Power Factor Calculations.

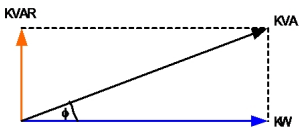
Power factor is the ratio between the KW and the KVA drawn by an electrical load where the KW is the actual load power and the KVA is the apparent load power. It is a measure of how effectively the current is being converted into useful work output and more particularly is a good indicator of the effect of the load current on the efficiency of the supply system.

There are two types of power factor, displacement power factor and distortion power factor. Only displacement power factor can be corrected by the addition of capacitors.

Displacement Power factor.

The Line Current comprises two components of current, a real component indicating work current, and a reactive component which is 90 degrees out of phase. The reactive current indicates either inductive or capacitive current and does not do any work. The Real current, or in phase current, generates Power (KW) in the load and reactive current does not generate power in the load. The effect of the reactive curent is measured in KVARs. The composite line current is measured in KVA.
The vectors can be represented as two equivilant triangles, one triangle being the real current, the reactive current and the composite (line) current. The cosine of the angle between the line current phasor and the real current represents the power factor.
The second identical triangle is made up of the KW KVA and KVAR vectors.

For a given power factor and KVA (line current) the KVAR (reactive current) can be calculated as the KVA times the sine of the angle between the KVA and KW.



Three phase calculations:

KVA = Line Current x Line Voltage x sqrt(3) / 1000
KVA = I x V x 1.732 / 1000
KW = True Power
pf = Power Factor = Cos(Ø)

KW = KVA x pf = V x I x sqrt(3) x pf
KVAR = KVA x Sine(Ø) = KVA x sqrt(1 -pf x pf)

Single phase calculations:

KVA = Line Current x phase Voltage /1000
KVA = I x V / 1000
KW = True Power
pf = Power Factor = Cos(Ø)

KW = KVA x pf = V x I x sqrt(3) x pf
KVAR = KVA x Sine(Ø) = KVA x sqrt(1 -pf x pf)

To calculate the correction to correct a load to unity, measure the KVA and the displacement power factor, calculate the KVAR as above and you have the required correcion.

To calculate the correction from a known pf to a target pf, first calculate the KVAR in the load at the known power factor, than calculate the KVAR in the load for the target power factor and the required correction is the difference between the two. i.e.

Measured Load Conditions:
KVA = 560
pf = 0.55

Target pf = 0.95

(1) KVAR = KVA x sqrt(1 - pf x pf) = 560 x sqrt(1 - 0.55 x 0.55)
= 560 x 0.835
= 467.7 KVAR

(2) KVAR = KVA x sqrt(1 - pf x pf) = 560 x sqrt(1 - 0.95 x 0.95)
= 560 x 0.3122
= 174.86 KVAR

(3) Correction required to correct from 0.55 to 0.95 is (1) - (2)
= 292.8 KVAR (= 300 KVAR)

To calculate the reduction in line current or KVA by the addition of power factor correction for a known initial KVA and power factor and a target power factor, we first calculate the KW from the known KVA and power factor. From that KW and the target power factor, we can calculate the new KVA (or line current). i.e.

Initial KVA = 560
Initial pf = 0.55
Target pf = 0.95

(1) KW = KVA x pf = 560 x 0.55 = 308 KW
(2) KVA = KW / pf = 308 / 0.95 = 324 KVA
=> KVA reduction from 560 KVA to 324 KVA
=> Current reduction to 57% (43% reduction)