WHAT IS REACTIVE ENERGY

Reactive energy is a part of the consumed power, which is not converted into useful work.
All individual loads that have to contain magnetic field to be able to work are called Inductive loads.

Such loads are:

- electro motors
- transformers
- fluorescent and street ligts
- inductive electro thermal devices etc.

Energy consumed to generate magnetic field in general is supplied from the distributive net.
The reactive energy, although necessary for these devices to be able to work, does not produce useful work.
Electrical energy that is used by inductive loads consists:

• "P" - active electrical power is electrical power converted into some kind of useful work.
This power is measured in kWh

• "Q" - reactive power, electrical power that generates magnetic field which is a base for working of the inductive electro motors.
This power is measured in kVArh

Reactive energy is a part of the consumed power that is not converted into useful work.
According the above these consumers use active and reactive power, and the only used part of the power is – the active one.

POWER FACTOR COSφ

The ratio between active and reactive power is called power factor and is marked cosφ::

$$\cos\varphi = \frac{\text{Active power}}{\text{Appsrent power}} = \frac{P}{S} = \frac{kW}{kVA}$$

Power factor is different for each device and usually it may be from 0.4 to 1.

As much as the power factor is closer to zero, that much the usage of the active energy is lower.
The best case is when the power factor is 1, because in such case the total consumed energy is transferred into useful work.

Average values of power factor cosφ for different electrical devices

Cooling devices

cosφ = 0,8 - 0,9

Welding devices

cosφ = 0,4 - 0,65

Cranes, lifts

cosφ = 0,5 - 0,6

Ventilators

cosφ = 0,7 - 0,8

Water pumps

cosφ = 0,8 - 0,85

Compressors

cosφ = 0,7 - 0,8

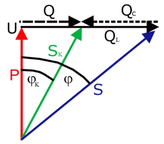
REACTIVE ENERGY COMPENSATION

The reactive power that is needed for the operation of the inductive devices can be obtained in another way not only through the distribution network.

The reactive power that is needed for functioning of the AC inductive devices is obtained by capacitors batteries with parallel capacitors.

This procedure is called reactive power compensation.

Graphical display of the reactive power compensation capabilities:



Where :

φ - phase angle
S - uncompensated barren energy
Sk - compensated barren energy
P - active energy
Q - reactive energy
Ql - inductive reactive energy
Qc - capacitive reactive energy

From the above diagram the following formula are created :

$$S = \sqrt{P^2 + Q^2} \qquad Q = \sqrt{S^2 - P^2} \qquad P = \sqrt{S^2 - Q^2}$$

RADE KONCAR - KONTAKTORI I RELEI OFFERS COMPLETE SOLUTIONS FOR COMPENSATION OF REACTIVE POWER:

- Measuring and determine the real situation of the reactive power
- Preparing the project for reactive power compensation and study for the project feasibility
- Performance of the complete work

The reactive energy compensation project includes the following elements:
- Automatic detection of reactive power
- Automatic regulation of reactive power
- Low voltage equipment
- Capacitors
- Cable installation

APPLICATION

The automatic power factor correction units are designed for group and central reactive power compensation in the industrial, electrical power and other production facilities and institutions . The units with smaller power, up to 90 kVAr, are intended for an installation in the production plants and facilities which have relatively low consumption of reactive power, but much variable in time, that automatic regulation is needed. The higher power units are intended for industrial and power plants, for an indoor and outdoor installation.

TECHNICAL CHARACTERISTIC

1. Capacitors RKC 440 S

Metalized polypropylene capacitors from 5 kVAr to 30 kVAr with cylindrical form and impregnated biodegradable soft resin.
Double safety: Self healing technology and over pressure tear - off fuse. Finger proof terminals. Massive connection studs.
They can be used for power factor correction in industrial and semi industrial applications.

TYPE	Voltage (V)	Power (Q) (kVAR)		Capacitance (μF)	Rated current (A)		Dimension (mm)
		50Hz	60Hz		50Hz	60Hz	
RKC 440 5	440	5	6	27,5	6,56	7,87	63,5x154
RKC 440 7,5	440	7,5	9	41	9,8	11,8	78,4x159
RKC 440 10	440	10	12	55	13,1	15,7	78,4x195
RKC 440 12,5	440	12,5	15	68,5	16,4	19,7	88,4x195
RKC 440 15	440	15	18	82,2	19,7	23,6	88,4x270
RKC 440 20	440	20	24	110	26,2	31,5	88,4x270
RKC 440 25	440	25	30	137,1	32,8	39,4	88,4x345
RKC 440 30	440	30	36	164,5	39,4	47,2	88,4x345

2. Capacitor contactors

The capacitor contactors CNNK and CNKM are chosen according the capacitor's power.
For a group and central regulated compensation, in cases when the three phase filter reactor are not being used, it is recommended a selection of contactors for one degree higher values, compared to the nominal value of the corresponding capacitor.

Type		CNNK 2.5 10(017) CNNK 5 10(01)* CNNK 7,5 09 *	CNNK 10 20 CNNK 10 11 CNNK 10 02	CNNK 12 20 CNNK 12 11 CNNK 12 02	CNNK 15 20 CNNK 15 11 CNNK 15 02	CNNK 20 10 CNNK 20 01	CNNK 25 10* CNNK 25E 10** CNNK 25 01*	CNNK 30 10 CNNK 30 01	CNNK 40 10 CNNK 40 01	CNNK 50 10 CNNK 50 01	CNNK 60 10 CNNK 60 01	CNKM 60 22	CNKM 75 22
AC 6b category of use Capacitor rating at operating voltage 50/60Hz	230V kVar	1.4/2.8/4	5	6.7	8.5	11	14	20	25	29	32	34	38
	400V kVar	2.5/5/7.5	10	12.5	15	20	25	30	40	50	60	60	75
	690V kVar	3.7/7.5 /11	15	18	22	30	35	40	58	70	80	92	100
Rated operatioonal current Ie 400V A		3.6/7.2/11	14	18	22	29	36	44	58	72	87	87	108
Insolatoion rating	V	690						1000					
Permissible ambient temperature	°C	- 25 ,40 + 55											
Coil voltage tolerances		0,85 - 1,1 Un											
Maximum permisible fuse ratings Main circuit gI/Gg A Auxiliary Circuit A		20/25/40 16/20/25	25 16	35 16	50 16	50 16	63 16	80 16	100 16	125 16	160 16	160 16	160 16
Frequency of switching operations	s/h	240				120		100					
Electrical endurance	min.	100 000	200 000		150 000			100 000				75 000	
Size of connecting conductors main circuit multi-wire conductor multi-wire conductor with cable shoe	mm² mm²	1.5-6/1.5-6/ 2.5-10 1.5-6/1.5-6/ 2.5-10	1.5 - 6		2.5 - 10	6 - 25 2.5 - 10	6 - 25	16 - 35				35 - 50	
Screw head		M4/PZ2	M4/PZ2		M4/PZ2	M5/Hexagon socket M4/PZ2		M6/PZ2				M8/PZ2	
Tightening torque	Nm	1.2/1.2/1.4	1.2		1.4	2/1.6		3.5				3.5	

3.Power Factor Controllers

- Measurement and control in one or three phases
- 3 ways of operation
- Three-phase measurement and display of the following parameters: cosφ, voltage, reactive power, active power, apparent power, temperature, reactive power capacity.
- Intelligent turning on and off of the capacitors without required program
- Automatic recognition of capacitors
- Measuring and monitoring the current values of the capacitors
- 4, 6, 8, 12 and 15 degrees of regulation
- Most importantly: easy installation..

Capacitors 400/440V from 5 to 30 kVAr (1 phase and 3 phase)

Power Factor Controllers 4, 6, 8,12 and 15 steps

Contactors CNNK И CNKM from 2.5 to 75 kVAr

Reactors for 5 - 60 kVAr

MODULS FOR REACTIVE POWER COMPENSATION

- Compact modules for compensation - ideal for installation in all standard distribution boards
- Up to 100 kVAr
- Easy increase of the reactive power compensation unit capacity

Electrical cabinets for reactive power compensation up to 600 kVAr

CONSTRUCTION OF THE ELECTRICAL CABINETS

The electrical cabinets have a metal case, they are prepared for a standing mounting position with a low voltage switches MCCB built-in as a standard mode.

We make:

AUTOMATIC POWER FACTOR CORRECTION UNIT FROM 15 TO 65 kVAr

AUTOMATIC POWER FACTOR CORRECTION UNIT FROM 70 TO 160 kVAr

RADE KONČAR
KONTAKTORI I RELEI D.O.O.

1000 - Skopje, Macedonia
III Makedonska brigada br. 54
Tel./Fax ++389 (0)2/ 2461 106; 2463 620;
2465 586; 2463 596
E-mail: marketing@radekoncar.com.mk
E-mail: export@radekoncar.com.mk
http: //www.radekoncar.eu

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AUTOMATIC POWER FACTOR CORRECTION UNIT FROM 165 TO 300 kVAr

AUTOMATIC POWER FACTOR CORRECTION UNIT FROM 350 TO 600 kVAr

Type	Power (kvar)	Dimensions HxWxD (mm)
AKRE	15 - 65	900x600x280
AKRE	70 - 160	1200x700x300
AKRE	165 - 300	2150x680x430
AKRE	325 - 420	2150x900x430
AKRE	450 - 660	2150x1400x430

WITH REACTORS "5H" - 183Hz P = 7%		
AKRE	do 75	1450x850x360
AKRE	80 - 200	1950x850x520
AKRE	225 - 375	2270x1200x600
AKRE	400 - 660	2270x1600x600

Technical data:
Rated Voltage: 400V, 50Hz; 3; Regulation Voltage: 230V, 50Hz
Tolerance: 1,1 x Un & 1,3 x Ie
Mechanical protection: IP 20

H - Height, W - Width, D - Depth

BENEFITS OF REACTIVE POWER COMPENSATION

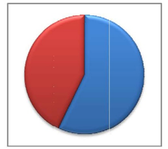
BENEFITS BY IMPROVING COSφ

BENEFITS TO THE ELECTRIC POWER SYSTEM

- Improved efficiency of the whole electric power system through the reduction of losses in electric power system
- For the same volume of energy consumption, reduced volume production, reduced emission of CO2 gases, reduced barren in the production of energy in power plants
- Gaining KVA in the system
- Reduction of losses in the distributive transformers and lines
- Lower voltage drop in long distributive conductors, thus improving the electric power system stability.
- Lower heating in the conductors, which continues the service life of the conductors insulation.
- Lower heating of electrical engines, transformers and other electrical appliances which extents their service life.

Example:

For electro motor of P=10kW (from the above mentioned example), the current that flows because of the active component is 25A, and because of the reactive component 18.75A. Through the cable flows total 43.75A, which directly causes increase of the general loses in the cable (heating of the cable). As consequence of the heating of the cable, which causes increase of the resistance, the increased voltage fall is generated that rises with the length of the cable.



cosφ = 0.8

cosφ = 1

Occupation of cable capacity

ECONOMICAL BENEFITS OF THE POWER FACTOR COMPENSATION

- The allowed cosφ in R. Macedonia is >0.95. All of the consumers that have cosφ lower than 0.95, pay for the reactive energy to the Electrical Distribution in RM.
- The term 'consumers' refers to: all electromotor plants, supermarkets, hotels, hospitals, banks, schools…
- With a quality installed reactive energy compensation, the cosφ improves in the limits where the reactive energy consumption is permitted and it is not being charged.
-The experience show that the whole investment pays back for a period of 8 to 12 months.

RADE KONČAR kontaktori i relei

AUTOMATIC POWER FACTOR CORRECTION UNIT

Type: AKRE