WYANDOTTE MUNICIPAL SERVICES

INTRODUCTION TO POWER FACTOR

Your hometown community-owned services provider *Revision September 15, 2004*

Low Power Factor in your facility can increase your electricity costs, reduce electrical distribution capacity, cause sluggish motor performance and increase the frequency of voltage drops. That's why it is important to understand what power factor is and what you can do to improve it.

WHAT IS POWER FACTOR?

Power factor is an energy concept that is related to power flow in electrical systems. To understand power factor, it is helpful to understand three different types of power in electrical systems.

- **Real Power** is the power that is actually converted into useful work for creating heat, light and motion. Real power is measured in kilowatts (kW) and is totalized by the electric billing meter in kilowatt-hours (kWH). An example of real power is the useful work that directly turns the shaft of a motor.
- **Reactive Power** is the power used to sustain the electromagnetic field in inductive and capacitive equipment. It is the non-working power component. Reactive power is measured in kilovolt-amperes reactive (kVAR). Reactive power does not appear on the customer billing statement.
- **Total Power** or Apparent power is the combination of real power and reactive power. Total power is measured in kilovolt-amperes (kVA) and is totalized by the electric billing meter in kilovolt-ampere-hours (kVAH). Wyandotte Municipal Service provides generation, transmission and distribution capacity to supply both real and reactive power to all its customers.

Power factor (PF) is defined as the ratio of real power to total power, and is expressed as a percentage (%).

$$PF = \frac{\textbf{Real Power (kWH)}}{\textbf{Total Power (kVAH)}} \times 100$$

POWER FACTOR AND ELECTRICAL LOADS

In general, electrical systems are made up of three components: resistors, inductors and capacitors. Inductive equipment requires an electromagnetic field to operate. Because of this, inductive loads require both real and reactive power to operate. The power factor of inductive loads is referred to as lagging, or less than 100%, based upon our power factor ratio.

In most commercial and industrial facilities, a majority of the electrical equipment acts as a resistor or an inductor. Resistive loads include incandescent lights, baseboard heaters and cooking ovens. Inductive loads include fluorescent lights, AC induction motors, arc welders and transformers.

Typical average power factor values for some inductive loads:

Load	PF %
Induction Motor	70-90
Small Adjustable Speed Drive	90-98
Fluorescent Lights	
Magnetic Ballast	70-80
Electronic Ballast	90-95
Arc Welders	35-80

Capacitors also require reactive power to operate. However, capacitors and inductors have an opposite affect on reactive power. The power factor for capacitors are leading. Therefore capacitors are installed to counteract the effect of reactive power used by inductive equipment.

HOW DOES WYANDOTTE MUNICIPAL SERVICES MEASURE POWER FACTOR?

For billing purposes, an average power factor is used for the monthly billing period. To understand the energy terms used on your billing statement, it is helpful to understand the following key electrical principals.

- Real Power is measured by the electric billing meter in kilowatt-hours (kWH), which is the totalization of real power (kW) used over a time period of hours.
- Total Power is measured by the electric billing meter in kilovolt-ampere-hours (kVAH), which is the totalization of total power (kVA) over a time period of hours.

Baseboard Heating Example

For a baseboard heater that is rated at 1 kilowatt to run for an entire month (30 days x 24 hours per day = 720 hours), the real power measured would be the following:

1 kW x 720 hours = 720 kWH

Because the baseboard heater is a resistive load, the total power measured by the billing meter could be 720 kVAH.

PF = 720 kWH / 720kVAH x 100

PF = 100%

Motor Example

For a motor that is rated at 5 kilowatts to run for 200 hours, the real power measured would be the following:

5 kW x 200 hours = 1,000 kWH

Because the motor is an inductive load, the total power measured by the billing meter could be 1,400 kVAH.

PF = 1,000 kWH/1,400 kVAH x 100

PF = 71.4%

HOW IS YOUR BILL ADJUSTED FOR LOW POWER FACTOR?

A power factor of 90% or greater will not have an adjustment made to the billing demand (kW). A power factor of less than 90% will result in additional demand charges in the form of a power factor correction incentive.

Power Factor correction incentive formula:

1 + (90% - PF%) x Demand (kW)

Power Factor Correction Incentive Example

A customer's meter measures a consumption of 10,000 kWH Real Power, 12,000 kVAH Total Power and has a demand of 10 kW for the month.

The power factor is calculated by:

PF = 10,000 kWH / 12,000 kVAH * 100

PF = 83.33%

Because the power factor is less than 90%, the power factor correction incentive is calculated by:

Demand =1+(.90-.833)*10 kW

Demand = 10.67 kW

This example shows the customer paying an additional .67 kW demand charge on their utility statement, due to a power factor less than 90%.

For additional questions about power factor, please contact a WMS representative at (734) 324-7190.