Submersible motor pumps for well diameters from 100 mm (4 inches) on

Applications

Pumps are suitable for delivery of clean or slightly dirty water, sand content ≤ 50 mg/l, temperature ≤ 30 ℃:

- Drinking water supply by waterworks
- Drainage in mines and civil engineering
- Irrigation plants
- Process water supply in power stations and industries
- Pressure rising in systems
- Utilisation of geothermal energy
- Environmental technology

Design

oddesse-submersible motor pumps and motors form a complete unit. The pump end of one or more stages is designed as external casing pump or as structured pump with radial or semi-axial impellers. Non-return valve as standard version and discharge end with Whitworth pipe thread or flange connection.

The submersible motor **oddesse** brand is a three-phase asynchronous motor with a short circuit rotor. It is designed as a wet-running rewindable motor with a watertight insulated winding. The motor connection for 4-, 6- and 8-inch are according to NEMA-standard, 10- and 12-inch are according to international standards. Motors are earthed inside and encapsulated by a mechanical seal. 4-inch motors are also suitable for single phase currency.

Normally submersible motor pumps shall be used in vertical position, but optionally, depending on number of stages and motor power rate, it may also be used in horizontal or angular position. The bearings are lubricated by the pumped liquid or the motor filling. Axial thrust is born by the axial thrust bearing with individual tilting pads.

All pump components are made of high quality materials. Motor cable is conducted through a cable protector alongside the pump body.

- Voltage: three phase 230 - 1000 V, po-so/4 also as 230 V single phase
- Frequency: 50 and 60 Hz
- Degree of protection: IP 68
- switching frequency: max. 20 / h
- all motors are earthed inside.

Special design (on request)

- higher temperature
- voltage up to 1000 V
- other fluid medium quality
- other construction materials
- with suction jacked
- as booster pump
- different discharge connections

Complete program of electrical and mechanical accessories

- Motor starters, autotransformer, frequency transformer
- Microprocessor controlled motor monitoring
- Submersible cable
- Heat-shrinkable hose coupling
- Cast-resin connectors
- Suction jacket
- Pressure jacket
- Rising pipes
- Reducers
- Supporting clips

subject to alterations

Frequency transformer operation

Every **oddesse** motor is usable for frequency transformer operations. Following items should be considered:

- the frequency transformer must be conform to the nominal currency of the submersible motor,
- the maximal working range from 30 Hz up to 60 Hz, corresponding speed from 1.740 up to 3.460 1/min,
- the using of a sine-wave generator protect against high voltage peaks
- the minimum rate of flow must be 10 % of the nominal rate of flow of the pump.

Soft starter operation

Soft starters are very qualified to start a submersible motor. It grants:

- reducing of starting current
- avoidance of water hammer while starting causing switch off of the pump.

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- Drainage in mines and civil engineering
- Irrigation plants
- Process water supply in power stations and industries
- Pressure rising in systems
- Utilisation of geothermal energy
- Environmental technology
- Handling of sea water and handling of extreme water in mines
- In Situ leaching mining

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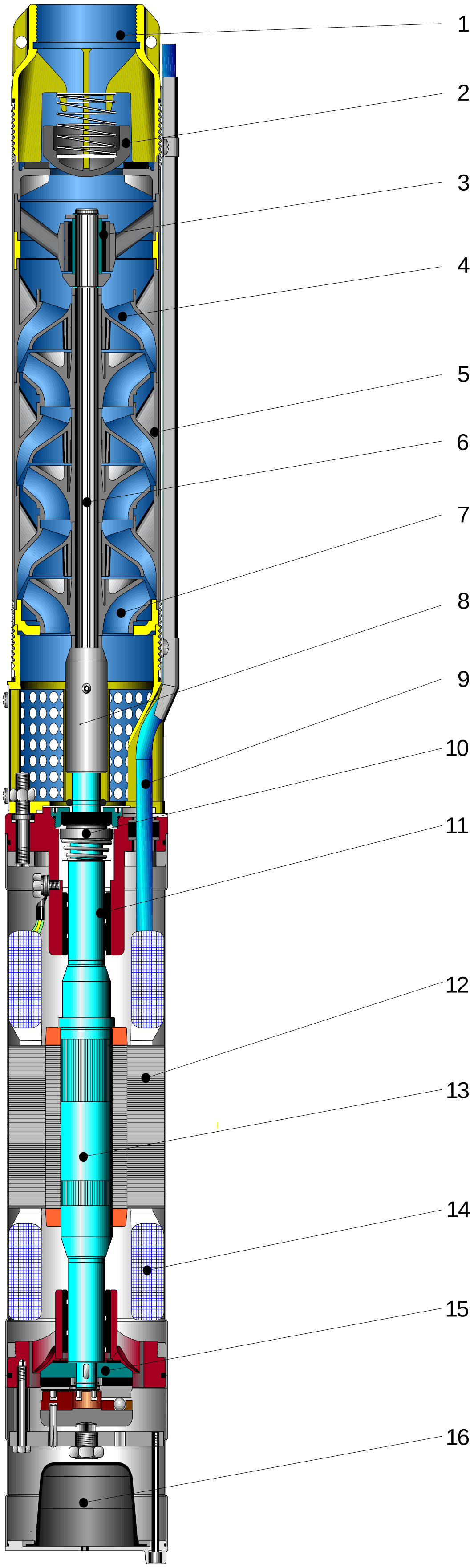
- reducing of starting current
- avoidance of water hammer while starting causing switch off of the pump.

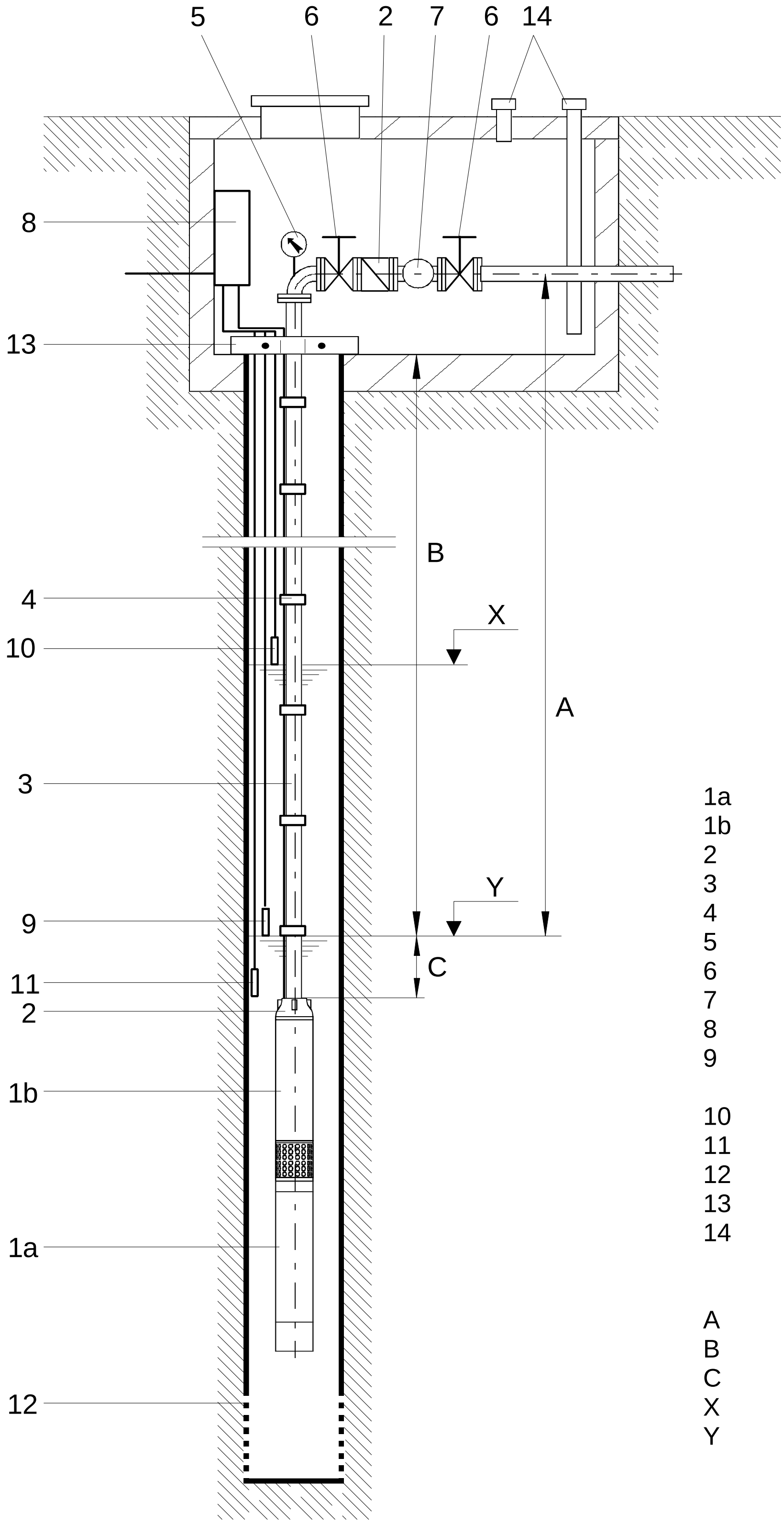
Design:



1 pipe connection
2 non-return valve
3 bearing
4 diffuser
5 stage casing
6 shaft
7 impeller
8 coupling
9 cable
10 mechanical seal
11 motor bearing
12 stator
13 rotor
14 windings
15 thrust bearing
16 breather diaphragm

subject to alterations

Mounting example



1a	submersible motor
1b	submersible pump
2	non-return valve
3	riser pipe
4	cable clip
5	manometer with cock
6	stop valve
7	flow meter
8	control box
9	switching electrode -off- protection against dry running
10	switching electrode -on-
11	manometric or float switch
12	screen tube
13	supporting clip
14	well shaft ventilation

A	geodetic delivery head
B	depth of immersion
C	minimum water level
X	upper dynamic water level
Y	lower dynamic water level

subject to alternations

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Design of pump installation (calculation, friction losses)

Determination of flow

The pumping capacity depends on the maximum water requirement. This requirement is the result of the type and number of consumers and their max. requirements (max. Q [m³/h]).

If these values are not known, information may be taken from water engineering literature.

Determination of head:

$H\,[m] = H_{geo} + H_V + p_2 \cdot 10.2$

- H_{geo} [m] geodetic pumping head: $H_{geo} = H_1 + H_2$

  height difference H_1 [m]: Water level in the well (tank) at capacity Q to Top of well

  height difference H_2 [m]: Top of the well / bore hole to highest water level in elevated tank or highest point of pipe system (in case of open discharge).

- H_V [m] Pipe friction loss in the rising main and the fittings, see also table here after

- p_2 [bar] Discharge pressure required at the end of the pipe line or cut-off pressure in the pressure tank

Example

water requirement:	Q = 60 m³/h
height difference H_1:	$H_1 = 80$ m
height difference H_2:	$H_2 = 50$ m
cut-of pressure in the pressure tank:	$p_2 = 6$ bar

pipeline of rolled steel clear dim. of pipe 4", length 250 m

Calculation:

H_V = Friction loss from table/100 · length of pipe

$H_V = 4.595/100 \cdot 250 = 11.49$ m

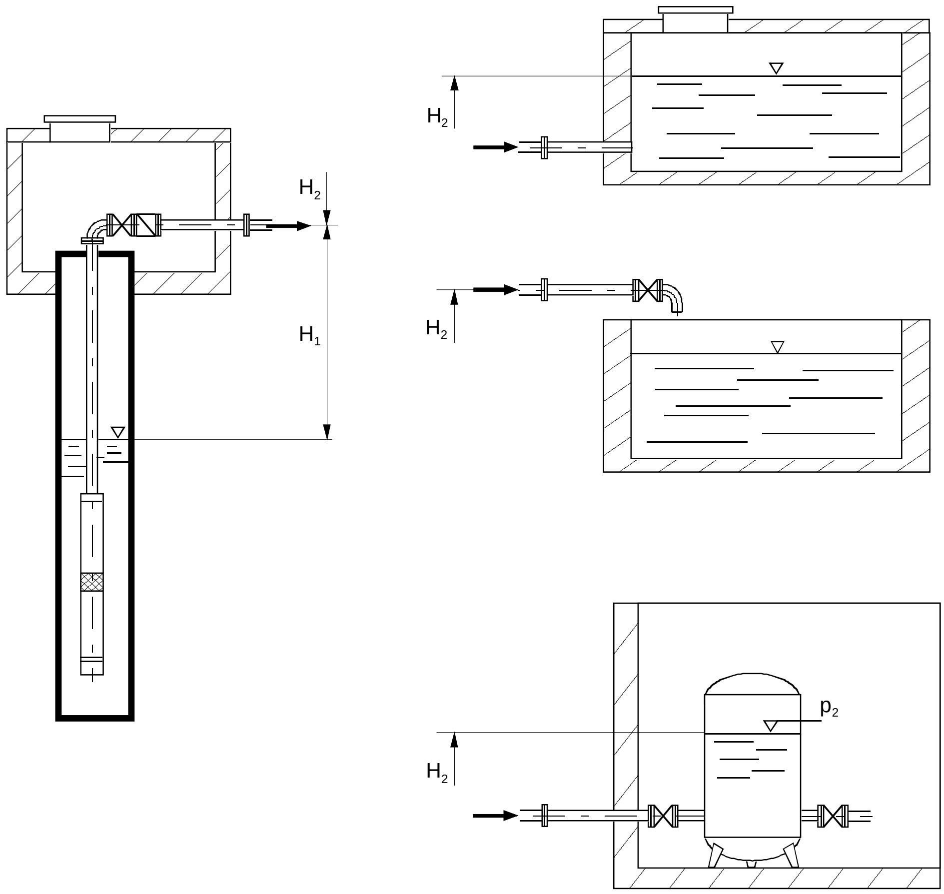
$H\,[m] = H_{geo} + H_V + p_2 \cdot 10.2$

$H\,[m] = 130 + 11.49 + 6 \cdot 10.2$

$H\,[m] = 202.69$ m

Remark: Calculation next side

Installations for pumping water from wells - calculation



Geodetic pumping head and discharge pressure					
Height difference H_1: Water level in the well at capacity Q up to top of well			H_1 =		m
Height difference H_2: Top of well to highest water level in the elevated tank or highest point of pipe system in case of open discharge			H_2 =		m
Discharge pressure required at the end of the pipe line or cut-off pressure in the pressure tank			P_2 [bar] · 10.2 =		m
Pipe friction losses					
Length of rising pipe: DN		m	H_{V1} =		m
Length of pressure pipe: DN		m	H_{V2} =		m
Number of hydraulic accessories: DN		piece			
Equivalent length of m in straight pipe work		m	H_{V3} =		m
Number of fittings: DN		piece			
Equivalent length of m in straight pipe work		m	H_{V4} =		m
Total height: Amount H:			**H =**		**m**

Remark: Clean Water $\gamma = 1$
Values of friction losses see table

Friction losses for steel pipes

Upper figures - velocity of flow in m/s
Lower figures - friction losses in meters for 100 m new steel pipeline

Flow			Friction losses of steel pipes											
			Nominal diameter in inch and inside diameter in mm											
m³/h	l/min	l/s	½" 15.75	¾" 21.25	1" 27.00	1 ¼" 35.75	1 ½" 41.25	2" 52.50	2 ½" 68.00	3" 80.25	3 ½" 92.50	4" 105.0	5" 130.0	6" 155.5
0.6	10	0.16	**0.855** 9.910	**0.470** 2.407	**0.292** 0.784									
0.9	15	0.25	**1.282** 20.11	**0.705** 4.862	**0.438** 1.570	**0.249** 0.416								
1.2	20	0.33	**1.710** 33.53	**0.940** 8.035	**0.584** 2.588	**0.331** 0.677	**0.249** 0.346							
1.5	25	0.42	**2.138** 49.93	**1.174** 11.91	**0.730** 3.834	**0.415** 1.004	**0.312** 0.510							
1.8	30	0.50	**2.565** 69.34	**1.409** 16.50	**0.876** 5.277	**0.498** 1.379	**0.374** 0.700	**0.231** 0.223						
2.1	35	0.58	**2.993** 91.54	**1.644** 21.75	**1.022** 6.949	**0.581** 1.811	**0.436** 0.914	**0.269** 0.291						
2.4	40	0.67		**1.879** 27.66	**1.168** 8.820	**0.664** 2.290	**0.499** 1.160	**0.308** 0.368						
3.0	50	0.83		**2.349** 41.40	**1.460** 13.14	**0.830** 3.403	**0.623** 1.719	**0.385** 0.544	**0.229** 0.159					
3.6	60	1.00		**2.819** 57.74	**1.751** 18.28	**0.996** 4.718	**0.748** 2.375	**0.462** 0.751	**0.275** 0.218					
4.2	70	1.12		**3.288** 76.49	**2.043** 24.18	**1.162** 6.231	**0.873** 3.132	**0.539** 0.988	**0.321** 0.287	**0.231** 0.131				
4.8	80	1.33			**2.335** 30.87	**1.328** 7.940	**0.997** 3.988	**0.616** 1.254	**0.367** 0.363	**0.263** 0.164				
5.4	90	1.50			**2.627** 38.30	**1.494** 9.828	**1.122** 4.927	**0.693** 1.551	**0.413** 0.449	**0.269** 0.203				
6.0	100	1.67			**2.919** 46.49	**1.660** 11.90	**1.247** 5.972	**0.770** 1.875	**0.459** 0.542	**0.329** 0.244	**0.248** 0.124			
7.5	125	2.08			**3.649** 70.41	**2.075** 17.93	**1.558** 8.967	**0.962** 2.802	**0.574** 0.809	**0.412** 0.365	**0.310** 0.185	**0.241** 0.101		
9.0	150	2.50				**2.490** 25.11	**1.870** 12.53	**1.154** 3.903	**0.668** 1.124	**0.494** 0.506	**0.372** 0.256	**0.289** 0.140		
10.5	175	2.92				**2.904** 33.32	**2.182** 16.66	**1.347** 5.179	**0.803** 1.488	**0.576** 0.670	**0.434** 0.338	**0.337** 0.184		
12	200	3.33				**3.319** 42.75	**2.493** 21.36	**1.539** 6.624	**0.918** 1.901	**0.659** 0.855	**0.496** 0.431	**0.385** 0.234	**0.251** 0.084	
15	250	4.71				**4.149** 64.86	**3.117** 32.32	**1.924** 10.03	**1.147** 2.860	**0.823** 1.282	**0.620** 0.646	**0.481** 0.350	**0.314** 0.126	
18	300	5.00					**3.740** 45.52	**2.309** 14.04	**1.377** 4.009	**0.988** 1.792	**0.744** 0.903	**0.577** 0.488	**0.377** 0.175	**0.263** 0.074
24	400	6.67					**4.987** 78.17	**3.078** 24.04	**1.836** 6.828	**1.317** 3.053	**0.992** 1.530	**0.770** 0.829	**0.502** 0.294	**0.351** 0.124
30	500	8.33						**3.848** 36.71	**2.295** 10.40	**1.647** 4.622	**1.240** 2.315	**0.962** 1.254	**0.628** 0.445	**0.439** 0.187
36	600	10.0						**4.618** 51.84	**2.753** 14.62	**1.976** 6.505	**1.488** 3.261	**1.155** 1.757	**0.753** 0.623	**0.526** 0.260
42	700	11.7							**3.212** 19.52	**2.306** 8.693	**1.736** 4.356	**1.347** 2.345	**0.879** 0.831	**0.614** 0.347
48	800	13.3							**3.671** 25.20	**2.635** 11.18	**1.984** 5.582	**1.540** 3.009	**1.005** 1.066	**0.702** 0.445
54	900	15.0							**4.130** 31.51	**2.964** 13.97	**2.232** 6.983	**1.732** 3.762	**1.130** 1.328	**0.790** 0.555
60	1000	16.7							**4.589** 38.43	**3.294** 17.06	**2.480** 8.521	**1.925** 4.595	**1.256** 1.616	**0.877** 0.674
75	1250	20.8								**4.117** 26.10	**3.100** 13.00	**2.406** 7.010	**1.570** 2.458	**1.097** 1.027
90	1500	25.0								**4.941** 36.97	**3.720** 18.42	**2.887** 9.892	**1.883** 3.468	**1.316** 1.444
105	1750	29.2									**4.340** 24.76	**3.368** 13.30	**2.197** 4.665	**1.535** 1.934
120	2000	33.3									**4.960** 31.94	**3.850** 17.16	**2.511** 5.995	**1.754** 2.496
150	2500	41.7										**4.812** 26.26	**3.139** 9.216	**2.193** 3.807
180	3000	50.0											**3.767** 13.05	**2.632** 5.417
240	4000	66.7											**5.023** 22.72	**3.509** 8.926
300	5000	83.3												**4.386** 14.42
90° bend, stop valve			1.0	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.6	1.7	2.0	2.5
Branch piece, none-return valve			4.0	4.0	4.0	5.0	5.0	5.0	6.0	6.0	6.0	7.0	8.0	9.0

Friction losses in bends, stop valves, branch pieces and none return valves conforms to length of straight pipework as printed in the last lines of table. Friction losses in foot valve = 2 × friction losses of branch piece.
For friction losses at new plastic pipes use multiplier 1.0, for cast iron use multiplier 1.25, for older rusty iron pipes use multiplier 1.5 and for pipes with encrustation use multiplier 2.2.

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Instructions for cable dimensioning of submersible pumps

The minimum cross-section of the cable required results from the current charge while the current charge depends on the maximum ambient temperature (cf. tables). Another criterion for the cable selection (cable cross-section) is the voltage drop. In order to keep line losses at a reasonable level, we recommend a permissible voltage drop below 3 %.

The following diagrams will help you determine the cable cross-section for cable on D.O.L. starting (also applicable to auto-transformer starting) or star-delta starting. The curves shown characterise the range that ensures a voltage drop of 3 %. The power-factor is 0.85 and the voltage 400 V.

The diagrams are designed for **oddesse** multi-core cables with an ambient temperature of 30 °C, they are not depending on current frequency.

For higher temperatures and single-core cable use the tables to re-calculate found values.

For other service voltages than 400 V, the current has to be re-calculated. See also example 2

When specifying cross section dimensions, it should be considered that higher voltage loss means higher power loss and thus higher energy cost. Depending on operating time, it may be advisable to specify a value below the voltage losses to ensure trouble-free operation.

Using of the diagrams

General:

Bring values on vertical (current) and horizontal (length) diagram axis to a projected cross-point to find right hand from there the required cross-section given for the cable line.

Example 1:

D.O.L. starting:	
Service voltage:	400 V
Rated current:	75 A
Single cable length:	180 m
Ambient temperature air/water:	40 °C / 20 °C

With a rated current of 75 A and a single cable length of 180 m you find in the diagram 1 a cross-section of 35 mm². The maximum allowed length is 210 m. The voltage loss is

$$U_V = \frac{180\,m}{210\,m} \cdot 3\% = 2.57\%$$

The next smaller cross-section is 25 mm². It is use able up to 98 m length. The voltage losses in this case is

$$U_V = \frac{180\text{ m}}{98\text{ m}} \cdot 3\% = 5.51\%$$

You have to select the cross-section of 35 mm² with a voltage losses of U_V = 2.57 %.

The re-calculation of the current charge (see table below diagram 1) shows that this cross-section given may be used at 40 °C up to 147 A . The current charge i s in this case not a criterion for the cross-section to be defined.

subject to alterations

Example 2

D.O.L. starting (service voltage different from 400 V !)

Service voltage:	440 V
Rated current:	55 A
Single cable length:	100 m
Ambient temperature air/water:	40 °C / 20 °C

Use the diagram correctly to re-calculate current charge

$$I_{calculated} = \frac{400\ V}{nom.voltage} \cdot nom.current$$

$$I_{calculated} = \frac{400\ V}{440\ V} \cdot 55\ A = 50\ A$$

With the calculated current you find in diagram 1 a cross-section of 16 mm² and a usable cable length of 160 m. The voltage loss at 100 m is:

$$U_V = \frac{100\ m}{160\ m} \cdot 3\ \% = 1.87\ \%$$

Select a cross-section of 16 mm² with a voltage loss of UV = 1.87 %.

For re-calculation of the current charge, use the rated current of 55 A (see table below diagram 1) that may be used (this cross-section) at 40 °C up to 90 A . The rated-current is, in this case, not a criterion for the cross-section.

Example 3:

Star-delta starting

Service voltage:	400 V
Rated current:	45 A
Single cable length:	220 m
Ambient temperature air/water:	40 °C / 20 °C

The procedures are the same as in example 1 and 2. In this case use the diagram 2.

With a rated current of 45 A and a single cable length of 220 m you find in diagram 2 a cross-section of 16 mm². The maximum permissible length is 210 m. The voltage loss is

$$U_V = \frac{220\ m}{255\ m} \cdot 3\ \% = 2.59\ \%$$

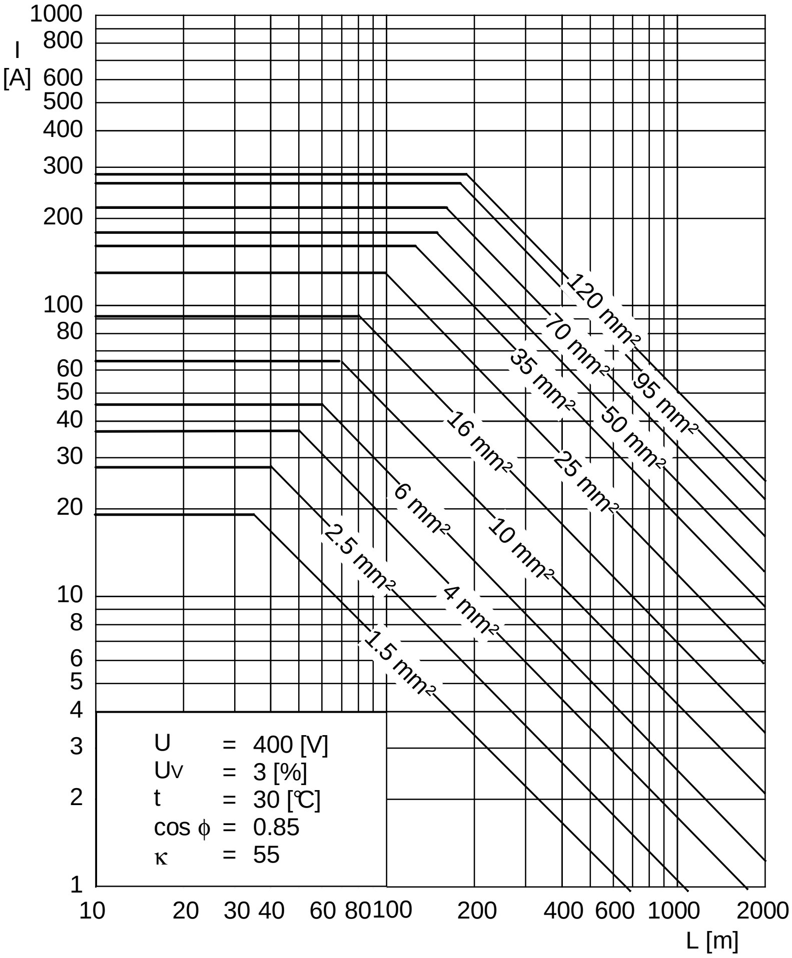
The next smaller cross-section is 10 mm². It is applicable up to 150 m length. The voltage losses in this case are

$$U_V = \frac{220\ m}{150\ m} \cdot 3\ \% = 4.40\ \%$$

Select cross-section of 16 mm² with a voltage loss of U_V = 2.59 %.

The re-calculation of the current charge (see table below diagram 2) shows that this cross-section may be used at 40 °C up to 178 A . The current charge is, in this case, not a criterion for the cross-section.

Diagram 1: D.O.L and auto-transformer starting



ambient temp. [℃]	30	35	40	45	50	55	60
cross-section [mm²]	max. permissible current-carrying capacity multi-wire cables, 3 **current-carrying wires**						
	Motor rated current [A]						
1.5	18	17	16	15	13	11	10
2.5	26	25	24	22	19	17	14
4	34	33	31	28	25	22	18
6	44	42	40	37	33	28	23
10	61	59	56	51	46	39	32
16	82	79	75	68	61	52	43
25	108	104	98	90	81	69	57
35	135	130	123	113	101	86	72
50	168	161	153	140	125	107	89
70	207	199	188	173	154	131	110
95	250	240	228	209	187	159	132
120	292	280	266	244	218	185	155

ambient temp. [℃]	30	35	40	45	50	55	60
cross-section t [mm²]	max. permissible current-carrying capacity multi-wire cables, **single wire cable**						
	Motor rated current [A]						
6	54	52	49	45	40	34	29
10	73	70	66	61	54	46	39
16	98	94	89	82	73	62	52
25	129	124	117	108	96	82	68
35	158	152	144	132	118	100	84
50	198	190	180	165	148	126	105
70	245	235	223	205	183	156	130
95	292	280	266	244	218	185	155
120	344	330	313	287	257	218	182

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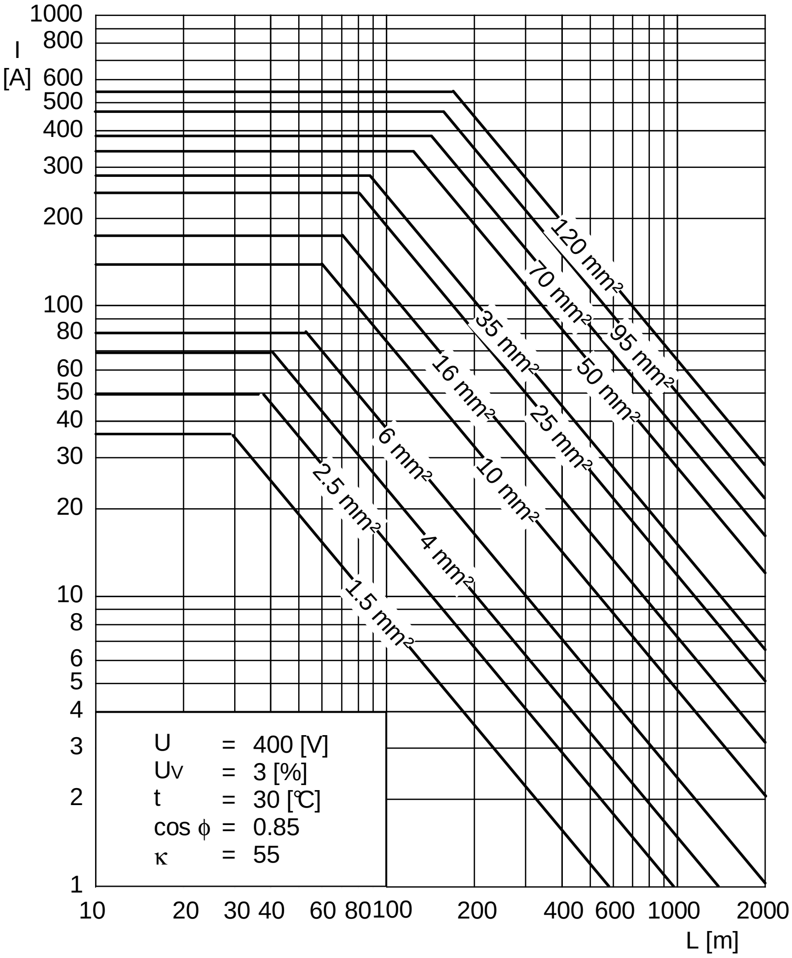
Diagram 2: star-delta-starting



ambient temp. [℃]	30	35	40	45	50	55	60
cross-section [mm²]	max. permissible current-carrying capacity multi-wire cables, 3 **current-carrying wires**						
	Motor rated current [A]						
1.5	31	30	28	26	23	20	16
2.5	45	43	41	38	34	29	24
4	59	56	54	49	44	37	31
6	76	73	69	64	57	48	40
10	106	101	96	88	79	67	56
16	142	136	129	118	106	90	75
25	187	179	170	156	139	119	99
35	234	224	213	195	174	148	124
50	291	279	264	243	217	184	154
70	358	344	326	299	267	227	190
95	433	415	394	361	323	275	229
120	505	485	460	422	377	321	268

ambient temp. [℃]	30	35	40	45	50	55	60
cross-section [mm²]	max. permissible current-carrying capacity multi-wire cables, **single wire cable**						
	Motor rated current [A]						
6	93	90	85	78	70	59	49
10	126	121	115	105	94	80	67
16	170	163	154	142	127	108	90
25	223	214	203	186	167	142	118
35	273	262	249	228	204	174	145
50	343	329	312	286	256	217	181
70	424	407	386	354	316	269	225
95	505	485	460	422	377	321	268
120	595	571	542	497	444	378	315

1 Assessment of the corrosion behaviour

Following schema allow to estimate a water analysis.

Thereto eliminate step by step all characteristics which are not applicable.

1.1 Carbonate hardness < 6°dH

1.1.1 Free oxygen < 4 mg/l

pH >=	GW (pH):	harmless
pH <	GW (pH):	iron attacking, attack increases with dropping pH value

1.1.2 Free oxygen >= 4 mg/

iron attacking, attack increases with an increasing oxygen content

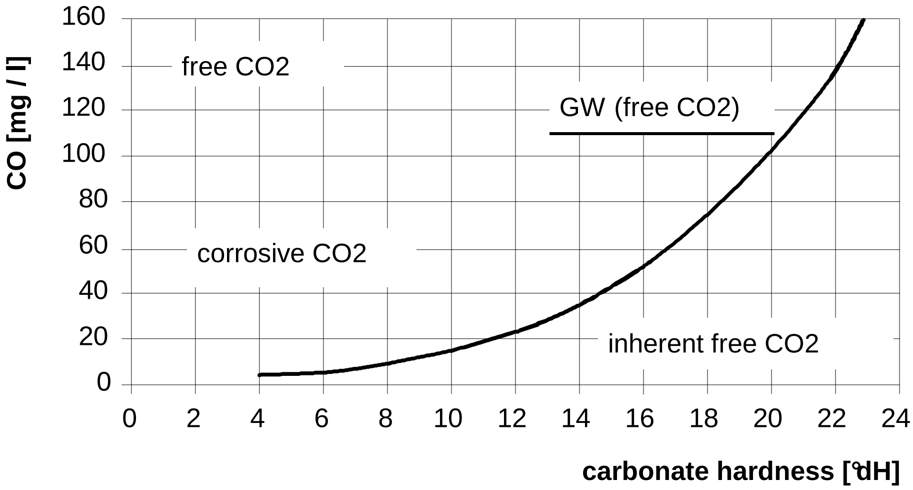
1.2 Carbonate hardness >= 6°dH

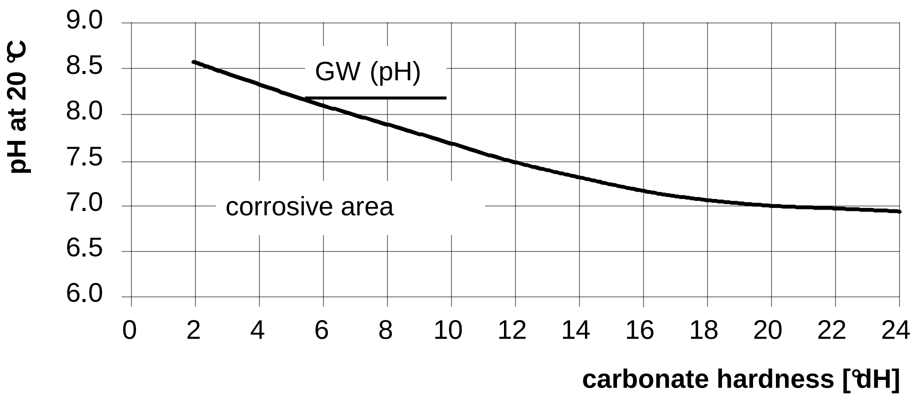
1.2.1 Free oxygen ≈ 0 mg/l

pH >=	GW (pH):	harmless
pH <	GW (pH):	iron attacking, attack increases with dropping pH value

1.2.2 Free oxygen > 0 mg/l

free CO2 <= GW (free CO2) or pH >=	GW (pH):	harmless
free CO2 > GW (free CO2) or pH <	GW (pH):	iron attacking, attack increases with a growing O2 salary at formation of bubbles, pitting





1.3 Salts

dry evaporation residue <= 500 mg/l: harmless
dry evaporation residue > 500 mg/l: avoid different metals, or electrochemical corrosion conducting ability increases with increasing salt concentration, do not use any metals located far off in the voltage series table

1.4 Chlorides

contains < 150 mg/l: harmless (taste limit)
> 150 mg/l: beware different metals, pitting

1.5 Unbound acids

humic acids, sulfur hydrogen, if present iron attacking

2 Judgment on depositions

2.1 Lime

free CO2 > GW (free CO2): no depositions
free CO2 < GW (free CO2): the larger the CO2-lack is higher

O2 ≈ 0, deposition as mud
O2 > 0, deposition as a scale

2.2 Iron and manganese

2.2.1 Iron

iron < 0.2 mg/l no depositions
iron => 0.2 mg/l ocre incrustation, increasing with Fe- and O2-content

2.2.2 Manganese

manganese < 0.1 mg/l: no depositions
manganese => 0.1 mg/l: manganese incrustation, increasing with Mn- and O2- salary

Iron and manganese depositions cannot be prevented. From time to time it is necessary to clean the pumps and motors mechanically.

3 Wear

Even at little sand quotas in the water it leads to erosion of impellers and cases. Beside of the quantity of sand erosion depends on the grain size, the grain kind and the kind of the mineral. **oddesse** pumps are designed for a maximum sand content of 50 mg/l. Larger sand quantities are dubious.

Remark:

The complete hardness of the water is not responsible for the aggressiveness of it. The aggressiveness arrives from the carbonate hardness here, this corresponds to the quota of the calcium carbonate Ca(HCO3)2 in the water.

1 °dH = 29.91 mg/l Ca(HCO3)2
1 mg/l Ca(HCO3)2 = 0.0033 °dH

°dH (german hardness)	° French hardness	° English hardness	°USA hardness
1.000	1.79	1.25	17.85
0.800	1.43	1.00	14.28
0.560	1.00	0.70	10.00
0.056	0.10	0.07	1.00

Conversion of rates of flow