

# GEARBOXES FOR COOLING TOWERS



6th edition

07/2006



**ZTS Sabinov, a.s.**

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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 assortment 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:

- Ø **bevel**
- Ø **spur**
- Ø **bevel - spur**
- Ø **worm**
- Ø **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 divided 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 applications**

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:

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

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

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

$P_{1N}$  - calculated necessary output of the gearbox [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:

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

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

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

$M_z < M_{\max}$  – 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  $P_{t\max}$ , tab.No.2, 3 and 4.

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

when

$$P_{t\max} \geq P_t \quad [\text{kW}] \quad [4]$$

$P_t$  - gearbox heat output [kW] is power transmitted through 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  $k_5$**

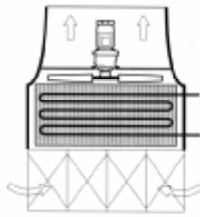
		Ambient temperature [°C]		
		30	40	50
coefficient $k_5$	Without fan on the input pinion	1,2	1,7	2,2
	With fan on the input pinion (Fig. No.11)	1,1	1,5	2,0

b/ Cooling tower construction coefficient  $k_6$ .

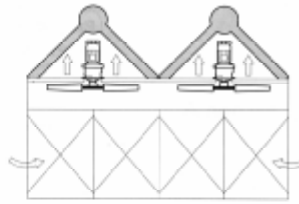
$k_6 = 1$  - **in open construction** – free air circulation between gearbox, cooling tower diffuser and the cooling tower construction itself – see fig.No.1.

$k_6 = 1,15$  - **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 allow 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 <sup>-1</sup> ]	$P_{t\ max}$ [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 <sup>-1</sup> ]	$P_{t\ max}$ [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.

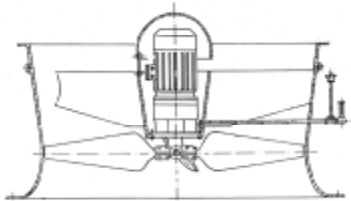


Fig.No..3



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 <sup>-1</sup> ]	$P_1$ [kW]	$n_{output}$ [min <sup>-1</sup> ]	$M_{koutput}$ [Nm]
<b>3.15</b> <b>(3.13)</b>	1 500	74	479	1431
	1 000	60	319	1742
	750	44	239	1705
<b>4</b> <b>(3.9)</b>	1 500	74	384	1785
	1 000	60	256	2170
	750	44	192	2122
<b>5</b> <b>(5)</b>	1 500	44	300	1358
	1 000	37	200	1713
	750	30	150	1852
<b>6.3</b> <b>(6.33)</b>	1 500	37	236	1452
	1 000	22	157	1297
	750	15	118	1177
<b>8</b> <b>(7.93)</b>	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° 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).

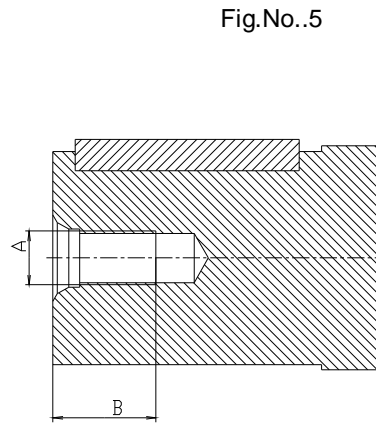
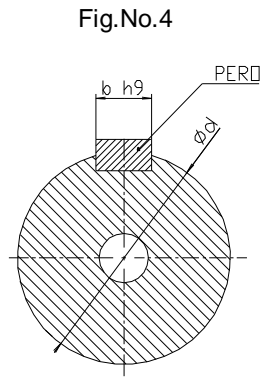


Table No.6 Key and threads dimensions of the output shaft in EP41WT

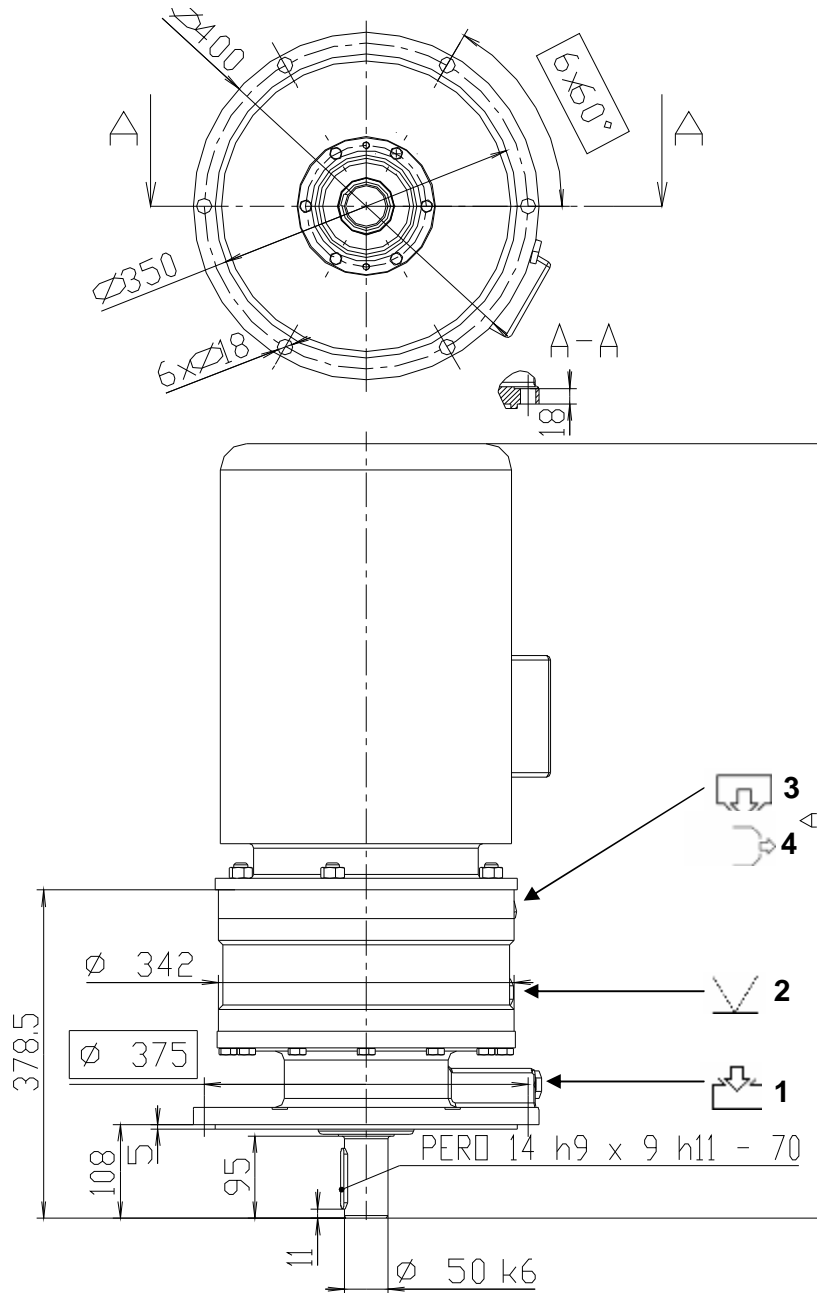
					[mm]
<b>Output shaft</b>	<b>Key</b>	<b>b</b>	<b>d</b>	<b>A</b>	<b>B</b>
	Key 14x9x70	14h9	50k6	M16	32

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

## 2.4 Basic dimensions

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

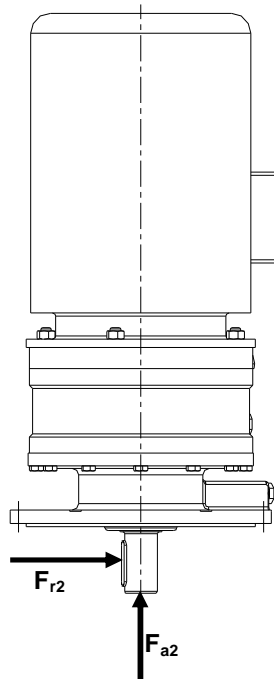
Fig. No. 6



A – total length 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

Gearboxes 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 Gdańsk, 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 <sup>-1</sup> ]	$P_1$ [kW]	$n_{output}$ [min <sup>-1</sup> ]	$M_{koutput}$ [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.

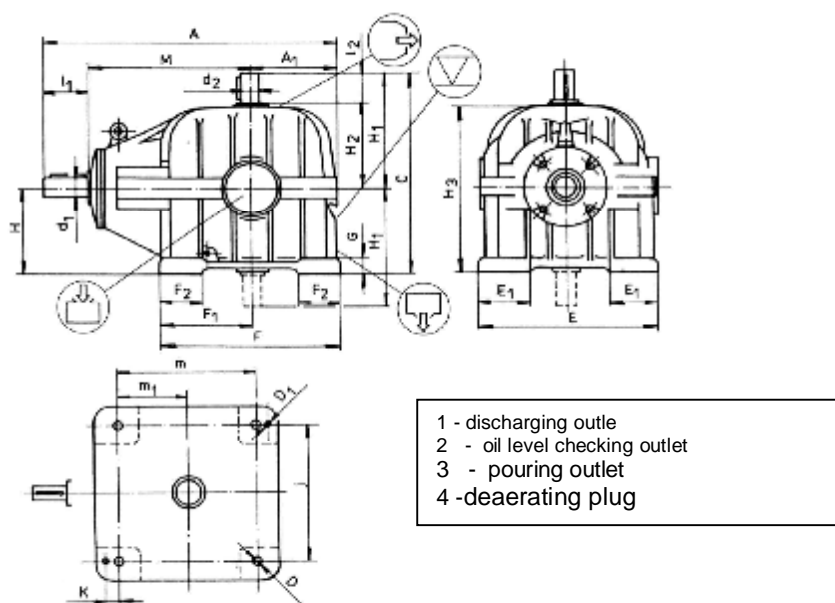
[mm]

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

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

### 3.4 Basic dimensions

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



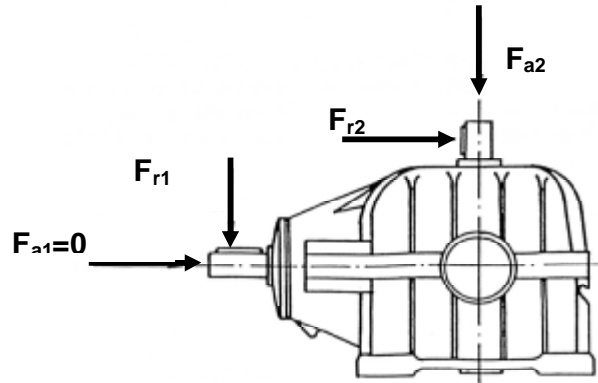
**Table No.10** Gearboxes TSA 031 351-06, TSA 031 351-07, TSA 031 351-08 basic dimensions. [mm]

	Size		
	06	07	08
H	250	315	400
A	735	958	1143
A <sub>1</sub>	235	308	373
C	607,5	758	957
D	28	35	35
D <sub>1</sub>	12	16	16
E	480	620	750
E <sub>1</sub>	120	150	165
F	480	620	750
F <sub>1</sub>	240	310	375
F <sub>2</sub>	110	160	170
G	32	45	50
H <sub>1</sub>	357,5±1	443,5±1	557±1
H <sub>2</sub>	252,2	313,5	392
H <sub>3</sub>	492,5	617,5	780
K	33	45	50
M	390	510	600
d <sub>1</sub>	50k6	65m6	85m6
d <sub>2</sub>	60m6	80m6	100m6
l <sub>1</sub>	110	140	170
l <sub>2</sub>	105	130	165
j	420	550	670
m	370	490	600
m <sub>1</sub>	185	245	300
Weight [kg]	275	600	900

Dimension l<sub>1</sub> considers also the length for fan fixation. In case of using fan the length 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

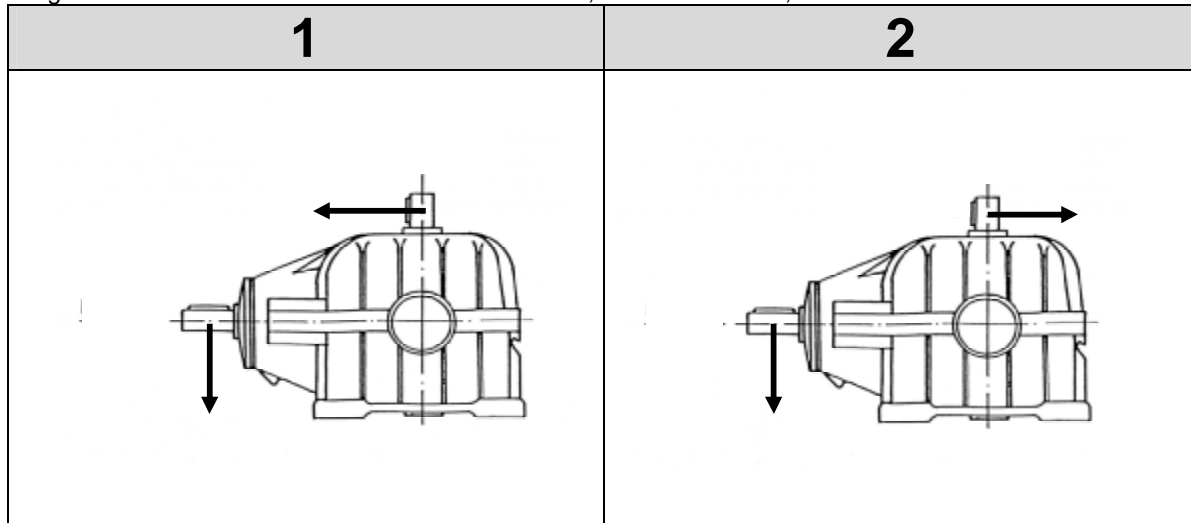
When ordering gearboxes TSA 031 351-06, TSA 031 351-07, TSA 031 351-08 please specify following:

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.



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.

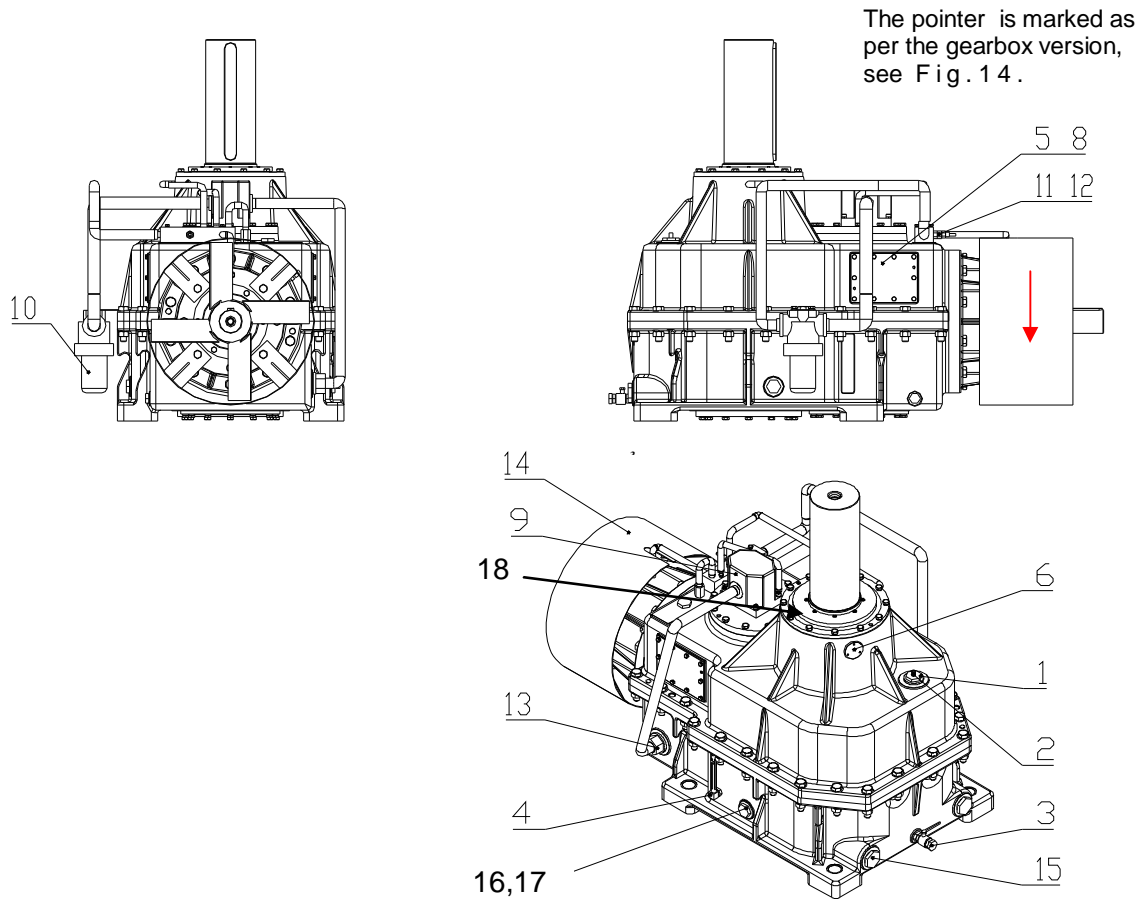
Gearboxes KCV6, KCV8, KCV10, KCV12:

- are closed tightly and can work in dusty, moisty, chemically non-defective 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 Nasirija, 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  $\phi 12\text{mm}$ , 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 gears
- 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 diffuser 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 <sup>-1</sup> ]	$P_1$ [kW]	$n_{output}$ [min <sup>-1</sup> ]	$M_{koutput}$ [Nm]	$F_{a2}$ [kN]	SIZE	$i_c$	$i_{real}$	$n_1$ [min <sup>-1</sup> ]	$P_1$ [kW]	$n_{output}$ [min <sup>-1</sup> ]	$M_{koutput}$ [Nm]	$F_{a2}$ [kN]
<b>KCV6</b>	6,3	6,2	1 500	285	239,6	10 904	18	<b>KCV8</b>	6,3	6,2	1 500	460	238,1	17 711	23
			1 000	190	159,7	10 904	19				1 000	310	158,7	17 903	25
			750	140	119,8	10 712	21				750	231	119,0	17 788	27
	7,1	6.98	1 500	265	214,9	11 305	18		7,1	7,0	1 500	410	211,2	17 791	23
			1 000	180	143,2	11 518	19				1 000	275	140,8	17 899	25
			750	135	107,4	11 518	21				750	208	105,6	18 051	27
	8	8.2	1 500	245	182,7	12 293	17		8	7.9	1 500	375	187,5	18 334	24
			1 000	170	121,8	12 795	17				1 000	250	125,0	18 334	26
			750	130	91,3	13 046	19				750	190	93,7	18 579	27
	9	8.9	1 500	210	168,3	11 435	19		9	8.9	1 500	325	166,6	17 876	24
			1 000	140	112,2	11 435	20				1 000	220	111,1	18 151	27
			750	105	84,1	11 435	21				750	162	83,3	17 820	28
	10	9.9	1 500	200	150,6	12 174	17		10	9.9	1 500	300	150	18 334	25
			1 000	140	100,4	12 783	18				1 000	200	100	18 334	27
			750	105	75,3	12 783	20				750	150	75	18 334	29
	11,2	11,1	1 500	170	135	11 543	19		11,2	11,1	1 500	250	133,9	17 112	26
			1 000	115	90	11 713	21				1 000	170	89,2	17 454	27
			750	85	67,5	11 543	23				750	130	66,9	17 796	22
	12,5	12,5	1 500	145	119,6	11 113	20		12,5	12,4	1 500	215	120	16 425	28
			1 000	100	79,7	11 496	22				1 000	140	80	16 043	30
			750	75	59,8	11 496	24				750	105	60	16 043	32
	14	13.9	1 500	135	107,2	11 534	20		14	13.8	1 500	205	107,1	17 540	25
			1 000	90	71,5	11 534	22				1 000	140	71,4	17 967	28
			750	68	53,6	11 620	25				750	105	53,5	17 967	32
16	15.9	1 500	105	94	10 235	23	16	15.8	1 500	150	93,7	14 667	32		
		1 000	70	62,6	10 235	26			1 000	100	62,5	14 667	34		
		750	50	47	9 748	29			750	75	46,88	14 667	38		

$k_c$  - service factor  
 $P_1$  - standard gearbox power [kW]  
 $F_{a2}$  - axial load of output shaft [kN]

$i_c$  - total gear ratio  
 $n_{output}$  - output revolutions [rev/min]

$i_{real}$  - real gear ratio  
 $M_{koutput}$  - output torque [Nm]  
 $n_1$  - input revolutions [rev/min]

SIZE	$i_c$	$i_{real}$	$n_1$ [min <sup>-1</sup> ]	$P_1$ [kW]	$n_{output}$ [min <sup>-1</sup> ]	$M_{koutput}$ [Nm]	$F_{a2}$ [kN]	SIZE	$i_c$	$i_{real}$	$n_1$ [min <sup>-1</sup> ]	$P_1$ [kW]	$n_{output}$ [min <sup>-1</sup> ]	$M_{koutput}$ [Nm]	$F_{a2}$ [kN]
<b>KCV10</b>	6,3	6,07	1 500	618	247,1	22 926	35	<b>KCV12</b>	6,3	6,2	1 500	870	238,1	33 497	55
			1 000	450	164,7	25 041	37				1 000	630	158,7	36 385	57
			750	336	123,5	24 929	41				750	470	119,0	36 192	60
	7,1	6,9	1 500	618	217,3	26 061	35		7,1	7,0	1 500	870	211,2	37 751	52
			1 000	420	144,9	26 567	39				1 000	630	140,8	41 005	55
			750	315	108,6	26 567	40				750	470	105,6	40 788	58
	8	7,88	1 500	595	190,3	28 655	35		8	7,9	1 500	820	187,5	40 092	49
			1 000	400	126,9	28 895	39				1 000	560	125,0	41 069	54
			750	302	95,1	29 088	41				750	420	93,7	41 069	57
	9	9,06	1 500	495	165,5	27 408	37		9	8,9	1 500	720	166,6	39 603	54
			1 000	330	110,3	27 408	40				1 000	490	111,1	40 428	57
			750	250	82,7	27 685	43				750	370	83,3	40 702	61
	10	10,36	1 500	480	144,7	30 392	37		10	9,9	1 500	670	150	40 947	52
			1 000	320	96,5	30 392	40				1 000	450	100	41 252	56
			750	240	72,3	30 392	43				750	340	75	41 558	59
	11,2	11,15	1 500	400	134,5	27 258	37		11,2	11,1	1 500	590	133,9	40 384	55
			1 000	270	89,6	27 598	40				1 000	395	89,2	40 556	59
			750	200	67,2	27 258	43				750	295	66,9	40 384	63
	12,5	12,22	1 500	362	122,7	27 035	40		12,5	12,4	1 500	480	120	36 669	58
			1 000	240	81,8	26 886	43				1 000	320	80	36 669	63
			750	180	61,3	26 886	48				750	240	60	36 669	68
	14	14,44	1 500	320	103,8	28 240	40		14	13,8	1 500	470	107,1	40 213	57
			1 000	214	69,2	28 329	43				1 000	310	71,4	39 785	62
			750	160	51,9	28 240	46				750	235	53,5	40 213	66
16	15,88	1 500	245	94,4	23 778	46	16	15,8	1 500	340	93,7	33 247	65		
		1 000	164	62,9	23 875	50			1 000	225	62,5	33 002	71		
		750	120	47,2	23 292	54			750	170	46,88	33 247	74		

$k_c$  - service factor  
 $P_1$  - standard gearbox power [kW]  
 $F_{a2}$  - axial load of output shaft [kN]

$i_c$  - total gear ratio  
 $n_{output}$  - output revolutions [rev/min]

$i_{real}$  - real gear ratio  
 $M_{koutput}$  - output torque [Nm]  
 $n_1$  - input revolutions [rev/min]

Maximum gearbox noisiness level (when measured under 45° 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°.

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.

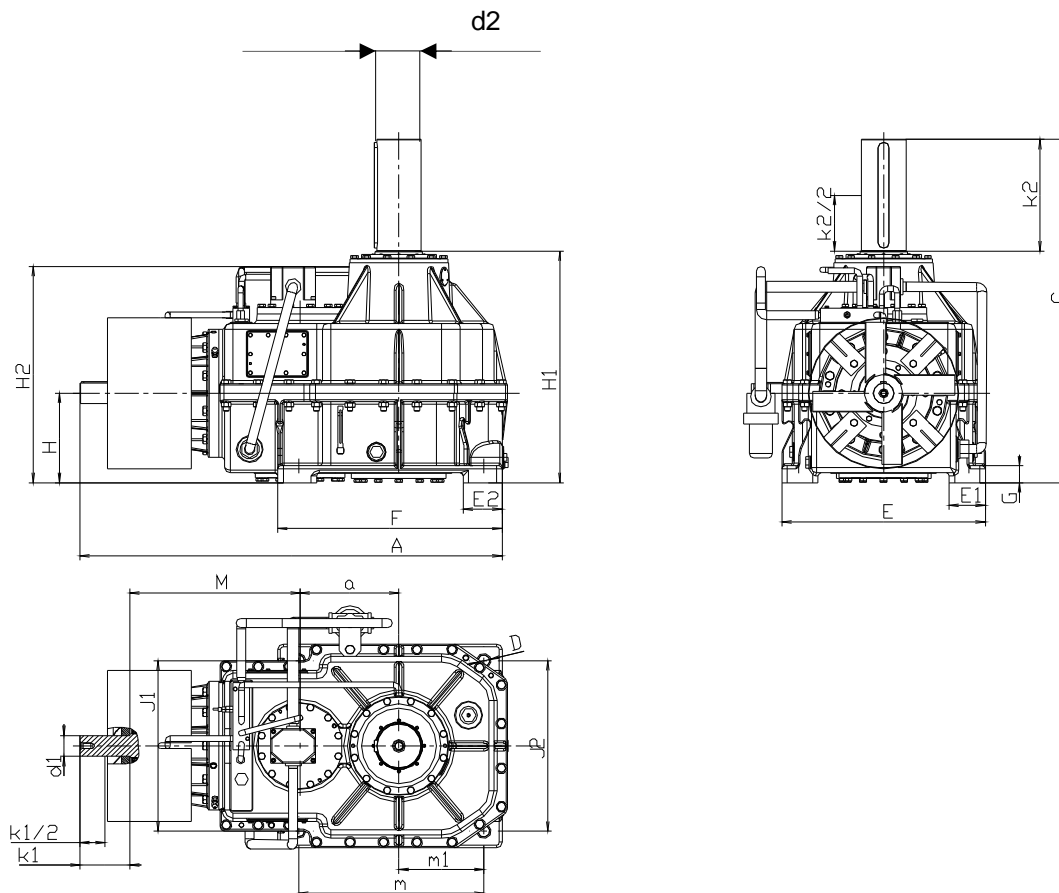
[mm]

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>b</b>	14h9	18h9	18h9	20h9	28h9	32h9	36h9	40h9
<b>d</b>	50m6	60m6	65m6	75m6	105m6	115m6	135m6	160m6
<b>A</b>	M16	M20	M20	M20	M20	M24	M30	M30
<b>B</b>	32	39	39	39	39	48	65	65

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

## 4.4 Basic dimensions

Fig.No. 12



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

[ mm ]

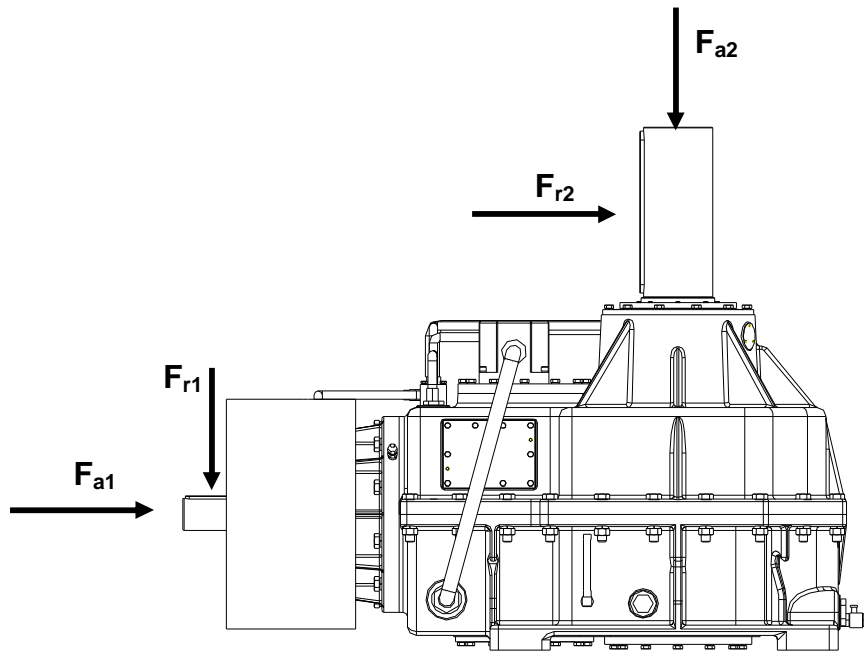
TYPE	A	C	D	E	E1	E2	F	G	H	H1	H2	M	a	d1	d2	k1	k2	m	m1	J1	J2	Hmotn. [kg]
<b>KCV6</b>	1065	740	28	560	90	90	690	55	230	530	601	480	250	50	105	110	210	620	190	490	490	550
<b>KCV8</b>	1172	782	35	574	95	95	590	55	255	572	607	500	280	60	115	140	210	500	202	510	510	720
<b>KCV10</b>	1291	900	35	633	125	125	640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

Dimensions H<sub>1</sub>, H<sub>2</sub>, d<sub>1</sub>, d<sub>2</sub>, k<sub>1</sub>, k<sub>2</sub> – can be adjusted according to the customers' requirements.

Dimension k<sub>1</sub> on the input shaft is the length of input shaft with the fan hob length( 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 - $F_{r2max}$	$F_{r2max} = 0,1 \times F_{a2}$
Maximum axial force acting to the input shaft axis - $F_{a1max}$	$F_{a1max} = 0$
Maximum radial force acting in the mid of input shaft - $F_{r1max}$	$F_{r1max} = 1 \text{ kN}$

## 4.6 Ordering

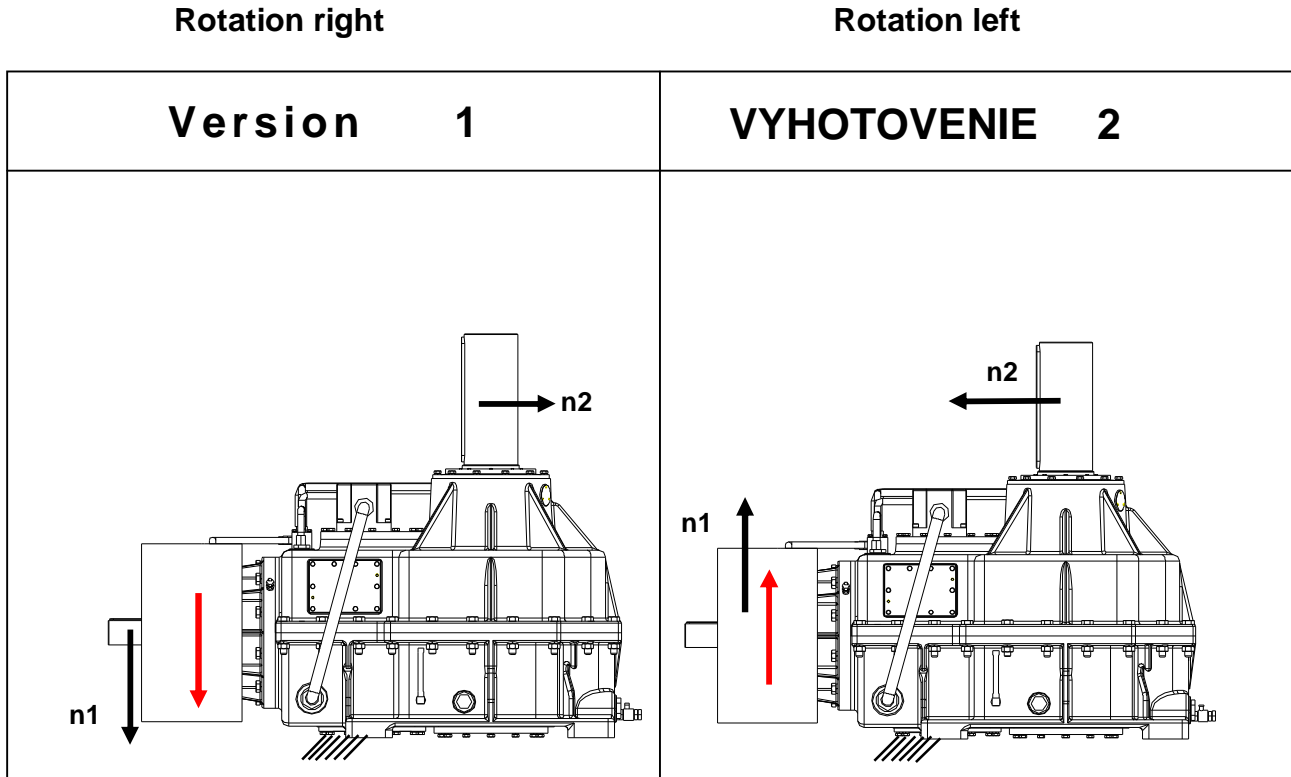
When ordering gearbox KCV6, KCV8, KCV10, KCV12 please specify following:

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.



Versions and working positions of gearboxes KCV6, KCV8, KCV10, KCV12 are 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 recommended 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 <sub>ef</sub> [ 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 V <sub>ef</sub> (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 questionnaire for the gearboxes for cooling towers specification.

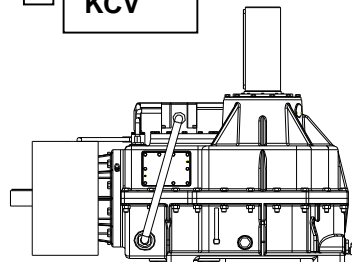
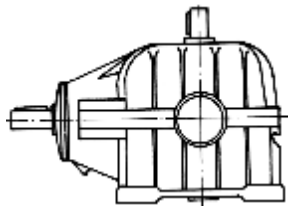
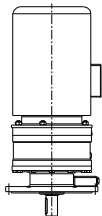
Customer (name of the firm)..... Request No.:.....  
 Developed by (name):..... Tel.:..... Fax:.....  
 Project / country of final use .....

Type / Gearbox mounting position:

EP41WT

TSA 031 351

KCV



## FAN:

FAN  $\phi$  ..... mm / No. of blades in screw-propeller..... moment of inertia .....kg / m<sup>2</sup>  
 Gearbox working ambient temperature: min ..... °C max. .... °C  
 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:

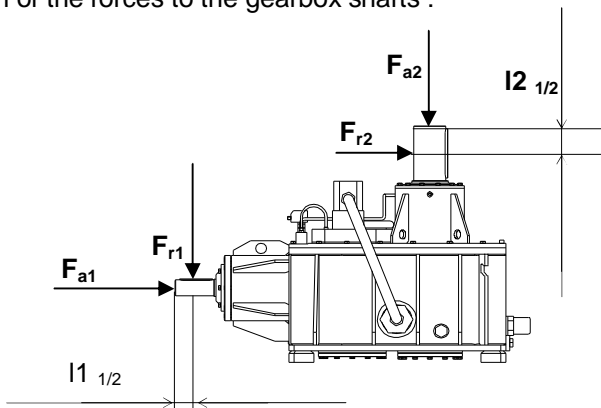
El. motor power ..... kW El. motor revolutions :.....rev/ min  
 Electric motor type ..... Relative starting torque of electric motor.....  
 Start of el. motor by frequency changer : yes  no   
 Start of el. motor by one-speed el. motor: yes  no   
 El. motor connection: star / triangle  triangle   
 Start of el. motor by two-speed el. motor: yes  no

## Gearbox:

Number of pieces: ..... pcs  
 Gear ratio = ..... 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



