BASIC ELECTRICITY TROUBLESHOOTING FOR L&L KILNS

BASIC ELECTRICITY

OHMS LAW: AMPS, VOLTS, OHMS, AND WATTS

Ohms Law governs electricity. It provides formulas that show the mathematical relationships inherent in the nature of the phenomenon we call electricity.

ELECTRICITY IS ANALOGOUS TO WATER

Electricity is easiest to understand when compared to water flow and pressure. As far as your kiln is concerned, its supply of electricity is like a huge reservoir of water. Imagine that a kiln is like a bucket with small holes for the water to leak out of (which would represent the heat loss of the kiln). Imagine that the water flowing into the bucket is like electricity. To fill two different sized buckets with the same porosity (i.e. same number of small holes per square inch which would be like the standard heat loss in firebrick) you will need different flow rates of water. If you turn on the small 2.6 cubic foot model J18, electricity will flow into the kiln at one particular rate, measurable in "watts" per hour (actually Kilowatts per hour, or kWh, 1000 watts = 1 kWh). If you turn on L&L's largest kiln, the 34.5 cubic foot model T3445, electricity will flow into it at a much greater rate, still measurable in watts per hour. Likewise the larger bucket needs more gallons per hour than the smaller bucket not only to get filled at the same speed but to get filled up at all (because of the porosity). This analogy can help you to understand why it takes longer or might even be impossible for some kilns to heat up to very high temperatures. Note that the heat loss gets greater as the kiln gets hotter so it takes more and more electricity to heat a kiln the hotter it gets. It is like the porosity increasing over time as you fill up the bucket in the above analogy.

AMPS (AMPERES) = FLOW

If the volume of water can be measured in gallons per second, then the volume of electricity flowing is measured in "amps", a particular amount of electrons flowing through a wire in one second.

VOLTS (VOLTAGE) = PRESSURE

Water is forced through the pipes by water pressure. A water tank at the top of a hill will provide you with more water pressure than a water tank only half-way up the hill. Electricity is forced through the wires by electrical pressure, called volts. A 12 volt battery is like the lower water tank: there is not much voltage to push the electrons along the wire. A 120 volt house power source is like the higher water tank, pushing a much greater volume of electricity (many more amps) down the same diameter wire than the 12 volt source.

OHMS (RESISTANCE) = RESISTANCE TO FLOW

Say your house in the valley is somehow fed by both of these two water tanks. Sink number one has water from the top-of-the-hill water tank flowing to it. Sink number two, which is right next to sink number one, has water from the half-way-up-the-hill water tank flowing to it. Sink number one will have much greater water pressure and much more water coming from it than sink number two (assuming the same size orifice in the faucet). To get them to flow at the same rate, you must use a smaller diameter pipe to connect the water to sink number one than the pipe connecting the water to sink number two. By restricting the heavier flow of water with a smaller pipe, you can make the same amount of water come out of each sink. Electricity can be restricted (or "resisted") as well. A small diameter wire can resist electricity like the smaller pipe resisted the water. In the same way that a large pipe will let more water through than a small pipe, a thick wire will have less resistance and will allow more electricity through than a thin wire. A short wire will have less resistance and let more electricity through than a long wire. This amount of electrical resistance can be measured in terms of "ohms". The higher the number of ohms, the higher the resistance of the circuit.

WATTS (POWER) = WORK

In the same way that the combination of water pressure and the actual water itself (measured in gallons per second) comes together to perform "work", the combination of voltage (pressure) and amps (volume) comes together to perform "work" as well. This electrical work is measured by multiplying the values of the volts and the amps together. The result is called "watts". Watts are a measurement of the work done by electricity.

MATHEMATICAL RELATIONSHIPS (FORMULAS)

For use with single phase only:

The electrical industry has designated letters to stand for amps, volts, ohms, and watts.

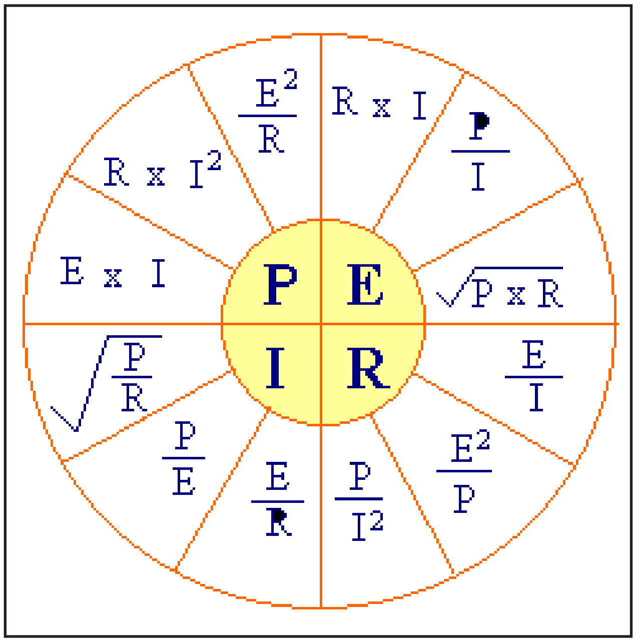
Amps = "I" (think "intensity of amperage")

Volts = "E" (think "energy")

Ohms = "R" (think "resistance") (Ω is the symbol used to indicate ohms)

Watts = "P" (think "power")

Ohms Law in diagram form.



WHERE YOU CAN GET MORE INFORMATION ABOUT ELECTRICITY

www.hotkilns.com/volts.pdf
www.elec-toolbox.com

SINGLE PHASE POWER

Like voltage, the phase is specific to each location. The huge electrical lines you see across the country use three "hot" lines, what is termed "three phase", with 1000's of volts running through them. From these three "hot" lines any two can be tapped (eventually, after stepping down the voltage through transformers) to provide power for any single phase circuit. To use a small electrical appliance as an example, if you trace the two wires that make up the cord for the appliance back through the lines you will eventually end up at two of the three wires from some main power line, and from there back to the generating plant. Often the power for a residential area is all single phase, from a junction station to a single house in the neighborhood. There may be no way for three phase power to be obtained without the equipment (mainly the extra line) in place. Industrial areas, large facilities, and schools usually have access to three phase power. Even then, sometimes the three phase ends at the main junction box in the building and the single phase power supplies branch out from there.

THREE PHASE POWER

Three phase power uses three "hot" wires to supply electricity to the circuit. From the main power supply, the three lines remain three lines all the way through to the circuit. The same amount of electricity is simply split over three wires instead of two. The benefit of three phase is not a lower electric bill, since the kilowatts used are still the same. The benefit is in the cost of setting up the supply line itself. For example, a model T3427 208 volt in single phase draws 119.88 amps. It will need two "2/0" awg wires to supply it with power. The circuit breaker would need to be a two pole, 150 amp breaker, and any safety switches would need to be rated for at least 150 amps, if not more. That same kiln in three phase will draw 69.21 amps. It would only need three 2 awg wires to supply it with power. The circuit breaker would only need to be a three pole, 90 amp breaker, and any safety switches would only need a 90 or more amp rating. The cost of material and components for creating electrical lines are expensive. This cost increases exponentially with the size of the service. A 2/0 awg wire costs considerably more per foot than a 2 awg wire. The size of the conduit that houses the wires costs more as the diameter increases. A 150 amp circuit breaker is large and has a heavy protective housing. It has mechanical arms to provide leverage and physically move the electrical contacts together or apart. A 90 amp breaker is more familiar looking, with its plastic switching arm and the way it sits side-by-side with the other breakers in the box. The total cost (especially if power needs to be run for some distance) is much less for three phase than for single phase. The cost for another wire in the three phase is almost always offset by the potentially vast difference in total cost between installing single and three phase.

SERIES CIRCUITS

A circuit that only has one path over which current can flow is a series circuit. A break in any part of a series circuit stops current flow. All components in a series circuit see the same amount of current; therefore, each component must be capable of carrying that number of amperes.

RULES FOR SERIES CIRCUITS

1) The value of a current flowing in a series circuit is the same through all parts of the circuit.

2) The total voltage of a series circuit is equal to the sum of the voltages across each part of the circuit.

3) The total resistance of a series circuit is equal to the sum of the resistances across each part of the circuit.

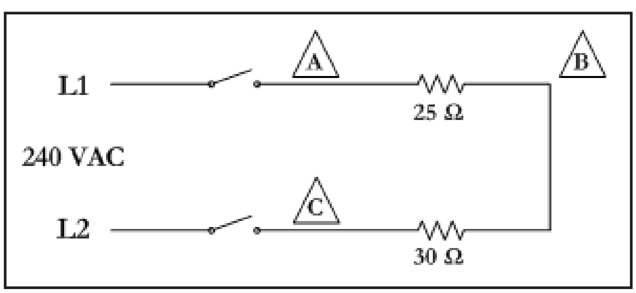
4) Line voltage is divided across each component in a series circuit in proportion to the component resistance values. Referring to the schematic below, the total resistance is (25Ω + 30Ω = 55Ω). Voltage measured between points A and B is:

240 x (25Ω/55Ω) = 109 Volts.

Voltage measured between points B and C is:

240 x (33Ω/55Ω) = 144 Volts.

Series circuit.



If there were (2) resistances whose values were equal, the voltage would be divided equally in half, and would measure 120 Volts.

MEASURING RESISTANCE IN SERIES CIRCUITS

The total resistance of the circuit is the sum of all individual resistances.

PARALLEL CIRCUITS

A circuit that has two or more current paths is a parallel circuit. Each component is connected to line voltage, and current still flows through part of the circuit if one component fails. Each component must be capable of withstanding line voltage. The number of amperes varies according to the resistance of the component.

The more circuit paths, the less opposition to the flow of electrons. Total circuit resistance decreases when more paths are added.

RULES FOR PARALLEL CIRCUITS

1) The total current supplied to a parallel circuit is equal to the sum of the currents through the branches.

2) The voltage across any branch of a parallel circuit is equal to the supply voltage.

3) The total resistance of a parallel circuit is always less than the resistance of any of the branches.

4) The following parallel circuit is typical of the DaVinci, Doll and J2900 kiln rings; there are (3) elements per ring, connected in parallel.

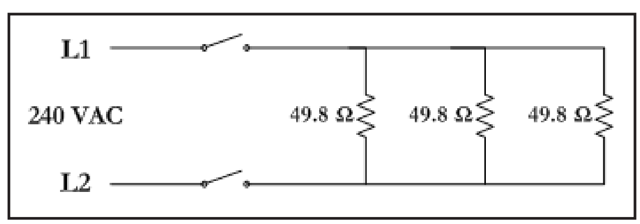
In this example, each element has a resistance of 49.8Ω. At 240 VAC, each element develops

(240 VAC/49.8Ω) = 4.82 Amperes

The total circuit amperes, then, is

4.82 + 4.82 + 4.82 = 14.46 Amperes.

Parallel ircuit.



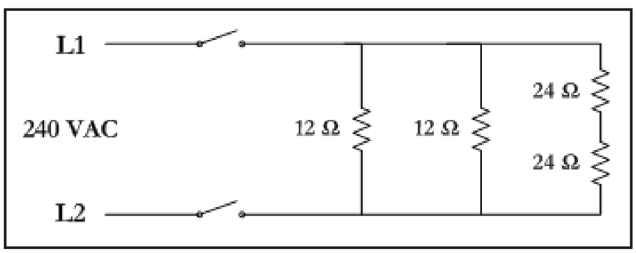
MEASURING RESISTANCE IN PARALLEL CIRCUITS

The total resistance is always less than the lowest reading of a single element. Often this is difficult to measure if all the elements in the circuit are connected to two points with no way to isolate them. If they are known to all have the same resistance then you can multiply the number of elements by the resistance value of the entire circuit to get one element's approximate resistance. If the elements in the circuit have different resistances, like in B model kilns, there is no easy way to determine the individual resistances of the elements. The best way to solve an element problem with these kilns is to replace all the elements in the troublesome circuit

SERIES/PARALLEL or COMBINATION CIRCUITS

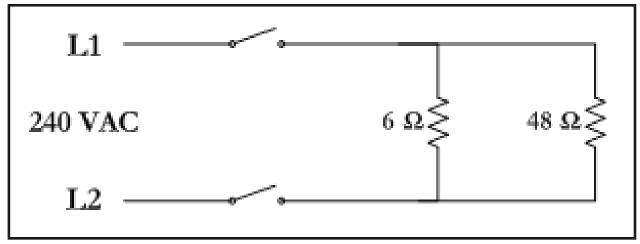
Certain circumstances require the use of Series/Parallel, or Combination, circuits, in which series and parallel circuits are combined. In some front-loading industrial furnaces these circuits are used to combine, for instance, sidewall heating elements and backwall heating elements (often shorter than sidewall) in a branch circuit that is controlled by a power relay.

Series/Parallel circuit.



In the above example, the total resistance can be found by first dealing with each branch circuit individually. Starting from the right, this circuit is a series circuit; add the (24Ω + 24Ω = 48Ω). The other two circuits are parallel and are equal in value (12ΩW each); therefore, the resistance value of these two circuits is equal to (12Ω/2 = 6Ω). Drawing an equivalent circuit with (2) parallel circuits, one of 6Ω and one of 48Ω, looks like the following:

Series/Parallel circuit simplified.



Solving for this circuit:

R = (6Ω x 48Ω) / (6Ω x 48Ω) = 5.33Ω.

The total resistance is lower than that for any of the branch circuits.