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JAPANESE INDUSTRIAL STANDARD

Small Size Multi-Stage Centrifugal Pumps

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Small Size Multi-Stage
Centrifugal Pumps

B 8319-1987

1. Scope

This Japanese Industrial Standard specifies the commonly used small size, single suction multi-stage centrifugal pumps ⁽⁴⁾, hereinafter referred to as the "pumps", for handling water of ordinary temperature ⁽¹⁾ to be used to the highest using pressure 2.8 MPa {28.6 kgf/cm²} with a suction bore ⁽²⁾ of 40 to 200 mm and the number of stages ⁽³⁾ of 2 to 15 stages, being coupled with two-pole or four-pole, three-phase induction motor of 50 or 60 Hz through flexible coupling on common bed.

Notes ⁽¹⁾ The ordinary temperature means 5 to 35°C.

⁽²⁾ The pump bore shall be expressed by nominal diameter of flange.

⁽³⁾ The number of stages means the number of impellers.

⁽⁴⁾ The centrifugal pump herein means the generic name of diffuser pumps and volute pumps.

Remarks 1. This Standard is applicable to pumps to be used at a temperature other than ordinary temperature, but in this case the manufacturer shall make clear the limit of its temperature.

2. In this Standard the units and numerical values shown in { } are in accordance with the gravitational unit system and are appended for informative reference.

2. Sizes and Classification

2.1 Sizes The size of pumps shall be expressed by nominal suction bore and discharge as well as number of stages as given in Table 1.

The pump with the suction and discharge openings of the same bores shall be expressed by one bore and number of stages, and the pump with different bores, by both bores and the number of stages.

Example: 100 mm 3 stages, 100 mm x 80 mm 3 stages

Table 1. Nominal Diameters of Suction Bores and Discharge Bores

Unit: mm

Nominal diameter	32 ⁽⁵⁾ , 40, 50, 65, 80, 100, 125, 150, 200
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Note ⁽⁵⁾ This is used only for discharge bore.

Applicable Standards: See page 15.

2.2 Classification Pumps shall be classified and expressed according to the size, frequency and number of poles of the motor. However, the relation between the number of poles of motor and the suction bore shall, as a rule, be in accordance with Table 2.

Table 2. Number of Poles of Motor and Suction Bore

Suction bore mm		40	50	65	80	100	125	150	200
Number of poles of motor	2 poles	-	○	○	○	○	○	-	-
	4 poles	○	○	○	○	○	○	○	○

Remark: In the case where the discharge amount range is as given in Table 3 B, the motor is exclusively of 4 poles and therefore the number of poles may be abbreviated.

3. Performances

3.1 Specified Discharge Amount ⁽⁶⁾ The specified discharge amount of pump shall be within the range of Table 3 A, as a rule, relative to the suction bore. However, the pumps with suction bore of 40 to 150 mm, number of stages of 2 to 10 stages of 4 pole 3 phase induction motor may be within the range of Table 3 B for a while.

Note ⁽⁶⁾ The specified discharge amount means generally the contracted value between the manufacturer and the purchaser.

Table 3 A. Range of Discharge Amount

Unit: m³/min

Suction bore (mm)		50	65	80	100	125	150	200
Range of discharge amount	50 Hz	2 poles	0.32 max.	0.20to0.63	0.40to1.25	0.80to2.5	1.6 to5.0	—
		4 poles	0.16 max.	0.10to0.32	0.20to0.63	0.40to1.25	0.80to2.5	1.6 to5.0
	60 Hz	2 poles	0.40 max.	0.25to0.80	0.50to1.60	1.0 to3.15	2.0 to6.3	—
		4 poles	0.20 max.	0.12to0.40	0.25to0.80	0.50to1.60	1.0 to3.15	2.0to6.3

Table 3 B. Range of Discharge Amount

Unit: m³/min

Suction bore (mm)		40	50	65	80	100	125	150
Range of discharge amount (4 poles)	50 Hz	0.20 max.	0.16to0.32	0.25to0.50	0.40to0.80	0.63to1.25	1.00to2.00	1.60to3.15
	60 Hz	0.22 max.	0.18to0.36	0.28to0.56	0.45to0.90	0.71to1.40	1.12to2.24	1.80to3.55

Remark: Depending upon the agreement between the manufacturer and the purchaser, the specified discharge amount may be expanded to 63 % of minimum discharge amount and 125 % of maximum discharge amount of Table 3 B.

3.2 Total Pump Head The total pump head relative to the specified discharge amount shall be in accordance with Attached Figs. 3 A and 4 A. However, in the case where the range of discharge amount is in accordance with Table 3 B, it shall be in accordance with Attached Figs. 3 B and 4 B.

Remark: In this Standard, the pump head and head mean the fluid energy per unit mass, that is, the specific energy divided by acceleration of free falling at that place.

3.3 Maximum Suction Head The maximum suction head is the suction total head ⁽⁷⁾ converted to the specified discharge amount of Table 3 A at pump reference surface (according to 5. of JIS B 8301) and shall be as given in Table 4, and the pump, capable of operating without abnormalities at that state.

Further, in the case where the range of discharge amount is in accordance with Table 3 B, it shall be the suction total head ⁽⁷⁾ converted to the specified discharge amount at pump reference surface to be 6 m (in the case of suction bore of not less than 125 mm, to be 5.5 m) and, capable of operating without abnormalities at that state.

Note ⁽⁷⁾ The suction total head is the value of head corresponding to reading of vacuum gauge at suction opening converted to the pump reference surface subtracted by the speed head at the section of vacuum gauge take-out opening.

Example: In the case where the reading of vacuum gauge at suction opening is 58.8 kPa {0.6 kgf/cm²} and the suction head corresponding to this is 6 m, and the speed at section of vacuum gauge take-out opening is 4.4 m/s, that is, the speed head is 1 m, the suction total head is 5 m.

Table 4. Maximum Suction Total Head

Unit: m

Suction bore (mm)		50	65	80	100	125	150	200
Maximum suction total head	50 Hz	2 poles	6	6	5.5	3	Press-in 2 ⁽⁸⁾	—
		4 poles	6	6	6	6	5.5	3
	60 Hz	2 poles	6	5.5	3	Press-in 1 ⁽⁸⁾	Press-in 8 ⁽⁸⁾	—
		4 poles	6	6	6	6	5.5	3
								Press-in 1 ⁽⁸⁾

Note ⁽⁸⁾ This indicates the minimum value of press-in total head.

3.4 Pump Efficiency The highest value of pump efficiency shall be not less than efficiency A of Attached Fig. 5 at its discharge amount.

Further, the pump efficiency at the specified discharge amount shall be not less than efficiency B of Attached Fig. 5.

Furthermore, the tolerance value of efficiency shall be in accordance with 9.3 of JIS B 8301.

3.5 Shaft Power The shaft power shall be in accordance with 9.2 of JIS B 8301.

3.6 State of Operation The state of operation shall be in accordance with 9.4 of JIS B 8301.

3.7 Water-Pressure Resistance The water-pressure resistance shall be as follows:

- (1) When the water pressure is applied according to 9.7, each part shall be free from abnormalities such as water leakage.
- (2) The pump shall be free from abnormalities such as water leakage or the like from the fitting surfaces of pump body other than stuffing box.

4. Construction

4.1 General Pumps shall be constructed as shown in Attached Figs. 1 and 2 and, composed of the pump body, impeller, guide vanes (in the case of diffuser pump), main shaft, bearings and a balancing device for axial thrust, etc.

Remark: Attached Figs. 1 and 2 are the explanatory figures and do not specify the construction of pump.

4.2 Body The body shall be as follows:

- (1) The body shall be composed of a suction casing, intermediate casings and a discharge casing and these be combined with spigot joints and fastened by bolts for the suction opening to be horizontal and for the discharge opening to be upward.
- (2) The flanges shall conform to nominal pressure 10 K or 20 K of JIS B 2210. Flanges of nominal pressure exceeding this may be used. However, in this case, companion flanges of welding type shall be attached.
- (3) The height of shaft centre line should preferably conform to JIS B 0902.
- (4) A drain hole shall be provided on each casing, a pressure take-out hole, on each of the suction and discharge casings, and an air vent and a priming hole, on either one of these casings.
The screw threads for these holes shall conform to JIS B 0202. However, the places fitted with plugs and pipes may be threaded in accordance with JIS B 0203.
- (5) Liner rings shall be provided on water leaking parts between the impellers and the pump body. The liner rings and bushings shall be driven-fitted or screw locked to prevent their rotation during operation. However, the intermediate bushings out of bushings may be not provided.
- (6) In the stuffing box, sealing rings shall be provided to seal water. However, in the case where inside pressure of the stuffing box rises to the atmospheric pressure or higher during operation, the sealing rings may not be provided.

- (7) Packing of square shape shall be used. Three or more pieces of the packings shall be inserted and their joints, arranged alternately.
- (8) When the packing gland is kept at a distance from the casing, it shall be so constructed that the gland can be disconnected from the gland bolts and that the interval between the gland and the stuffing box is not less than the total thickness of four pieces of packings to allow easy replacement of the packings.
- (9) Instead of packings, mechanical seals may be used. In this case, however, the gland portion shall be so constructed that the packings may also be used.

4.3 Impellers The impellers shall be as follows:

- (1) The balance quality of impellers (including shaft for test) shall be "balance quality G 6.3" according to JIS B 0905. However, in the case where the mass of impeller (including shaft for test) is not more than 2 kg, it may be "balance quality G 16".
- (2) Outer diameter of impeller, sliding parts, shaft hole of the shaft and both end faces shall be machine processed.

4.4 Guide Vanes The guide vanes shall conform to the following:

- (1) The number of guide vanes shall have no common divisor other than one with the number of impeller vanes.
- (2) In the case where the guide vanes are fitted with the casing, these shall be locked with screws, knocks or others to prevent from loosening during operation.

4.5 Main Shaft The main shaft shall conform to the following:

- (1) The shaft threads shall be cut in the direction that the nut can not be loosened on starting of the pump, or alternatively the nut shall be prevented from turning by other means such as using washers.
- (2) The main shaft shall be provided with drain grooves, deflectors or other appropriate devices to prevent water from intruding into its bearings.

4.6 Bearings The bearings shall conform to the following:

- (1) The bearings shall be equipped on both sides of the pump body, and bearing bushes or rolling bearings specified in JIS B 1521, JIS B 1522, JIS B 1523, or JIS B 1533 shall be used. The bearing bushes shall be lubricated with oil and the rolling bearings, lubricated with grease or oil.

- (2) The bearings shall be free from flowing out or splashing of oil or grease during operation. The oil-lubricated bearings shall be such that the oil level can be checked from outside, and, also, the oil drain hole shall be provided. When oil rings are used, peep holes for oil rings shall be provided.

In the case where the bearings are grease-lubricated, no grease supply hole shall generally be provided.

- (3) The oil rings shall have ample capacity with wide contacting surface for supplying oil.
- (4) The fitting portion of bearings shall be provided with a water drain hole and a over-flow hole in order to prevent the leaked water from a stuffing box from intruding into the interior of bearings.

4.7 Balancing Device for Axial Thrust The balancing device for axial thrust shall conform to the following:

- (1) The axial thrust shall be balanced with one of the following means: the balancing disc, balancing piston, balancing hole or pump outvanes.
- (2) The pump with the balancing disc shall be equipped with a device indicating the wearing allowance of the balancing disc. Further, the others shall be so constructed as to support the axial displacement, safely and firmly, with ball bearings.
- (3) The pump with the balancing disc or balancing piston shall be so constructed as to balance the axial thrust by a balancing pipe that introduces water discharged from the balancing chamber. The balancing pipe shall generally be connected with the suction casing.
- (4) Cocks shall not be attached to the balancing pipe.
- (5) When impellers are provided with balancing holes or pump outvanes, the discharge side packings shall be so made that the direct high pressure is not applied.

4.8 Other Parts The construction of other parts shall conform to the following:

- (1) Pumps shall generally rotate clockwise, viewing from the motor side.
- (2) The suction and discharge casings and the intermediate casings, as required, shall be provided with pedestals of the pump in order to stabilize the pump body, and the number of fixing bolts thereof shall be 4 and the number of foundation bolts of the common bed, 4 or more as well.
- (3) The fastening bolts shall have sufficient size so that the spigot joint parts of the casing are free from water leakage in the hydrostatic test.

- (4) No external leakage of water shall arise between the shaft and the sleeves.
- (5) Respective seats for the pump and the motor on the common bed shall respectively be in the same plane. When they are directly coupled, if necessary, liners of a uniform thickness may be inserted between either of them.
- (6) The size of the seats on the common bed shall be equal to or larger than that of the pedestals of the pump or motor to be mounted thereon.
- (7) A coupling guard shall be provided at the outside of a shaft coupling.

5. Dimensions and Fits

5.1 Nominal Diameter and Actual Bore The nominal diameter and actual bore of the pump shall conform to Table 5.

Table 5. Actual Bores

Unit: mm

Nominal diameter		32	40	50	65	80	100	125	150	200
Actual bore	Reference dimensions	32	40	50	65	80	100	125	150	200
	Tolerances	± 3	± 3	± 3	± 4	± 4	± 4	± 4	± 5	± 5

5.2 Pump Body The pump body shall conform to the following:

- (1) The minimum thickness of wall of pressure resistance parts of the casing, even when the wall thickness varies, shall conform to Table 6.

Table 6. Minimum Wall Thickness of Casing

Unit: mm

Suction bore	Minimum wall thickness
40 to 80	5
100 to 200	6

- (2) The tolerances on the thickness of flanges shall be + 15 % and -5 %.
- (3) The clearance between the inside diameter of the stuffing box and the outside diameter of sleeve shall be not less than 1/6 of the outside diameter of sleeve, and generally, 6 mm, 8 mm, 10 mm or 13 mm.

5.3 Impeller The wall thickness of impeller shall conform to Table 7. However, the thickness of the inlet and outlet tips of the vane shall be optional.

Table 7. Minimum Wall Thickness of Impeller

Unit: mm

Outer diameter of impeller	Minimum wall thickness		
	Castings		Stainless steel plate
	Both side plate	Vane	
200 and under	2.5	2.0	0.8
Over 200	3.0	2.5	-

5.4 Wall Thickness of Guide Vanes The wall thickness of guide vanes shall conform to Table 8. However, the wall thickness of the inlet and outlet tips of the guide vanes shall be optional.

Table 8. Minimum Wall Thickness of Guide Vanes

Unit: mm

Outer diameter of impeller	Minimum wall thickness
200 and under	2.0
Over 200	2.5

5.5 Diameter of Main Shaft The diameter d (°) of the main shaft shall be not less than the value calculated according to the following formula:

$$d = K \sqrt[3]{\frac{L}{n}} \text{ (mm)}$$

where L : shaft power (kW)

n : speed of rotation (min^{-1})

K : 125 in the case of S 30 C of JIS G 4051,
116 in the case of SUS 403 of JIS G 4303