Single-Phase Frigitek® Calculations and Factors explained – Page 1

1) Motor Type and Power Factor – The Power Factor is a measure of how effectively the motor uses electricity (similar to, but not the same as efficiency). Different types of motors have different Power Factors. Selecting the motor type automatically selects the correct Power Factor. The three motor type selections are (S)haded Pole Motor, (C)apacitor-run Motor and (E)CM (Electronically Commutated Motor). The Shaded-Pole motor is the most commonly used in walk-in refrigerators and freezers.

2) Compressor Type – Typically compressors use three-phase motors, for their increased efficiency. However, in smaller systems, or in facilities without three-phase power, less efficient single-phase motors may be used (either 120V or 240V). If you can't tell which type it is, use the (T)hree-phase designator.

3) Electricity Cost per kWh – This is the customer's cost of electricity. It should be determined from a recent electric bill, by dividing the total billing amount by the number of kilowatt-hours listed on the bill. This will then take into account all of the fees and taxes which add to the basic cost of the electricity used.

4) Normal Duty Cycle - The "Duty Cycle" is the percentage of time this room is being actively cooled. (Note that it does not necessarily directly relate to compressor run time.) We have found, after hundreds of installations, that this is typically 40%. This is the number which should be used in the calculations, unless a test has been made to determine that the duty cycle for this room is different.

5) Operation Time Factor – This factor allows an adjustment for the amount of time the system is actually in operation during the year. Some refrigerators are only used seasonally, as in the case where vegetables are harvested and stored for a short time before delivery to customers or processors. Normally, this factor is left at 100, but, if a refrigerator is used less, the number may be adjusted.

6) Frigitek Duty Cycle – The refrigeration system duty cycle under Frigitek operation is reduced because of the reduced heat injected into the cooled chamber. This reduced Duty Cycle is used in calculating the Frigitek savings. The Duty Cycle reduction is different for the different motor types, and is 20% for Shaded-pole, 15% for Capacitor, and 25% for ECM motors.

7) Total Fan Motor Watts – This is the *Fan Voltage* times the total motor amps, times the *Power Factor*.

8) Total Frigitek Savings – This is the sum of the evaporator fan savings, the compressor savings and the condenser fan savings, presented in KwH and dollars per month and per year.

9) Payback Time – This is the *Total Cost* divided by the *Total Frigitek Dollar Savings* per month to determine the number of months of savings required to repay the cost of installing the Frigitek.

10) Before Frigitek - Full-time High Speed Fan Cost – This is the current average monthly and yearly cost of the fans in the evaporator. It is calculated by multiplying the *Electricity Cost per KwH* by the *Fan Motors KwH/Mo* and the *Operation time factor*. It does not include compressor operating costs.

11) With Frigitek - Fan Power Reduction Factor – This is the factor by which the Frigitek reduces fan motor power and heat when it operates the fans at low speed. For shaded-pole motors, the factor is 80%; for capacitor-run motors, the factor is 72%; and for ECM motors, the factor is 95%, all determined by tests in ECE's motor laboratory.

12) With Frigitek - Fan High Speed Cost – This is determined by multiplying the *Full-time High Speed Fan Cost* by the *Frigitek Duty Cycle*. With the Frigitek, the fans will be at high speed only during the time the refrigerator is actively cooling.

Single-Phase Frigitek® Calculations and Factors explained – Page 2

13) With Frigitek - Fan Low Speed Cost – This is determined by multiplying by the *Full-time High Speed Fan Cost* by the inverse of the *Frigitek Duty Cycle,* (the time the refrigeration system is not actively cooling the room), to determine the low-speed cost under Frigitek control, and then multiplying by the inverse of the *Frigitek Power Reduction Factor* (for the low-speed power usage).

14) With Frigitek - Fan Dollar Savings - The *Full-time High Speed Fan Cost* minus *Total Fan Cost with Frigitek.*

15) Compressor Cost Reduction - Fan Power Reduction – All the electrical power used by the fans actually ends up as heat inside the refrigerator, which must then be removed by the compressor. This number is the amount of power which is no longer injected into the refrigerator when the Frigitek is operating. It is determined by multiplying the *Total Fan Motor Watts* times the inverse of the *Frigitek Duty Cycle* times the *Operation time factor*, times the *Frigitek Power Reduction Factor*.

16) Heat Transfer Factor – The Heat Transfer Factor is the amount of heat that the refrigeration system can transfer per compressor horsepower. This factor allows accurate calculation of the electrical energy used in the transfer of a given amount of heat. Although many references place this number at 12,600 BTU/Hp, operating refrigeration systems usually have lower efficiencies, because of factors such as ambient temperature, piping runs and refrigerant charge. A practical number for this factor is 9500.

17) Compressor Cost Reduction - Fan Heat Reduction – Because the compressor uses a specific amount of electricity per BTU in its heat-transfer function, we convert the power reduction to BTU for the subsequent calculations. This number is determined by multiplying the *Fan Power Reduction* by the Kw-BTU conversion factor of 3412.1 Btu/Kw.

18) Compressor Kw/Hp – This factor allows accurate calculation of energy cost per BTU transferred for different types of compressor motors. Single-phase compressors typically use about 1.55 Kw/Hp, being about 50% efficient. Three-phase compressors are typically about 60% efficient, and use about 1.36 Kw/Hp. These numbers also take into account the start-up surge power which the motors use as they are stopped and re-started during normal operation. This number is automatically determined from the "Compressor Type" entry, but may be over-ridden if desired.

19) Compressor Cost Reduction - Compressor Hp use Reduction – This is determined by dividing the *Fan Heat Reduction* by the compressor *Heat Transfer Factor*.

20) Compressor Cost Reduction - Compressor Power use Reduction – This is determined by multiplying the *Compressor Hp use Reduction* by the *Compressor Kw/Hp*.

21) Condenser Fan Savings – Because of the reduced compressor operating time, the Condenser Fan use is also reduced. This is estimated at 9% of the *Compressor Power Use Reduction*, and multiplied by the *Electricity Cost per KwH*, to determine the dollar savings attributed to the condenser fan motor.

22) Compressor Cost reduction - This is determined by multiplying the *Compressor Power Use Reduction* in KwH/Mo by the *Electricity Cost per KwH*, and adding in the *Condenser Fan Savings*.

Revision – 05/15/07