Absorption vs. Electric Chiller Technologies

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Exceeding Your Expectations
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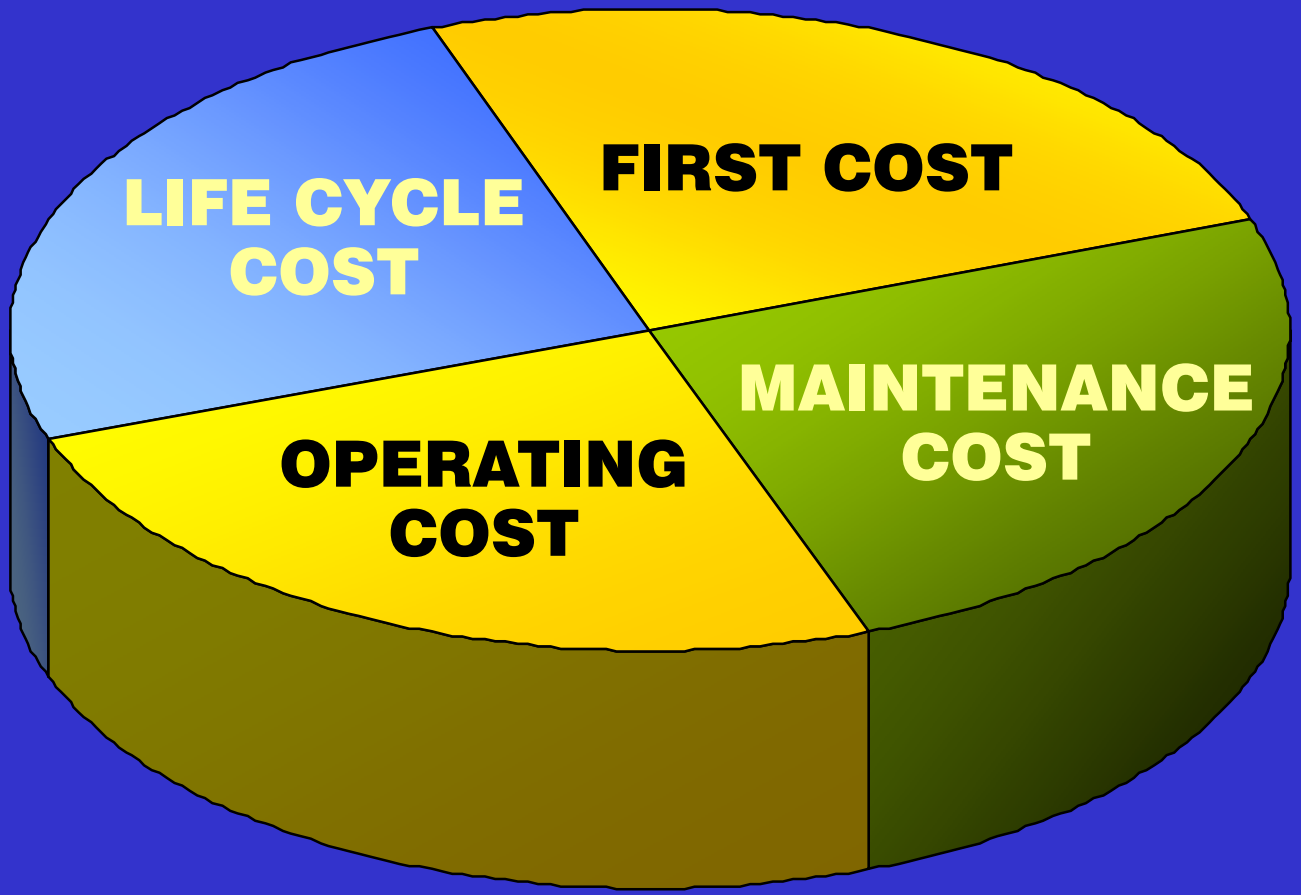
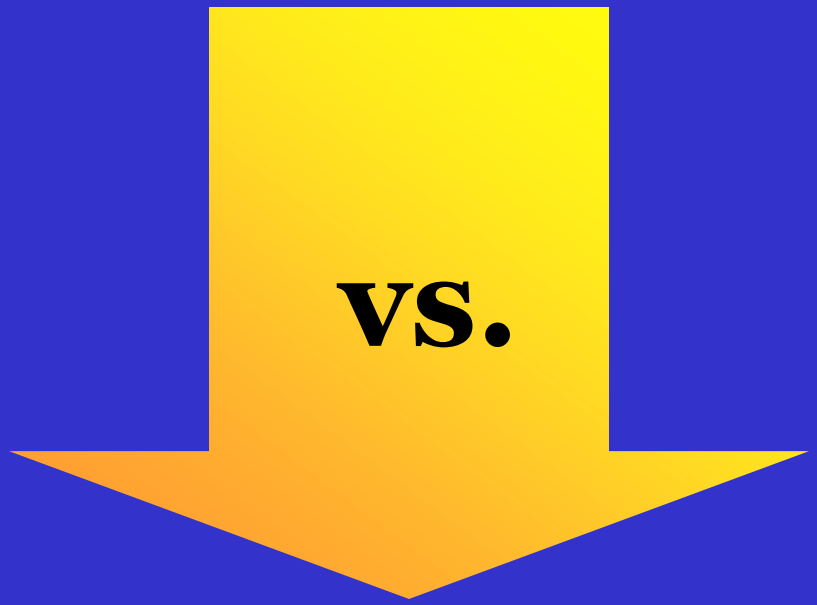
EVALUATION CRITERIA



CLIENT ATTENTION GETTER

Detailed Evaluation



Simplified Evaluation of Operating Costs

Simplified Approach Applies to the equipment only

Assuming that the auxiliary support equipment is not a major factor

Absorption vs. Electric Chillers

Chilled Water Pumps = 0

Condenser Water Pumps

Cooling Power Fans

Absorption Machine Auxiliaries

More horsepower required for absorption – but not a significant impact to the evaluation

The Simplified Evaluation is most effective for chilled water systems when comparing heat vs. electric cooling technology

Rebates & Grants From Utility Companies & Government Agencies

Simplified Version is usually not used for following technologies:

- **Rooftop**
- **PTAC (Hot Water Heating Coil)**
- **PTAC (Heat Pump)**
- **PTAC (Geothermal)**

EQUIPMENT SIZE

Determine the tonnage and select the types of electric or absorption chillers to be used in the comparison

THREE STEP APPROACH TO SIMPLIFIED EVALUATION

OCF – Operating Cost Factor

x

EF – Efficiency Factor

x

EC – Energy Cost

=

AOEC – Annual Operating Energy Cost

OPERATING COST FACTOR (OCF)

Total Full Load
Annual Operating Hours

(usually 800 to 1,000 hours)

X

Equipment Size ***(tonnage)***

EFFICIENCY FACTOR (EF)

Based on coefficient of performance (COP) from ASHRAE Standard 90.1 (energy code)

$$COP = \frac{Output}{Input}$$

Energy standard for buildings except low-rise residential buildings (Table 6.2.1C)

Water chilling packages Minimum efficiency requirements			Conversion calculation to determine the efficiency factor (EF)		
Equipment type	Size category	Minimum efficiency	COP = Output/Input		Efficiency Factor (EF)
Air cooled without condenser, electrically operated	<150 tons ≥150 tons	2.8 COP	2.8 = 12,000 Btu/4,286 Btu 3.51 kW/1.25 kW		1.25 kW/ton
Air cooled without condenser, electrically operated	All capacities	3.10 COP	3.10 = 12,000 Btu/3,871 Btu 3.51 kW/1.13 kW		1.13 kW/ton
Water cooled, electrically operated, positive displacement (reciprocating)	All capacities	4.20 COP	4.2 = 12,000 Btu/2,857 3.51 kW/0.84 kW		0.84 kW/ton
Water cooled, electrically operated, positive displacement, rotary screw and scroll	<150 tons	4.45 COP	4.45 = 12,000 Btu/2,696 kW/0.79 kW		0.79 kW/ton
	150 tons and <300 tons	4.90 COP	4.9 = 12,000 Btu/2,449 Btu 3.51 kW/0.72 kW		0.72 kW/ton
	≤300 tons	5.50 COP	5.5 = 12,000 Btu/2,182 Btu 3.51 kW/0.64 kW		0.64 kW/ton
Water cooled, electrically operated centrifugal	<150 tons	5.00 COP	5.00 = 12,000 Btu/2,400 Btu 3.51 kW/0.70 kW		0.70 kW/ton
	≥150 tons and ≥300 tons	5.55 COP	5.55 = 12,000 Btu/2,162 Btu 3.51 kW/0.63 kW		0.63 kW/ton
	≥300 tons	6.10 COP	6.10 = 12,000 Btu/1,967 Btu 3.51 kW/0.58 kW		0.58 kW/ton
Air cooled, absorption single effect	All capacities	0.60 COP	.6 = 12,000 Btu/ 20,000 Btu	20,000 Btu/ 949 Btu/lb*	21 lb stm/ton
Water-cooled, absorption single effect	All capacities	0.7 COP	.7 = 12,000 Btu/ 17.143 Btu	17,143 Btu/ 950.02 Btu/lb*	18 lb stm/ton
Absorption, double effect indirect-fired	All capacities	1.00 COP	1.00 = 12,000 Btu/ 12,000 Btu	12,000 Btu/ 880 Btu/lb**	13.7 lb stm/ton
Absorption, double effect direct-fired	All capacities	1.00 COP	12,000 Btu/100,000 Btu/therm		.12 therms/ton

* *The enthalpy value for 12 psig steam is 949 Btu/lb*
** *The enthalpy value for 100 psig steam is 880 Btu/lb*

Energy Standard for Buildings Except Low-Rise Residential Buildings (Table 6.2.1C)				
Water Chilling Packages Minimum efficiency requirements			Conversion calculation to determine the efficiency factor (EF)	
Equipment type	Size category	Minimum efficiency	COP = Output/Input or Input = Output/COP	Efficiency Factor (EF)
Water cooled, electrically operated centrifugal	≥ 300 tons	6.10 COP	Input = 12000 BTU/6.1 1967 BTU = 12000BTU/6.1 $\frac{12000\ \text{BTU}}{3415\ \text{BTU/KW}} = 3.51\ \text{KW}$ .58 KW = 3.51 KW/6.1	.58 KW/Ton
Absorption, double effect indirect-fired	All capacities	1.00 COP	12000 BTU/100000 BTU/Therm	.12 Therms/Ton

ANNUAL OPERATING ENERGY COSTS

$$\frac{\text{Therm}}{\text{KW}} = \frac{\text{100,000 BTU}}{\text{3,415 BTU}} = \text{29.28}$$

KILOWATT CHARGE MUST BE MULTIPLIED BY 29.28 IN ORDER TO COMPARE IT TO THE THERM COST

$$\frac{\text{29.28 KW}}{\text{Therm}} \times \frac{\text{\$0.12}}{\text{KW}} = \frac{\text{\$3.51}}{\text{Therm}}$$

GAS VS. ELECTRIC UTILITY RATE COMPARISON RATE SCHEDULE

Electric x 29.28 = Gas

$/KWH	$/Therm
$0.03	$0.88
$0.04	$1.17
$0.05	$1.46
$0.06	$1.76
$0.07	$2.05
$0.10	$2.93
$0.12	$3.51
$0.14	$4.10
$0.16	$4.68

ENERGY COSTS (EC)

GAS - $/Therm

Electric - $/KWH

Steam - $/1,000 lb of Steam (high temperature hot water)

DETERMINATION OF "EC" FOR GAS AND ELECTRIC

$$\frac{\text{Total Monthly Utility Bill (\$)}}{\text{Total Therms or KWH's}} = \frac{\text{(\$)}}{\text{Therm or KWH}}$$

DETERMINATION OF "EC" FOR STEAM

As of October 29, 2007

$$\frac{\$10.00}{1000 \text{ lbs. Steam}}$$

GAS-FIRED DOUBLE EFFECT ABSORPTION MACHINE

$$EF_{(INPUT)} = \frac{OUTPUT}{COP} \times \text{CONVERSION UNITS FACTOR}$$

$$EF = \frac{12{,}000\ BTU}{1.0} \times \frac{Therms}{100{,}000\ BTU}$$

$$EF = .12\ Therms/Ton = 12{,}000\ BTU/Ton$$

EF FOR A 300 TON OR LARGER ELECTRIC CENTRIFUGAL

$$EF_{(INPUT)} = \frac{OUTPUT}{COP} \times \text{CONVERSION UNITS FACTOR}$$

$$EF = \frac{12{,}000\ BTU/Ton}{6.1} \times \frac{1\ KW}{3{,}415\ BTU}$$

$$EF = .58\ KW/Ton$$

AOEC FOR ELECTRIC CENTRIFUGAL

$$300 \text{ Tons} \times \frac{.58 \text{ KW}}{\text{Ton}} \times \frac{\$0.20}{\text{KW}} \times 1{,}000 \text{ Hours}$$

$$= \$34{,}800$$

AOEC FOR ABSORPTION MACHINE

$$300 \text{ Tons} \times \frac{.12 \text{ Therms}}{\text{Ton}} \times \frac{\$1.50}{\text{Therm}} \times 1{,}000 \text{ Hours}$$

$$= \$54{,}000$$

For this example only:

Choose an electric centrifugal chiller

- **Lower First Cost**
- **Lower Operating Cost**
- **Lower Maintenance Cost**
- **Smaller Footprint**
- **Excellent Part Load Performance**
- **Licensed boiler operators**

For this example only:

Reasons not to choose an electric centrifugal chiller:

- **Electric service a problem**
- **Electric service costs**
- **Summer Steam plant operation**
- **Prefer absorption machines**
- **Steam turbine driven centrifugal**
- **Screw versus centrifugal**
- **Licensed refrigeration operators**