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NIKKISO NON-SEAL PUMP SGM SERIES

TECHNICAL DATA

NIKKISO NON-SEAL PUMP SGM Series is a canned motor centrifugal pump capable of pumping various types of liquids safely in a wide range of chemical processes. In order to comply with the various applications, many types and models are available for NIKKISO NON-SEAL PUMP. For the most appropriate selection of a pump, according to the purpose and condition of the application, it is important to carry out careful planning. The Non-Seal Pump Technical Data supplies fundamental technical data required for studying the use of the Non-Seal Pump—basic values required in pump planning, matters to be considered, detailed construction drawings, etc. However, it might not be possible to make final selection of the most appropriate types and models of pumps for processes involving various conditions with only the technical data so it would be advisable to consult NIKKISO CO., LTD., agents or distributors of Nikkiso for final selection.

It would also be advisable to study the Instruction Manual together with the Technical Data for using the pump under the best condition.

Contents

1 NIKKISO NON-SEAL PUMP/CONSTRUCTION

The Major feature of **the SGM Series NIKKISO NON-SEAL PUMP** is the building block system with the pump and motor sections completely independent of each other. And this permits selection of the pump and motor combination best suited to the particular application.

Basic Construction

The pump and motor are integrated into one piece, providing a leak-proof structure. All rotating parts are surrounded by liquid so that no gaskets or mechanical seals are necessary.

Basically, the pump section does not differ from the conventional centrifugal pump in performance characteristics. The models shown in the composite characteristic curve are all single stage over-hang type pumps.

Basically the motor is a 3-phase induction motor but the inner surface of the stator as well as the outer surface of the rotor are hermetically sealed with non-magnetic stainless steel.

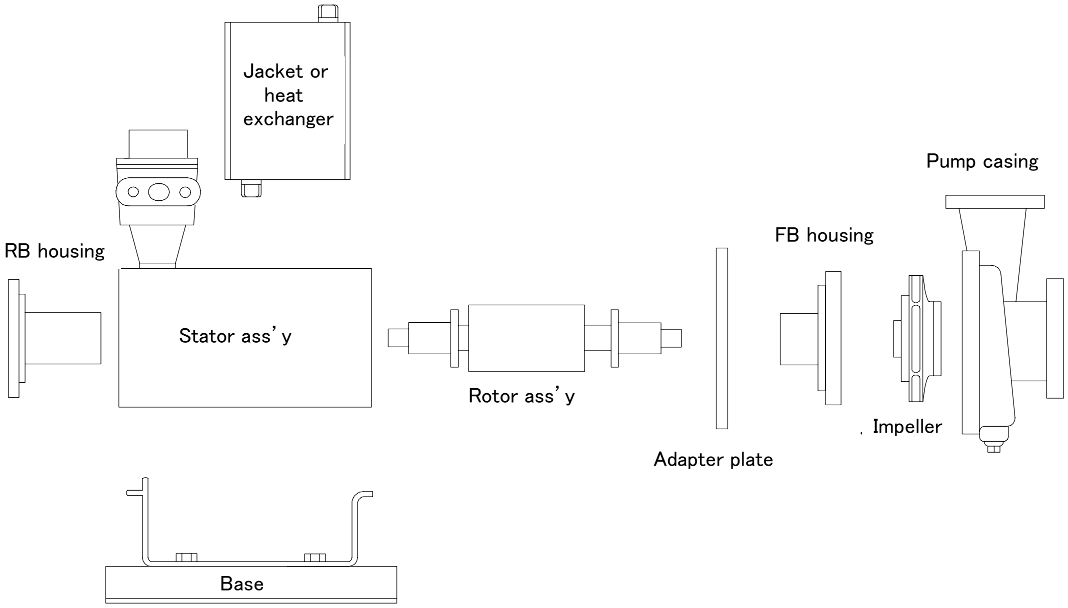


Fig. 1-1 Basic construction

1 NIKKISO NON-SEAL PUMP/CONSTRUCTION

1. Basic Type (N Type)

The pump and motor are connected by an adapter plate or a FB housing. A portion of the liquid being handled is taken from the impeller outlet part of the pump chamber into the rotor chamber for the purposes of cooling the motor and lubricating the bearings and returned to the pump chamber through the hollow shaft.

A jacket may be fitted to the outer wall of the stator assembly depending on the temperature and other characteristics of the liquid being pumped.

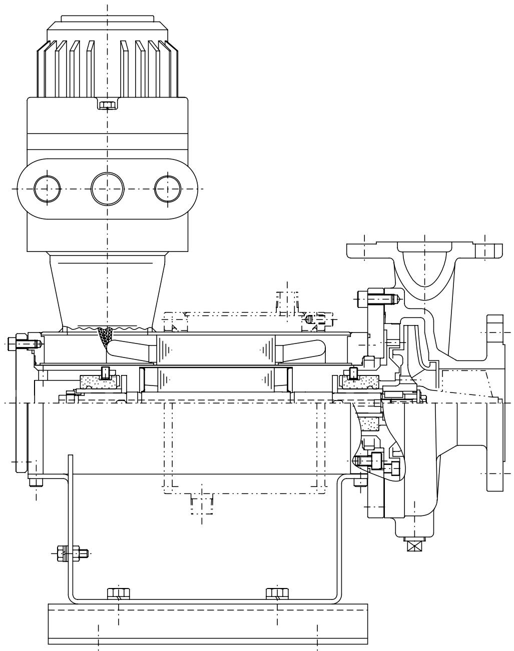


Fig. 1-2 Basic type, Circulation boost Basic Type

2. Circulation Boost Basic Type (V Type)

The cross-sectional dimensions are the same as those of the basic type (N type), but the return passage is wider to maintain a return flow of liquid when handling high-viscosity (80 to 200 mPa·s) liquids.

3. High Temperature Type (T Type)

The pump and motor are connected by an adaptor. The adaptor separates thermally the pump from the motor and prevents heat transfer from the pump to the motor. In the High Temperature Type, an independent circulating system is provided for cooling the motor and lubricating the bearings.

Circulation is effected by the auxiliary impeller located at the fore end of the rotor chamber.

A heat exchanger is fitted to the outer wall of the stator assembly to cool the circulation liquid.

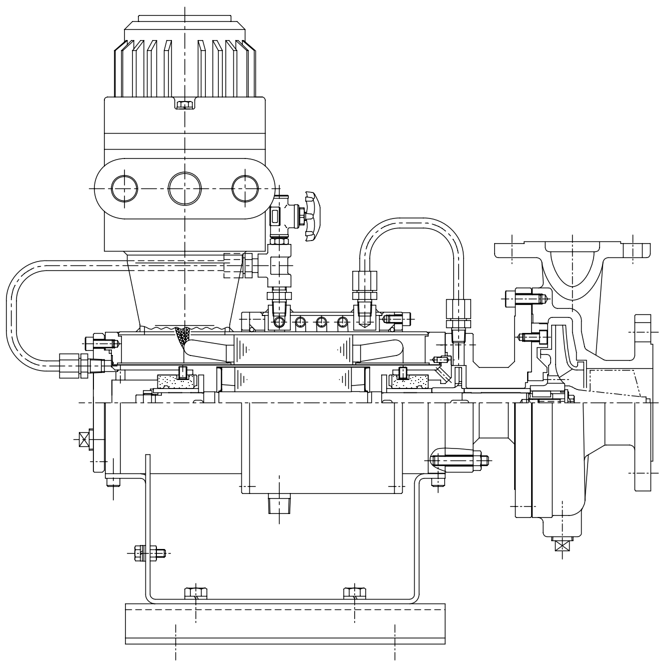


Fig. 1-3 High temperature type

4. Slurry Handling Type (S, M, G Type)

4.1 Standard Type (S Type)

The basic construction is identical with that of the High-Temperature Type. The function of this arrangement is to prevent the slurry handled from entering into the rotor chamber.

Clean compatible liquid with the liquid handled is flushed from the inlet port established at the rear of the motor to prevent slurry from entering into the rotor chamber, for which back flushing line would have to be established.

See Fig. 4-1 for the amount of liquid used for back flushing.

4.2 Slurry Handling Type with a Mechanical Seal (M Type)

In response to the necessity of decreasing a back flushing volume, a type incorporating a mechanical seal between the pump and motor is also available. (See Fig. 1-5)

Such type is called a Slurry Handling Type with a Mechanical Seal (M Type). The back flushing volume can be decreased up to 100 ml/day to 500 ml/d. (See Fig. 4-2)

4.3 Gas Seal Slurry Handling Type (G Type)

A gas seal type is also available which is suitable for handling heavily corrosive liquid, liquid liable to polymerize or highly concentrated slurry liquid. (See Fig. 1-6) The construction is basically identical with that of the above Slurry Handling Type with a Mechanical Seal and the feature of this type is that a gas chamber has been installed between the pump unit and motor unit.

The pump unit has totally been separated from the motor unit with the gas chamber, thus banishing a fear of the mechanical seal wearing out or corroding by handled liquid.

As the back flushing liquid (100 ml/day to 500 ml/day), clean mother liquid or clean liquid permitted to get mixed in the handled liquid if only being a very small quantity may be used. Also, as a gas charged in the gas seal chamber, for example, air on N_2 can be used. (See Fig. 4-3)

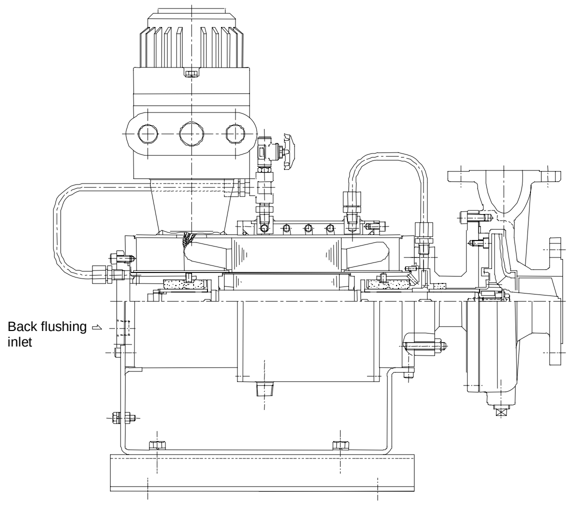


Fig. 1-4 Standard type (S type)

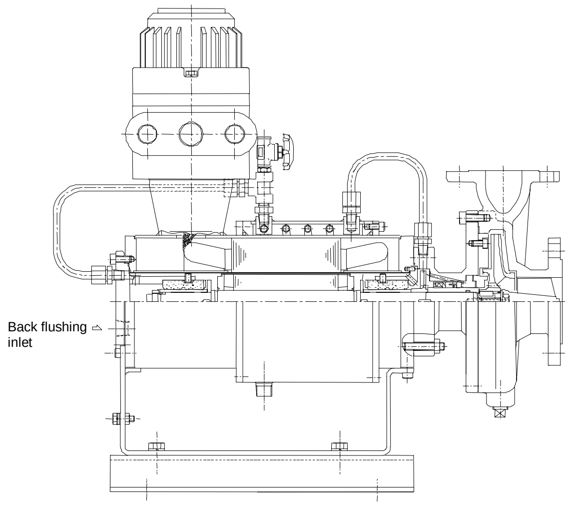


Fig. 1-5 Slurry handling type with a mechanical seal (M type)

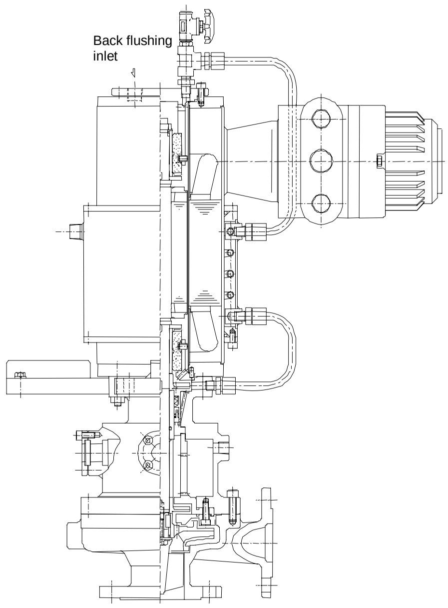


Fig. 1-6 Slurry handling type gas seal type (G type)

5. Reverse Circulation Type (Q Type)

The feature of this pump is that the circulation line does not form a closed circuit.

The circulation liquid passes through the front bearing housing from the impeller outlet part of the pump volute chamber into the rotor chamber, passes through the rotor chamber and after being extracted from the outlet of the rear bearing housing at the rear of the motor is returned to the vapour zone in the suction tank through the reverse circulation line. (See Fig. 4-4)

With the basic type, in case of liquid which vaporizes easily, if the temperature of the circulation liquid rises even slightly, the liquid will vaporize when it passes through the rotor chamber and result in cavitation, etc.

6. Self-priming Horizontal Type (DN Type)

The basic construction is identical with that of the Basic Type and this type has been so built as to allow a self-priming with no flap valve provided.

Since there is no flap valve, heavily corrosive liquid can also be handled and further, there is no possibility of a poor self-priming due to clogging in the flap valve.

7. High Melting Point Type (B & C Types)

This pump has a construction suitable for handling liquid with a high solidifying point.

This pump is provided with a heating jacket on the outer face of the pump and the motor to prevent liquid from solidifying at a time of the liquid filling and during the pump operation. According to the solidifying point of the liquid and the liquid temperature, a Simple High Melting Point Type (C Type) and a Complete High Melting Point Type (B Type) may be used with a proper selection.

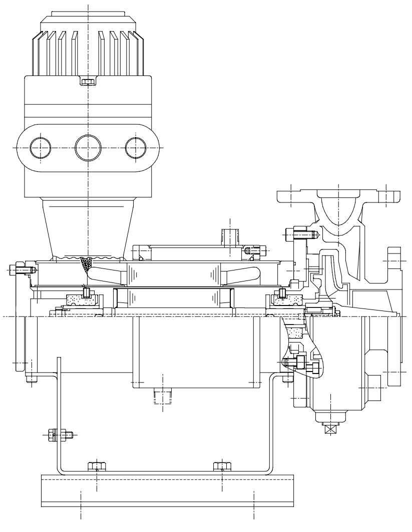


Fig. 1-9 Simple high melting point type

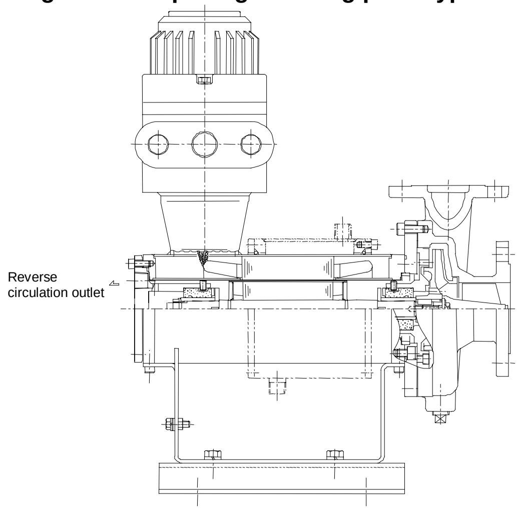


Fig. 1-7 Reverse circulation type

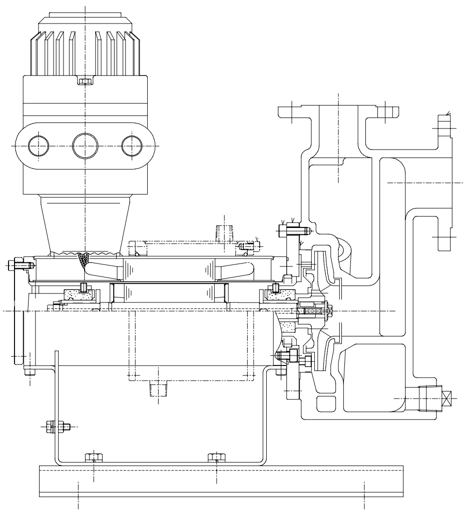


Fig. 1-8 Self-priming horizontal type

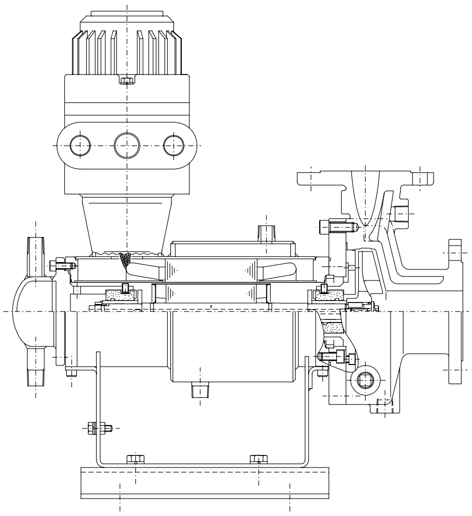


Fig. 1-10 Complete high melting point type

NIKKISO NON-SEAL PUMP/PLANNING

1. Pump Model No. Indication

Pump Model				Motor
H	N	21A	——	A1
[1]	[2]	[3]		[4]

[1] Pump Type:
- H ... Horizontal type
- L ... In-line vertical type
- B ... Motor top vertical type
- T ... Pump top vertical type
- D ... Self-priming horizontal type

[2] Pump Construction:
- N ... Basic type
- T ... High temperature type
- S ... Slurry handling type
- M ... Slurry handling type (With a mechanical type)
- G ... Slurry handling type (Gas seal type)
- V … Circulation boost basic type
- B ... Complete high-melting point type
- C ... Simple high-melting point type

[3] Pump No. Indication: Consists of three figures

[4] Motor Frame No. Indication: e.g. A2

<Remarks>

1. The maximum allowable pressures of the SGM series are:
   2 MPa (at 350°C)
   4 MPa (at 350°C)
2. Upon request, an inducer may be mounted to satisfy strict suction requirements.
3. The pumps are equipped with a bearing monitor for monitoring the degree of bearing wear.

2. Pump Selection

2.1 Select the adequate pump number from the composite characteristic curve according to the required capacity and head.

2.2 Power Calculation

Next, plot the required capacity and head on the individual characteristic curve of pump number selected according to 2.1 above, read out the pump efficiency and calculate the required power by the following equation.

$$\mathrm{Pmo} = \frac{0.0163 \times \gamma \cdot H \cdot Q}{\eta p}$$

Where

Pmo:	Pump power	kW
H:	Total Head	m
Q:	Flow rate	l/min
γ:	Specific Gravity of the Liquid pumped	kg/l
ηp:	Pump Efficiency	%

Multiply the power surplus rate by the calculated power required (kW) and decide the drive motor output, but especially when there is no specific designation, about 10% will be sufficient for power surplus rate.

When the motor power surplus rate is specified, the rate specified must be used. For example, the API610 standard specifies a power surplus rate of 10 to 25%, depending on motor output.

The degree of influence of liquid viscosity on the head and flow rate is about the same as that with a common centrifugal pump. In a canned motor pump, the rotor rotates in the liquid. Therefore, when viscosity is larger than 1 mPa·s, the power required slightly increases, necessitating viscosity corrections.

For a canned motor pump, when the viscosity increases, with the flow rate and head decreasing and the power required increasing, the circulation volume and Reynolds number also decrease, which may result in insufficient cooling. A canned motor pump can handle a viscosity limit of about 80 mPa·s without special measures. When the viscosity exceeds 200 mPa·s, some measures must be taken, such as back flushing with a low-viscosity liquid.

2.3 When Specific Gravity and Viscosity differ from those of Water

Correction of the head, flow rate and power required (kW) in accordance with the viscosity and specific gravity is required.

As a general rule, even when the specific gravity of the liquid differs from that of water, total head remains the same as for the case of water, as long as the discharge pressure produced by the pump is indicated in liquid column. However, in actual practice, the pump characteristics will change slightly and the capacity-head curve will become erroneous.

In case of specific gravity of the liquid to be considerably smaller than 1.0, though actual operation with such liquid requires smaller motor, operation with water requires the corresponding motor size. Therefore, it is necessary to consider the case of shop test with water when deciding motor size.

2.4 Capacity-Head Curve (Characteristic Curve)

Pump characteristic curves show the NPSH required and pump efficiency curve, in addition to the capacity-head curves, for the various impeller diameters being employed with the same volute casing. Note that these curves are for water having a specific gravity of 1.0 and a viscosity of 1.0 mPa·s.

"Head" in the curves indicates 'Total Differential Head'.

Total Differential Head is defined as follows:

$$H = \frac{1000(Pd - Ps)}{\gamma \times g} + (hd - hs) + hsl$$

H = Total differential head (m)
Ps = Pressure on liquid surface of suction vessel (MPa)
Pd = Pressure on liquid surface of discharge vessel (MPa)
hd = Height from center of the pump to liquid level of discharge vessel (m)
hs = Height from center of the pump to liquid level of suction vessel (m).
Higher than center (+)
Lower than center (-)
hl = Total piping loss (m)
γ = Specific gravity of liquid (kg/liter)
g = Gravitational acceleration of 9.80665 m/s^2

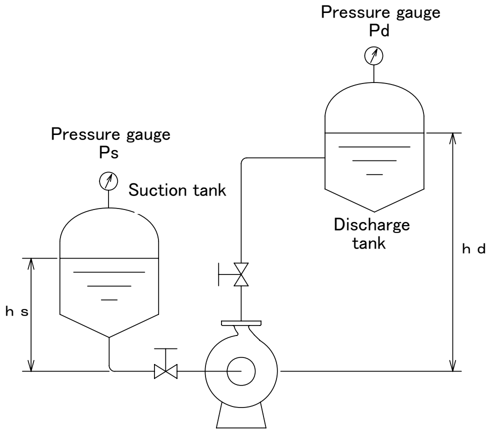


Fig. 2-1 Piping condition

Please note that all head curves are given in terms of liquid column (in meters). When the specific gravity of the liquid differs from that of water, a large error will be produced if calculation is based merely on a pressure of 1 MPa = 100 m. For example, when a pump (with sufficient power) has a non-discharge head of 200 m in the water column and the specific gravity of liquid is 1.5, the discharge pressure will be 3 MPa.

Conversely, when the specific gravity of liquid is 0.5, although the head is also 200 m in the liquid column, the pressure gauge will only read 1 MPa. Therefore, for example, in pumping liquid with a specific gravity of 0.5 to a discharge side vessel of pressure 2 MPa, other factors may be neglected, but a pump with a head of 400m must be selected; that is, H = 200/0.5 = 400 m.

2.5 NPSH

NPSH is the abbreviation for Net Positive Suction Head. If the minimum suction head required by the pump is not obtained, cavitation will occur and the pump cannot handle the liquid or if it can handle it, it will be unstable. Since the pump may also suffer considerable damage, either a pump which satisfies these conditions must be selected in accordance with the following equation or make the installation conditions to match with it.

$$NPSHA = \frac{1000\left(Ps - Pv\right)}{\gamma \times \mathrm{g}} + \mathrm{hs} - \mathrm{hsl}$$

Ps = Absolute pressure on liquid surface of suction vessel (MPa abs.)
γ = Specific gravity of liquid (kg/liter)
hs = Height from center line of pump inlet to liquid level of suction vessel (m)
Higher than center (+)
Lower than center (-)
hsl = Total suction side piping loss (m)
Pv = Vapor pressure of liquid at pump suction port temperature (MPa abs.)
g = Gravitational acceleration of 9.80665 m/s^2

The NPSH required of the pump is shown in the separate characteristic curves. Generally a NPSHavail. ≥ 1.3 × NPSH required must prevail to provide a margin.

[Precautions as to NPSH]

[1] As well as the total head, NPSH required is represented in meters (m). This NPSH required is given also in meters (m) of liquid column. As long as the NPSH available is given in meters (m), it is not necessary to divide by the specific gravity.

[2] The major point to note in the case of the Non-Seal Pump is that, with the basic type model, the liquid which returns to the pump chamber from the rotor chamber cools the motor and, as a result, a temperature rise of about 1–3°C occurs.

Therefore, Pv in the above equation must be calculated not only with the pump inlet temperature but also with the suction port temperature plus temperature rise when liquid is passing through the rotor chamber.

This temperature rise can generally be disregarded, however, in the case of saturated liquified gas, a construction like the Reverse Circulation Type is selected which will not be affected by temperature rise.

[3] To satisfy a lower available NPSH condition, to equip an inducer is systematized in the Non-Seal Pump. Since the same models of the pump can offer NPSH required even below 0.5 meter, please consult us when a condition should be critical.

2.6 Temperature

Selection of the type basing on the temperature is mainly made by the class of insulation, the degree of ex-proof protection and the arrangement of cooling jacket on the canned motor.

Liquid temperature limits given are for pumping water or equivalent liquid, and when the specific heat and heat conduction factor of the liquid is poor, it is necessary to deem this limit to be lower by 5–10°C.

For liquid temperatures of -40°C or below, use insulation Class C.

2.7 Vapour Pressure

Since the Non-Seal pump contains no dynamic seal, it is ideal for the handling of liquids having a high vapour pressure or of liquified gases.

However, the following precautions should be observed.

[1] Cooling the motor itself with a stator jacket will be required if there may be the case of the considerable drop in the NPSH due to the temperature rise of the liquid passing through the rotor chamber.

[2] Cooling water, low temperature brine, or other cooling liquids must be used in accordance with conditions. However, there are also cases that the motor is cooled with latent heat by passing a part of the pumped liquid vapourized through a jacket.

In both cases, extreme care if required to insure that cooling system operation does not stop.

[3] Reverse circulation is one method of insuring that the temperature rise, which occurs when the liquid passes through the inside of the rotor chamber, does not cause a drop in the NPSH.

The circulation liquid passes through the rotor chamber from the pump chamber and then returns to the vapour zone of suction vessel from rear part of pump.

For details, refer to paragraph “Reverse circulation piping” on the 4.2.3.

2.8 Slurry

Since the Non-Seal Pump has no dynamic seal, it can handle slurries, which can not be pumped by the conventional centrifugal pumps, without any trouble.

Of course, as slurry must be prevented from entering the rotor chamber, Slurry Type construction which can prevent slurry from entering the rotor chamber with only a small volume of external back flushing from the pump rear port must be selected.

In the case of slurry, basing on apparent viscosity, over-all specific gravity etc. the calculation of required power should be made. Furthermore according to the characteristic of slurry, it might adhere to the impeller. In such cases, please consult us.

2.9 Motor

3-phase motor is used for the canned motor of the Non-Seal Pump and is fundamentally similar to the ordinary induction motor.

However by “canning”;

[1] When the revolving magnetic flux, which rotates the rotor, passes through the stationary can, eddy current will develop in the can. (mainly in the stator can and very little in the rotor can).

This eddy current will be accompanied by excessive heat but this value will be settled by the specific resistance of can material. Standard material of can is SUS316L (18Ni-12Cr-2.5Mo low carbon stainless steel) or HC.

[2] There are no cooling fans for the motor and cooling is performed by the liquid handled. By recirculating a part of the pumping liquid, both cooling of the motor and lubricating of the bearings are performed.

If the temperature of liquid handled is high, motor winding of higher insulation class (Class F or Class C) is selected or a jacket or heat exchanger is installed around the outer surface of the stator.

Temperature limits of motor winding of Non-Seal Pump are as follows:

Table 2-1 Thermostat Activation Temperature

Insulation	Thermostat Activation Temperature
Class F	155 ± 6°C
Class C	224 ± 9°C

The maximum load carrying capacity of the thermostat is as follows:

Voltage: 220 VAC, 50 to 60 Hz

Current: 1.5 A

[3] Explosion Proof (Flame proof) authorization by RIIS (Research Institute of Industrial Safty, Ministry of Labor Japan) has been acquired for Non-Seal Pumps.

[4] One of the main features of the Non-Seal Pump is that all motors are connectable to the pump of each model. This simplifies maintenance and specification changes.

Table 2-2 shows a possible combination of pump No. and canned motor.

The motors between the thick vertical lines indicate that outside diameter are identical except the lengths.

In other words, in this section, bearings, shaft sleeves, thrust washers etc. wearing parts are interchangeable for easy maintenance. The parts printed in black show pumps and motors combined mutually.

Table 2-2 Pump and canned motor combination

■ : Combination of pump and standard motor

Motor frame No. / Pump No.	A1	A2	A3	B1	B2	B3	C1	C2	C3	C4	D1	D2
21A	■	■	■									
21B	■	■	■									
21C	■	■	■									
22A	■	■	■									
22B	■	■	■									
22C	■	■	■	■	■	■						
22D	■	■	■	■	■	■						
22E				■	■	■	■	■	■	■		
23A	■	■	■									
23B	■	■	■	■	■	■						
23C	■	■	■	■	■	■						
23D				■	■	■	■	■	■	■		
23E				■	■	■	■	■	■	■		
23F							■	■	■	■	■	■
24A	■	■	■	■	■	■						
24B	■	■	■	■	■	■						
24C				■	■	■	■	■	■	■		
24D				■	■	■	■	■	■	■		
24E							■	■	■	■	■	■
25B				■	■	■	■	■	■	■		
25C				■	■	■	■	■	■	■	■	■
25D							■	■	■	■	■	■
25E							■	■	■	■	■	■

2.10 Motor Performance (d2G3)

Liquid temperature: Max. 80°C Insulation Class F Motor size (A1 to A3, B1 to B3)
50Hz 200V Liquid temperature: Max. 50°C Insulation Class F Motor size (C1 to C3, D1 to D2)

Pump construction	Motor size	Motor output (kW)	Full-load current (A)	Apparent input (kVA)	Starting current (A)	Starting input (kVA)	Starting time (sec)	Q'ty of thermostat
N (w/o J) Q (w/o J) V (w/o J)	A1	1.1	5.5	1.9	16.0	5.5	Within 0.5	1
	A2	2.1	10.0	3.5	33.2	11.5		
	A3	2.6	12.1	4.2	48.9	16.9		
	B1	4.5	21.7	7.5	80	27.7	Within 0.7	
	B2	5.9	26.6	9.2	129	44.7		
	B3	8.1	35.2	12.2	179	62.0		
	C1	11	44	15.2	190	65	Within 1.0	2
	C2	15	61	21.1	310	108		
	C3	18.5	74	25.6	370	128		
	C4	22	91	31.5	440	153		
	D1	—	—	—	—	—		—
	D2	—	—	—	—	—		

50Hz 200V Liquid temperature: Max. 50°C Insulation Class F

N (w/o J) Q (w/o J) V (w/o J)	D1	30	116	40.1	450	156	Within 1.0	3
	D2	37	144	49.8	590	204		

50Hz 200V Liquid temperature: Max. 105°C Insulation Class F

N (w/o J) Q (w/o J) V (w/o J)	A1	0.9	4.8	1.7	16.0	5.5	Within 0.5	1
	A2	1.8	9.3	3.2	33.2	11.5		
	A3	2.4	11.8	4.1	48.9	16.9		
	B1	3.5	15.4	5.3	80	27.7	Within 0.7	
	B2	5.1	24.5	8.5	129	44.7		
	B3	6.3	28.6	10.0	179	62.0		
	C1	11	44	15.2	190	65	Within 1.0	2
	C2	15	61	21.1	310	108		
	C3	18.5	74	25.6	370	128		
	C4	22	91	31.5	440	153		
	D1	22.5	90	31.1	450	156		3
	D2	28	114	39.4	590	204		

50Hz 200V Liquid temperature: Max. 105°C Insulation Class F

N (w/o J) Q (w/o J) V (w/o J)	D1	26	102	35.2	450	156	Within 1.0	3
	D2	32	126	43.5	590	204		

50Hz 200V Liquid temperature: Max. 105°C Insulation Class F

N (w/J) Q (w/J) V (w/J))	A1	1.1	5.6	1.9	16.0	5.5	Within 0.5	1
	A2	2.1	10.5	3.6	33.2	11.5		
	A3	3.2	14.8	5.1	48.9	16.9		
	B1	5.4	24.5	8.5	80	27.7	Within 0.7	
	B2	7.7	34.4	11.9	129	44.7		
	B3	10.5	46.4	16.1	179	62.0		
	C1	12	49	16.9	190	65	Within 1.0	2
	C2	16.5	67	23.2	310	108		
	C3	20.5	82	28.3	370	128		
	C4	24	99	34.2	440	153		
	D1	26	102	35.2	450	156		3
	D2	32	126	43.5	590	204		

(d2G3)

Insulation Class F Motor size (A1 to A3, B1 to B3)
50Hz 200V Liquid temperature: Max. 350°C Insulation Class F Motor size (C1 to C3, D1 to D2)

Pump construction	Motor size	Motor output (kW)	Full-load current (A)	Apparent input (kVA)	Starting current (A)	Starting input (kVA)	Starting time (sec)	Q'ty of thermostat
T S M G	A1	1.1	5.6	1.9	16.0	5.5	Within 0.5	1
	A2	2.2	10.5	3.6	33.2	11.5		
	A3	3.3	14.8	5.1	48.9	16.9		
	B1	5.5	24.5	8.5	80	27.7	Within 0.7	
	B2	8.2	35.7	12.4	129	44.7		
	B3	11.2	49.0	17.0	179	62.0		
	C1	11	44	15.3	190	65	Within 1.0	2
	C2	15	61	21.1	310	108		
	C3	18.5	74	25.6	370	128		
	C4	22	91	31.5	440	153		
	D1	30	116	40.1	450	156		3
	D2	37	144	49.8	590	204		

Liquid temperature: Max. 80°C Insulation Class F Motor size (A1 to A3, B1 to B3)
60Hz 220V Liquid temperature: Max. 50°C Insulation Class F Motor size (C1 to C3, D1 to D2)

Pump construction	Motor size	Motor output (kW)	Full-load current (A)	Apparent input (kVA)	Starting current (A)	Starting input (kVA)	Starting time (sec)	Q'ty of thermostat
N (w/o J) Q (w/o J) V (w/o J)	A1	1.1	5.5	2.1	15.3	5.8	Within 0.5	1
	A2	2.1	9.1	3.5	32.3	12.3		
	A3	2.6	11.0	4.2	47.1	17.9		
	B1	4.5	19.8	7.5	77	29.4	Within 0.7	
	B2	5.9	24.2	9.2	123	46.9		
	B3	8.1	32.0	12.2	175	66.7		
	C1	12	43	16.3	180	69	Within 1.0	2
	C2	16	58	22.1	290	111		
	C3	20	72	27.4	350	134		
	C4	24	88	33.5	410	157		
	D1	—	—	—	—	—	—	—
	D2	—	—	—	—	—		

60Hz 220V Liquid temperature: Max. 50°C Insulation Class F

N (w/J) Q (w/J) V (w/J)	D1	32	114	44	410	157	Within 1.0	3
	D2	40	142	54	540	206		

60Hz 220V Liquid temperature: Max. 105°C Insulation Class C

N (w/o J) Q (w/o J) V (w/o J)	A1	0.95	4.5	1.7	15.3	5.8	Within 0.5	1
	A2	1.9	8.4	3.2	32.3	12.3		
	A3	2.8	11.6	4.4	47.1	17.9		
	B1	3.5	14.2	5.4	77	29.4	Within 0.7	
	B2	5.3	22.5	8.6	123	46.9		
	B3	6.3	26.0	9.9	175	66.7		
	C1	11.5	42	16.0	180	69	Within 1.0	2
	C2	16	58	22.1	290	111		
	C3	19.5	70	26.6	350	134		
	C4	23.5	87	33.1	410	157		
	D1	24	88	33.5	410	157		3
	D2	30	112	42.6	540	206		

60Hz 220V Liquid temperature: Max. 105°C Insulation Class F

N (w/J) Q (w/J) V (w/J)	D1	27.5	100	38.1	410	157	Within 1.0	3
	D2	34	124	47.2	540	206		

(d2G3)

60Hz 220V — Liquid temperature: Max. 155°C Insulation Class C

Pump construction	Motor size	Motor output (kW)	Full-load current (A)	Apparent input (kVA)	Starting current (A)	Starting input (kVA)	Starting time (sec)	Q'ty of thermostat
N (w/J) Q (w/J) V (w/J)	A1	1.1	5.1	1.9	15.3	5.8	Within 0.5	1
	A2	2.2	9.6	3.7	32.3	12.3		
	A3	3.3	13.5	5.1	47.1	17.9		
	B1	5.5	22.3	8.5	77	29.4	Within 0.7	
	B2	8.2	32.5	12.4	123	46.9		
	B3	11.2	44.6	17.0	175	66.7		
	C1	13	47	17.9	180	69	Within 1.0	2
	C2	17.5	63	24.0	290	111		
	C3	21.5	77	29.3	350	134		
	C4	26	95	36.2	410	157		
	D1	27.5	100	38.1	410	157		3
	D2	34	124	47.2	540	206		

Insulation Class F Motor size (A1 to A3, B1 to B3)

60Hz 220V — Liquid temperature: Max. 350°C Insulation Class C Motor size (C1 to C3, D1 to D2)

Pump construction	Motor size	Motor output (kW)	Full-load current (A)	Apparent input (kVA)	Starting current (A)	Starting input (kVA)	Starting time (sec)	Q'ty of thermostat
T S M G	A1	1.1	5.1	1.9	15.3	5.8	Within 0.5	1
	A2	2.2	9.6	3.7	32.3	12.3		
	A3	3.3	13.5	5.1	47.1	17.9		
	B1	5.5	22.3	8.5	77	29.4	Within 0.7	
	B2	8.2	32.5	12.4	123	46.9		
	B3	11.2	44.6	17.0	175	66.7		
	C1	12	43	16.3	180	69	Within 1.0	2
	C2	16	58	22.1	290	111		
	C3	20	72	27.5	350	134		
	C4	24	88	33.5	410	157		
	D1	30	108	41.1	410	157		3
	D2	37	133	50.6	540	206		

(Simple and complete high melting point types) Insulation Class C

50Hz 200V d2G3 Liquid temperature: Max. 105°C Heating source hot water: Max. 95°C

Pump construction	Motor size	Motor output (kW)	Full-load current (A)	Apparent input (kVA)	Starting current (A)	Starting input (kVA)	Starting time (sec)	Q'ty of thermostat
C B	A1	1.0	5.2	1.8	16.0	5.6	Within 0.5	1
	A2	2.1	10.5	3.7	33.2	11.5		
	A3	3.1	14.6	5.1	48.9	17.0		
	B1	5.1	23.3	8.1	80	27.8	Within 0.7	1
	B2	7.6	33.4	11.6	129	44.7		
	B3	10.4	46.0	16.0	179	62.0		

50Hz 200V d2G3 Liquid temperature: Max. 155°C Heating source hot water: Max. 95°C

Pump construction	Motor size	Motor output (kW)	Full-load current (A)	Apparent input (kVA)	Starting current (A)	Starting input (kVA)	Starting time (sec)	Q'ty of thermostat
C B	A1	0.95	5.0	1.8	16.0	5.6	Within 0.5	1
	A2	1.9	9.6	3.4	33.2	11.5		
	A3	2.8	13.3	4.6	48.9	17.0		
	B1	4.5	19.6	6.8	80	27.8	Within 0.7	1
	B2	6.7	30.2	10.5	129	44.7		
	B3	9.2	40.0	13.9	179	62.0		

50Hz 200V d2G3 Liquid temperature: Max. 200°C Heating source hot water: Max. 95°C

Pump construction	Motor size	Motor output (kW)	Full-load current (A)	Apparent input (kVA)	Starting current (A)	Starting input (kVA)	Starting time (sec)	Q'ty of thermostat
C B	A1	0.7	4.1	1.5	16.0	5.6	Within 0.5	1
	A2	1.5	8.2	2.9	33.2	11.5		
	A3	2.2	11.1	3.9	48.9	17.0		
	B1	3.8	16.8	5.9	80	27.8	Within 0.7	1
	B2	5.6	26.0	9.0	129	44.7		
	B3	7.7	33.6	11.7	179	62.0		

50Hz 200V d2G3 Liquid temperature: Max. 105°C Heating source steam: Max. 155°C

Pump construction	Motor size	Motor output (kW)	Full-load current (A)	Apparent input (kVA)	Starting current (A)	Starting input (kVA)	Starting time (sec)	Q'ty of thermostat
C B	A1	0.8	4.4	1.6	16.0	5.6	Within 0.5	1
	A2	1.5	8.2	2.9	33.2	11.5		
	A3	2.2	11.1	3.9	48.9	17.0		
	B1	4.3	18.8	6.6	80	27.8	Within 0.7	1
	B2	6.4	29.3	10.2	129	44.7		
	B3	8.7	37.5	11.0	179	62.0		

50Hz 200V Liquid temperature: Max. 155°C Heating source steam: Max. 155°C

Pump construction	Motor size	Motor output (kW)	Full-load current (A)	Apparent input (kVA)	Starting current (A)	Starting input (kVA)	Starting time (sec)	Q'ty of thermostat
C B	A1	0.6	3.8	1.4	16.0	5.6	Within 0.5	1
	A2	1.2	7.3	2.6	33.2	11.5		
	A3	1.7	9.6	3.4	48.9	17.0		
	B1	3.4	15.1	5.3	80	27.8	Within 0.7	1
	B2	5.0	24.1	8.4	129	44.7		
	B3	6.9	30.8	10.7	179	62.0		

(Simple and complete high melting point types) Insulation Class C

60Hz 220V d2G3 Liquid temperature: Max. 105°C Heating source hot water: Max. 95°C

Pump construction	Motor size	Motor output (kW)	Full-load current (A)	Apparent input (kVA)	Starting current (A)	Starting input (kVA)	Starting time (sec)	Q'ty of thermostat
C B	A1	1.1	5.1	2.0	15.3	5.9	Within 0.5	1
	A2	2.2	9.6	3.7	32.3	12.3		
	A3	3.3	13.5	5.2	47.1	18.0		
	B1	5.4	21.5	8.2	77	29.4	Within 0.7	1
	B2	8.0	31.2	11.9	123	46.9		
	B3	11.0	43.5	16.6	175	66.7		

60Hz 220V d2G3 Liquid temperature: Max. 155°C Heating source hot water: Max. 95°C

Pump construction	Motor size	Motor output (kW)	Full-load current (A)	Apparent input (kVA)	Starting current (A)	Starting input (kVA)	Starting time (sec)	Q'ty of thermostat
C B	A1	1.1	5.1	2.0	15.3	5.9	Within 0.5	1
	A2	2.2	9.6	3.7	32.3	12.3		
	A3	3.2	13.3	5.1	47.1	18.0		
	B1	4.8	19.0	7.3	77	29.4	Within 0.7	1
	B2	7.1	28.4	10.9	123	46.9		
	B3	9.7	37.8	14.4	175	66.7		

60Hz 220V d2G3 Liquid temperature: Max. 200°C Heating source hot water: Max. 95°C

Pump construction	Motor size	Motor output (kW)	Full-load current (A)	Apparent input (kVA)	Starting current (A)	Starting input (kVA)	Starting time (sec)	Q'ty of thermostat
C B	A1	0.8	4.0	1.6	15.3	5.9	Within 0.5	1
	A2	1.7	7.8	3.0	32.3	12.3		
	A3	2.5	10.8	4.2	47.1	18.0		
	B1	4.0	15.9	6.1	77	29.4	Within 0.7	1
	B2	5.9	24.2	9.3	123	46.9		
	B3	8.1	32.0	12.2	175	66.7		

60Hz 220V d2G3 Liquid temperature: Max. 105°C Heating source steam: Max. 155°C

Pump construction	Motor size	Motor output (kW)	Full-load current (A)	Apparent input (kVA)	Starting current (A)	Starting input (kVA)	Starting time (sec)	Q'ty of thermostat
C B	A1	0.9	4.3	1.7	15.3	5.9	Within 0.5	1
	A2	1.7	7.8	3.0	32.3	12.3		
	A3	2.6	11.0	4.2	47.1	18.0		
	B1	4.5	17.8	6.8	77	29.4	Within 0.7	1
	B2	6.7	27.0	10.3	123	46.9		
	B3	9.2	36.0	13.8	175	66.7		

60Hz 220V Liquid temperature: Max. 155°C Heating source steam: Max. 155°C

Pump construction	Motor size	Motor output (kW)	Full-load current (A)	Apparent input (kVA)	Starting current (A)	Starting input (kVA)	Starting time (sec)	Q'ty of thermostat
C B	A1	0.68	3.6	1.4	15.3	5.9	Within 0.5	1
	A2	1.4	6.9	2.7	32.3	12.3		
	A3	2.0	9.2	3.5	47.1	18.0		
	B1	3.6	14.4	5.5	77	29.4	Within 0.7	1
	B2	5.3	22.5	8.6	123	46.9		
	B3	7.3	29.2	11.2	175	66.7		

3 NIKKISO NON-SEAL PUMP/PROTECTION DEVICE

The Non-Seal Pump differs from conventional pumps in that the motor is isolated by a comparatively thin can, bearing lubrication and motor cooling are performed by the pumped liquid which generally has poor lubricating characteristics, and the rotating components cannot be seen from the outside.

These points will naturally give rise to uncertainty and hesitation when first employing the pump regardless of its many advantages.

The various protection devices provided will dispel these uncertainties.

1. Bearing Monitor (Standard)

The bearings of the Non-Seal Pump can normally withstand more than one year of continuous operation.

Therefore, replacement, if necessary, during yearly inspection is sufficient.

However, wear may be accelerated by abnormal operating conditions, erroneous operation, etc. If operation of the pump is continued in such cases, the rotor will contact the stator, the stator can and the motor will be damaged.

There are rare cases too where the can will be damaged due to unforeseen corrosion. The bearing monitor checks for abnormal wear of bearings or corrosion of the can during operation outside the pump. The monitor issues a warning upon detection of such a fault. Electrical and mechanical bearing monitors are available.

1.1 Electrical Bearing Monitor (E Monitor)

The E Monitor accurately detects and displays various types of bearing wear, such as one-sided wear (both front and rear) in the axial direction, which is important for a pump, or in the radial direction. The direction of rotation is easily checked. The condition of wear is checked visually. The monitoring helps to determine when to replace the bearings, drastically reducing maintenance costs and improving production planning.

The E Monitor is equipped with a standard external output terminal. By connecting a 3-core cable to the terminal, the E Monitor can be connected to the pump central control room. A remote surveillance E Monitor is also available. The remote surveillance E Monitor monitors multiple pumps and eliminates the need for site patrol, thus saving manpower. The remote surveillance E Monitor is equipped with contacts (with an alarm level setting function) for alarm output and for stopping the pump.

Principles of Operation Detection

The E Monitor has a stator with a built-in search coil. By using the starting voltage generated in the search coil, the E Monitor electrically detects positional changes of the rotor (in the radial/axial directions) caused by worn bearings. The LED lamp indicates any change. The E Monitor has four search coils on each side of the stator (for a total of eight coils). Two search coils on both the front and the rear are used to detect wear in the axial and radial directions.

[1] Local Type

The display unit of the E Monitor is mounted on the pump’s terminal box. The E Monitor display unit is connected to the pump at our factory before shipment.

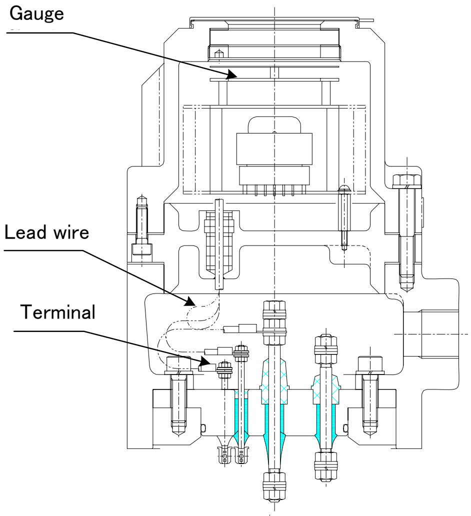
Normal operation state

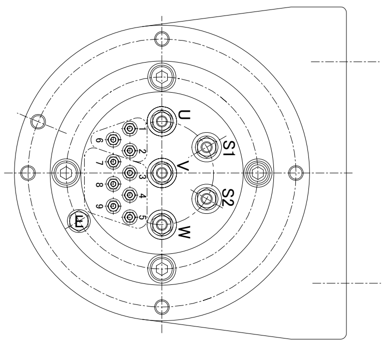
Bearing needs inspection

The pump is not in operation

Table 3-1 Terminal Block and Terminal Code

Item	Terminal Code
Power and E Monitor power supply (M6)	U, V, W
Thermostat output (M6)	S1, S2
Detection coil output (M3)	3, 4 ,5, 7, 8, 9
E Monitor output (M3)	1, 2 , 6





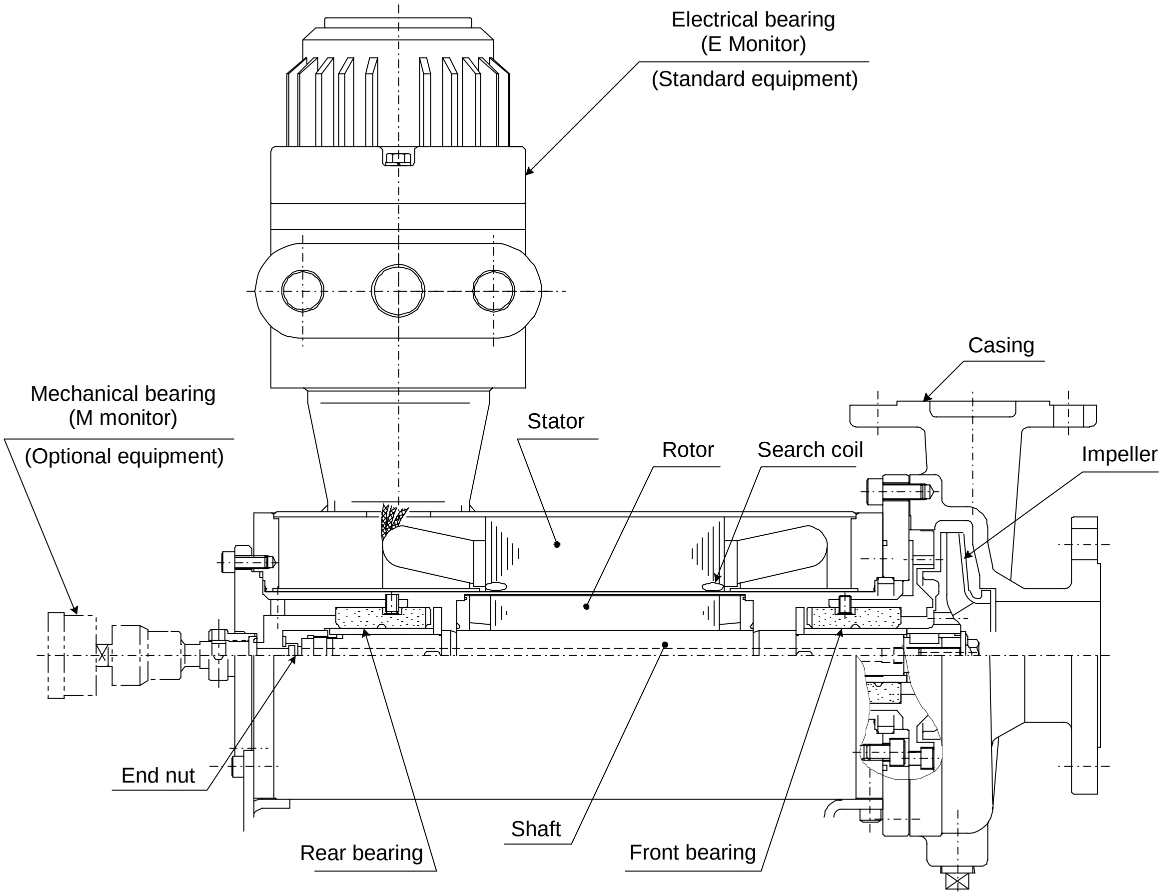


Fig. 3-1 E Monitor

[2] Remote Type

Upon receiving digital signal (RS-422) signals from the on-site E Monitor, the remote surveillance E Monitor starts flashing the LED meter and lets you monitor bearings from a remote location (e.g., central control room).

Moreover, the remote surveillance E Monitor has a function to issue a warning alarm (relay contact output) when the limit value is exceeded.

(1) Input Signal

Input Signal is digital signal based RS-422.

(2) Output Signal

Alarm output
Contact structure: 1C
Contact rating: 125 VAC/5 A, 30 VDC/5 A

(3) Display Format

Thrust wear
Radial wear
Switch input

(4) Power Supply

Input voltage: 85 to 132 VAC
Input frequency: 47 to 440 Hz

(5) Ambient Temperature

0°C to 75°C

(6) Relative Humidity

RH 90% or less with no condensation

Table 3-2 Comparison of E Monitor and M Monitor specifications

		Electrical (E Monitor)	Mechanical (M Monitor)	Remarks
Principle of detection		Search coil	Physical contact	
Detected item	Radial direction (parallel wear)	○	○	○: Detectable △: Detectable under some conditions ×: Not detectable
	Radial direction (one-sided wear)	○	△	
	Axial-direction wear	○	○	
	Direction of rotation	○	×	
	Corrosion	×	○	
Indication	On site	Current status	Normal or abnormal	
	External	Available as standard equipment	Optional	

1.2 Mechanical Bearing Monitor (M Monitor)

(1) Structure and Principles of Operation

The mechanical bearing monitor (M Monitor) is a kind of gas-filled pressure gauge. The M Monitor is mounted on the rear bearing (RB) housing and its probe is inserted into the end nut of the rotating shaft as shown in Fig. 3-2. When bearing wear exceeds the predetermined limit, the probe strikes the inner wall of the end nut and breaks, thus changing the pressure and indicating an abnormal state. The MS-01 is filled with argon gas to maintain a certain pressure. When the probe is broken, the pressure of the argon gas is released, thus reducing the pressure. Therefore, any drop in pressure results in indication of an abnormal state. The MS-02 is maintained at atmospheric pressure. When the probe is broken, the pressure increases as the liquid enters from the pump. Therefore, any increase in pressure results in indication of an abnormal state.

Since the probe is made of the same material as that of the stator liner (although thinner), the monitor can detect stator liner corrosion. Inert fluorine oil is filled between the probe and pressure gauge, and the entire structure is designed to withstand pressure.

(2) Types

Table 3-3 lists various types of monitors according to pump suction pressure. The design pressure of the standard types is 2 MPa. The MS-03, with a design pressure of 5 MPa, is also available.

Table 3-3 Bearing Monitor Model No. and Specifications

Bearing Monitor Model No.	Material	Pump Suction Pressure	Monitor Withstand Pressure
MS-01	SUS316 (standard) CA20 (special) HC (special)	0.245 or less	2.0
MS-02		Higher than 0.245 or 2.0 or less	

Note: For a vertical type of pump, the gauge is positioned horizontally. For these pumps, the model No. changes from MS-01 to MS-11 and from MS-02 to MS-12, but the specifications are the same.

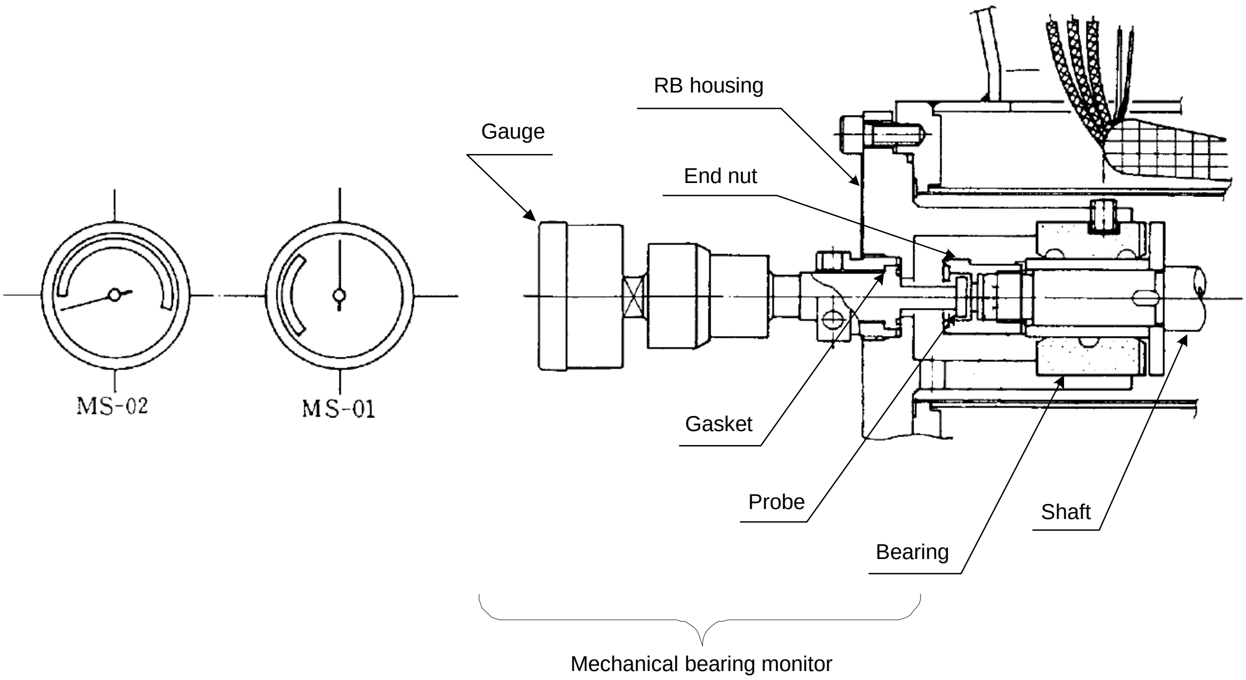


Fig. 3-2 Mechanical Bearing Monitor

2. Automatic Thrust Balance

The load applying to the journal part of bearing in case of the horizontal type pump will only be a weight of rotating part and a slight radial reaction force developed by the impeller and the volute chamber.

Consequently, as the load will be comparatively small and as it will not differ much from the value calculated beforehand, it can be kept down to within a sufficiently permissible range even under the worst lubrication condition so there will be no problem.

However, by simply adjusting the impeller thrust by the balance holes of impeller only, if the Q-H point differs, a large thrust will develop and frequently surpass the permissible load of thrust bearing part, which in the case of usual canned motor pumps, heretofore, might have caused abnormal wear of thrust bearing part.

By employing the automatic thrust balance mechanism for the NON-SEAL PUMP, the thrust is balanced along the entire range from the shut-off to the fully open condition and as there is no contact of thrust bearing part to cause wear during normal operation, the bearing will have an exceptionally long life.

In the pump part, a thrust balance chamber is established at the rear of the impeller. This thrust balance chamber (pressure balancing chamber) is composed of the fixed orifice parts, which is equivalent to a wearing ring clearance of a conventional centrifugal pump, and a variable orifice part.

The pressure drops at the fixed orifice part in front of and in the rear of the impeller so designed not to be affected too much by the clearances (overlapping degree) due to the to and fro movements of the impeller and will be almost constant.

However, the pressure loss at the variable orifice part will change greatly with the movements of the impeller. Consequently, if the impeller moves front, the pressure in the thrust balance chamber will drop, so the pressure distributed in front side of the impeller will be larger than that of in rear side and the impeller will be forced back to the rear. On the contrary, if the impeller moves rear, the variable orifice parts become narrower, the pressure of trust balance chamber will increase and the impeller will be maintained hydrodynamically at a certain balanced position.

The thrust washer and thrust bearing part are effective also to protect the pump in case there is no thrust balance function at start up and shut down or during abnormal operation, i.e., cavitation, etc.

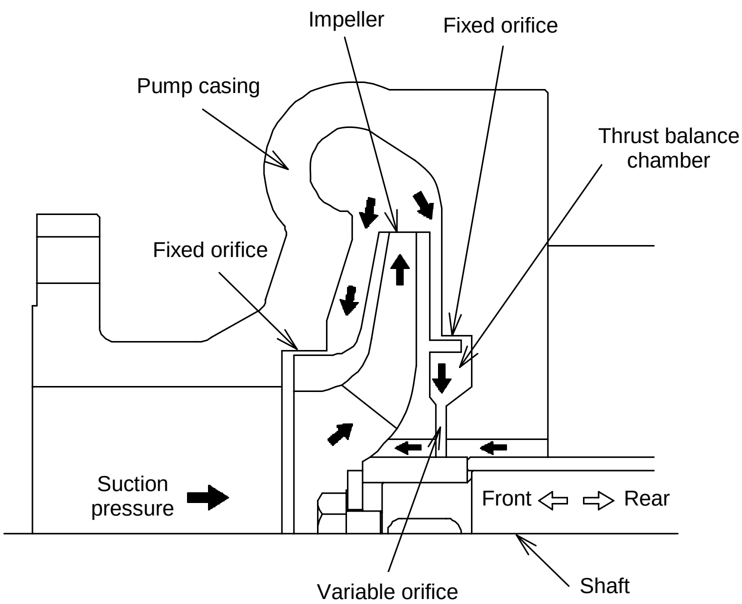


Fig. 3-3 Automatic thrust balance explanation dwg.

3. Dry Operation Preventive Device

When a canned motor pump shall be operated continuously in a dry condition, the pump may result in a damage due to excess wears of the bearings, excess temperature rise, etc. To prevent such phenomenon, current sensing type (SAO Relay) of Dry Operation Preventive Device can be furnished.

3.1 Current Sensing Device (SAO Relay)

This device is for the purpose of insuring the safety of the pump also during operation by stopping the pump immediately when electric current falls below the rated value due to reduction of pump load and decrease in electric current caused by cavitation or the sucking in of a large volume of air bubbles.
This sensing device is an electrical device designed for installation in an electrical room. It is not built to withstand explosions.

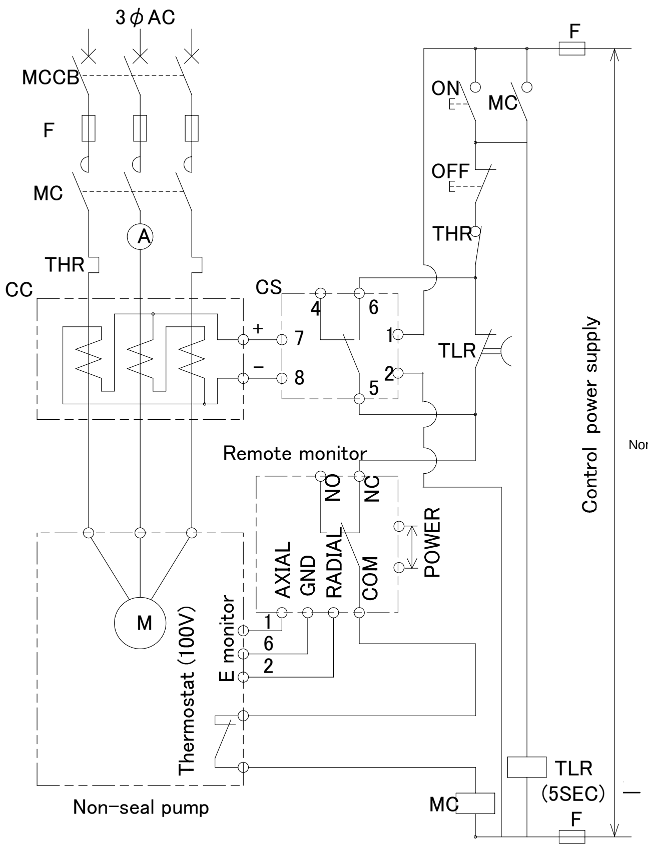


Fig. 3-4 Wiring diagram

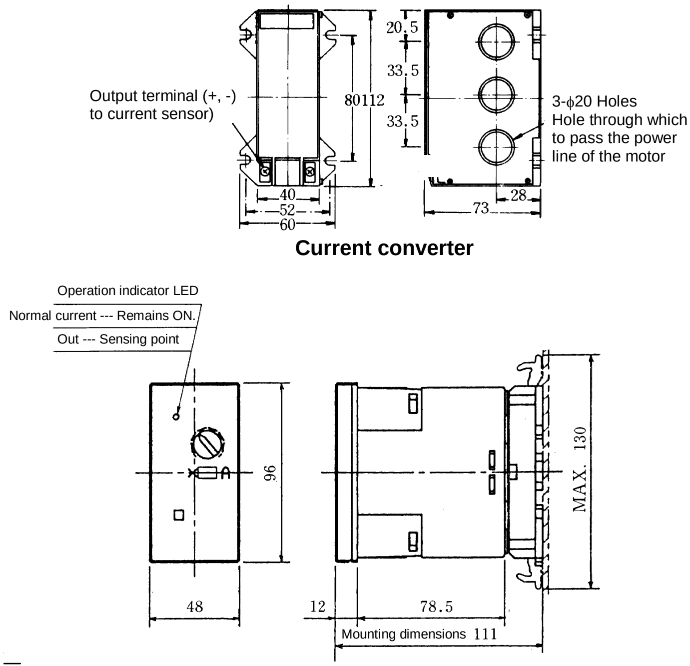


Fig. 3-5 Dry operation preventive device

4. Thermostat

The motor of a canned motor pump is cooled by the liquid handled, therefore, depending on the temperature of the handling liquid, suitable insulation class is selected, water jacket for cooling of the stator is provided, or High-Temperature Type is selected.

However, when a temperature of handling liquid happens to exceed the specific temperature, and/or, no cooling water flow available on the heat exchanger or on the cooling jacket, the motor winding temperature may exceed allowable limit.

The thermostat is embedded in the motor winding to protect the motor winding from overheat, it will be actuated at the preset temperature and it open the motor protection circuit to trip off the motor.

Usually the thermostat has normally closed contact and it is provided with the motor of the Non-Seal Pump as the standard feature, it is recommendable to be connected in series on thermal overload relay circuit without fail. The thermostat has been selected by the classification of the motor insulation.

See Table 1-1 for thermostat activation temperature. When you need a pump for liquid with a high melting point or a special temperature monitoring system, an embedded thermocouple is also available in addition to the thermostat.
A thermostat is one safety measure to improve explosion-proof capability.

4 NIKKISO NON-SEAL PUMP/PIPING PLAN

For the Non-Seal Pump, in addition to the main piping of pump suction and discharge ports, auxiliary pipings for jacket and heat exchanger, for back flushing and for reverse circualation are required.

1. Main Piping

Piping line of pump suction and discharge is not always dependent on the port sizes of pump, but the pipe to be used should be considered on calculation based on the pipe friction loss.

Especially, please select the piping size for suction side to satisfy the condition of "NPSH"

For piping, please take care of the following.

- Remove burrs and the like on the edge of pipes or flanges.
- When using a flange, make sure that the gasket is concentric with the pipe hole to avoid pockets of air or the accumulation of foreign matter.
- Arrange the pipings so as not to form air pocket in them, and reduce the elbows and bends as much as possible.
- Take care not to load the pump with the stress of thermal strains or the weight of pipings, and if necessary, provide with stress-buffer such as expansion joint, and support the piping. Allowable force and moment vary from pump to pump. Please contact us for allowable limits.
- In case of piping with different pipe sizes, use the eccentric reducer to prevent formation of air-pocket.
- Piping Accessories

  On main piping, please arrange the following accessories to be provided.
- Pressure gauge: Be sure to attach a pressure gauge to the pump outlet side for monitoring the operating condition. Fit the pressure gauge between the pump and discharge valve. Also at the suction side, attach the pressure gauge between a strainer and the pump to check a decrease of the suction pressure due to clogging of the strainer.
- Strainer: Even in case that no foreign material may enter the piping in normal operation, please arrange for a strainer temporarily on the suction side of pump when initial running and remove this strainer only after confirming that no foreign material exists.

  A strainer with 60 to 80 mesh is necessary. A strainer has large flow-resistance and in cases where foreign material will easily clog, depending on the condition of cloggage, the flow-resistance will increase greatly; so, use a large sized strainer and make a regular cleaning according to the liquid condition.

  Heavy clogging of the strainer causes cavitation. To prevent such trouble as cavitation, check the suction pressure and clean the strainer periodically.
- Stop Valve: Please provide with valves for maintenance, at the suction and discharge sides of pump. Especially, use gate-valve on the suction side to decrease flow-resistance and flow regulating valve on the discharge side. The handle of this gate-valve should be kept horizontal for "air-pocket"-proof.

2. Auxiliary Piping

Usually, the following auxiliary pipings are required for Non-Seal Pump according to the pump type and usage.

- Pipings for cooling (or heating) medium of motor jacket and heat exchanger.
- Pipings for heating (or cooling) medium of pump casing jacket.
- Pipings for back-flushing–Slurry Handling Types
- Pipings for reverse circulation–Reverse Circulation Types

2.1 Piping for cooling (or heating) medium of motor jacket and heat exchanger

For pumps provided with jacket around motor or with heat exchanger, piping for cooling water is required.

A) The inlet of jacket piping is the port located at the lowest portion of jacket–both for vertical and horizontal. If the upper port is used as inlet, air will remain in the jacket, so use the lower port as inlet of cooling water.

B) Necessary volumes of cooling water are described in Table 4-1.

The volume of cooling water is an approximate value when using industrial water at lower than 35°C.

Table 4-1 Volume of cooling water for jacket and heat exchanger

Motor Rating	Volume of Cooling Water m³/h	Connecting bore
A1–A3	0.5–0.6	R1/2
B1–B3	0.8–1.1	
C1–C4	1.5–2.0	R1
D1–D2	2.0–3.0	

[Note] Depending upon the characteristic, temperature, etc. of the liquid handled, there are cases where steam, warm water, etc. should be used for the motor jacket or cases where brine of less than 0°C should be used. For details, please refer to the separate instruction manual and specifications.

2.2 Back Flushing Piping for Slurry Handling Type

(A) Standard type (without mechanical seal)

With the Slurry Handling Type, back flushing is required for preventing solid particles from entering the rotor chamber. In many cases, the mother liquid line is branched off or flushing pump is established in common with several slurry pumps for the flushing source. Fig. 4-1 shows an example of typical piping.

Check valves should be installed without fail in the flushing line and also a throttle valve and flow meter to control the flushing volume.

For carrying out back flushing, a reciprocating pump can be used. If a reciprocating pump is used, attach an accumulator to eliminate pulsation.

The pressure at the injection point of back flushing should be higher than the suction pressure by 0.05–0.1 MPa.

Table-4-2 Volume of the back flushing for the slurry type

Moter Rating	Back flushing Volume (l/h)	Connecting bore
A1–A3	min. 16	Rc1/2
B1–B3	min. 20	
C1–C4	min. 50	
D1–D2	min. 50	

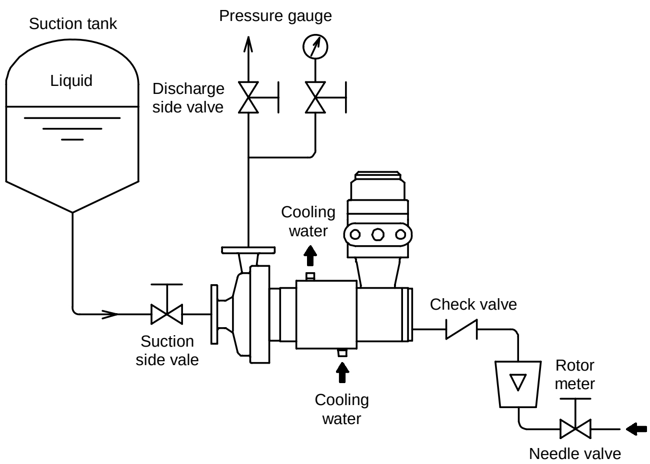


Fig. 4-1 An example of piping for slurry handling type

(B) Mechanical seal type

When it is desired to prevent back flushing liquid from getting mixed with pumping liquid as much as possible or there is no appropriate flushing source, a mechanical seal is provided between the pump chamber and rotor chamber in order to keep the flushing volume down as much as possible. This is the Slurry Handling Type with a mechanical seal.

A typical flushing method in this case is shown in Fig. 4-2.

When this flushing method is adopted, the back flushing volume is usually about 100 ml/day to 500 ml/day.

Set the pressure of a seal pot higher 0.2 to 0.3 MPa than the pump suction pressure.

Apply the pressure generally by connecting to a pressure air source or using N_2 cylinder.

For preventing the seal pot from becoming empty, a visual check type level gauge has been attached.

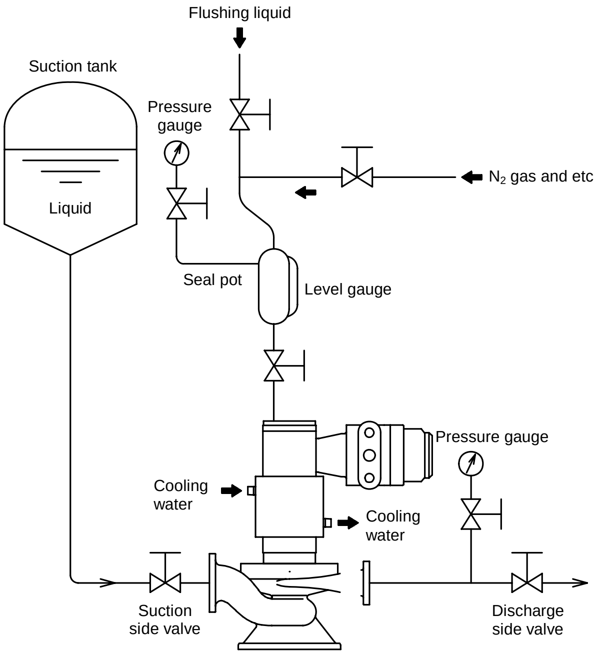


Fig. 4-2 An example of piping for mechanical seal type

(C) Gas seal type

Basically, the construction is identical with that of the Slurry Handling Type with a mechanical seal. The feature of this type pump is that a gas chamber installed between the pump unit and motor unit does not allow handled liquid to contact directly with the mechanical seal.

The flushing piping is exactly the same as that of the Slurry Handling Type with a mechanical seal; however, a seal gas piping connected to the gas chamber becomes necessary.

In such a case where gas is apt to dissolve into pumping liquid, a regulator may be put on the seal gas piping, which provides easy maintenance. Fig. 4-3 shows an example of typical piping.

Seal pot pressure: The pressure must be set higher 0.03 to 0.1MPa than the pressure of gas chamber.

Gas chamber pressure: Prepare a pressure higher 0.2 to 0.3 MPa than the suction pressure and the pressure must be regulated according to the liquid level.

When the suction pressure is a negative pressure, there is a case where a piping connected to a vacuum line is required.

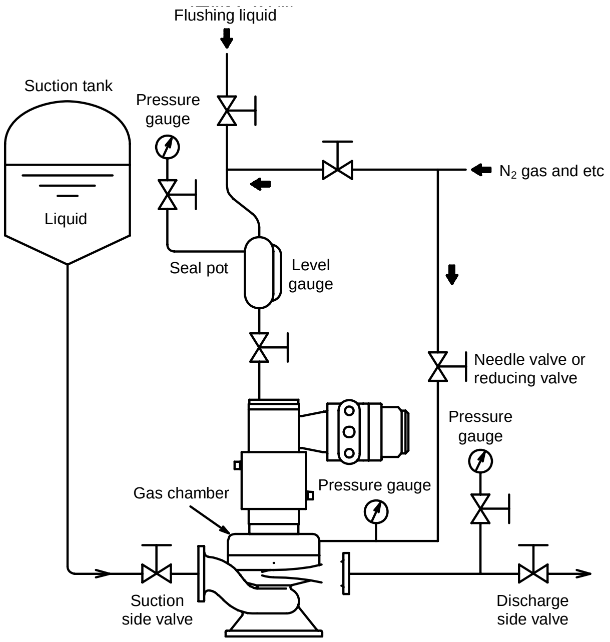


Fig. 4-3 An example of piping for gas seal type

2.3 Reverse Circulation Piping for Reverse Circulation Types

When handling liquid under saturated vapour pressure with the basic type, temperature of the liquid will rise in passing through the rotor chamber and a portion which has evaporated will return to pump chamber resulting in cavitation. To prevent this, a reverse circulation piping to take the circulating liquid out from the rear side of pump and to return it to the vapour zone in the suction tank is required for the reverse circulation type pumps. This piping also serves as gas vent piping.

- Fig. 4-4 shows an example of a typical reverse circulation line.
  Needle valve or orifice should be installed to control the circulation volume in the reverse line.
- When the length of reverse circulation piping is less than 10 m, the pipe bore may be 1/2 or 3/4B.
- If the appropriate rotameter is not available, you can use a sight flow indicator instead.
- Table-4-3 shows the reverse circulation volume required.

Table 4-3 Reverse circulation volume

Motor Rating	Reverse Circulation Volume l/min.	Connecting bore
A1, A2, A3	8–15	Rc1/2
B1, B2, B3	13–18	
C1, C2, C3, C4	25–30	
D1, D2	35–40	

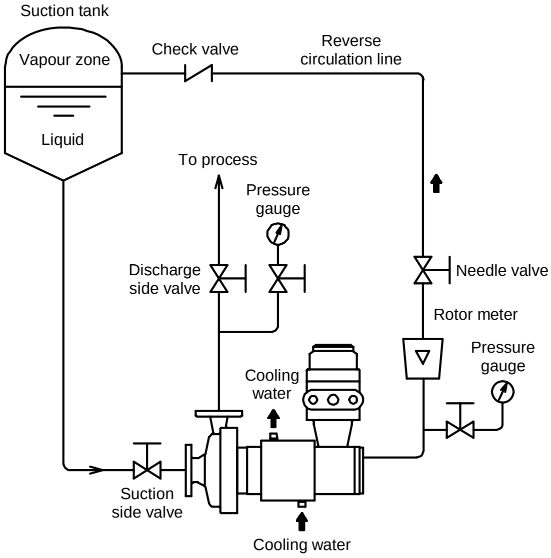


Fig. 4-4 An example of reverse circulation type

2.4 By-Pass piping

Similar to the conventional centrifugal pump, if the Nikkiso Non-Seal Pump is operated continuously for long periods with a low flow rate, temperature of liquid in the pump casing will rise which is undesirable in operation.

It is necessary to operate the Non-Seal Pump with the flow rate as in Table-4-4 at least.

However as the minimum flow rates given in this Table are identical to water, consideration should be made according to the characteristics of the liquid pumped.

Especially, when handling liquid with small specific heat or liquid in saturated condition, care should be taken.

Table 4-4 Minimum flow rate

Pump No.		Minimum Flow Rate without Inducer	Minimum Flow Rate with Inducer
21A 21B 21C		10 l/min (25)	—
22A 22B 22C	22D 22E	20 l/min (50)	50 l/min (50)
23A 23B 23C	23D 23E 23F	40 l/min (100)	100 l/min (100)
24A 24B 24C	24D 24E	80 l/min (200)	200 l/min (200)
25B 25C 25D	25E	160 l/min (400)	400 l/min (400)

(NOTE) If pump has a discharge orifice, the min. flow rate is shown by parenthesized figures.

2.5 Pump Noise and Vibration

A. Noise

Nominal noise level will be approx. less than 70 dB (A) for larger pumps and will be approx. less than 60 dB (A) for smaller pumps, at one (1) meter away from its pump casing. The noise will be generated by high velocity of the liquid. Main noise sources will be at a stop valve in a pump discharge or at a pump casing of a certain model which are apparently different from the mechanical noise of general rotating machinery.

B. Vibration

The vibration of the Nikkiso Non-Seal Pump will be quite low level which will be less than 30 μm (peak to peak) and will be quiet operation.

5 NIKKISO NON-SEAL PUMP/APPLICATIONS

Examples of Liquids which can be used with the Nikkiso Non-Seal Pump

Non-Seal pumps are recognized as the world's most practical process pumps and are being widely used in the chemical, petrochemical, textile, petroleum refining, atomic power industries and for other special applications.

Non-Seal pumps are employed in almost all the major related industries and boast an outstanding record of achievements in the handling of almost all types of general liquids. A large number are also being used for general water pumping and circulation of hot water, without the problem of leakage, due to compactness, ease of maintenance and low noise.

The outstanding features of Non-Seal Pumps are especially displayed when used with liquids which may pollute or contaminate the surrounding environment or when the danger of fire or explosion is present, if leakage occurs, and with liquids which cause a public hazard by their toxiousness of offensive smell, liquids which produce a reaction when they contact air or are detrimental to the process if air enters, liquids which solidify easily, high temperature or cryogenic liquids, liquids which contain solid particles, or when handling liquids under high line pressure or other severe conditions.

Table-5-1 gives some typical examples of liquids actually being handled by Nikkiso Non-Seal Pumps.

Table 5-1 Liquids used with non-seal pump

Acids	Sulphuric acid, Hydraulic acid, Nitric acid, Mixed acids, Phosphoric acid, Hydrofluoric acid, Hydrocyanic acid, Acetic acid, Chromic acid, Formic acid, Oxalic acid, Lactic acid, Methacrlic acid, Chlorosulfonic acid, Fatty acid, Propionic acid, Boric acid, Sulfurous acid
Alkalis	Caustic soda, Caustic potash, Ammonia water
Salts	Calcium chloride, Sodium chloride, Sodium carbonate, Ammonium sulfate, Hypo, Sodium Cyanide, Potassium bichromate, Lithium chloride, Ammonium sulphite, Sodium hypochlorite, Sodium chlorate, Lithium bromide, Aluminum sulfate, Sodium silicate, Sodium sulfide, Ammonium sulfide, Ammonium copper acetate, Ammonium peroxodisulfate
Esters	Methyl acetate, Ethyl acetate, Amyl acetate, Methyl acrylate, Methyl methacrylate
Aromatic Compounds	Benzene, Toluene, Xylene, Phenol, Naphthalene, Dichlorobenzene, Cresol, TDI, Mehtyl naphthalene, TPA slurry, Alkylbenzenes
Hydrocarbons (other than aromatics)	Butane, Nonane, Cyclohexane, Cyclohexanol, Hexane, Anol
Monomers and Polymers	PVC, PVA, Styrene, Caprolactam, Chlorophrene, Butadiene, Vinyl ether, Acrylonitrile, Acetonitrile
Alcohols	Methanol, Ethanol, Butanol, Hexanol, Isopropyl alcohol, Octyl alcohol, Glycerine, Ethylene glycol, Propylene glycol
Oxo-Compounds and Ethers	Formaldehide, Acetoaldehyde, Benzaldehyde, Methyl ethers, Ethyl ethers, Methyl ether kentone, Acetone, Ethylene oxide, Prophylene oxide, Acrolein, Crotonaldehyde, Allyl acetone, Acetic anhydride, Hexanone, Furfural
Halogenides	Carbon tetrachloride, Trichloroethylene, Allyl chloride, Phosgene, Liquid chlorine, Anhydrous hydrogen chloride, Anhydrous hydrogen fluoride, Methylene chloride, Methyl chloride, Titanium tetrachloride, Silicon tetrachloride, Phosphorus oxychloride, Phosphorus trichloride, Ethylene dichloride (EDC), Propylene dichloride, Tetrachloroethylene, Chloroform, Silicochloroform, Diethyl aluminum chloride, PAC
Nitrogen and Sulfur Compounds	Carbon disulfide, Anhydrous sulfur dioxide, anhydrous ammonia, Pyridine, Hydrazine, Methyl hydrazine, Aniline, Amidol, Lactonitrile, Acetone cyanohydrine, Acrylamide, Dimethyl formamide, Ethanol amine and other amine, Methyl sulfoxide
Cryogenic Liquids	Freon, Liquid carbon dioxide, Liquid methane, Liquid ethylene, LPG, Liquid propane, Liquid prophylene, Liquid ammonia
Oils	Petroleum (Naphtha, Crude oil, Gasoline), Transformer oil, Cooking oil, Lubricants
Heat Transfer Medium	Dowtherm, Mobiltherm and other heat transfer media, KC, SK oil
Water	Sea water, Pure water, Boiler water feed, Waste water and other types of water
Coolants	Flon, Liquified ammonia, Lithium bromide, Methyl chloride and other coolant
Others	Merucry, Tetraethyl lead, Triethyl aluminum silane, Methyl silane, Hydrogen peroxide, Plasticizers, Developers, Gelatine, Detergents, Syrups, Paints, Various solvents, Various polymer slurry, Various catalyst slurry, Silane, Fermentation solution

6 NIKKISO NON-SEAL PUMP/MATERIALS

Table 6-1 Standard material construction

Parts \ Material Symbol	A2	C1	D1	Remarks
Casing	*4 FCD450	SCS13	SCS14	
Impeller	*4 FCD450	SCS13	SCS14	
Bearing *1	CG11	CG11	CG11	
Stator liner Rotor sleeve	*5 SUS316L	*5 SUS316L	*5 SUS316L	
Shaft	SUS316	SUS316	SUS316	
Thrust washer Shaft sleeve *2	SUS316/HCR	SUS316/HCR	SUS316/HCR	
Pump gasket *3	PTFE-GL	PTFE-GL	PTFE-GL	
Motor gasket	PTFE	PTFE	PTFE	
Circulation pipe	SUS316	SUS316	SUS316	Same as heat exchanger
End bell	S25C	SUS304	SUS316	
Stator band	SS400	SS400	SS400	

*1 For motor frame No. D1 and D2, CG21 is used as a standard material.
Besides CG11, metal or resin impregnated carbon graphite of plane type, glass filled PTFE or PTFE impregnated carbon of tape type, can be furnished.
When using PTFE-GL tape bearing, do not select hard chromium plated material for shaft sleeve and thrust washer.

*2 Special products are available to meet corrosion resistance requirements, such as products surface-treated with M16C, M15E, S12, or RC, and those made of SUS316, CA20, HB, HC, or T12 without surface treatment.

*3 Most products are asbestos-free (V6501). PTFE and PTFE-GL are available to meet corrosion resistance requirements.

*4 This material is used for pumps No.21A, 21B, 21C, 22B, 22C, 22D, and 23C. For other pumps, SCS13 is used.

*5 For motor frame No. is D1 or D2, HC-N is used.

Table 6-2 Description of material codes

Material Description		JIS code or generic name	Material Description		JIS code or generic name
Ferrous Metals	S25C FCD450 SCW480 SS400	Carbon steel for mechanical construction Class 2 spheroidal graphite cast iron Steel casting for welded construction Flat-rolled steel product for general construction	Gasket/ O-Ring Materials	PTFE PTFE-GL V6501	Polytetrafluroethylene (Teflon or equivalent) Glass filled polytetrafluoroethylene Gasket Asbestos-free sheet
Austenitic Stainless Steels	SUS304 SUS316 SUS316L SCS13 SCS14 CA20-N	Stainless steel (SUS304) Stainless steel (SUS316) Stainless steel (SUS316L) Stainless steel casting Stainless steel casting Carpenter 20 or equivalent	Bearing Materials	CG11 CG21, CG2 PTFE-GL R3 CG43 CG93	Graphite carbon Furan resin impregnated carbon graphite Glass filled polytetrafluoroethylene Carbon filled polytetrafluoroethylene Metal impregnated carbon graphite Silicon carbide impregnated carbon graphite
Nickel Base Alloys	HB HB-N HC HC-N	Hastelloy B Hastelloy B or equivalent Hastelly C Hastelly C or equivalent	Hard Facing Materials for Shaft Sleeves etc.	/HCR /M15E /M16C /S12 /RC /WC-Ni	Hard chromium plating METCO 15E metallizing METCO 16C metallizing #12 Stellited Rokide C (Cr2O3) coating Tungsten carbide
Miscellaneous Metals	T12	Titanium class 2			

Table 6-3 Chemical composition of materials

Chemical Composition / Material Name	C	Si	Mn	P	S	Ni	Cr	Mo	Cu	Others	Equivalent to	
											ASTM	DIN
Stainless Steels SUS304	Max. 0.08	Max. 1.00	Max. 2.00	Max. 0.04	Max. 0.03	8.00–10.50	18.00–20.00	—	—	—	A182 F304 A276 304	1.4301
Stainless Steels SUS316	Max. 0.08	Max. 1.00	Max. 2.00	Max. 0.04	Max. 0.03	10.00–14.00	16.00–18.00	2.00–3.00	—	—	A182 F316 A276 316	1.4401
Stainless Steels SUS316L	Max. 0.03	Max. 1.00	Max. 2.00	Max. 0.04	Max. 0.03	12.00–15.00	16.00–18.00	2.00–3.00	—	—	A182 F316L A276 316L	1.4435
Stainless Steel Castings SCS 13	Max. 0.08	Max. 2.00	Max. 2.00	Max. 0.04	Max. 0.04	8.00–11.00	18.00–21.00	—	—	—	A296 CF8	1.4308
Stainless Steel Castings SCS 14	Max. 0.08	Max. 1.50	Max. 2.00	Max. 0.04	Max. 0.04	10.00–14.00	17.00–20.00	2.00–3.00	—	—	A296 CF8M	1.4408
Carpenter 20 or equivalent	Max. 0.07	Max. 1.50	Max. 2.00	Max. 0.04	Max. 0.035	24.00–32.00	19.00–21.00	2.00–3.00	2.75–4.00	—	—	—
Hastelloy B or equivalent	Max. 0.12	Max. 1.0	Max. 1.0	Max. 0.025	Max. 0.03	bal	Max. 1.0	26.00–3.00	—	Fe 4.0—7.0	B335–62	2.4600
Hastelloy C or equivalent	Max. 0.12	Max. 1.0	Max. 1.0	Max. 0.04	Max. 0.03	bal	14.50–17.50	15.00–18.00	—	Fe 4.7—7.0 w3.0—5.25	B336–62	2.4602

	(H)	(O)	(N)	(Fe)	(Ti)	(Mn)	(Zr)	(Al)		Others	—	—
Titanium (Class 2)	Max. 0.015	Max. 0.20	Max. 0.05	Max. 0.25	bal	—	—	—	—	—	B348II	—

Table 6-4 Descriptions of materials for shaft sleeves and thrust washers

Chemical Composition / Material Name	C	Si	Ni	Cr	B	Fe	Cu	Mo	W	Co	Al	Hardness H_RC
METCO 15E	1.0	4.0	bal	17.0	3.5	4.0	—	—	—	—	—	62
METCO 16C	0.5	4.0	bal	16.0	4.0	2.5	3.0	3.0	—	3.0	—	60
STELLITE #12	1.35	—	—	28.00–32.0	—	Max. 2.50	—	—	8.0	bal	—	47
ROKIDE C	—	(SiO_2) 2.21	—	(Cr_2O_3) 96.71	—	(Fe_2O_3) 0.04	—	—	—	—	(Al_2O_3) 0.44	80
Hard chromium plating	—	—	—	100	—	—	—	—	—	—	—	65～70

7 NIKKISO N-SEAL PUMP/INQUIRY DATA

1. Liquid Pumped

* Name ________________________________Conc. ________________________ % Spec. Grav. (Max. __________ Nor. _____________)

* Temperature (Max. ______ °C Nor. _____ °C Min. _____ °C) Melt. Point ______ °C Viscosity (Max. __________ Nor. _____________)

Vapour Pressure (Max. ________ Nor. _________) Specific Heat _________

Suspended mt'ls (Yes) (No) Name __________________ Conc. ______________ wt.% Grain Size (Max. ___________ Nor. __________)

Spec. Gravity ____________ Viscosity (Mother Liquid ________________ Apparent ___________________)

Remarkable Characteristics ____

(Adhesiveness, Sedimentation, Hardness, Solubility, Degeneration Grain-Size Distribution)

Others ____

(Corrosion/Erosion, Compressibility, Boiling point, Crystallization, Thermal Conductivity, Polymerization, Degeneration, etc.)

2. Pump Specification (Required Characteristics)

Pump Type (Normal, Self Priming Type, Submerged)

Impeller Type (Open, Closed) only when requested

* Flow Rate (Max. _________ Nor. _________ Min. _________ *Total Head __________ m Differential Pressure ______)

* Suction Pressure (Max. _________ Nor. _________ Min. _________) Dis. Pressure (Max. ______ Nor. ______ Min. __)

Pump Operation (Independently, In Series, In Parallel)

Back Flushing (Yes) (No) Liquid ___________________ Temperature ________ °C Pressure ___________

Starter (Direct. Transformer. Reactor)

Operating Condition (Continuous, Intermittent _________ hr/day)

Terminal Box Cable Entry (Steel Conduit Type, Bell Mouth Type, Packing Type)

Liquid End

Materials ____________________________________ Flange St'd (Suc. ________ Disc. _____________)

Jacket (Yes) (No) Heating/Cooling Medium ______________________________ Temp. ________ °C Press. _________

Others ____

(Material Selection, Restriction to Dome Curve, Suction Height, Submerged Depth, Back Flushing Volume Limit Flange Direction, Designated Motor Revolution Speed, Possibility of Operation with Water, impeller Diameter Limit etc.)

3. Installation Condition

Ambient Temp. (Max. ____________ °C Nor. ____________ °C Min. ____________ °C) Elevation _________

* Location (Indoor, Outdoor) Mounting (Horizontal, Vertical, In-Line)

* Electric Source (3ϕ ____________ Hz ___________ V) *Explosion Proof Class _______________

Applicable Regulations ____

Utility ____

(Cooling Water, Stem, Electric source for Instrument, Gas etc.)

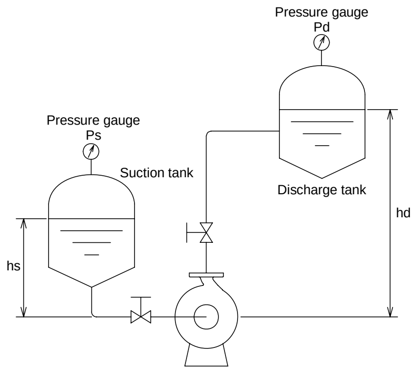
Others ____

(Installation Space, Designated Motor Insulation Class, Noise, Vibration Limit, Piping Load etc.)

4. Piping Condition

* NPSH (A) ____________________

(Suction Side)	Ps ________ kgf/cm^2	Hs ________ m	Dp1 ________ m
	Lp1 ______ m	Le1 _______ m	Pv _________ kgf/cm^2abs
(Disc. Side)	Pd ________ kgf/cm^2	Hd ________ m	Dp2 ________ m
	Lp2 ______ m	Le2 _______ m	



5. Others

Spare Parts ____

Accessories ____

Remarks ____

[Note] Information marked with * are essential for selection of pump.