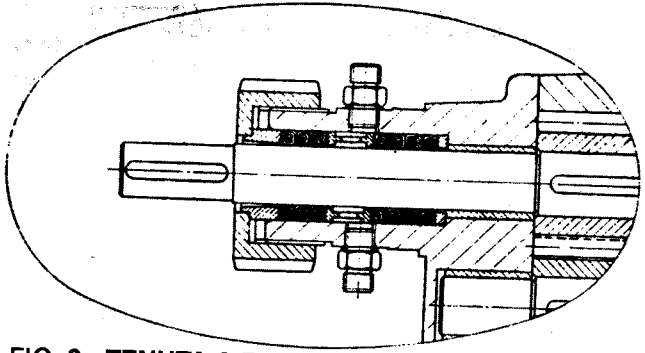


FIG. 2 - TENUTA A BADERNA FLUSSATA

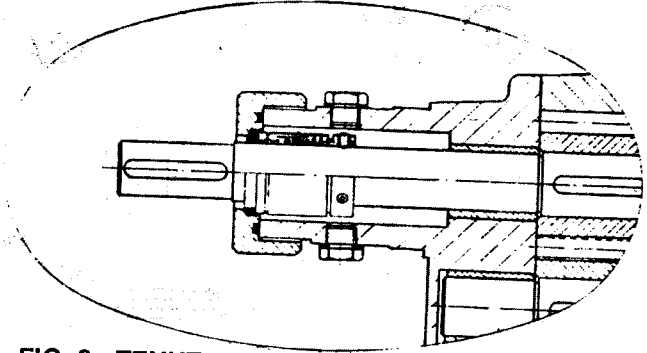


FIG. 3 - TENUTA MECCANICA

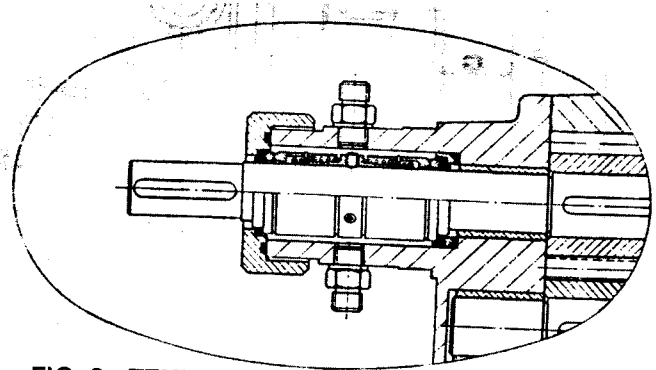


FIG. 3 - TENUTA MECCANICA FLUSSATA

③ DATI CARATTERISTICI DI FUNZIONAMENTO

Costruzione Standard

Tipo	∅ Bocche	Giri/1'	1 bar		5 bar		10 bar		15 bar		20 bar	
	mm		l/h	kW	l/h	kW	l/h	kW	l/h	kW	l/h	kW
V. 15	15	1450	1.300	0,18	1.280	0,35	1.230	0,67	1.170	0,96	1.060	1,18
V. 29	20	1450	2.500	0,31	2.450	0,67	2.370	1,29	2.240	1,84	2.040	2,21
V. 52	25	1450	4.500	0,52	4.430	1,22	4.260	2,32	4.040	3,32	3.680	4,02
V. 92	32	1450	8.000	0,86	7.870	2,14	7.590	4,13	7.180	5,89	6.550	7,14
V. 138	40	1450	12.000	1,18	11.800	3,24	11.360	6,19	10.780	8,84	9.830	10,75
V. 230	50	1450	20.000	1,84	19.680	5,38	18.940	10,30	17.960	14,72	16.380	17,89
V. 345	65	1450	30.000	2,58	29.500	8,02	28.400	15,46	26.940	22,10	24.570	26,80
V. 460	80	1450	40.000	3,24	39.400	10,75	37.880	20,60	35.920	29,44	32.760	35,70

(Collaudo secondo le norme UNI.6871-71P Cat. II)
(Tolleranza 10%)

④

I dati di funzionamento indicati nelle tabelle si riferiscono a liquidi con viscosità 10° Engler e peso specifico 1 kg/dm³. Le portate indicate, valgono per l'aspirazione di liquidi da un'altezza max di 5 m, a temperatura ambiente (15 ÷ 20 °C) ed alla pressione barometrica di 760 mm Hg (1013 mbar).

PER APPLICAZIONI CON MOTORI ELETTRICI A 60 Hz CONSIDERARE I SEGUENTI INCREMENTI:

PORTATA: +20%
N. GIRI: +20%
POTENZA ASSORBITA: ~ +30%

Costruzione in Acciaio Inox

Tipo	∅ Bocche	Giri/1'	1 bar		5 bar		10 bar	
	mm.		l/h	kW	l/h	kW	l/h	kW
V. 15	15	960	860	0,12	850	0,22	815	0,45
V. 29	20	960	1.650	0,23	1.620	0,45	1.570	0,85
V. 52	25	960	3.000	0,34	2.930	0,81	2.820	1,55
V. 92	32	960	5.300	0,56	5.210	1,40	5.020	2,73
V. 138	40	960	8.000	0,79	7.815	2,14	7.520	4,13
V. 230	50	960	13.250	1,26	13.000	3,57	12.540	6,85
V. 345	65	960	19.900	1,69	19.530	5,30	18.800	10,30
V. 460	80	960	26.500	2,14	26.090	7,14	25.080	13,70

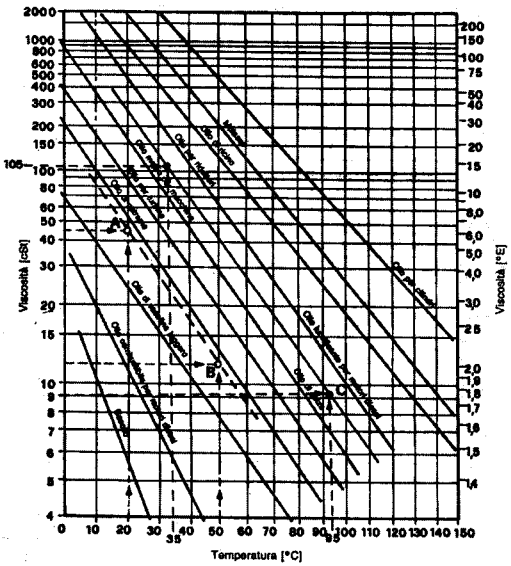


DIAGRAMMA DELLA VARIAZIONE DELLA VISCOSITA' CON LA TEMPERATURA DI ALCUNI PRODOTTI DI USO COMUNE E SIMILI

Le coordinate sono state stabilite in modo da far risultare la **linea caratteristica di stato** del prodotto una linea retta.

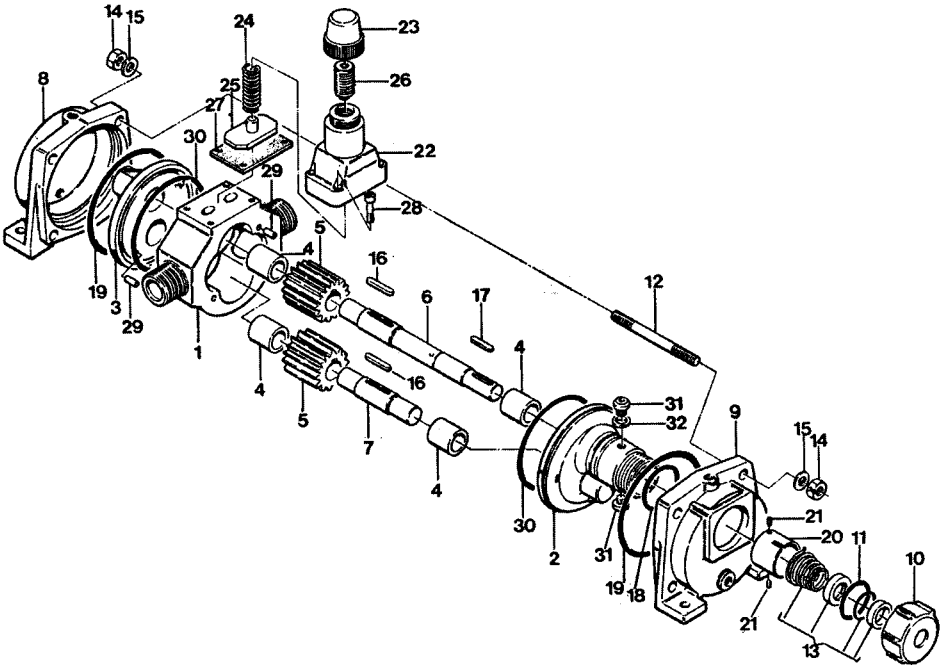
Tutti i valori che risultano dal diagramma si devono ritenere approssimati, sufficienti però per dare una indicazione del comportamento del liquido ed aiutare nella scelta della pompa.

Il diagramma serve anche per conoscere il comportamento di altri liquidi non inclusi nello stesso:

1) Se conosciamo le coordinate di due punti (viscosità - temperatura) la caratteristica di stato può essere ottenuta collegando i due punti.
   Esempio: Punti «A» e «B» del diagramma.

2) La caratteristica di stato può essere ottenuta anche conoscendo soltanto le coordinate di un solo punto (C).
   In questo caso è sufficiente tracciare una linea retta passante per il punto «C» e parallela alle altre linee.
   Prendiamo per esempio un olio con 9 cSt. di viscosità a 95 °C: per conoscere la sua viscosità a 35 °C seguendo la retta che passa per il punto «C» troveremo una viscosità di 105 cSt.

$$c\,St = \frac{c\,P}{\text{Peso Specifico}}$$



No. pos.	Q.tà	Descrizione
1	1	Corpo pompa
2	1	Supporto lato comando
3	1	Supporto lato opposto comando
4	4	Bronzine
5	2	Ingranaggi conduttore/condotto
6	1	Albero conduttore
7	1	Albero condotto
8	1	Camera raffreddamento L.O.C.
9	1	Camera raffreddamento L.C.
10	1	Girello
11	1	Anello O-Ring girello

No. pos.	Q.tà	Descrizione
12	4	Tirante
13	1	Tenuta meccanica reversibile
14	6	Dado per tirante
15	6	Rondella
16	2	Linguetta ingranaggio
17	1	Linguetta giunto
18	1	Anello O-Ring camera raffr.
19	2	Anello O-Ring camera raffr.
20	1	Contenitore trascinatore T.M.
21	2	Grano fissaggio cont./trasc. T.M.
22	1	Corpo by-pass

No. pos.	Q.tà	Descrizione
23	1	Coperchio by-pass
24	1	Molla by-pass
25	1	Valvola by-pass
26	1	Vite regolazione by-pass
27	1	Guarnizione by-pass
28	4	Vite fissaggio by-pass
29	4	Spina di centraggio
30	2	Anello O-Ring corpo pompa
31	2	Tappo di chiusura
32	2	Guarnizione per tappo

L.C. = lato comando L.O.C. = lato opposto comando T.M. = tenuta meccanica

Nella richiesta di parti di ricambio citare sempre il tipo della pompa e il numero di matricola

USER MANUAL

"V" pump is set on base with electric motor and motor coupling included.

1 –DESCRIPTION
It is a rotary self-priming positive displacement pump with spur gears (fig. 1 -2- 3 -4).

The liquid transfer from the suction side to the batch side is assured by a toothed couple of wheels with direct teeth and in-volute profile correct and rectified. One of these two wheels is linked, by a coupling, with the electric 'motor; the other one is dragged from the first one. The two rotors are lodged inside the body in seats realized with a high degree of finish and very narrow tolerances of work. The transport of the fluid is continuous without emulsions that could alter the pumped product. The pump is able to create the necessary and sufficient empty space to inspire the liquid and it can be used, with the same results, in a sense or in the contrary sense. Delivery capacity increases in direct proportion with the rotation speed. The batch pressure does not depend from the rotation speed.

2-EXECUTION
2.1 -Standard execution
2.2 -Stainless steel execution
2.3 -Special execution

2.1 -Standard Building
- Body -covers and bearings made in high quality cast iron.
- Gears and shafts made in carbon steel.
- Gaskets among coupling plans of different elements are made of rubber rings
- Bearings are realized in bronze impregnated with lubricant and they are disassembling to have a very easy replacement,
  for wear and tear.
- Batch and suction mouth are externally threaded. It is possible to mount flanges UNI 2223/29PN25 and also flanges ANSI
  B 16,5.
- A mechanical seal, O-ring type with carbon steel faces, guarantees the shaft seal.
  We could also mount uni-directional mechanical seals with gaskets in PTFE
  and seals with rings (static and rotating) in special materials like: tungsten carbide and/or silicon carbide.
  By request we can supply pumps with puddening seal and also with hydraulic barrage lantern.

2.2 -Inox Building
- Body, covers and bearing are in fused steel (CF8M).
- Gears and shafts are in INOX steel (AISI 316) hardened.
- Gaskets among coupling plans of different elements are made of VITON rings. By request we could made them in PTFE.
- Bearings are realized with self-lubricant graphite/resin bushings.
- Batch and suction mouths are the same of STANDARD BUILDING.
- The shaft seal is guaranteed by a UNI directional mechanical seal in steel/graphite with O-ring made of PTFE. By request
  we can also mount, like the standard pumps, special uni-directional mechanical seals and/or mount seals with Teflon
  puddening or in PTFE with or without hydraulic barrage.

2.3 -Special Buildings
By request of the customer, we can realize special buildings, both for the materials and seals.

P.S.:
a) Don't use the pumps with mechanical seals if there are liquids containing abrasive particles.
b) Within fluxed seals, must flow the same liquid that is pumped, or a compatible liquid.

3 **-TECHNICAL INFORMATIONS**

3.1- Encumbered dimensions: (Table 2 and picture)

3.2- Working information: (Table 3 and 4 + diagrams)

For pumps, which have a cooling/, heating jacket fluid must not exceed the following limits:
-Max pressure: 6 bar
-Max temperature: 260° + ^{o}C
-Min. temperature: 10° -^{o}C
As regards acoustic pressure, the steady and pondered A value is: [dB] 74,0.

4-SEALS

(Pictures 1-2-3-4)

5-INSTALLATION

5.1 -Coupling basis

When the pump is supplied with motor, coupling and pedestal, our workshops provide with best care to put together all these elements. It's opportune, however, before the installation, to control if there is damages occurred during the transport and if the pump is conforming to that ordered. When the pump is supplied with naked shaft, its coupling is executed by specialized staff. A bad assembly can cause working accidents and a pre- mature wear of the pump.
The motor-pump group should be mounted on a only base of anchorage and put in a perfect horizontal position. If necessary put a thickness in correspondence to the anchorage bolts. In this case the coupling has the function of transmitting the rotation to the pump.

5.2- Axis line

After the motor-pump coupling, control that the shafts are perfectly lined up. So, control carefully, that the external surfaces of the two mid-couplings are lined up and that their faces are parallel. The alignment controls must be executed in three different positions at least, at 120°.
Control should be considered right if the irregularities are within *+1-* 0,05 mm. Then the group must be placed on a cement bed, beforehand realized, another control should be effected with care about the motor-pump coupling, eventually improve it, putting thickness under the metal pedestal.

5.3 -Anchorage

Put in seat the anchorage bolts, lined up. If the alignment is right, fill the sumps with quick-setting cement. When the cement will be hardened, break the bolts, then connect pipes and control again the group alignment. Only during the linking of pipes, take off the protection closings.

5.4- Pipes

To remove any possible bad solicitation, link the sucking and forcing pipes, with their own threaded mouths in the right way. Then, pipes must not encumber on the pump itself. The diameters of the batch and suction mouths depends on the pump, so it is necessary choose carefully the interior pipes diameters, to reduce the possibilities of suffering big bad losses or bad performances. However, it's letter to have pipes with a diameter not smaller than the mouths where they must be linked. Put only big bending radius in the pipe. Control, that the seal gaskets, among flanges, don't stick out inside the tubes. Clean carefully pipes before its linking at the pump. Apply the interception sluice gates on each side of the pump. Don't move pump or pipes, to avoid dangerous solicitations.

5.5- Suction height working

-Before the installation of the pump, be sure there are no losses in the suction pipe doing a water pressing 3,5 BAR.
-Use the shortest pipe you can.
-Remove any obstacles that can increase suction bad losses.
-When you work with suction height only, obstruct lightly the exhaust until you get a batch prevalence of 0,3 BAR about. So you have not air in the pump.
-The suction pipe must be set inside the tank not too near at the bottom to avoid the solid parts suction there deposited. Don't put it too near at the free surface because a whirl can cause an income of air in the suction pipe, reason for a bad working of the pump.

-The suction pipe must be linked at the pump and the horizontal line has a light inclination towards above.
-If you have a low NPHS use a bottom valve for low viscous liquids.

5.6 –By Pass

By-pass is used to protect pump and pipes against extreme pressures.
We have two kinds of by-pass:
a) Proportional acting valve on pump cover. It's called “a”.
b) External valve on the batch pipe and it may be, at proportional action or "all or nothing" type, with return at the suction tank.

Don't use "a" by-pass when batch is closed for many minutes.
In fact a long pump working with the batch closed can cause the liquid heating. When this kind of operation is necessary, occur a "b" by-pass, that works with the "all or nothing" system and discharge the product in the suction tank. If this last operation is not possible, by-pass return connection on the suction pipe must be as near as possible to the suction tank.
If the absolute pressure of the system may exceed 20 bar for cast iron and
10 bar for steel, there must be an auxiliary valve, external to the pump, that allows the coming back of the liquid in the suction tank. Factors conditioning the liquid re-using quantity thank to inner by-pass valve, A type, for a certain setting position are: rotation speed, specific gravity, viscosity.

5.7 -Filter

To avoid a possible damage at the pump from unknown elements, it is good to have a suction filter. The kind of filter depends on different factors like pumped liquid, fluid speed in the pipe, the particles consistence in the liquid. Usually an "y" filter is sufficient.

5.8- Control instruments

To have a good and constant control is opportune the installation of a manometer on the batch pipe and a vacuum gauge on the suction pipe. A tap commands these two instruments.
Bottom scale will show an higher pressure of 50% respect to the normal. If you pump corrosive liquids, instruments must be made in appropriate materials, resistant to corrosion. To have a long using of manometers, put them under pressure only at
Bottom scale will show an higher pressure of 50% respect to the normal. If you pump corrosive liquids, instruments must be made in appropriate materials, resistant to corrosion. To have a long using of manometers, put them under pressure only at the reading moment. To get a faithful reading, put these two instruments quiet far from curves, sluice gates...

P.S.: Don't use wagons to increase Cocking couple

6 -**PUMP TESTING**

6. 1 Make sure that the motor-pump coupling protection is set.
6. 2 Make sure that there is liquid in the suction tank.
6. 3 Make sure that is possible to send the liquid in the tank, at the bottom.
6. 4 Open the suction-valve.
6. 5 Open the batch valve and (if there is) the unloaded valve to deviate a part of the batch to the suction tank.
6. 6 If the pump is equipped with cooling/heating chamber:
-First open the bottom valve
-Then open the top one. This one must be set in action very slowly to avoid dangerous shocks.
Do not exceed temperature and pressure limits indicated in the - paragraph 3.2.
6. 7 Start up the motor.
6. 8 If the pump works sucking from a tank with a liquid level lower than its rotation axis close the batch valve in order to obtain a pressure of 0,3 bar about.
6. 9 Control that there are no liquid losses from the pump. If there are any losses:
a) Stop the motor
b) If there are losses from the tallying surfaces among body and its heads control the union bolts closing (pict2). Start the motor again.
c) If there are losses referred to seal level.
c1) if it is a puddening seal press lightly the small ring (picture. 1-2).

Anyway a very small loss is allowed to grant a light lubrication of the shaft surface.
c2) if there is a mechanical seal look at the paragraph 10.

6.10 Regulate batch pressure to have a correct working of the system. If you exceed the established value open by-pass valve on the pipe at the bottom of the pump until you get the pressure value you want.

7-WORKING PROCEDURE

7.1 -Starting

7.1.1 Make sure there is liquid in the pump.
7.1.2 If the pump is equipped with cooling/heating chambers, make sure there is conditioning fluid.
7.1.3 Open valve of cooling/heating fluid interception at the bottom of the pump.
7.1.4 Open slowly valve of cooling/heating fluid interception at the top of the pump.
7.1.5 Open, in the order, the batch pump valve and the suction one.
7.1.6 Start the motor.
7.1.7 Regulate the batch pipe valve and the by-pass valve (see 5.6/b) until you get the pressure you want.

7.2 -Stop

7.2.1 Stop the motor
7.2.2 Close batch valve, the suction one and the by-pass one.
7.2.3 If you have cooling/heating fluid, close the interception valves.

P.S.:
A) If the pump is stopped like that, it remains full of liquid. If this is not possible it is necessary washing the pump with a liquid compatible with pump and seal materials. In this case make idle the pump for necessary time, pumping the washing liquid. It can be mixed with the process liquid or kept apart

B) The information in these two lost paragraphs are not important if the pump is included in a system and works automatically. In this situation make sure of the correct working of the pump, looking particularly to any possible losses. This control should be effected two times at the turn and during its working at last.

8- ANOMALIES

8.1 DELIVERY CAPACITY = 0		
Nº	CAUSE	REMEDY
1	There is no liquid	Supply the pump with liquid
2	Obstructed batch mouth	• Open suction valve • Change broken valve with closed obturator
3	Bottom valve or filter completely obstructed	Take to pieces and cleaning
4	Extreme suction height for that kind of liquid or for its temperature	Reduce suction height
5	Air coming in the suction pipe	Close flanges and replace, if necessary, threadings teflon trip
6	By-pass valve incorporated in the pump or on open batch pipe	-Regulate valve -Make sure there are no unknown elements in valve seats that obstruct the closing

8.2 WRONG DELIVERY CAPACITY		
N°	CAUSE	REMEDY
1	Air coming in the suction pipe	Block up flanges and/or sleeves on suction pipe, and, if necessary, replace gaskets or wrapped teflon on threadings
2	Bottom valve or suction filter obstructed	Take to pieces and clean
3	Suction pipe extremities not enough plunged in the liquid	Increase the pipe suction lift
4	Wrong way of the suction pipe with creation of air-pockets	Modification of way
5	Not sufficient rotation speed	Increase revolutions of 1'. Pump delivery capacity increases in proportion
6	By-pass valve not well regulated or partially opened because of any foreign body in its seat	Regulate the valve, if it is necessary, take it to pieces and clean well the seat
7	Wear and tear of the pump	Take to pieces the pump and control carefully sliding surface and, if there wear of some pieces, change them

8.3 PRIMING LOSS		
N°	CAUSE	REMEDY
1	Air coming in suction	Verify flanges and/or sleeves seal
2	Gas or air in the pumped fluid	Gas must be separated from liquid
3	Suction static height too high	Decrease suction height

8.4 EXCESSIVE POWER USE		
N°	CAUSE	REMEDY
1	Specific gravity of liquids and/or too much viscosity	At the same quantity of delivery capacity and pressure change motor with another one more powerful til the highest level of kw pump can stand (look at the table prg.3.2)
2	Rotation speed to high	Decrease rotation speed til it get to the highest amperage allowed by motor. If the reduction is unacceptable, change pump system.
3	Small ring too close (the shaft is in overheating)	Slacken the small ring. A little loss is good to lubricate the seal
4	Working pressure too high	Decrease pressure opening by-pass valve at the bottom of the pump
5	Alignment loss pump-motor	Align like specified (paragraph 5)

8.5 NOISE, WATER HAMMERS, VIBRATIONS		
N°	CAUSE	REMEDY
1	Air or gas in the pumped liquid	• Verify the suction pipe seal • Extremities of suction pipe not enough immersed: PLUNGE THE PIPE IN THE LIQUID • Air or gas in the liquid: GAS SEPARATED FROM LIQUID

8.6 CAVITATION		
N°	CAUSE	REMEDY
1	Vapour pressure too high (in suction liquid can have pressure and temperature like those of boiling)	If possible try to decrease suction height. Differently, control carefully the pump system project
2	High suction height	Decrease suction height
3	Overpressure valve clattering inside the pump	Increase valve setting

9- MAINTENANCE

There is no a special maintenance for the pump, but you have to clean the cooling/heating chambers. Use right liquid and procedure for the conditioning of the pump (refer to fluid pumped).

10 -DISASSEMBLY AND REASSEMBLING A PUMP

Referred to the picture I take pieces a pump means:
1) Take down by-pass from the body loosening 4 pos. screws.
2) Loosen and take away the small ring.
3) If the pump has a puddening seal take away seal rings with a bronze or
brass tool. If the pump is equipped with mechanical seal take away small ring and the two fixed rings with their own spring. We recommend best care during the execution oh these operations.
4) Unscrew 4 dice of pump connecting rods (pos.l) from cover side. Take away the connecting rods.
5) Keep far pump covers, using a rubber or bad hammer.
6) Because of the marking of gears with a pen or some chalk, you can locate toothed wheels. They must be taken away.
7) Blocking by-pass body with care, unscrew the top cover, loosen by- pass adjusting screw take away spring and its valve.

Reassembling:
* All gaskets must be changed periodically, even if you not see damages. * Before the assembling:
- Wash carefully all the parts with a detergent
- Examine with best care each particular in order to establish wear degree. Particularly be careful to shaft delivery capacities and bushings. If surfaces are furrowed, do not try to smooth them, but change them.
Verify carefully the state of covers surfaces in correspondence with gears. If ports are worn rectify surfaces using abrasive lapping wheel in corundum, grain 500. This operation must be executed to grant parallelism between 2 plans of each gear (extreme error admitted 0,01 mm.) and the perfect orthogonal among cover rectified surface and shafts rotation axes. Final clearance among first pump covers and their gears must be of 0,05 mm.
-When you mount pieces wet them to grand lubrication. If lubricant oil is incompatible with the product, use, for the first lubrication, the same process liquid or a liquid compatible with it.

For the assembly, follow the instructions:
1) Mount gears on shafts
2) Thread shafts in order to put gears in the body seat
3) Mount O-ring seal rings on covers
4) Approach pump covers
5) Thread connecting rods and block nuts. Do not use wagons to increase closing.
6) Mount the seal:
    a) If mechanical, thread the bushing, spring and rotating ring in the seat and block it with screws.
    Thread lock ring and screw the small ring spin pressure must be very low, because a stronger spin must be effected to avoid the seal dripping, if necessary.
    b) If it is a puddening seal, put the same quantity of seal rings taken away during disassembling, in the cavity between shaft and body. Screw lightly the small ring. Remember that pudding seal always must lose some liquid drops of process.
7) Mount by-pass.

When you finish the assembling start the pump and regulate the pressure with regulation screw under by-pass protection cover.

11 -SPARE PARTS AND ORDER PROCEDURE

You can see spare parts in the pump picture. Each spare part has a specific number.
To order spare parts say:
-Kind of pump and number
-Motor power
-Pump's RPM
-Year of construction
-Number of pieces needed
-Kind of pumped liquid

12 -TEMPORARY OFF DUTY SETTING

Temporary off duty setting can be affected executing the following operations.
1) Put some detergent liquid in the pump (compatible with pump materials) and make dripping it rotating the shaft.
2) In case pump was setting up for a long time, control wear and tear of its parts. For disassembly and reassembling look at the paragraph 10.
3) Take away dregs from the cooling/heating chamber (use a liquid compatible with that used for the conditioning of pump

13 -DEMOLITION

Take away the liquid from the pump and take it to pieces. Differentiate materials in homogeneous groups, to destine them in specific boxes like steel pieces, cast iron, stainless steel, bronze, rubber, plastic, and graphite.