

The world of Mini Chillers and Heat Pump Solutions by YORK®

Trusted in the world's most prestigious buildings for over 145 years





YORK[®]: The power behind **your mission**

When you have critical applications to be cooled or heated, you can count on efficient, reliable cooling and heating solutions provided by YORK[®] to lower cost and maximize uptime. You can have a peace of mind knowing that Johnson Controls has the largest service and preventive maintenance support in the world.

YORK[®] systems enable appreciable savings in primary energy use which results in reduction of operating costs. Various Industrial applications and comfort cooling requirements often require simultaneous cooling and heating. With very high coefficient of performance (COP) can help you leverage YORK[®] solutions for more operation cost savings, reliability and uptime.

Multiple Applications, One Solution



Life Science



Food & Beverage



Process Industries



Healthcare



Education



Comfort Cooling and Heating



Office buildings



Shopping Malls



Entertainment & Leisure

YORK® YVAG Air-Cooled DC Inverter Scroll Chiller

High efficiency:

Part-load performances meet the highest efficiency values and deliver performance beyond typical efficiency levels in cooling and heating. It uses a high-efficiency DC inverter compressor together with advanced variable frequency drive technology. Compressor frequency range goes from 15-120 percent to quickly and efficiently meet the needs of building or process load changes. It uses dual fans equipped with high-efficiency, low-noise DC inverter motor which adjusts the air flow to exactly match the capacity in a more accurate and efficient way.

Easy installation and operation:

- **Modular concept:** The small packaged YORK® YVAG heat pump comes as standard with a hydronic loop circulating pump, expansion tank, water flow switch, safety valve, fill valve, and wye strainer, saving space in the room and making installations easy and fast. The units are designed for modular installations (up to four module combinations among all the models). This permits installed capacities from 11.2-160kW.
- **Perfect comfort in a wide operating range:** Wide operating envelope with lower sound levels. With its wide operating range, the YORK® YVAG is perfect for all



climates. It does not matter if the ambient temperature in summer is 48°C or if in winter is -27°C, as the unit will maintain the efficiency in stable operation. With heating outlet water temperatures up to 58°C, the unit is perfect for radiant panels.

- **Optimized for low sound:** Thanks to the component design, the unit's sound emissions are as low as 51 dB(A) Sound Pressure at full load, reducing to as low as 40 dB(A) at part-load operation.

Take SMART control of your spaces:

Get SMART control of your environment with the YORK® YVAG system.

The highly sensitive T8610 intelligent thermostat closely monitors the actual and target temperatures of every room, instantly communicating requirements and load changes to the system and gathering data on usage requirements over time.

The YORK® YVAG system adaptively adjusts the water temperature, compressor, and water pump running state in accordance with indoor and outdoor load changes. The results? More comfortable temperatures and humidity levels as well as annual operating costs that can be reduced by up to 18 percent.

YORK® YVAG Air-Cooled DC Inverter Scroll Chiller

Technical Data:

Model			YVAG 012RSE	YVAG 014RSE	YVAG 016RSE	YVAG 018RSE	YVAG 020RSE	YVAG 022RSE	YVAG 025RSE	YVAG 028RSE	YVAG 033RSE	YVAG 040RSE	
Performance	Nominal Cooling Capacity	kW	11.2	14	15.5	18	20	22	25	28	32	40	
	Nominal Heating Capacity	kW	12.6	16.1	18	19.5	22	24	27	30	34	42	
	Sound Pressure Level	dB(A)	54	55	53	57	56	56.5	57	57	59	62	
Compressor	Type		Rotary DC Inverter					EVI DC Inverter					
	Quantity		1	1	1	1	1	1	1	1	1	1	
Air Side Heat exchanger	Fan Motor Type		Brushless DC Fan Motor										
	Fans Quantity		2	2	2	2	2	2	2	2	2	2	
	Airflow	m ³ /h	2500-6500					2500-10500					
Water Side Heat Exchanger	Type		Braze Plate Heat Exchanger										
	Pump Type		Multiple-Stage Centrifugal Pump										
	Nominal Water Flow	m ³ /h	1.95	2.41	2.67	3.30	3.44	3.78	4.30	4.82	5.50	6.36	
	Unit External Head	m	15	13	12	11	22	21	19	18	14	14	
Dimensions & Weight	Height	mm	1320					1500					1700
	Width	mm	995					2300					1300
	Depth	mm	360					400					760
	Operating Weight	kg	126	126	141	141	210	210	210	215	215	350	
Electrical	Power Supply	V/ph/Hz	220/1/50					400/3/50					

Nominal Conditions : Cooling capacities in kW given for 12/7°C water leaving temperature and 35°C ambient temperature
 Heating capacities in kW given for 40/45°C water leaving temperature and 7°C ambient temperature

YORK[®] YMAE Air-Cooled DC Inverter Scroll Chiller



High efficiency:

- **BLDC Fan:** The fan blades have been aerodynamically optimized for streamlined style to deliver extraordinarily low operation noise. The high-efficiency electronically commutated DC brushless BLDC motor regulates fan using a stepless speed method. The fan blades and motor align perfectly to deliver great low energy consumption.
- **Brazed Plate Heat Exchanger (BPHE):** A stainless steel high-efficiency BPHE ensures optimum heat transfer efficiency. This provides superior performance and longer life cycle. In addition, the cross and counter flow design supplies water to the refrigerant circuit for full heat transfer with each refrigerant system, maximizing chiller efficiency, especially under part-load operation.

- **Fin Plate Coil:** The airside heat exchanger features new corrugated fins with 7mm internal threaded copper tubes. The fins are made of hydrophilic aluminum foil to provide excellent hydrophilicity and corrosion resistance. The wave pattern design provides low airflow resistance, strengthens airflow disturbance and expands the heat transfer area. This makes for more effective heat exchange, which improves heat transfer efficiency.

Wide operating range:

YMAE has a wide operating range for full-year operation:

- **Cooling:** Operating ambient temperature from - 15°C to 48°C for superior cooling performance.
- **Heating:** Operating ambient temperature from - 27°C to 43°C for stable heating performance that caters to different customer requirements.

YORK® YMAE Air-Cooled DC Inverter Scroll Chiller

Technical Data:

Model			YMAE045XRME	YMAE065XRME
Nominal Cooling Capacity		kW	45	65
Nominal Heating Capacity		kW	46	66
Refrigerant		Type	R410A	
		Amount Injected (Kg)	9.5	13.5
Electrical Parameter	Power Supply	V/Ph/Hz	400/3/50	
Water Flow	Evaporator Side	m ³ /hr	7.7	11.2
Water Pressure Drop	Evaporator Side	kPa	45	50
Compressor	Type	/	Inverter	
	Quantity	/	1	
Fan	Fan Type	/	BLDC Fan	
	Fan Quantity	/	2	
Heat Exchanger	Evaporator Type	/	Plate Heat Exchanger	
	Condenser Type	/	Copper tubes; Hydrophilic Aluminum fins	
	Inlet / Outlet Pipe	Inch	G1-1/2' external thread	G2' external thread
	Connection Style	/	Threaded Connection	Clamp Connection
Measurements	Height	mm	1700	
	Length	mm	1300	1650
	Width	mm	760	
Unit Weight	Transportation	kg	332	410
	Operation	kg	339	413

Nominal Conditions : Rated cooling capacities in kW given for 12/7°C water-leaving temperature and 35°C dry bulb (DB) ambient temperature. Rated heating capacities in kW given for 40/45°C water-leaving temperature and 7°C DB ambient temperature.

YORK® YMAA Series Air-Cooled Inverter Scroll Chillers and Heat Pumps

The YORK® Amichi Series Air-Cooled DC Inverter Scroll Chillers and Heat Pumps have been designed to meet tomorrow's efficiency standards today. Delivering performance beyond typical chiller and heat pump efficiency levels, the YORK® Amichi Series meets or exceeds stringent regulatory requirements through an optimized combination of efficiency-enhancing technologies from YORK®.

Direct current (DC) inverter technology:

Provides variable capacity control and allows Amichi Series chiller compressors to operate more efficiently across all cooling load and ambient temperature conditions versus constant-speed chillers that use a step unloading design.

Electronically commutated (EC) fans:

Use more efficient motors and better aerodynamics to improve overall system efficiency and sound performance, particularly in part-load conditions. At reduced ambient



temperatures, the head pressure control varies fan speeds to optimize the system efficiency and ensure reliable operation. This combination of variable speed compressor and fans provides a displacement power factor as high as 0.93, lowering electricity costs.

High-efficiency brazed plate heat exchanger:

Uses less refrigerant and transfers heat from the liquid to refrigerant more efficiently, providing excellent heat transfer performance in a compact design. This also results in a lower water side pressure drop, allowing the use of smaller pumps to further minimize building power consumption.

Tandem compressor design:

Uses several circuits, which improves off-design and part-load efficiency by using the entire surface area of the heat exchanger at all conditions while also providing partial redundancy.

YORK® YMAA Series Air-Cooled DV Inverter Scroll Chillers and Heat Pumps

Technical Data:

Model			YMAA Series Chiller and YMPA Series Heat Pump								
			0045	0065	0080	0100	0130	0160	0200	0230	0260
Performance	Cooling Capacity, YMAA/YMPA Series	kW	45	60	78	99	122	159	188	222	255
	Heating Capacity, YMPA Series	kW	49	60	87	99	131	161	190	230	255
	Capacity Steps		Stepless (Inverter)								
	Sound Power Level STD / LN	dB(A)	80/75	82/77	81/77	83/79	84/80	86/82	87/82	88/83	89/84
Refrigerant	Refrigerant Circuits	#	1	1	2	2	2	3	3	4	4
		kg	9.5	12.3	8.5	9.5	11.4	9.5	11	9.5	11.4
	Refrigerant (R410A) Charge / Circuit		-	-	9.05	11	11.4	10	10.5	11	11.4
			-	-	-	-	-	10	10.5	11.4	11.4
			-	-	-	-	-	-	-	11.4	11.4
Compressor	Compressor type		DC Scroll Inverter + Scroll								
	Quantity	/	2	2	3	3	4	5	6	7	8
Air Side Heat Exchanger	Fan Motor Type		EC Motor								
	Fans Quantity	#	1	1	2	2	2	3	3	4	4
	Working Ambient Temp, Cooling Mode	°C	-18 - 48°C								
	Working Ambient Temp, Heat Mode	°C	-15 - 25°C								
Water Side Heat Exchanger	Type		Plate Heat Exchanger								
	Unit Water Volume (W Pump Kit)	l	7	10	14	16	16	27	29	32	34
	Nominal Water Flow	l/s	2.2	2.9	3.8	4.8	5.9	7.4	9.1	10.5	11.9
	Pressure Drop	kPa	30	30	28	32	36	23	29	41	38
	Working Range Water Leaving Temp. Cooling	°C	-8 - 20°C								
	Working Range Water Leaving Temp. Heating	°C	25 - 55°C								
	Water Connections Type		Victaulic								
Dimensions & Weight	Height, Base Model	mm	2440				2500				
	Width, Base Model	mm	1200				3050				
	Length, Base Model	mm	1500			2240			2240		
	Shipping Weight, Base Model	kg	605	625	919	944	1023	1895	1974	2203	2282
	Operation Weight, Base Model	kg	587	610	893	920	999	1922	2003	2235	2316
Electrical features	Voltage / Phases / Frequency	V/ph /hz	400 / 3 / 50								

YMAA : Cooling only units models.

YMPA : Air to water heat pump models.

Nominal Conditions : Cooling capacity in kW given for 7°C water leaving temperature Δt 5°C and 35°C ambient temperature
Heating Capacities in kW given for 45°C water leaving temperature and 7°C ambient temperature

YORK[®] YCAE-X Air-Cooled Scroll Chiller



Efficient design:

- **A parallel design with compressors:** When a compressor operates, the heat exchange area of the air-side heat Exchanger and the water-side heat exchanger can be fully utilized, to effectively improve unit performance, especially the part-load performance
- **A design with two refrigerant systems and an independent air duct:** The two refrigerant systems within a single module can easily achieve independent operation, lowering the fan's power consumption at part-load for improved performance
- **Multi-level energy regulation:** Up to 32 units can be connected together with a wider range of energy regulation (as much as 128 levels), which is close to stepless regulation, have a higher efficiency and a better performance in saving energy.

Reliable operation:

- **Tested by the Highly Accelerating Lifecycle Testing Lab:** Each model of the YCAE-X series has been tested in the Highly Accelerating Lifecycle Testing Lab. This test simulates various extremely harsh conditions encountered by the units under various weather conditions (e.g. wind, snow, rain, and frost). The entire year's operating conditions are simulated during a

period of 2-4 weeks to ensure the reliable operation of the units in the field.

- **The air-side heat exchanger:**
 - Unique U-shaped heat exchanger, multi-side heat transfer, and optimized wind field
 - Standard hydrophilic aluminum foil fins: for strong anti-oxidation and corrosion-resistance performance
- **Efficient stainless steel plate heat exchanger:** The stainless steel structure provides stability and reliability; the asymmetric flow field design lowers the pressure drop on the water side and improves the antifreeze performance
- **Electronic expansion valve:** The 480-step high precision electronic expansion valves are used to make intelligent adjustments to the flow of the refrigerant, ensuring that the refrigerant flow is precise, and the unit's operation pressure and temperature are optimal
- **Filter & water flow switch:**
 - The copper filter is standard to prevent dirt from entering the system, which prevents clogging
 - Provide water flow switch as standard to prevent the unit from being froze-cracked due to poor water flow

YORK® YCAE-X Air-Cooled Scroll Chiller

Technical Data:

Model			YCAE065XRME	YCAE100XRME	YCAE130XRME
Nominal Cooling Capacity		kW	65.0	100.0	130.0
Nominal Heating Capacity		kW	66.0	100.7	131.9
Refrigerant	Type		R410A		
	Amount Injected (Kg)		12.5	20	23
Electrical Parameter	Power Supply	V/Ph/Hz	400/3/50		
Water Flow	Evaporator Side	m ³ /hr	11.2	17.2	22.4
Water Pressure Drop	Evaporator Side	kPa	61	60	60
Compressor	Type	/	Scroll		
	Quantity	/	2	3	4
Heat Exchanger	Evaporator Type	/	Plate Heat Exchanger		
	Condenser Type	/	Copper tubes; Hydrophilic Aluminum fins		
	Inlet / Outlet Pipe	mm	DN50	DN65	
	Connection Style	/	Threaded Connection	Clamp Connection	
Measurements	Height	mm	1700	2420	
	Length	mm	1650	2250	
	Width	mm	775	1200	
Unit Weight	Transportation	kg	380	540	690
	Operation	kg	430	590	770

Nominal Conditions:

Cooling capacities in kW given for 12/7°C water leaving temperature and 35°C(DB) ambient temperature.

Heating capacities in kW given for 40/45°C water leaving temperature and 7°C (DB) ambient temperature.

YORK[®] YCWE-E Water-Cooled Scroll Chiller

A multiple-compressor design:

Each unit involves multiple compressors. The failure of a single unit won't affect the normal operation of another unit. This ensures reliable operation of the entire system.

Reliable configuration:

- **The R410A Scroll Compressor:** The low-pressure chamber structure is designed with crankcase in a low temperature area, and the motor is cooled by the refrigerant in the low temperature return gas, this extends the motor's life
- **Stainless steel evaporator:** The asymmetric flow field design lowers the pressure drop on the water side and improves the antifreeze performance, to ensure the stable operation of the system
- **Electronic expansion valve:** The high-precision electronic expansion valves are used to make intelligent and adaptive adjustments to the flow of the refrigerant, ensuring the flow of the refrigerant is



precise and the system's operation pressure and temperature are optimal

- **Single-piece standard efficient all-copper filter:** This can prevent dirt from entering the system, which prevents clogging
- **Single-piece standard water flow switch:** This can prevent the system from being froze-cracked due to poor water flow

Flexible configuration:

Each unit can be installed and operated separately. Multiple units can also be combined for optimal performance depending on the customer's need. Different models can be combined with up to 8 units connected.

Compact design:

The units can be moved using freight elevators to save the installation.

YORK® YCWE-E Water-Cooled Scroll Chiller

Technical Data:

Model		YCWE021XSME	YCWE032XSME	YCWE042XSME	
Nominal Cooling Capacity	kW	76.2	114.2	151.9	
Nominal Heating Capacity	kW	83.3	123.3	165.3	
Refrigerant	Type	R410A			
	Amount Injected (Kg)	12	18	28	
Electrical Parameter	Power Supply	V/Ph/Hz 400/3/50			
Water Flow	Evaporator Side	m ³ /hr	13.1	19.6	26.1
	Condenser Side	m ³ /hr	16.4	24.6	32.7
Water Pressure Drop	Evaporator Side	kPa	73	28	30
	Condenser Side	kPa	72	60	60
Compressor	Type	/	Scroll		
	Quantity	/	2	3	4
Heat Exchanger	Evaporator Type	/	Plate Heat Exchanger		
	Condenser Type	/	Efficient Shell and Tube		
	Inlet / Outlet Pipe	mm	DN50	DN65	
	Connection Style	/	Clamp Connection		
Measurements	Height	mm	1330		
	Length	mm	1480		
	Width	mm	775		
Unit Weight	Transportation	kg	380	540	690
	Operation	kg	430	590	770

Notes:

1. Each unit must be installed with a Y-shaped filter that comes with the unit at the water inlet of the evaporator.
2. The cooling water and chilled water of the unit must be softened, to prevent the heat exchanger from scaling.
3. Cooling capacities in kW given for 12°C/ 7°C chilled water entering / leaving temperature and 30°C/ 35°C cooling water entering / leaving temperature.

YORK® YLAA Air Cooled Scroll Chiller

Efficient Design

Brazed Plate Heat Exchanger (BPHE):

Stainless steel high-efficiency BPHE ensures optimum heat transfer efficiency. This provides superior performance and longer life cycle. In addition, the cross and counter flow design supplies water to the refrigerant circuit for full heat transfer with each refrigerant system, maximizing chiller efficiency, especially under part-load operation.

The R410A scroll compressor:

The low-pressure chamber structure is designed with crankcase in a low temperature area, and the motor is cooled by the refrigerant in the low temperature return gas, this extends the motor's life.

Corrosion-resistant condenser coils:

YLAA chillers use microchannel coils that have fins, tubes, and headers made with aluminum. These coils



are lightweight, robust and can avoid galvanic corrosion as a result. The coils have an integral sub cooling system to improve the performance.

Optimized Configuration

Easy and economical maintenance:

YLAA chillers use significantly less refrigerant compared to a typical chiller. For added convenience, isolation valves in the discharge and suction lines are standard. The microchannel coils are rugged and can be safely pressure-washed at up to 1500 psi, saving labor costs and simplifying maintenance cycles.

Wide range of operation:

- **Cooling:** Chilled water operation from - 12°C to 13°C for superior cooling performance.
- **Heat Recovery:** Heat Recovery operation up to 60°C for superior heating performance

YORK® YLAA Air-Cooled Scroll Chiller

Technical Data:

Model			0195HE	0221HE	0261HE	0301HE	0350HE	0391HE	0442HE	0457HE	0517HE	
Nominal Cooling Capacity		kW	199	212	249	296	344.6	380.5	427.3	456.9	520.6	
Refrigerant		Type	R410A									
		Amount Injected (Kg)	41	48	50	53	56	61	66	72	79	
Electrical Parameter	Power Supply	V/Ph/Hz	400/3/50									
Compressor	Type	/	Scroll									
	Quantity	/	5	5	6	5	4	6	5	6	6	
Fan	Fan Type	/	AC Motor Fan									
	Fan Quantity	/	4			5	6		7	8		
Heat Exchanger	Evaporator Type	/	Plate Heat Exchanger									
	Condenser Type	/	Microchannel									
	Inlet / Outlet Pipe	inch	3						4			
Measurements	Height	mm					2393					
	Length	mm	2911				3690			4807		
	Width	mm					2242					
Unit Weight	Transportation	kg	1681	1696	1818	2087	2301	2392	3294	3443	3561	
	Operation	kg	1706	1721	1851	2120	2339	2442	3343	3481	3615	

Notes:

Rating conditions at AHRI 551/591 Standard conditions with ambient temperature of 35°C and a leaving chilled water temperature of 7°C.

YORK® YGWS Water-Cooled Screw Chiller



Efficiency

- High efficiency semi-hermetic screw compressor
- Patented hybrid falling film evaporator offers excellent efficiency of heat transfer with optimized heat exchanger design and compact structure
- Step-less capacity control keeps the compressor operating efficiently at every load point

Flexibility

- Button start, easy to install and operate
- Supports remote monitoring and control via Modbus protocol
- Compact design yields a small footprint saving customer installation cost

Reliability

- Every chiller undergoes functional tests to ensure key parameters meet specific requirement
- Internal oil system provides adequate protection to the unit's compressor

Sustainability

- YGWS chiller uses environment-friendly refrigerant R134a which has no phase-out schedule under Montreal Protocol
- Patented hybrid falling film evaporator operates with less refrigerant charge

YORK® YGWS Water-Cooled Screw Chiller

Technical Data:

Model			YGWS 100	YGWS 130	YGWS 160	YGWS 175	YGWS 200	YGWS 230	YGWS 260	YGWS 300	YGWS 330
Nominal Cooling Capacity		kW	340.5	424.9	557.2	616.8	669.3	800.3	910.9	1061	1149
Refrigerant		Type	R134A								
		Amount Injected (Kg)	75	90	95	110	110	150	150	200	210
Electrical Parameter	Power Supply	V/Ph/Hz	400/3/50								
	Capacity Steps	/	Stepless								
Water Flow	Evaporator Side	m³/hr	52.6	65.6	86	95.25	103.4	123.6	140.7	162.4	177.4
	Condenser Side	m³/hr	68.5	85.3	111.6	123.6	134.1	160.5	182.3	210.2	230
Water Pressure Drop	Evaporator Side	kPa	21.5	48.7	32.9	34.1	35.6	48.4	46.9	76.2	78.6
	Condenser Side	kPa	43.6	61	51.1	58.9	57.1	74.1	73.5	44.8	45.1
Compressor	Type	/	Screw								
	Quantity	/	1								
Heat Exchanger	Type	/	Efficient Shell and Tube								
	Evaporator Inlet / Outlet Pipe	mm	125			150					
	Condenser Inlet / Outlet Pipe	mm	125			150			200		
	Connection Style	/	Victaulic Groove								
Measurements	Height	mm	1483	1492	1554	1604		1897		2003	
	Length	mm	2427	2726	2726	2749		3114		3595	
	Width	mm	1280	1280	1300	1380		1630		1680	
Unit Weight	Transportation	kg	2470	2710	3010	3210	3300	4540	4600	5410	5440
	Operation	kg	2600	2850	3190	3410	3520	4900	4990	5910	5940

Remarks:

1. Chilled liquid leaving / entering temperature 44F/54F, fouling factor 0.0001hr ft² °F / Btu.
2. Condenser liquid entering / leaving temperature 85F/94.3F, fouling factor 0.00025hr ft² °F / Btu.

HVAC – Useful formulas & Conversion

PLANT ROOM EQUIPMENT

Water Flow Measurements

$$\text{USGPM} = \text{m}^3 / \text{hr} \times 4.404$$

$$\text{USGPM} = \text{L} / \text{s} \times 15.85$$

$$\text{L} / \text{S} \times 3.6 = \text{m}^3 / \text{hr}$$

Air Flow Measurements

$$\text{CFM} = \text{L} / \text{S} \times 2.118$$

$$\text{CFM} = \text{m}^3 / \text{hr} \times 0.588$$

Pressure Measurements

$$1 \text{ bar} = 100 \text{ kPa} = 10 \text{ m water} = 14.7 \text{ PSIG}$$

$$1 \text{ kPa} = 0.1 \text{ m water column}$$

$$1 \text{ PSIG} = 2.31 \text{ feet water column}$$

Chillers

$$1 \text{ TR} = 12000 \text{ Btu} / \text{hr} = 3.516 \text{ kW}$$

$$\text{Chiller Capacity (TR)} = \frac{\text{Evaporator Flow (USGPM)} \times \text{Delta T} (^{\circ}\text{F})}{24}$$

$$\text{Coefficient Of Performance (COP)} = \frac{\text{Chiller Output (kW)}}{\text{Input energy (kW)}} = 3.516 / (\text{iKW/TR})$$

$$\text{EER} = 12 / (\text{iKW/TR}) = 3.4 \times \text{COP}$$

$$\text{IPLV} / \text{NPLV} =$$

$$1$$

$$\frac{0.01}{\text{COP at 100\%}} + \frac{0.42}{\text{COP at 75\%}} + \frac{0.45}{\text{COP at 50\%}} + \frac{0.12}{\text{COP at 25\%}}$$

Pumps

$$\text{Pressure (PSI)} = \frac{\text{Head (Feet)} \times \text{Specific Gravity}}{2.31}$$

$$\text{Horsepower (Brake)} = \frac{\text{GPM} \times \text{Head (Feet)} \times \text{Specific Gravity}}{3960 \times \text{Pump Efficiency}}$$

Affinity Law

Law 1a: Flow is proportional to shaft speed $\frac{Q_1}{Q_2} = \frac{N_1}{N_2}$

Law 1b: Pressure or head is proportional to the square of shaft speed $\frac{H_1}{H_2} = \left(\frac{N_1}{N_2}\right)^2$

Law 1c: Power is proportional to the cube of shaft speed $\frac{P_1}{P_2} = \left(\frac{N_1}{N_2}\right)^3$

Where Q = GPM, H = Head, P = BHP, N = RPM

Cooling Tower

$$\text{Heat Rejected by Machine (TR)} = \text{Evaporator Capacity (TR)} + \frac{\text{Compressor Input Power (kW)}}{3.516}$$

$$\text{Cooling Tower Approach} = \left(\text{Entering Condenser water temperature} \right) - \left(\text{Ambient Wet Bulb Temperature} \right)$$

$$\text{Cooling Tower Efficiency (\%)} = 100 \times \frac{\text{Range}}{(\text{Range} + \text{Approach})}$$

Electrical

$$1 \text{ Horsepower (HP)} = 746 \text{ Watts}$$

$$1 \text{ kW} = 3413 \text{ Btu}$$

$$\text{Power} = \text{Voltage} \times \text{Current}$$

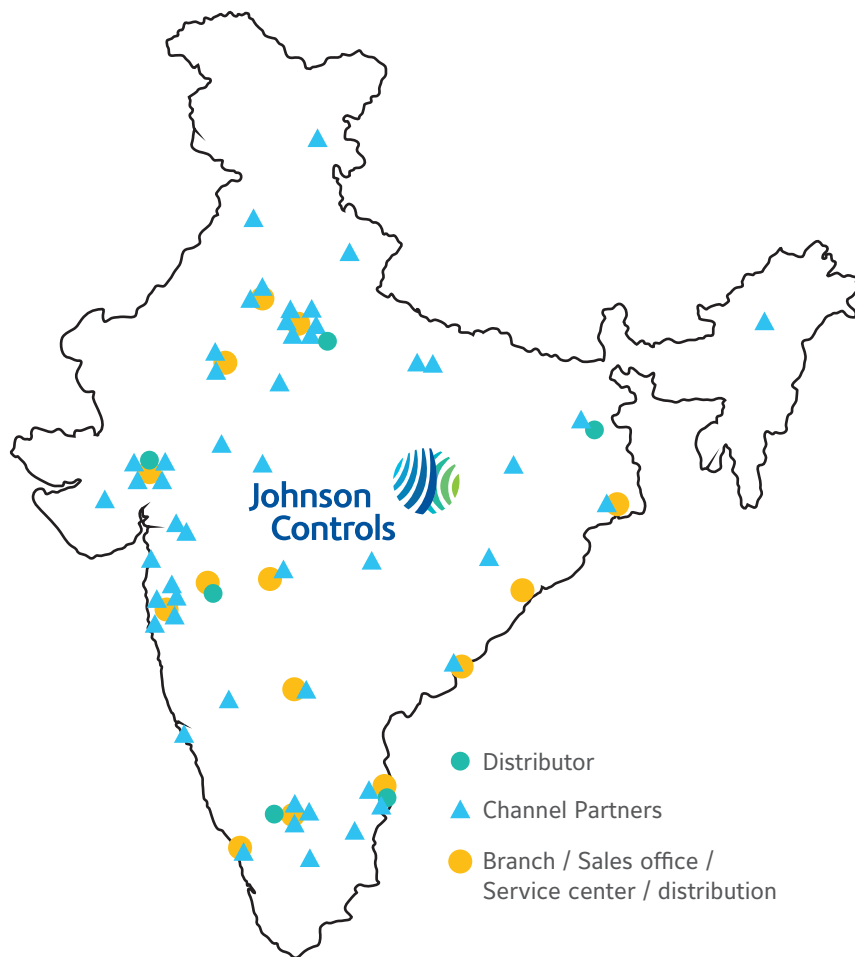
$$\text{Power (3 Phase)} = 1.732 \times \text{Voltage} \times \text{Current} \times \text{Power Factor}$$

$$\text{Speed of Electric Motor (RPM)} = \frac{120 \times \text{frequency of power}}{\text{Number of motor poles}}$$

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About Johnson Controls

At Johnson Controls, we transform the environments where people live, work, learn and play. From optimizing building performance to improving safety and enhancing comfort, we drive the outcomes that matter most. We deliver our promise in industries such as healthcare, education, data centers and manufacturing. With a global team of 105,000 experts in more than 150 countries and over 130 years of innovation, we are the power behind our customers' mission. Our leading portfolio of building technology and solutions includes some of the most trusted names in the industry, such as Tyco®, YORK®, Metasys®, Ruskin®, Titus®, Frick®, Penn®, Sabroe®, Simplex®, Ansul® and Grinnell®.

Johnson Controls

B2, 3rd Floor, Cerebrum IT Park,
Kumar city, Kalyani Nagar,
Pune, Maharashtra 411014. India

For more information visit
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