GEARBOXES FOR COOLING TOWERS

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Dear ladies and gentlemen,

this commercial catalogue presented to our clients represents our long-time experience in the field of production and supplying of the drives for cooling towers.
The team of our best specialists collected specific requirements and advices of our customers, and the result of this effort is submitted sortiment of the products that we hope you find useful in our present, and also possible future partnership and cooperation.

At the beginning please see some basic information about the company:

ZTS Sabinov, a.s. is the joint stock company operating in the field of engineering industry. The company has 270 employees
Most of its production is formed by gearboxes of following types:

- **bevel**
- **spur**
- **bevel - spur**
- **worm**
- **planetary**

Gearboxes are produced in types as standard – catalogue – with wide range of possibilities for use in various types of industry.
ZTS Sabinov, a.s. produces also the gearboxes for special use that can be devided into following groups:

- **gearboxes for truck mounted and stationary concrete mixers**
- **gearboxes for cooling towers**
- **gearboxes – distributors to mobile building machines**
- **gearboxes – winches for lifting the wagon platform in railway transport**
- **other**

Big group is also formed by the gearboxes designed and produced on the base of customers´ requirements or based on their technical documentation.

Export territories and aplications

Our products are supplied to USA, Germany, Czech republic, United Kingdom, Ireland, Netherlands, Poland, Russia, Hungary, Spain, China and also to many other countries.
Our products are exported also indirectly – by investment suppliers (technologies) as sugar refineries, steelworks, cement works, ceramics manufacturing, power stations etc.

Quality

In 1997 we implemented and we use quality system management according to EN ISO 9001.

Contact

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1. Choosing the gearbox

1.1 Specification of gearbox type

In standard proposal of cooling tower based on the required technical parameters it is necessary to specify gearbox type.

Types of gearboxes for cooling towers:
1.1.1 EP41WT
planetary gearbox with el. motor, see fig.No.6,
working position: see fig.No.6, with output shaft down,
gear ratio range: from i=3,15 to i=8,
range of standard gearbox powers: P_1=11 to 74kW, when k_c=1.
1.1.2 TSA 031 351-06, TSA 031 351-07, TSA 031 351-08
bevel gearbox, fig. No.8,
working position see fig. No.10, with output shaft up,
gear ratio range: i=2,24 to 5,6,
range of standard gearbox powers: P=48 to 450kW, when k_c=1.
1.1.3 KCV8, KCV12
bevel-spur gearbox, see fig. No.12,
working position see fig. 14, with output shaft up ,
gear ratio range : i=6,3 to 16,
range of standard gearbox powers : P=50 to 870kW, when k_c=1.

After choosing gearbox type it is necessary to specify required gearbox power.

1.2 Determination of the Gearbox P_{1N} Power Required.

It is possible to achieve the high operating safety and required service life in the given gearbox when taking into consideration all the influences under which is the drive in operation exposed.

Calculated necessary output of the gearbox P_{1N} [1] is defined by the formula, as follows:

$\mathbf{P_{1N} = P_V \times k_c}$ [kW] [1]

Catalogue output of the gearbox P_1 [2] must be higher than calculated necessary output of the gearbox P_{1N} .

$\mathbf{P_1 > P_{1N}}$ [kW] [2]

P_{1N} - calculated necessary output of the gearbox [kW]P_V - utilized output of the electric motor [kW]
P_1 **-** catalogue output of the gearbox [kW]
P_2 **-** output of the electric motor [kW]

k_c - service factor, in the gearboxes EP41WT, TSA 031 351-06, 07, 08 and KCV, when placing the gearboxes on the fixed foundation column, it is valid **k_c = 2**.
k_c- service factor, in the gearboxes TSA 031 351-06, 07, 08 and KCV, when placing elastically the gearboxes, i.e. foundation of the gearbox is connected with load-bearing construction of cooling tower, it is valid **k_c = 2.2**.

In the case that $P_1 < P_{1N}$, it is necessary to choose the size of the gearbox which is one grade harder.

Example of choosing correct type and size of the gearbox:

Driving machine:	- electric motor:	P_2 = 250 kW
	- input revolutions of the electric motor:	n_1 = 1487 rev / min
Driven machine:	- gearbox for cooling towers	
	- utilized output:	P_V = 228 kW,
	- necessary output revolutions of the gearbox:	n_{vyst} = 106 rev / min,

Basic calculation.

Required gear: $i = n_1 / n_{vyst} = 14.02$
Chosen nearest gear: $i = 14$
Required output of the gearbox: $P_{1N} = P_V \times k_c = 228 \times 2 = 456$ kW
Chosen type of the gearbox: KCV12 s i = 14 and P_1 = 470 kW at 1500 rev / min

1.3 Determination of the Starting Torque.

Maximum starting torque moment of the motor must not exceed 1.7 – multiple of rating moment of the gearbox at input shaft of the gearbox.

In the case that the drive does not fulfil this condition, it is possible to achieve it in operation by, for example controlled start of the driving machine (two-speed motors, frequency converter, and etc.), and by using the clutch with soft start. It is not recommended to use the drive with squirrel-cage induction motor controlled by direct connection to network (stator winding is connected into triangle).

In the case that maximum starting moment of the electric motor cannot be observed, it is necessary to choose the size of the gearbox one grade higher.

Control of the starting torque moment:

Maximum starting torque moment of the motor must not exceed 1.7 – multiple of rating moment of the gearbox at input shaft of the gearbox:

$M_{max} = 1.7 \times 9550 \times P_1 / n_1 = 1.7 \times 9550 \times 470 / 1500 = 5086.9$ Nm

Starting moment of the electric motor from the catalogue of electric motors:

$M_z = 2.4 \times M_n = 2.4 \times 9550 \times P_2 / n_1 = 2.4 \times 9550 \times 250 / 1487 = 3853.3$ Nm

$M_z < M_{max}$ – this datum shows that gearbox is to be chosen correctly.

In the case that the drive does not fulfil this condition, it is possible to achieve it in operation by, for example controlled start of the driving machine (two-speed motors, frequency converter, and etc.), and by using the clutch with soft start.

1.4 Checking gearbox for heat output P_t.

To reach optimum running conditions, it means maximum oil temperature in gearbox is 85°C, it is necessary to check correctness of choosing gearbox to heat output.

Heat output P_t is counted as follows: power of el. motor P_2 is multiplied by ambient temperature influence coefficient k_5 (tab.No.1), and gearbox location coefficient k_6. Such counted values will be compared with maximum thermal output power values P_{tmax}, tab.No.2, 3 and 4.

$\mathbf{P_t = P_2 \times k_5 \times k_6}$ [kW] [3]

when

$\mathbf{P_{t\,max}}\ ^{3}\ \mathbf{P_t}$ [kW] [4]

P_t - gearbox heat output [kW] is power transmitted throuhg spreading heat,

$P_{t\,max}$ - maximum gearbox heat output [kW], is maximum power transmitted through spreading heat

Based on this comparison, formula No. 4, we can choose following gearbox versions:

- Ø Gearbox without fan on input pinion, see Fig. No.6.
- Ø Gearbox with a fan on input pinion, see Fig.No..11, pos.No.14.
- Ø Gearbox with external oil cooler – can be in gearboxes KCV only (hot oil from gearbox is sucked to cooler where it is cooled, cold oil is injected back to the gearbox) -choosing appropriate cooler and its connecting is recommended to be consulted with the producer of the gearbox-ZTS Sabinov a.s..

In case gearbox did not meet checking for heat output P_t, even in the version with using additional cooler on the input pinion, or you do not wish to use cooler, it is necessary to choose one degree stronger gearbox.

a/ Ambient temperature influence k_5

Table No.1 Ambient temperature influence coefficient k_5

		Ambient temperature [°C]		
		30	**40**	**50**
coefficient k_5	**Without fan on the input pinion**	1,2	1,7	2,2
	With fan on the inut pinion (Fig. No.11)	1,1	1,5	2,0

b/ Cooling tower construction coefficient k_6.

$k_6 = 1$ - **in open construction** – free air circulation between gearbox, cooling tower diffuser and the cooling tower construction itself – see fig.No.1.

$k_6 = 1,15$ - **in closed construction** – there is no free air circulation between gearbox, cooling tower diffuser and the cooling tower construction itself – see fig.No.2.

Fig.No.1

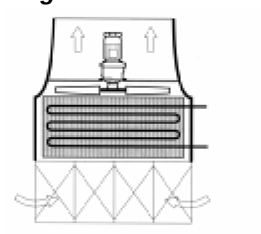
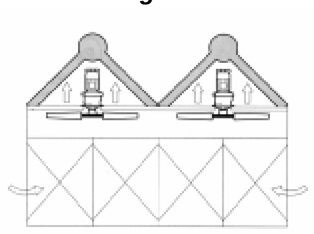


Fig.No.2



1.4.1 Maximum heat output $P_{t\,max}$ for gearboxes type EP41WT.

Table No.2 Maximum heat output $P_{t\,max}$

Gearboxes type EP41WT are not to be checked for heat output as this is considered in the power – see table No. 5 for technical parameters.

Construction of planetary gearbox does not alow to use additional cooling of the input pinion.

1.4.2 Maximum heat output $P_{t\,max}$ for gearboxes type TSA 031 351-06, TSA 031 351-07, TSA 031 351-08.

Table No.3 Maximum heat output $P_{t\,max}$

SIZE	n_1 [min^{-1}]	$P_{t\,max}$ [kW] Without fan on input pinion
TSA 031 351-06	**1500**	67
	1000	67
	750	50
TSA 031 351-07	**1500**	136
	1000	136
	750	100
TSA 031 351-08	**1500**	200
	1000	200
	750	165

n_1 - input revolutions [rev/min]
$P_{t\,max}$ – maximum heat output [kW]

1.4.3 Maximum heat output $P_{t\,max}$ for gearboxes type KCV6, KCV8, KCV10, KCV12.
Table No.4 Maximum heat output $P_{t\,max}$

SIZE	n_1 [min^{-1}]	$P_{t\,max}$ [kW] With fan on input pinion
KCV6	**1500**	280
	1000	240
	750	195
KCV8	**1500**	400
	1000	320
	750	240
KCV10	**1500**	485
	1000	400
	750	360
KCV12	**1500**	540
	1000	460
	750	420

n_1 - input revolutions [rev/min]
$P_{t\,max}$ - maximum heat output [kW]

2.EP41WT

2.1 *Description*

One-stage epicyclic gearboxes EP41WT are compact driving aggregates formed by connection of el.motor and driving device with epicyclic gearbox, see Fig. No.3 and 6.

Gearbox EP 41 WT:

- is equipped by single-way deaerator that protects the gearbox from moisty ambient air.
- is closed tightly and can work in dusty, moisty, chemically non-deffective ambient that does not lower the sealing ability of the seal rings. Gearboxes are equipped by 2 seal rings from material Viton on the output shaft.

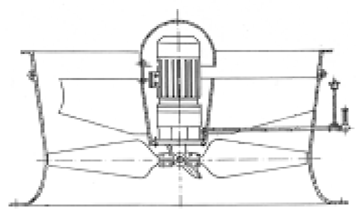


Fig.No..3

Gearboxes EP 41WT in the firm Janikosoda JANIKOWO

2.2 *Technical parameters*

Table No.5 Technical parameters of gearboxes EP41WT.

k_C=1

i_c (i_{real})	**n_1 [min^{-1}]**	**P_1 [kW]**	**n_{output} [min^{-1}]**	**$M_{koutput}$ [Nm]**
3.15 (3.13)	1 500	74	479	1431
	1 000	60	319	1742
	750	44	239	1705
4 (3.9)	1 500	74	384	1785
	1 000	60	256	2170
	750	44	192	2122
5 (5)	1 500	44	300	1358
	1 000	37	200	1713
	750	30	150	1852
6.3 (6.33)	1 500	37	236	1452
	1 000	22	157	1297
	750	15	118	1177
8 (7.93)	1 500	22	189	1078
	1 000	15	126	1102
	750	11	94	1083

i_C - total gear ratio
i_{real} - real gear ratio
n_1 - input revolutions [rev/min]
P_1 - standard gearbox power [kW]
n_{output} - output revolutions [rev/min]
$M_{koutput}$ - output torque [Nm]
k_c - service factor

Maximum gearbox noisiness level for standardly produced gearboxes (when measured under 45^{o} from the output shaft axis in 2m distance) is **82dB.**

It is possible to adjust the gearbox to a smaller electric motors.

2.3 Keys and threads dimensions on output and input shafts.

Keys are put at the ends of shafts (see Fig.No.4). For fitting couplings and their securing the shafts are equipped by threads (see Fig. No.5).

Fig.No.4

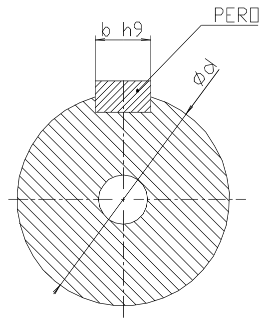


Fig.No..5

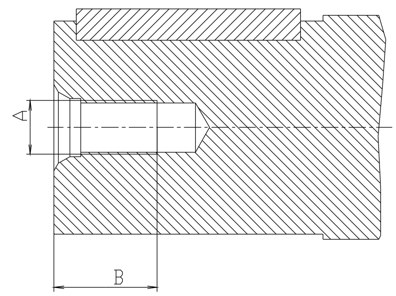


Table No.6 Key and threads dimensions of the output shaft in EP41WT

[mm]

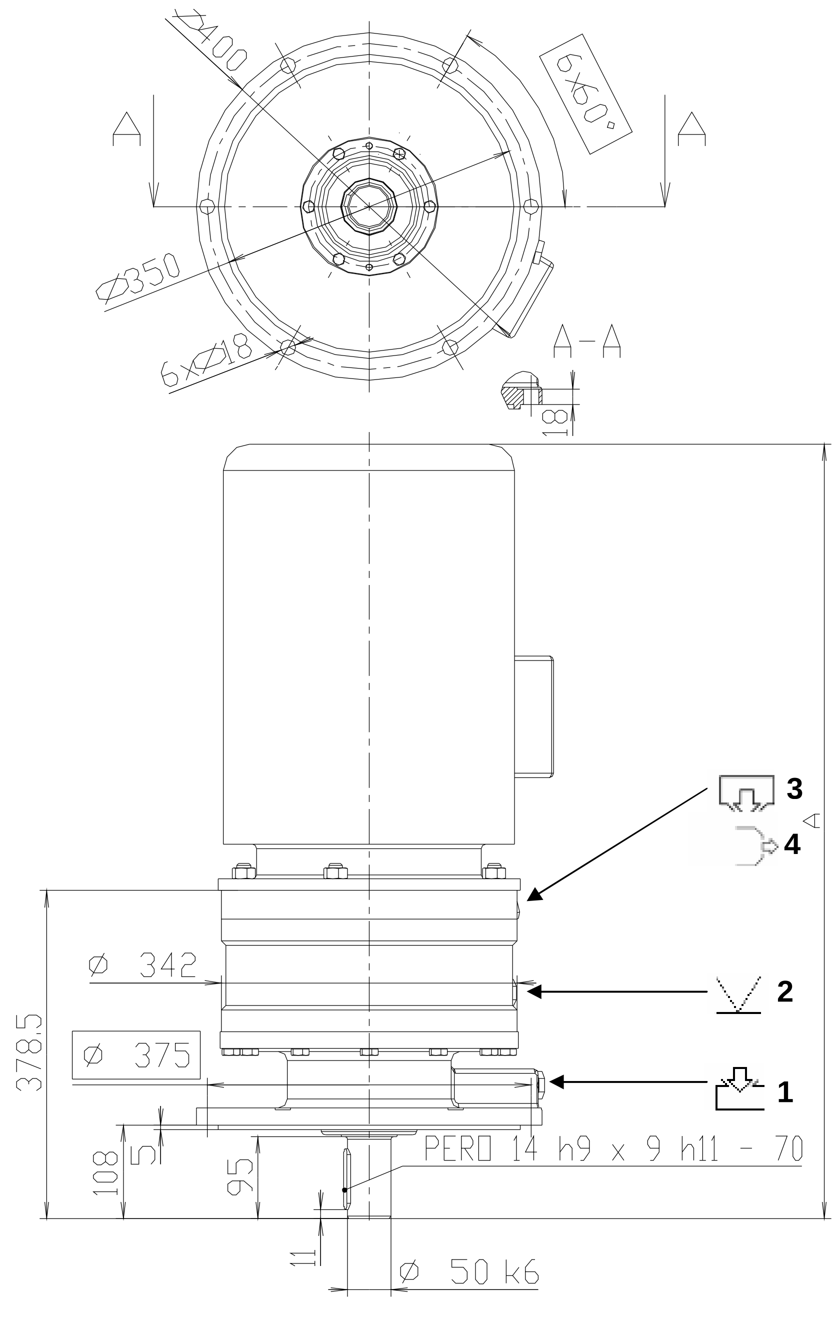
Output shaft	Key	b	d	A	B
	Key 14x9x70	14h9	50k6	M16	32

b - key width
d - output shaft diameter
A - thread dimension
B - thread lenght

2.4 Basic dimensions

– discharging outlet
– oil level checking outlet
– pouring outlet
– deaerating plug

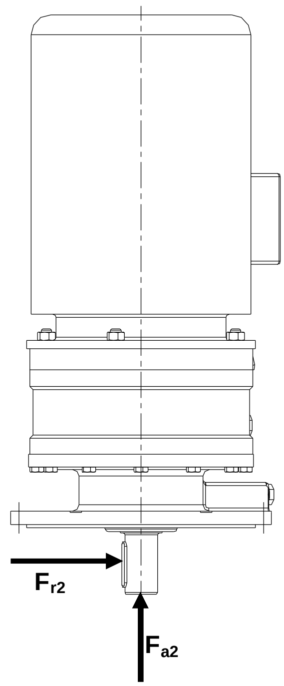
Fig. No. 6



A – total lenght of the gearbox and el. motor (depends on the type of el. motor used)
Gearbox EP41WT weight: 95 kg – without el. motor.

2.5 Scheme of load forces in output shaft

Fig.No.7 Scheme of load forces in output shaft of gearbox EP41WT.



F_{a2} **-** axial force on output shaft
F_{r2} **-** radial force on output shaft

Table No.7 Maximum allowed output shaft output shaft load for gearboxes EP41WT.

Size	**F_{a2} [N]**	**F_{r2} [N]**
EP41WT	6 000	600

2.6 Ordering

When ordering gearboxes type EP41WT please specify following information:
Type, gear ratio, input revolutions, el. motor type
Example.:EP41WT-5-1475-1LA6220-4AA

For monitoring the gearbox EP 41 WT run it is possible to supply the gearbox with the holes for connecting vibrations sensor (location, if required, is to be aspecified by the customer).

3. TSA 031 351-06, TSA 031 351-07, TSA 031 351-08.

3.1 Description

Gearbopxes type TSA 031 351-06, TSA 031 351-07, TSA 031 351-08, Fig. No.8, consist of box –casting, bevel gears type OERLIKON that are specially thermal treated. Vertical output shaft is placed in taper bearings, what allows considerable axial load of the gearbox output. That is precondition for direct catching powers from the fan propeller. Gearboxes are with integrated lubrication system.

Gearboxes TSA 031 351-06, TSA 031 351-07, TSA 031 351-08:

- are closed tightly and can work in dusty, moisty, chemically non-deffective ambient that does not lower the sealing ability of the seal rings.
  - gearboxes are equipped by 2 seal rings from material Viton on the output and input shaft.

Gearboxes TSA 351-08, refinery Gdaňsk, s.a., Poland

Gearboxes TSA 031 351-07, power station Tisová, Czech Republic

3.2 Technical parameters

k_C=1

Table No.8 Technical parameters of gearboxes TSA 031 351-06, TSA 031 351-07, TSA 031 351-08.

SIZE	i_c	i_{SKUT}	n_1 [min^{-1}]	P_1 [kW]	n_{output}t [min^{-1}]	$M_{koutput}$ [Nm]
TSA 031 351 - 06	2,24	2,24	1 500	140	669,6	1 966
			1 000	134	446,4	2 823
			750	110	334,8	3 090
	3,15	3,15	1 500	110	476,1	2 172
			1 000	101	317,4	2 992
			750	83	238,1	3 278
	4,5	4,5	1 500	98	333,3	2 765
			1 000	75	222,2	3 089
			750	61	166,6	3 443
	5	5	1 500	87	300	2 727
			1 000	66	200	3 104
			750	55	150	3 448
	5,6	5,6	1 500	78	267,8	2 738
			1 000	61	178,5	3 108
			750	48	133,9	3 371
TSA 031 351 - 07	2,24	2,24	1 500	250	669,6	3 512
			1 000	220	446,4	4 634
			750	196	334,8	5 506
	3,15	3,15	1 500	230	476,1	4 543
			1 000	196	317,4	5 807
			750	196	238,1	7 742
	4,5	4,5	1 500	190	333,3	5 361
			1 000	180	222,2	7 618
			750	138	166,6	7 787
	5	5	1 500	159	300	4 985
			1 000	151	200	7 054
			750	117	150	7 336
	5,6	5,6	1 500	175	267,8	6 146
			1 000	120	178,5	6 321
			750	94	133,9	6 601
TSA 031 351 - 08	2,24	2,24	1 500	450	669,6	6 321
			1 000	370	446,4	7 795
			750	320	334,8	8 989
	3,15	3,15	1 500	360	476,1	7 111
			1 000	320	317,4	9 481
			750	300	238,1	11 852
	4,5	4,5	1 500	320	333,3	9 029
			1 000	300	222,1	12 698
			750	210	166,6	11 855
	5	5	1 500	248	300	7 776
			1 000	248	200	11 663
			750	190	150	11 914
	5,6	5,6	1 500	220	267,8	7 725
			1 000	220	178,5	11 588
			750	172	133,9	12 079

i_C - total gear ratio
i_{real} - real gear ratio
n_1 - input revolutions [rev/min]
P_1 - standard gearbox power [kW]
n_{output} - output revolutions [rev/min]
$M_{koutput}$ - output torque [Nm]
k_c - service factor

Maximum gearbox noisiness level for standardly produced gearboxes (when measured under 45° from the output shaft axis in 2m distance) is **82dB.**

3.3 Keys and threads dimensions on output and input shafts.

Standard keys are supplied on input and output shafts, see Fig.No.4. Output shafts are equipped by 2 keys turned by 180°.
Shafts are equipped by threads that serve to fit and secure the couplings to the output and input shaft, see Fig.No.5 .
In case the construction of the shaft with 2 keys is not suitable for connection with the hub, it is possible to use connection by one key. This must be consulted with the producer.

Table No.9 Key and threads dimensions of the input and output shafts for gearboxes TSA 031 351-06, TSA 031 351-07, TSA 031 351-08.

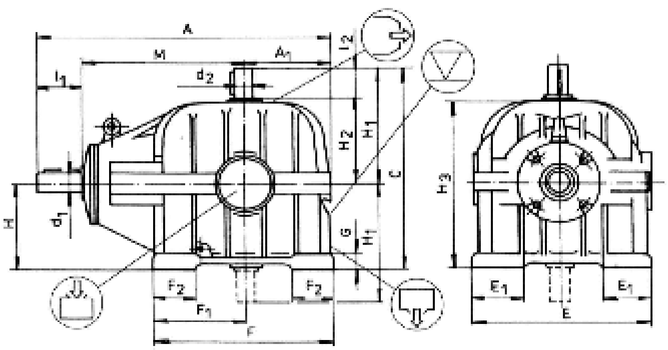
[mm]

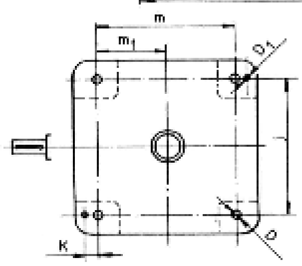
DIMENSION	Input shaft			Output shaft		
	GEARBOX SIZE					
	06	**07**	**08**	**06**	**07**	**08**
KEY	Key 14x9x105	Key 18x11x135	Key 22x14x162	Key 18x11x100	Key 22x14x122	Key 28x16x155
b	14h9	18h9	22h9	18h9	22h9	28h9
d	50k6	65m6	85m6	60m6	80m6	100m6
A	M16	M20	M20	M20	M20	M24
B	32	39	39	39	39	48

b - key width
d - output shaft diameter
A - thread dimension
B - thread lenght

3.4 Basic dimensions

Fig.No.8 Gearboxes TSA 031 351-06, TSA 031 351-07, TSA 031 351-08 basic dimensions**.**





1 - discharging outle
2 - oil level checking outlet
3 - pouring outlet
4 -deaerating plug

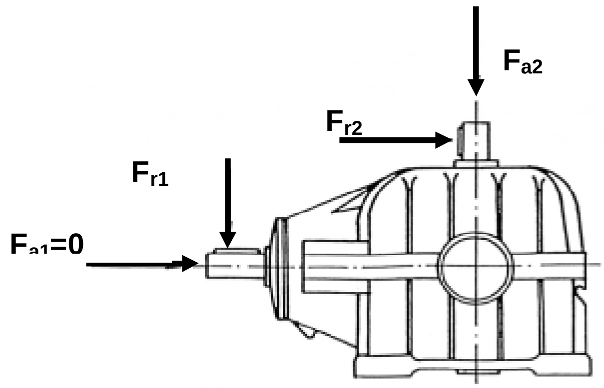
Table No.10 ***Gearboxes*** TSA 031 351-06, TSA 031 351-07, TSA 031 351-08 basic dimensions. [mm]

	Size		
	06	**07**	**08**
H	250	315	400
A	735	958	1143
A_1	235	308	373
C	607,5	758	957
D	28	35	35
D_1	12	16	16
E	480	620	750
E_1	120	150	165
F	480	620	750
F_1	240	310	375
F_2	110	160	170
G	32	45	50
H_1	357,5±1	443,5±1	557±1
H_2	252,2	313,5	392
H_3	492,5	617,5	780
K	33	45	50
M	390	510	600
d_1	50k6	65m6	85m6
d_2	60m6	80m6	100m6
l_1	110	140	170
l_2	105	130	165
j	420	550	670
m	370	490	600
m_1	185	245	300
Weight [kg]	275	600	900

Dimension l_1 considers also the lenght for fan fixation. In case of using fan the lenght of the hob of coupling must be 30 mm shorter.

5. Scheme of load forces in output shaft

Fig.No.9 Scheme of load forces in output shaft TSA 031 351-06, TSA 031 351-07, TSA 031 351-08.



F_{a1} - axial force on input shaft
F_{r1} - radial force on input shaft
F_{a2} - axial force on output shaft
F_{r2} - radial force on output shaft

Table No.11 Maximum allowed load of the gearbox shafts
TSA 031 351-06, TSA 031 351-07, TSA 031 351-08.

Size	F_{r1} [N]	F_{a2} [N]	F_{r2} [N]
06	380	4 100	410
07	970	9 850	985
08	1 070	13 200	1 350

3.6 Ordering

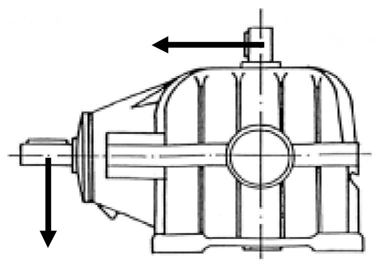
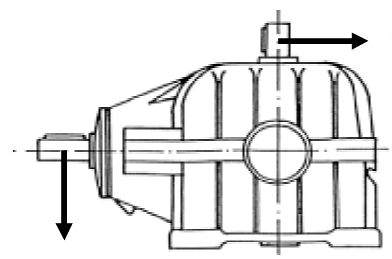
When ordering gearboxes TSA 031 351-06, TSA 031 351-07, TSA 031 351-08 please specify following:

Gearbox marking:

Type – size – version x gear ratio x n_1

Example: **TSA 031 351- 06- 2 x 2,24 x 1000**

Fig.No.10 Gearbox versions TSA 031 351-06, TSA 031 351-07, TSA 031 351-08.

1	2
	

As special accessories the gearboxes TSA 031 351-06, TSA 031 351-07, TSA 031 351-08 can be equipped by:

- device protecting reverse run (blocking device),
- cooling gearbox by a fan (in case checking the gearbox for heat output shows that it is necessary to use cooling.)

To secure monitoring of the gearboxes TSA 031 351-06, TSA 031 351-07, TSA 031 351-08 it is possible to supply the gearbox with the holes for connecting sensors for (location, if required, is to be aspecified by the customer):

- oil flow sensor,
- vibrations sensor,
- temperature sensor.

4. KCV6, KCV8, KCV10, KCV12

4.1 Description

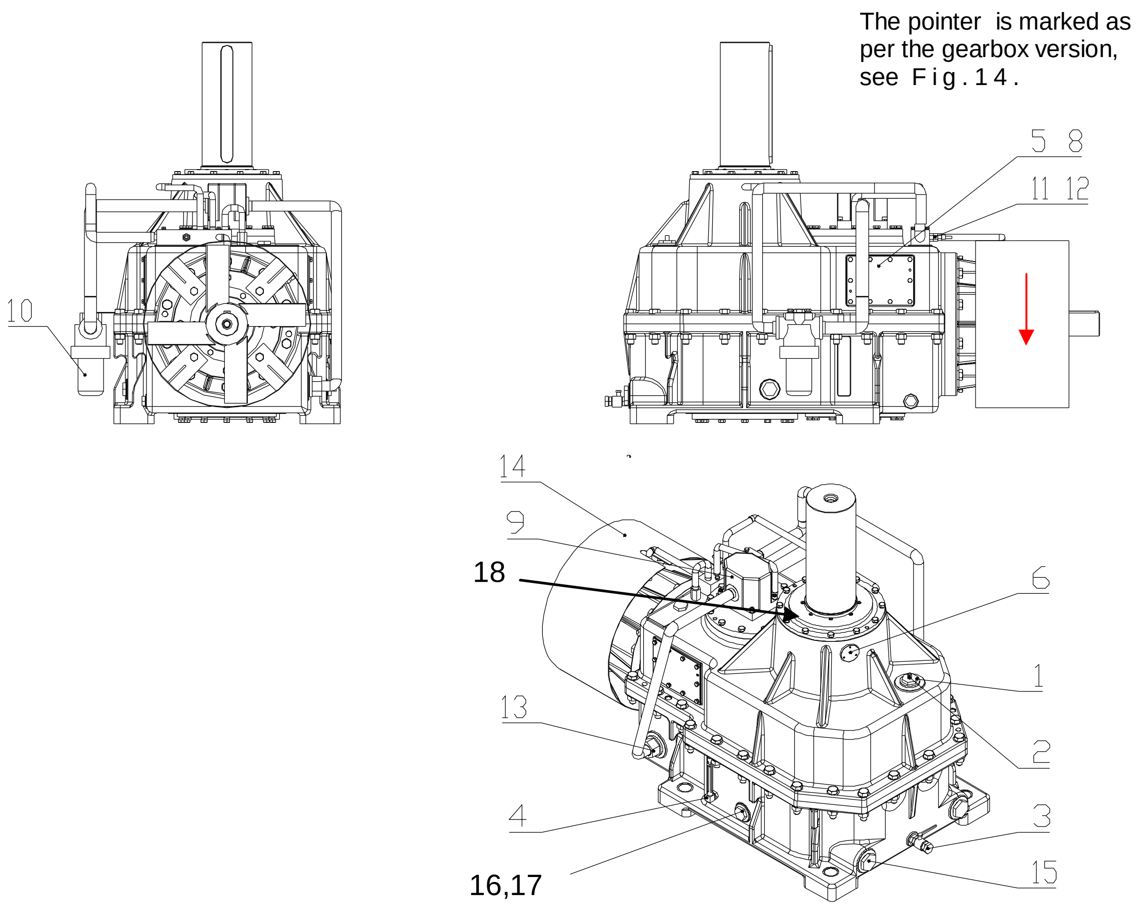
Gearboxes KCV6, KCV8, KCV10, KCV12 consist of: box-casting, one bevel gear type OERLIKON and one spur gear that are thermally treated. Vertical output shaft is placed in taper bearings, what allows considerable axial load of the gearbox output. That is precondition for direct catching powers from the fan propeller. Gearboxes are with integrated lubrication system.

Gearboxes KCV6, KCV8, KCV10, KCV12:

- are closed tightly and can work in dusty, moisty, chemically non-deffective ambient that does not lower the sealing ability of the seal rings.
- gearboxes are equipped by 2 seal rings from material Viton on the output and input shaft.

Gearbox KCV 12, power station Nasiríja, Iraq

Fig.No.11



1 - pouring plug M56x2
2 - deaerating plug - screw M56x2 (pos.1) is adapted for connection of the tube with inner diameter ϕ12mm, which will be led out of the cooling tower diffuser and which serves to deaerate the gearbox
3 - discharging plug G 1"
4 - oil gauge
5 - Cover for checking gearings
6 - hole for connecting vibrations sensor
8 - nameplate
9 - pump
10 - filter
11 - oil flow sensor
12 - oil flow sensor – evaluation unit
13 - sucking filter
14 - fan with cover
15 - heating spiral
16 - thermostat
17 - oil temperature sensor
18 - temperature pickup on surface of case (in place of output bearing)

User gearboxes for cooling towers must install on gearbox (by installation, operation and maintenance manual for gearboxes) external – outside diffusor cooling tower:

- oil tapping from gearbox,
- gearbox venting,
- oil level monitoring in gearbox

4.2 Technical parameters

Table No.12 Technical parameters of gearboxes types KCV6, KCV8, KCV10, KCV12.

k_C=1

SIZE	i_c	i_{real}	n_1 [min^{-1}]	P_1 [kW]	n_{output} [min^{-1}]	$M_{koutput}$ [Nm]	F_{a2} [kN]
KCV6	6,3	6,2	1 500	285	239,6	10 904	18
			1 000	190	159,7	10 904	19
			750	140	119,8	10 712	21
	7,1	6.98	1 500	265	214,9	11 305	18
			1 000	180	143,2	11 518	19
			750	135	107,4	11 518	21
	8	8.2	1 500	245	182,7	12 293	17
			1 000	170	121,8	12 795	17
			750	130	91,3	13 046	19
	9	8.9	1 500	210	168,3	11 435	19
			1 000	140	112,2	11 435	20
			750	105	84,1	11 435	21
	10	9.9	1 500	200	150,6	12 174	17
			1 000	140	100,4	12 783	18
			750	105	75,3	12 783	20
	11,2	11,1	1 500	170	135	11 543	19
			1 000	115	90	11 713	21
			750	85	67,5	11 543	23
	12,5	12,5	1 500	145	119,6	11 113	20
			1 000	100	79,7	11 496	22
			750	75	59,8	11 496	24
	14	13.9	1 500	135	107,2	11 534	20
			1 000	90	71,5	11 534	22
			750	68	53,6	11 620	25
	16	15.9	1 500	105	94	10 235	23
			1 000	70	62,6	10 235	26
			750	50	47	9 748	29

SIZE	i_c	i_{real}	n_1 [min^{-1}]	P_1 [kW]	n_{output} [min^{-1}]	$M_{koutput}$ [Nm]	F_{a2} [kN]
KCV8	6,3	6,2	1 500	460	238,1	17 711	23
			1 000	310	158,7	17 903	25
			750	231	119,0	17 788	27
	7,1	7,0	1 500	410	211,2	17 791	23
			1 000	275	140,8	17 899	25
			750	208	105,6	18 051	27
	8	7.9	1 500	375	187,5	18 334	24
			1 000	250	125,0	18 334	26
			750	190	93,7	18 579	27
	9	8.9	1 500	325	166,6	17 876	24
			1 000	220	111,1	18 151	27
			750	162	83,3	17 820	28
	10	9.9	1 500	300	150	18 334	25
			1 000	200	100	18 334	27
			750	150	75	18 334	29
	11,2	11,1	1 500	250	133,9	17 112	26
			1 000	170	89,2	17 454	27
			750	130	66,9	17 796	22
	12,5	12,4	1 500	215	120	16 425	28
			1 000	140	80	16 043	30
			750	105	60	16 043	32
	14	13.8	1 500	205	107,1	17 540	25
			1 000	140	71,4	17 967	28
			750	105	53,5	17 967	32
	16	15.8	1 500	150	93,7	14 667	32
			1 000	100	62,5	14 667	34
			750	75	46,88	14 667	38

k_c - service factor
i_C - total gear ratio
i_{real} - real gear ratio
n_1 - input revolutions [rev/min]
P_1 - standard gearbox power [kW]
n_{output} - output revolutions [rev/min]
$M_{koutput}$ - output torque [Nm]
F_{a2} - axial load of output shaft [kN]

$k_C=1$

SIZE	i_c	i_{real}	n_1 [min^{-1}]	P_1 [kW]	n_{output} [min^{-1}]	$M_{koutput}$ [Nm]	F_{a2} [kN]
KCV10	6,3	6,07	1 500	618	247,1	22 926	35
			1 000	450	164,7	25 041	37
			750	336	123,5	24 929	41
	7,1	6,9	1 500	618	217,3	26 061	35
			1 000	420	144,9	26 567	39
			750	315	108,6	26 567	40
	8	7,88	1 500	595	190,3	28 655	35
			1 000	400	126,9	28 895	39
			750	302	95,1	29 088	41
	9	9,06	1 500	495	165,5	27 408	37
			1 000	330	110,3	27 408	40
			750	250	82,7	27 685	43
	10	10,36	1 500	480	144,7	30 392	37
			1 000	320	96,5	30 392	40
			750	240	72,3	30 392	43
	11,2	11,15	1 500	400	134,5	27 258	37
			1 000	270	89,6	27 598	40
			750	200	67,2	27 258	43
	12,5	12,22	1 500	362	122,7	27 035	40
			1 000	240	81,8	26 886	43
			750	180	61,3	26 886	48
	14	14,44	1 500	320	103,8	28 240	40
			1 000	214	69,2	28 329	43
			750	160	51,9	28 240	46
	16	15,88	1 500	245	94,4	23 778	46
			1 000	164	62,9	23 875	50
			750	120	47,2	23 292	54

SIZE	i_c	i_{real}	n_1 [min^{-1}]	P_1 [kW]	n_{output} [min^{-1}]	$M_{koutput}$ [Nm]	F_{a2} [kN]
KCV12	6,3	6,2	1 500	870	238,1	33 497	55
			1 000	630	158,7	36 385	57
			750	470	119,0	36 192	60
	7,1	7,0	1 500	870	211,2	37 751	52
			1 000	630	140,8	41 005	55
			750	470	105,6	40 788	58
	8	7.9	1 500	820	187,5	40 092	49
			1 000	560	125,0	41 069	54
			750	420	93,7	41 069	57
	9	8.9	1 500	720	166,6	39 603	54
			1 000	490	111,1	40 428	57
			750	370	83,3	40 702	61
	10	9.9	1 500	670	150	40 947	52
			1 000	450	100	41 252	56
			750	340	75	41 558	59
	11,2	11,1	1 500	590	133,9	40 384	55
			1 000	395	89,2	40 556	59
			750	295	66,9	40 384	63
	12,5	12,4	1 500	480	120	36 669	58
			1 000	320	80	36 669	63
			750	240	60	36 669	68
	14	13.8	1 500	470	107,1	40 213	57
			1 000	310	71,4	39 785	62
			750	235	53,5	40 213	66
	16	15.8	1 500	340	93,7	33 247	65
			1 000	225	62,5	33 002	71
			750	170	46,88	33 247	74

k_c - service factor
i_C - total gear ratio
i_{real} - real gear ratio
n_1 - input revolutions [rev/min]
P_1 - standard gearbox power [kW]
n_{output} - output revolutions [rev/min]
$M_{koutput}$ - output torque [Nm]
F_{a2} - axial load of output shaft [k N]

Maximum gearbox noisiness level (when measured under 45^o from the output shaft axis in 2m distance) is **82dB.**

4.3 *Keys and threads dimensions on output and input shafts.*

Standard keys are supplied on input and output shafts, see Fig.No.3. Output shafts are equipped by 2 keys turned by 180^0.

Shafts are equipped by threads that serve to fit and secure the couplings to the output and input shaft, see Fig.No.4 .

In case the construction of the shaft with 2 keys is not suitable for connection with the hub, it is possible to use connection by one key. This must be consulted with the producer.

Table No.13 Key and threads dimensions of the input and output shafts for gearboxes KCV6, KCV8, KCV10, KCV12.

[mm]

DIMENSIONS	INPUT SHAFT				OUTPUT SHAFT			
	TYPE OF GEARBOX							
	KCV6	**KCV8**	**KCV10**	**KCV12**	**KCV6**	**KCV8**	**KCV10**	**KCV12**
KEY	Key 14x9x100	Key 18x11x120	Key 18x11x130	Key 20x12x170	Key 28x16x190	Key 32x18x190	Key 36x20x240	Key 40x22x380
b	14h9	18h9	18h9	20h9	28h9	32h9	36h9	40h9
d	50m6	60m6	65m6	75m6	105m6	115m6	135m6	160m6
A	M16	M20	M20	M20	M20	M24	M30	M30
B	32	39	39	39	39	48	65	65

b - key width
d - shaft diameter
A - thread dimension
B - thread lenght

4.4 Basic dimensions

Fig.No. 12

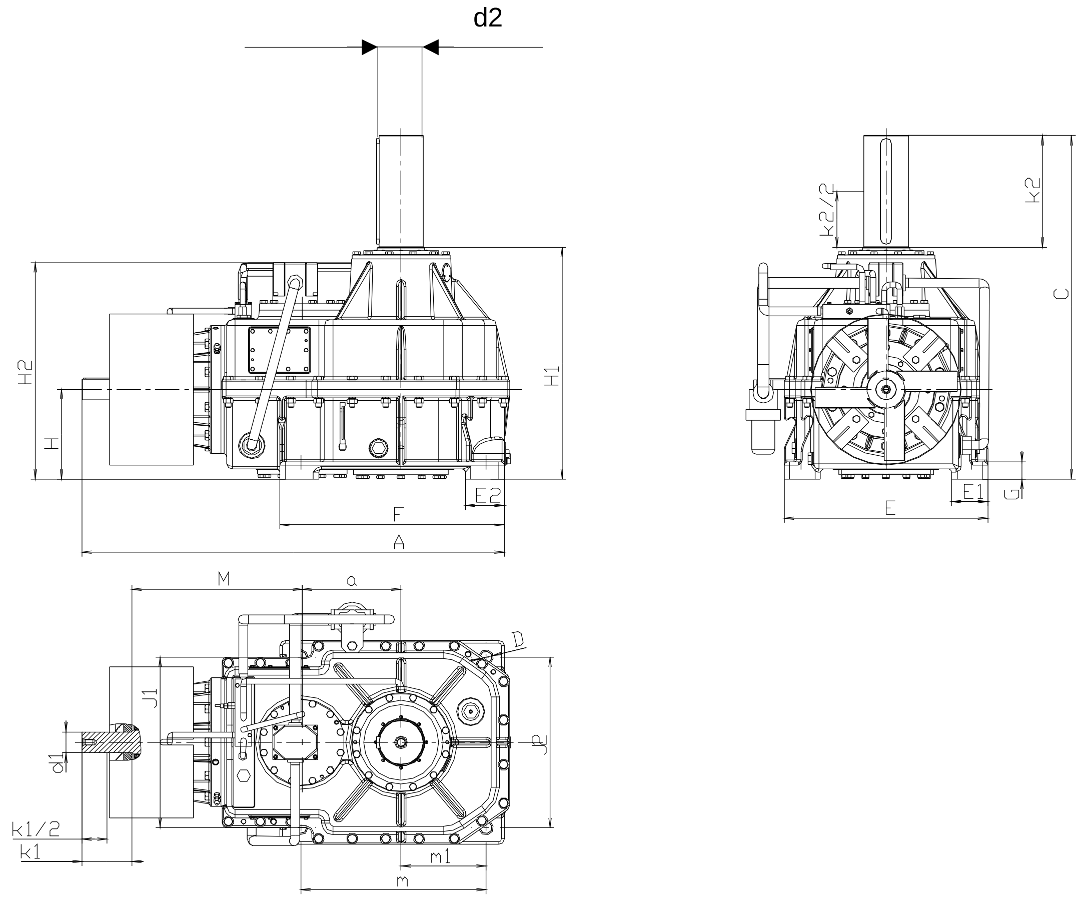


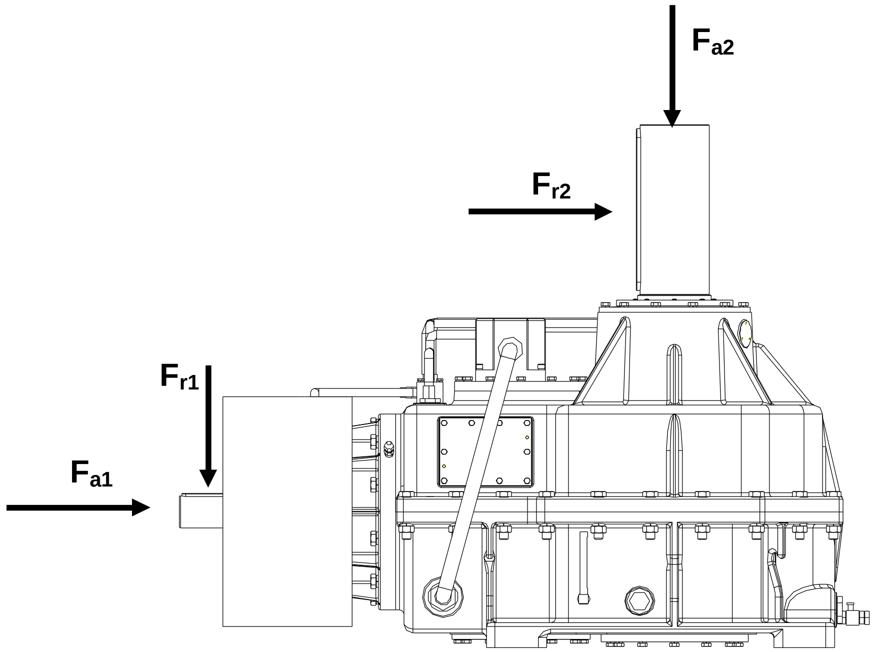
Table No.14 Basic dimensions of KCV6, KCV8,KCV10, KCV12 ***[mm]***

TYPE	A	C	D	E	E1	E2	F	G	H	H1	H2	M	a	d1	d2	k1	k2	m	m1	J1	J2	Hmotn. [kg]
KCV6	1065	740	28	560	90	90	690	55	230	530	601	480	250	50	105	110	210	620	190	490	490	550
KCV8	1172	782	35	574	95	95	590	55	255	572	607	500	280	60	115	140	210	500	202	510	510	720
KCV10	1291	900	35	633	125	125	640	60	280	680	678	550	315	65	135	140	250	550	250	560	560	1000
KCV12	1515	1229	42	730	130	140	805	60	320	829	773	610	355	75	160	180	400	665	305	610	610	1590

Dimensions H_1, H_2, d_1, d_2, k_1, k_2 – can be adjusted according to the customers´ requirements.
Dimension k1 on the input shaft is the lenght of input shaft with the fan hob lenght(cca. 30mm) – in case it is to be the part of delivery

4.5 Scheme of load forces in output shaft (*see Fig.No.13 and Table No.15*)

Fig.No. 13



F_{a1} - axial force on input shaft
F_{r1} - radial force on input shaft
F_{a2} - axial force on output shaft
F_{r2} - radial force on output shaft

Table No.15 Maximum allowed shafts load for gearboxes KCV6, KCV8, KCV10, KCV12.

Maximum radial force acting in the mid of output shaft - F_{r2max}	F_{r2max} = 0,1 x F_{a2}
Maximum axial force acting to the input shaft axis - F_{a1max}	F_{a1max} = 0
Maximum radial force acting in the mid of input shaft - F_{r1max}	F_{r1max} = 1 kN

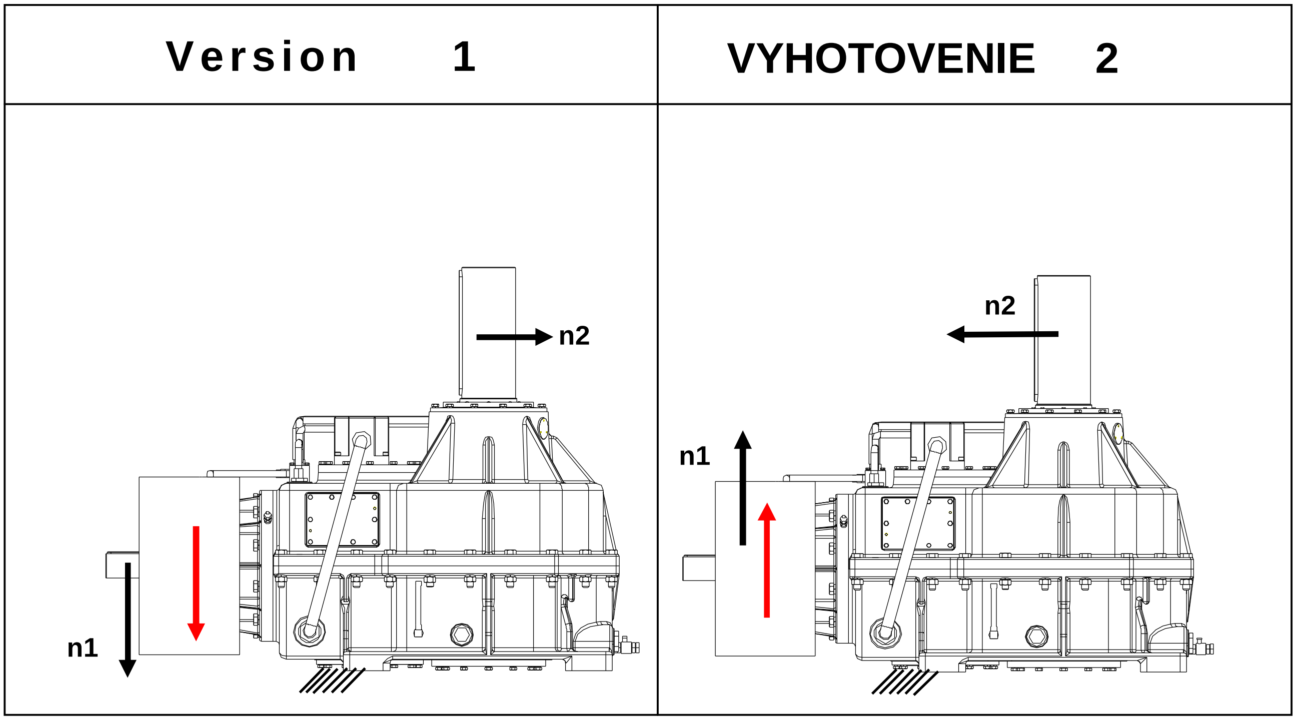
4.6 Ordering

When ordering gearbox KCV6, KCV8, KCV10, KCV12 please specify following:
Gearbox marking:
Type – size – version x gear ratio x input revolutions

Example:KCV – 12 – 1 x 10 x 1000

Fig.No.14 Gearboxes type KCV6, KCV8, KCV10, KCV12 versions.

Rotation right **Rotation left**



Versions and working positions of gearboxes KCV6, KCV8, KCV10, KCV12are shown in Fig.No.14.

As special accessories the gearboxes KCV6, KCV8, KCV10, KCV12 can be equipped by:
- cooling by a fan on input pinion, (in case checking the gearbox for heat output shows that it is necessary to use cooling.)
- cooling the gearbox by an outer circle – oil cooler – hot oil is sucked to the cooler and after cooling it is spreaded back to the gearbox, (in case checking the gearbox for heat output shows that it is necessary to use cooling.)
- Oil preheating – the gearbox can works for oil temperature above + 5 °C. The oil preheating safeguards sparing start of gearbox (in this event gearboxes are delivery with: reheating spirals, scanners on scan oil temperature and evaluation unit), scheme of connection reheating spirals is in direction .
- device protecting reverse run (blocking device).
- The gearboxes are delivery with labyrinth seals - for better tightening on input shaft and output shaft.

To secure monitoring of the gearboxes KCV6, KCV8, KCV10, KCV12 it is possible to supply the gearbox with the holes for connecting sensors for (location, if required, is to be aspecified by the customer):
- oil flow sensor,
- vibrations sensor,
- temperature

5. GENERAL CONDITIONS FOR USING GEARBOXES FOR COOLING TOWERS

A, It is recommended to consult the project of locating el. motor, coupling, connecting shaft, gearbox itself and propeller with the gearbox producer.

B, For all types of gearboxes for cooling towers the level of diagnostics (gearbox protection) must be agreed with the gearbox producer.

C, For gearboxes TSA and KCV it is recommended to use oil flow sensors that are connected together electrically so in case there is no oil flow in lubrication system, the el. motor is stopped automatically.

D, Gearbox operation is influenced by many different vibrations. In the sense of the Standard IS 10816-1 and related standards for fan operation, in gearbox operation it is recommendded not to overcome declared vibrations, see table 16.

When starting cooling tower operation, vibration values must be measured and analysed by method of vectors.

Table No.16 Allowed values of real vibration speed.

Druh konštrukcie ventilátora	Výkon ventilátora [kW]	osové ventilátory V_{ef} [mm/s]
PEVNÝ	do 50	4,0
	nad 50	5,6
ELASTICKÝ	do 50	5,6
	nad 50	8,0

E, Allowed vibration levels measured in operation in the place of output bearing according to ISO STANDARD 2372, VDI 2056 a SKF – SEE are stated in table No.17. In gearbox operation it is necessary not to overcome the levels stated in table 17 – conditions Good and Satisfactory.

Vibration values are measured and evaluated in individual directions.

Table No.17 Values declared as per ISO STANDARD 2372, VDI 2056.

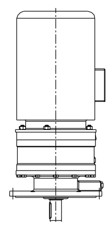
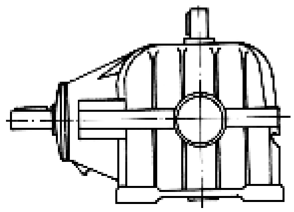
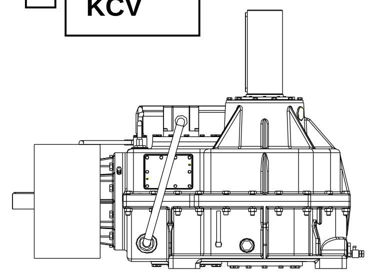
Group	Condition by the value Vef (mm/s)			
	GOOD	SATISFACTORY	CRITICAL (Gearbox can work for the short time, but the repair is necessary)	EMERGENCY (inadmissible)
III	≤ 2.8	2,9 – 7,1	7,2 - 18	> 18

THE PRODUCER RESERVES THE RIGHT OF TECHNICAL CHANGES

Technical questionaire for the gearboxes for cooling towers specification.

Customer (name of the firm)..................................... Request No.:...
Developed by (name):... Tel.:................................ Fax:...........................
Project / country of final use ....
Type / Gearbox mounting position:

☐ **EP41WT** ☐ **TSA 031 351** ☐ **KCV**

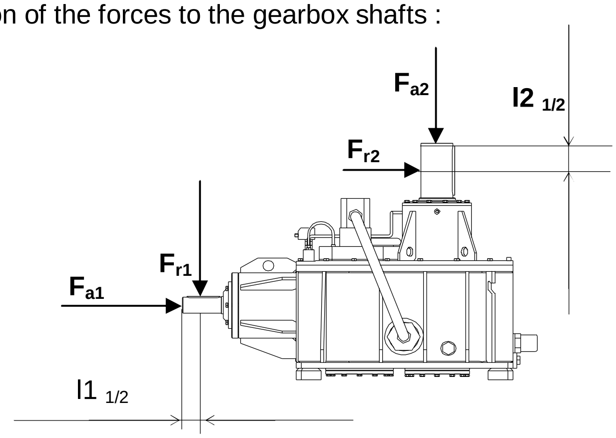
FAN:
FAN ϕ .... mm / No. of blades in screw-propeller...... moment of inertia ....kg / m^2
Gearbox working ambient temperature: min .... ^oC max. .... ^oC
Power of ventilator/ ventilator revolutions : .... kW .... rev / min
Reverse run: yes☐ no☐
Weight of fan:............... kg
Weight of hub:.................... kg Total weight of hub and fan:................................ kg

ELECTRIC MOTOR:
El. motor power .... kW El. motor revolutions :....................rev/ min
Electric motor type .... Relative starting torgue of electric motor......................

Start of el. motor by frequence changer : yes ☐ no ☐
Start of el. motor by one-speed el. motor: yes ☐ no ☐
El. motor connection: star / triangle ☐ triangle ☐
Start of el. motor by two-speed el.motor: yes ☐ no ☐

Gearbox:
Number of pieces: .... pcs
Gear ratioi = ... Output revolutions allowed deviation: - .... % + ... %
Sense of output shaft rotation when looking to the face of the output shaft:
right ☐ left ☐ reverse ☐ (in reverse run please declare main rotation direction)
right ☐ left ☐

air circulation speed : > 1,0 m/s ☐ > 2,0 m/s ☐ > 4,0 m/s ☐
Action of the forces to the gearbox shafts :



F_{a1} = ... kN

F_{r1} = ... kN

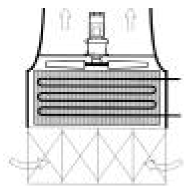
F_{a2} = ... kN

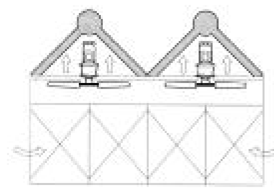
F_{r2} = ... kN

Radial power acting in fan destruction F_{rd} = ...kN

Location of gearbox in cooling tower: ☐ gearboxes are located on stable base
☐ gearboxes are located flexibly - the base of the gearbox is connected with the cooling tower frame

Cooling tower construction: Open construction ☐ Closed construction ☐





Gearbox lifetime required: .... hours

Surface treatment: Colour type : ☐ standard : primer: - epoxy SF 309606, thickness 130 µm
interlayer – epoxySF 30-7283, thickness 100 µm
top coat-polyurethane SF 15-5010, thickness 40 µm

☐ Other: ....

Colour tone: ☐ standard : RAL 5010
☐ Other: ....

Requirements to the quality certificates and documentation attached
Inspection certificate in the sense of the STN 10204 yes ☐ no ☐
Other, please specify ....
....
....

Slovak ☐ English ☐ German ☐ Polish ☐

Special reqiurements:

yes ☐ no ☐ device protecting gearbox against reverse running, (lock out facility)

yes ☐ no ☐ gearbox cooled by fan on the input shaft,

yes ☐ no ☐ gearbox cooled by external cooler,

yes ☐ no ☐ hole for attaching oil flow sensor

yes ☐ no ☐ hole for attaching vibrations sensor

yes ☐ no ☐ hole for attaching oil temperature sensor

yes ☐ no ☐ oil pre-heating (heating spiral including thermostat)

Maximum noisiness level for standard gearboxes (measured under 45^0 from the output shaft axis in 2 m distance) is **82 dB.**
In case of requiring other noisiness level please specify: the level is .... dB.

The way of choosing gearbox for cooling towers is described in the catalogue of gearboxes for cooling towers.
NOTES:
....
....
....